NANDTB 08.B / NDT TRAINING SYLLABUS

1.1. Penetrant Testing (PT)

1.1.1. PT General

PT - General (1/3)		
Principles	Physical principles	Surface tension
		Wetting
		Capillarity
	Penetrant systems	Penetrants
		Remover
		Developer
		Classification of penetrants
Cleaning	Precleaning Procedure	Types of precleaning
	Mechanical precleaning	Abrasive Blast
		Grinding, Sanding, Brushing
		Impact of the mechanical precleaning
		Removal of Material Smearing
		Impact on the figures after grinding
		Impact on the figures after shotpeening
	Chemical precleaning	Acid cleaning
		Watery degreasing
		Solvent Cleaning
		Vapour Degreasing
		Electrolytic cleaning
		Ultrasonic Cleaning
		Paint stripping agent
Process of testing	Penetration procedure	Temperature requirements as per standards
		Penetrant application
		Wetting
		Dwell time
		Factors influencing penetrant dwell time
		Dipping time, drain time
	Penetrant removal	Factors influencing penetrant removal
		Water
		Lipophilic emulsifier
		Solvent
		Hydrophilic remover
	Drying	Drying process after precleaning
		Drying process after penetrant removal

PT - General (2/3)		
Process of testing (continue)	Developing	Dry developer
		Water soluble developer
		Water suspended developer
		Solvent based developer
		Special developer
		Developer Dwell
		Comparison of Developers
	Radiation facilities	UV-A lamp
		Examination conditions
		Measuring tools for illumination and radiation
Viewing	Characteristic of human eye	Acuity performance
		Ability to discriminate colour
		Contrast sensitivity
		Brightness adaptation
		Astigmatism
Selection of penetrant	Classification of penetrant	Very low
		Low
		Medium
		High
		Ultra high
Control of penetrant characteristics	Penetrant testing as per EN ISO 3452-2	Sample test
		Batch testing
		Monitoring by the user
	Characteristics to be tested	Density
		Wetting/ marginal angles
		Viscosity
		Flashpoint
		Vapour pressure
		Colour
		Brightness
		Water tolerance
		Removability
		UV-Resistance
		Corrosive components
		Characteristics of developer

PT - General (3/3)		
Control of penetrant process	System performance check	Reference test block EN ISO 3452-3
		PSM star burst panel
		Storage of reference test block
	Additional testing of penetrant materials	Inspection booth checks
		Surface wetting test
		Penetrant rapid brightness test
		Lipophilic emulsifier removability test
		Hydrophilic remover refractometer test
		Hydrophilic remover hydrometer test
		Remover quick test for penetrant contamination
		Hydrophilic remover performance check
		Dry developer contamination test
		Water-suspended developer concentration test
		Water pressure and temperature check
		Measurement of black light intensity
Evaluation and reporting of testing instructions	Detectable defects on different materials	Related and non-related indication
		Inspection of non-metallic material
		Inspection of ceramic materials
		Inspection of composite
Safety	Product related risks	
	UV-related risks	
	Environmental waste water management	
Quality assessment	Procedures and standards	National and international standards
	Construction concept	Safe live
		Fail safe
		Damage tolerance
	Comparison to other NDT methods	Limits of PT inspections
		Detectable flaw size
		Other NDT procedures
	Documentation	Issue of inspection procedures
		Inspection reports
	Personnel requirements	

1.1.2. PT Specific

PT - Specific		
Airframe	Crack and corrosion detection in	Fittings and lugs
		Bolts
		Landing gear
		Rods
		Links
		Structure
		Skin
Engine	Crack detection in	Pins
		Gears
		Mounts
		Bolts
		Shafts
		Cases
		Blades
		Discs
		Slots
		Bores
Components & Reworked parts	Crack detection in	Wheels
		Pins
		Gears
		Mounts
		Bolts
		Shafts
		Cases
		Blades
		Discs
		Slots
		Bores

