

Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 1 of 10

| Contents | Level 1 | Level 2 | Level 3 |
|--|---|--|---|
| 1.0 Introduction, Terminology, | 1.0 History Purpose | 1.0 History Purpose | 1.0 History Purpose |
| History of NDT | 1.1 Terminology | 1.1 Terminology | 1.1 Terminology |
| | Electromagnetic radiation Energy Dose Dose rate | Wave-length Dose Dose rate Intensity Dose rate constant | EN 1330 - 3 |
| 2.0 Physical principles of the method and associated Knowledge | 2.0 Properties of X- and gamma Radiation Relevant standards: EN 444: General Principles Straight line propagation Effects of radiation Capability of penetration | 2.0 Properties of X- and gamma Radiation Photon Process of ionisation photochemical effects biological effects fluorescent effects Energy | 2.0 Properties of radiation X-radiography Gamma radiography Neutron radiography Electron radiography Process of ionization photochemical effects biological effects fluorescent effects |



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 2 of 10

| 2.1 Generation of X-radiation | 2.1 Generation of X-radiation | 2.1 Generation of X-radiation |
|---|---|---|
| Function of X-ray tubes Tube current I | Function of X-ray tubes | Function of X-ray tubes |
| High voltage U effects on dose rate and energy of radiation | Spectrum intensity max. energy effective energy change of spectrum by tube current and tube voltage Inherent filtering | Spectrum intensity max. energy effective energy change of spectrum by tube currer and tube voltage Characteristic radiation Inherent filtering Hardening effect |
| 2.2 Origin of gamma radiation | 2.2 Origin of gamma radiation | 2.2 Origin of gamma radiation |
| Radio isotope Ir 192, Co 60, Se 75 Activity half life characteristics of □-sources | Radio nuclide Isotope Ir 192, Co 60, Se 75, Yb 169 Activity A | Natural and artificial decay Decay series Radio nuclides for NDT Isotope Ir 192, Co 60, Se 75, Yb 169 |
| life time energy activity source size | Characteristics of □-sources half life decay curves maximum activity source size Characteristic of Gamma ray Dose rate constant Spectrum and effective energy | Activity A Characteristics of □-sources half life decay curves maximum activity source size Characteristic of Gamma ray Dose rate constant Spectrum and effective energy |



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 3 of 10

2.3 Interaction of radiation with matter

Attenuation
absorption
primary radiation
scattered radiation
Influence of:penetrated thickness

Type of material Energy Half value layer Tenth value layer

2.4 Properties of film systems and Screens

Construction
base, emulsion, silver bromide grain size
and distribution

Processing

Properties of films sensitivity granularity contrast optical density film system class 2.3 Interaction of radiation with matter

Attenuation
photo effect
coherent scattering
Compton scattering
pair production

Attenuation coefficient Scatter radiation Specific contrast Radiation contrast Effects of filtering Beam hardening

Construction

2.4 Properties of film systems and Screens

Latent image information origin
Photo process
Properties of film systems
characteristic curve
film gradient, film contrast, speed
influence of film processing
sensitivity
granularity
detail perceptibility

Classification of film systems according to. EN 584-1

2.3 Interaction of radiation with matter

Attenuation vs. energy photo effect coherent scattering Compton scattering pair production

Attenuation coefficient Scatter radiation Specific contrast Radiation contrast Effects of filtering Beam hardening Klein-Nishina law

2.4 Properties of film systems, screens and digital detection systems

additional to level 2

New detectors storage phosphor imaging plates flat panels x-ray intensifier line detector

Classification of detector systems application



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 4 of 10

| | Film screens type of film screens intensifying effect filtering effect film to screen contact | Film screens type of screens film screen contact inherent unsharpness intensifying effect of filtering screens for Co 60 and Linac | |
|---|---|--|---|
| | 2.5 Geometry for radiographic exposures Geometric unsharpness object to film distance focus size d source to object distance Source film distance | 2.5 Geometry for radiographic exposures Geometric unsharpness object to film distance focus size d source to object distance Source film distance Determination of the focal spot size of Gamma sources | 2.5 Geometry for radiographic exposures Additional to level 2 Method of focal spot measurement according to EN 12543, EN 12579 Requirements for optimisation by: Geometric unsharpness, total Unsharpness Focus size, current, voltage Source size, activity |
| 3.0 Product knowledge and capabilities of the method and derived techniques | 3.0 Typical weld defects imperfections Type of discontinuity according. to EN ISO 6520 | 3.0 Weld imperfections Type of weld seam and weld seam Preparation | 3.0 Weld imperfections Additional to level 2 Introduction to fracture mechanics working load |



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 5 of 10

| | | Welding process origin Type of discontinuity according to EN ISO 6520 | Materials properties Origin of defects Further NDT methods |
|-----------|---|---|--|
| | 3.1Typical defects in castings | 3.1 Defects in castings | 3.1 Defects in castings |
| | Types of defects | Casting process Types of cast imperfections and their origin Structural indications Beam direction to detectability | Casting process Type of cast imperfections and their origin Structural indications Working load Materials properties Production caused defects |
| | 3.2 Influence to detectability | 3.2 Influence to detectability | 3.2 Influence to detectability |
| | type of defect, size orientation | beam direction geometric distortion increase in wall