1.2. Magnetic Particle Testing (MT)

1.2.1. MT General

MT - General (1/4)		
Principles	Basic Principles	
Physical principles of magnetic particle inspection	Electrical parameters	Volt
		Current
		Frequency
		Electrical resistance
		Phase
		Electrical resistance
		Effect of electrical current
		Ohm's Law
		Circuit diagrams
		Direct current
		Alternating current
	Magnetical parameters	Ferromagnetism
		Magnetic fields
		Magnetic lines of force
		Magnetic field strength
		Permeability
		Magnetic flux
		Magnetic flux density
		Hysteresis
		Required field strength
	Electromagnetic induction	Transformation
		Skin effect
	Magnetic fields on electrical conductors	Field strength
		Flux density in and around electrical conductors
	Ferromagnetic materials in magnetic fields	
	Evidence of adequate field strength	Hall-effect gauss meter
	Combined procedures	Combination of two constant magnetic fields
		Combination of constant and alternating magnetic fields
		Combination of two alternating magnetic fields
		Phase shifted alternating magnetic fields
	Demagnetization	

MT - General (2/4)		
Magnetization	Principles of magnetization technique	Field Direction
		Field strength
		Magnetic field orientation and flaw
		Detectability
		Yoke magnetization
		Coil magnetization
		Circular magnetization with prods
		Circular magnetization with direct contact
		Circular magnetization with induced current
		Circular magnetic fields distribution and intensity
		Current amperage for the direct contact
		Longitudinal magnetization
		Cable wrap technique
		Current amperage for the longitudinal magnetization
		Method of current application
		Continuous application technique
		Residual application technique
		Combined techniques
Testing equipment and utilities	Equipment	Portable equipment
		Stationary equipment
		Demagnetization coils
	Test products	Wet-Bath method
		Dry particles
		Dry method or wet method
		Fluorescent and colored test products
		Visible particles or fluorescent particles
		Preparation of testing suspension
	Test blocks and tools	Test block for systems performance
		Test block for equipment performance

MT - General (3/4)		
Testing equipment and utilities (continue)	Tangential field strength measurement	Field strength measuring instrument
		Field indicators
		Hall-effect (gauss/tesla) meter
		Quantitative quality indicator
		Pie gage
		Berthold test block
		Test block for magnetization control
	Radiation facilities	UV-A lamp
		Examination conditions
		Measuring tools for illumination and radiation
Procedure monitoring	Illumination and radiation measurement	UV-A radiation measurement
		White light measurement
Viewing	Characteristic of human eye	Acuity performance
		Ability to discriminate color
		Contrast sensitivity
		Brightness adaptation
		Astigmatism
Evaluation and reporting of testing instructions	Evaluation	
	Assessment	
	Producing an indication	
	Interpreting the indication	
	Evaluating the indication	
	Non-relevant indications	
	Magnetic writing	
	Cold working	
	Abrupt changes of section	
	Elimination of non-relevant indications	
	Inspection protocol	
	Structure of inspection procedure	
	Case studies	
	Standards	
	Inspection instructions	
	Company internal regulations	
Material science	Defects during manufacturing process	Inclusion
		Porosity
		Cracks
		Pipe
		Blowholes
		Segregation

MT - General (4/4)		
Material science (continue)	Defects during machining process	Roll and forging flaws
		Turning and grinding flaws
		Flaws through hardening process
	Flaws through operation	Cracks
		Corrosion
Safety	Electrical hazards	
	Product related risks	
	UV-related risks	
Process Control	General description	
	System effectiveness check	
	Ammeter check	
	Quick break test	
	Dead weight check	
	Particle concentration test	
	Particle contamination tests	
	Lighting requirements	
Quality assessment	Construction concept	Safe live
		Fail safe
		Damage tolerance
	Comparison to other NDT methods	Limits of MT inspections
		Detectable flaw size
		Other NDT procedures
	Documentation	National and international standards
		Issue of inspection procedures
	Personnel requirements	

1.2.2. MT Specific

MT - Specific		
Airframe	Crack and corrosion detection in	Fittings and lugs
		Bolts
		Landing gear
		Rods
		Links
Engine	Crack detection in	Pins
		Gears
		Mounts
		Bolts
		Shafts
		Cases
Components & Reworked parts	Crack detection in	Tubes
		Welded parts
		Bolts
		Gears
		Shafts
		Cases

1.3. Eddy Current Testing (ET)

1.3.1. ET General

ET - General (1/3)		
Physic and fundamentals of eddy current	Electricity	Direct current; current and voltage
		Resistance
		Conductance
		Ohm's law
		Resistivity
		Conductivity
		Conductivity values for some metals
		Alternating current; sinusoidal current and voltage
		Amplitude
		Frequency
		Period
		Phase
		Vector representation
		Other periodic currents
	Magnetism	Magnetic field
		Lines of force
		Magnetic field strength
		Permeability
		Flux density (Induction)
		Flux, hysteresis loop
		Reluctance
		Magneto-motive force
		Diamagnetism
		Paramagnetism
		Ferromagnetism
	Electromagnetism	Magnetic field created by a current (wire, coil)
		Electromagnetic induction phenomenon
		Inductance
		Self inductance
		Inductive reactance
		Mutual induction
		Electromagnetic coupling
		Induced currents and secondary field
		Lenz's law
		Eddy current distribution in conducting materials
		Planar wave; standard depth of penetration
		Amplitude, phase

ET - General (2/3)		
Physic and fundamentals of eddy current (continue)	Electromagnetism (continue)	Cylindrical conductors; characteristic frequency
		Skin effect
		Penetration depth
	Impedance plane diagrams	Impedance
		Complex plane representation
		Influence of conductivity
		Influence of frequency
		Influence of permeability
		Influence of probe clearance
		Influence of thickness
		Influence of an on-conductive coating on conductive material
		Influence of a through defect
		Influence of internal defects
Eddy current equipment	ET Probes	Design of probes (Mechanical and electrical)
		Operation of probes (Absolute, differential)
		Use of probes (Pencil, borehole, sliding, etc.)
		Connections of probes with ET unit
	ET instruments	Display modes; needle, digital display
		Instrument modules
		Operating principle
		Signal excitation, reception, processing
		Compensation
		Wheatstone bridge
		Filtering; LPF, HPF, BPF
		Single frequency
		Multi frequency
	Reference standards	Design
		Production
		Storage
		Difference to real defects
Eddy current applications	ET Testing	Conductivity
		Material sorting
		Overheat damage
		Material identification
		Thickness of an on-conductive coating on conductive material
		Influence of temperature
		Influence of inspection speed
		Manual inspections
		Automated inspections
		External influence during ET testing
		Crack inspection

ET - General (3/3)		
Eddy current applications (continue)	ET Testing (continue)	Corrosion inspection
		Sliding probes
		Array applications
Quality assessment	Construction concept	Safe live
		Fail safe
		Damage tolerance
	Comparison to other NDT methods	Limits of ET inspections
		Detectable flaw size
		Other NDT procedures
	Procedures and standards	National and international standards
	Documentation	Issue of inspection procedures
		Inspection reports
	Personnel requirements	

1.3.2. ET Specific

ET - Specific		
Airframe	Paint thickness measurement	On metallic structure
	Cracks	Surface (HFEC)
		Subsurface (LFEC)
		Array applications
		Cracks in multilayered structure
		Cracks in riveted structure
		Bolt hole
	Material Characteristics	Conductivity
		Material sorting
		Overheat damage
		Material identification
	Corrosion detection	Single layer
		Multilayered structure
		Bolt holes
		Array applications
	Crack and discontinuous detection in	Fittings and lugs
		Fastener holes
		Riveted structures
		Bolts
		Tubes
		Multilayered structure
		Welded structure
		Wrought materials
		Forged materials
Engine	Crack detection in	Blades
		High energy rotating hardware (disc, shafts, blade slots)
		Stators
		Welded parts
		Wrought materials
		Forged materials
		Cast materials
		Automated systems
Components	Crack detection in	Wheels
		Tubes
		Welded parts
		Bolts
		Gears
		Automated systems
	Conductivity	Heat treatment
		Overheat damage

1.4. Ultrasonic Testing (UT)

1.4.1. UT General

UT - General (1/4)		
Basic principles of acoustics	Mathematic basics	
	Frequency, velocity and wavelength	
	Different acoustic waves	Long-waves
		Shear-waves
		Surface-waves
		Plate-waves
Generation of UT-waves	Generation	Piezoelectricity and types of crystals
		Frequency-crystal thickness relationships
		Conversion efficiencies of various crystals
	Characteristics of search units	Construction of ultrasonic search units
		Damping and resolution
	Sound beam	Sound beam characteristics
		Beam intensity characteristics
	Ultrasonic equipment	Broadband/Small band signal
		Beam divergence
		Near and far zones
		Attenuation
		Impulse form and repetitions Frequency
Propagation of UT-waves	Acoustic impedance	
	Reflection/Transmission	
	Phase inversion	
	Angle beam	
	Refraction	
	Wave transformation	
	Critical angle	
Propagation of UT-waves (continue)	Wave propagation in material and gas	
	Wave propagation in liquids	
UT methods	Contact testing	
	Immersion testing	
	Through transmission	
	Pulse-echo	
	Dual transducer	
	Angle beam	
	Phased arrays	

UT - General (2/4)		
UT Systems	Equipment	Analogue
		Digital
		Phased array (PAUT)
		Thickness gages
	Transducer	Straight beam transducers
		Dual transducers
		Angle beam transducer
		Phased array transducers
		Focused transducers
	Wedges	
	Couplants	
	Reference standards	Standardized reference standards
		Specific reference standards
	Cables	
Displays	A-scan	
	B-scan	
	C-scan	
	D-scan	
	Sector-scan	
Influence of part	Influence of surface/geometry	Surface roughness
		Concave/Convex surfaces
		Object geometry
		Wave transformation
		Triangle reflection
		Angle reflection
	Influence of material properties	Sound absorption
		Acoustic noise
		Diffusion
		Signal to noise ratio (SNR)
		Improvement of SNR
Calibration	Artificial defects	Flat bottom holes
		Cross holes
		Groove
		Ball reflector
		Variation of sound distance
		Variation of artificial defect
		Different defects
	Calibration and functional tests	Calibration standards
		Sensitivity
		Depth compensation
		Functional tests
		Analysis of probe data
		Redundancy checks

UT - General (3/4)		
Evaluation	Evaluation of indication	Display indications (True/false)
		Defects dependency
		Location of defects
		Depth of defects
		Half-value methods
		Loss of back wall signal
		Composition with artificial defects
		Evaluation with tables
		Detectable flaw size
		Discontinuity orientation
		Discontinuity spacing
		Types of discontinuity indications
		Delaminations
Quality assessment	Construction concept	Safe live
		Fail safe
		Damage tolerance
	Comparison to other NDT methods	Limits of UT inspections
		Detectable flaw size
		Other NDT procedures
	Procedures and standards	National and international standards
	Documentation	Issue of inspection procedures
		Inspection reports
	Personnel requirements	
UT applications	Castings	
	Forgings	
	Bars	
	Rolled sheet and plate	
	Testing pipe and tubing	
	Welds	
	Determining discontinuity location	
	Thickness measurement	
	Use of shear wave	
	Use of surface waves (Rayleigh waves)	
	Use of plate waves (Lamb waves)	

UT - General (4/4)		
Ultrasonic inspection process controls	Needs for process controls	
	System (Equipment) checks	Vertical linearity
		Inspection system sensitivity check
		Horizontal linearity
		Entry surface resolution
		Back surface resolution
	Angle Beam Checks	Angle beam point-of-incidence
		Angle beam point-of-incidence
		Angle beam angle determination
		Angle beam misalignment

1.4.2. UT Specific

UT - Specific (1/2)		
Airframe	Thickness measurement	Corrosion measurement
		Wall thickness measurement
		On metallic structure
		On composite structure
	Delamination	CFRP
		GFRP
		Glare
	Water ingress in honeycomb structures	
	Debonding	Honeycomb structure
		Glare
		Metallic structure
	Imperfections in composites	Blowholes
		Porosity
		Inclusions
	Crack and discontinuous detection in	Fittings and lugs
		Fastener holes
		Riveted structures
		Bolts
		Tubes
		Multilayered structure
		Welded structure
		Wrought materials
		Forged materials
		Other applications (glass, plastics)
Engine	Crack detection in	Blades
		High energy rotating hard ware (disc, shafts, blade slots)
		Stators
Engine (continue)	Crack detection in (continue)	Welded parts
		Wrought materials
		Forged materials
		Cast materials
	Thickness measurements	
	Delamination	Composite blades

UT - Specific (2/2)		
Composite	Delamination	CFRP
		GFRP
		Glare
	Water ingress in honeycomb structures	
	Debonding	Honeycomb structure
		Clare
	Imperfections in composites	Blowholes
		Porosity
		Inclusions
Components	Crack detection in	Wheels
		Tubes
		Welded parts
		Bolts
		Gears
	Delamination	CFRP
		GFRP
		Glare
	Water ingress in honeycomb structures	
	Debonding	Honeycomb structure
		Clare
	Imperfections in composites	Blowholes
		Porosity
		Inclusions

1.5. Radiographic Testing (RT)

1.5.1. RT General

RT - General (1/6)		
Theory, Physics	Introduction	History
		Philosophy
		Capabilities
		Process of radiography
		Types of electromagnetic radiation sources
		Electromagnetic spectrum
		Penetration ability or quality of x-rays and gamma rays
		X-ray tube
	Principles of radiography	Electromagnetic spectrum
		Significance of wavelength
		Theory, physics
		Characteristics and key properties
		Interaction; absorption and scatter
		Nature and properties of x-rays
		Interaction x-rays/materials
		X-rays absorption, attenuation coefficient
		Radiography principle
	X-rays generation	Generation principles, spectrum of radiation
		X-ray tubes up-to 420kV
		X-rays accelerator
	Gammagraph	Energy spectra
		Isotope source strength
		Isotope source focal spot size
		Isotope source decay characteristics
		Isotope source sensitivity
		Energy and equivalent energy
		Isotope requirements
		Characteristics and merits of isotopes
		Half-value layer
	Image formation	Rectilinear propagation
		Affecting factors
		Inverse square law consideration
		Types and choice of film
		Types and uses of screens

RT - General (2/6)		
Theory, Physics (continue)	Radiographic film	Radiation quality
		Effect of changing kV
		Significance and effect of type of x-ray source
		Effect of time
		Milliamperage and FFD on exposure
		Exposure charts
		Identification, marking out and sitting up
		Intensifying screens role and use
		Filters
Equipment	X-ray machine	
	Types of equipment	Selection of equipment
		X-ray control panel
		Isotope equipment
	Auxiliary equipment	
Exposure techniques	General principles	Geometric unsharpness
		Contrast; object, image, average gradient
		Radiation energy
		Scattered radiation, limitations
		Source-to-film distance
	Exposure	Focal-spot size
		Determination of focal spot size
		Exposure parameters determination
		RT-techniques, with constant exposure
		Defects position, triangulation
		Enlargement and projection
		Contrast
		Object, image, average gradient
		Heel effect
	Single-wall radiography	Specimen configuration
	Double-wall radiography	Double-wall exposure, single-wall viewing
		Offset double-wall exposure, single-wall viewing
		Elliptical projections
		Panoramic radiography
		Specimen configuration
		Discontinuity location radiographic configurations

RT - General (3/6)		
Exposure techniques (continue)	Multiple-film techniques	Use of multiple-film loading
		Thickness-variation parameters
		Film speed
		Film latitude
	Penetrameters or image quality indicators (IQI's)	Types of penetrameters or IQI's
		Use rules
		Standards
		Calculation of IQI sensitivity
Basic principles	Geometric exposure principles	Shadow formation and distortion
		Shadow enlargement calculation
		Shadow sharpness
		Geometric unsharpness
		Scattered radiation, limitations
	Radiographic screens	Lead intensifying screens
		Fluorescent intensifying screens
		Intensifying factors
		Importance of screen-to film contact
Radiographs	General	Film packing
		Film material and classification systems
		Formation of the latent image on film
		Inherent unsharpness
	Arithmetic of radiographic exposure	Milliamperage-distance-time relationship
		Reciprocity law
		Photographic density
		Inverse-square-law considerations
Radiographic image quality	Radiographic sensitivity	
	Radiographic contrast	
	Film contrast	
	Subject contrast	
	Film graininess and screen mottle effects	
	Penetrameters or image-quality indicators	
	Improving radiographic sensitivity	
Darkroom facilities, film processing	Photographic emulsion chemistry	
	Facilities and equipment	Automatic film processor versus manual processing

RT - General (4/6)		
Darkroom facilities, film processing (continue)	Processing of film-manual	Developer and replenishment
		Stopbath
		Fixer and replenishment
		Washing
		Prevention of water spots
		Drying
		Temperature control
	Film filing and storage	Retention-life measurements
		Long-term storage
		Filing and separation techniques
	Unsatisfactory radiographs-causes and cures	High film density
		Insufficient film density
		High contrast
		Low contrast
		Poor definition
		Fog
		Light leaks
		Handling faults, artifacts
	Film density	Step-wedge comparison film
		Densitometers
Forgings, castings	Metallurgy knowledge and manufacturing techniques	
	Defects met	Cavities, gasholes, shrinkage, foreign material
	Application of standards	Castings NDT inspection
		NDT technique instructions
		Shooting use of the IQI and interpretation/evaluation
		Disposition and NDT report
Assemblies, welding, brazing, riveting	Welding processes	
	Defects met	Cracks, lack of penetration or brazing, inclusions
	Application of standards	
	Welding NDT inspection	Examination of circumferential in pipes welding/butt-welds
		NDT technique instructions
		Disposition and NDT report
Composite materials	Concepts of development	
	Defects met	Cavities
	Application of standards	

RT - General (5/6)		
Composite materials (continue)	Composite NDT inspection	Tangential shooting
		NDT technique instructions
		Shooting use of the IQI and interpretation/evaluation
		Disposition and NDT report
Indications, discontinuities and defects	Indications	Adventitious images
		Causes and effects
	Discontinuities	Inherent
		Processing
		Service
	Defects	
Manufacturing processes and associated discontinuities	Casting processes and associated discontinuities	Ingots, blooms and billets
		Sand casting
		Centrifugal casting
		Investment casting
	Wrought processes and associated discontinuities	Forgings
		Rolled products
		Extruded products
	Welding processes and associated discontinuities	Submerged arc welding
		Shielded metal arc welding
		Gas metal arc welding
		Flux corded arc welding
		Gas tungsten arc welding
Evaluation	Radiographic standards	
	Radiographic viewing	Film-illuminator requirements
		Background lighting
		Multiple-composite viewing
		Penetrameter placement
		Personnel dark adaptation and visual acuity
		Film identification
		Location markers
		Film-density measurement
		Film artifacts
		Viewing conditions
		Illuminator requirements
	Evaluation of casting images	Casting-method review
		Casting discontinuities
		Origin and typical orientation of discontinuities
		Radiographic appearance

RT - General (6/6)		
Evaluation (continue)	Evaluation of casting images (continue)	Castings codes/standards-applicable acceptance criteria
		Reference radiographs
	Evaluation of welding images	Welding-method review
		Welding discontinuities
		Origin and typical orientation of discontinuities
		Radiographic appearance
		Welding codes/standards-applicable Acceptance criteria
		Reference radiographs or pictograms
Safety	Radiation safety principles	Controlling personnel exposure
		Time, distance, shielding concepts
		ALARA concepts
		Radiation-device operation characteristics
Quality assessment	Standards, codes and procedures for radiography	Acceptable radiographic techniques and setups
		Applicable employer procedures
		Procedure for radiograph parameter verification
		Radiographic reports
Quality assessment (continue)	Construction concept	Safe live
		Fail safe
		Damage tolerance
	Comparison to other NDT methods	Limits of RT inspections
		Detectable flaw size
		Other NDT procedures
	Documentation	Issue of inspection procedures
		Inspection reports
	Personnel requirements	

1.5.2. RT Specific

RT - Specific (1/2)		
Airframe	Water ingress in honeycomb structures	
	Imperfections in composites	Blowholes
		Porosity
		Inclusions
	Crack and corrosion, porosity detection in	Fittings and lugs
		Fastener holes
		Riveted structures
		Bolts
		Tubes
		Multilayered structure
		Welded structure
		Wrought materials
		Forged materials
Engine	Crack detection in	Blades
		Stators
		Welded parts
		Wrought materials
		Forged materials
		Cast materials
	General overview	Foreign objects
		Blocked gas passes
		Misalignments of parts
Composites	Water ingress in honeycomb structures	
	Imperfections in composites	Blowholes
		Porosity
		Inclusions
		Layer orientation
		Distribution of glass fibers
Components	Crack detection in	Tubes
		Welded parts
		Bolts
	Water ingress in honeycomb structures	
	Imperfections in composites	Blowholes
		Porosity
		Inclusions
		Foreign objects
		Blocked gas passes
		Misalignments of parts

RT - Specific (2/2)		
Process controls	Scope	
	Ventilation in darkroom	
	Safelights	
	Why test safelights	
	Individual safelight testing	
	Collective safelight testing	
	Safelight fog evaluation	
	Controlling the manual development process	
	Controlling the automatic development process	

1.6. Digital Radiography Testing (Digital RT)

Digital RT (1/2)		
Radiation contrast, noise	Signal-to-noise ratio (SNR)	
	Contrast-to-noise ratio	
	Basic spatial resolution	
	Pixel Size	
	Normalised SNR (SNRN)	
Optimization of image quality	Compensation principles	Contrast vs. SNR
		Basic spatial resolution s. SNR
		Local unsharpness vs. SNR
Geometrical projection conditions	Effect of magnification	
	Optimum magnification	
	Difference between radiography and radioscopy	
Image quality indicators	Measurement of basic spatial resolution	
	Converging line pairs	
	Line pair gauges (MTF)	
Computer-Radiography (CR), Imagine plates	Phosphor imaging plates	Introduction
		Design
	Imaging plate and CR-scanner	
	CR system and classification	
	Quality assurance (phantom)	
	Exposure conditions	
	Working with exposure charts	
	Handling	
	System selection	
DDA's	Digital Detector Arrays (DDA)	Introduction
		Design
	Indirect converting	
	Direct converting	
	Indirect converting	
	Direct converting	
	CCED, amporph. SI, CMOS	
	Detector calibration	
	Quality assurance	
	Exposure conditions	
	Handling	
	System selection	
LDA's	Line Detector Arrays (LDA)	Introduction
		Design
	Application areas	
	Comparison to DDA's	
	LDA's (continue) Quality assurance (phantom)	

Digital RT (2/2)		
LDA's (continue)	Exposure conditions and Diagrams	
	Handling	
	System Selection	
Intensifiers, fluoroscope	Introduction	
	Design	
	Application areas	
	Quality assurance (phantom)	
	Exposure conditions and diagrams	
	Handling	
	System Selection	
	Comparison to DDA's	
Date acquisition, detector calibration	A/D interface	
	Computer Structure	Processor
		Memory
		Bus
		Disk
	Load and safe of digital images	Image Formats
	Image integration	On chip integration/frame time
		In memory integration/frame number
	Optimum gain and latitude settings	Accumulation vs. integration
Digital Image Processing	Image structure, quantization (bit and Bytes)	
	Basic operations	Picture element (pixel)
		Gray value
	Point operations	Contrast
		Brightness
		Gamma correction
		Histogram
	Matrix operations, filters	Look up table (LUT)
		Smoothing, improvement of SNR
		High pass, gradient
		Edge enhancement, line extraction
		Median
	Measurement tools	Calibration
		Line profile
		Measurement of flaw length
		Measurement of areas
		Measurement of depth
	Correction of raw data	Linearization, LUT
		Bad pixel interpolation
Automated image interpretation	Principles	
	Binarization	
	Measurement of dimensions	

1.7. Thermographic Testing (TT)

1.7.1. TT General

TT - General		
Fundamentals of Thermography	Qualitative imagery	
	Quantitative thermography	
	Heat transfer theory	
Principles	Thermal radiation principles	
	Transmittance	
Applications	Infrared Thermography	Equipment overview
		Basic camera setup and operation
		Thermal measurement
		Moisture detection in honeycomb
		Heater blanket and hot air gun methods as outlined by producer
		Defining difference between excessive resin and fluid ingress
Safety	Thermography safety principles	
Quality assessment	Standards, codes and procedures for thermography	Acceptable thermographic techniques and setups
		Applicable employer procedures
		Procedure for thermograph parameter verification
		Thermographic reports
	Construction concept	Safe live
		Fail safe
		Damage tolerance
	Comparison to other NDT methods	Limits of TT inspections
		Detectable flaw size
		Other NDT procedures
	Documentation	Issue of inspection procedures
		Inspection reports
	Personnel requirements	

1.7.2. TT Specific

TT - Specific		
Composites	Water ingress in honeycomb structures	
	Imperfections in composites	Blowholes
		Porosity
		Inclusions
		Layer orientation
		Distribution of glass fibers

1.8. Barkhausen Noise Inspection (BNI)

1.8.1. BNI General

BNI - General	
Introduction Atoms & Bonds	Principles of method, applications, advantages/disadvantages, atoms & bonds, atomic structures
The Crystal Structure of Steels	Crystal structure of metals
	Steels & alloying elements, types of steel, grain structures, phases in steel
Stress and Strain	Definitions of stiffness, elasticity, strength, ductility, plasticity, yield point
	Hooke's Law, Young's Modulus, Axial, compressive and shear stress.
	Pre-stress and stress concentration, elastic stability and equilibrium
Magnetization	Magnetic field and induction, permeability and susceptibility, demagnetisation factor, ferromagnetism, hysteresis, magnetic domains/walls, reversible/irreversible domains, rotation of magnetism within domains, domain growth
Barkhausen Effect	Barkhausen effect, magneto acoustic emission, magneto striction
Using Barkhausen Noise	Relationship between Barkhausen noise and microstructure of steel
	Application of Barkhausen noise
	Stress, residual stress, decarburisation, heat treatmen

1.8.2. BNI Specific

BNI - Specific	
Stresscan Equipment	Manufacturers data
Specifications	
Practical Applications	Demonstration of and use of equipment to locate grinding abuse

1.9. Acid Etch Inspection (AEI)

1.9.1. AEI General

AEI - General	
Introduction Atoms & Bonds	Principles of method, applications, advantages/disadvantages, atoms & bonds, atomic structures
The Crystal Structure of Metals	Crystal structure of metals
	Steels & Alloying elements, types of steel, grain structures, phases in steel
Equilibrium Diagrams and The Iron Carbon Diagram	Equilibrium diagrams and the freezing of metals Iron carbon diagram, eutectoid steels,
Heat Treatment Processes and Machining Processes	Post-heat treatment, stress relief, annealing, hardening, tempering, normalizing, hydrogen release, grinding cracks, hydrogen cracking
Metallurgical Surface Conditions	Metallurgical surface conditions including re-hardening burn, tempering burn, carburizing, nit riding, low alloy martensitic steels, maraging steels
The Etched Structure	Etched structure appearance (abused & un-abused) & viewing conditions
Acid Etch Inspection	Applicability, equipment & materials, etch procedures, intermediate proof etching, etching of stainless steel parts

1.9.2. AEI Specific

AEI - Specific	
Solutions & Process Controls	Control checks, and recording
Inspection	Inspection & interpretation
Safety Precautions	
Practical Applications	Demonstration of immersion and swabbing techniques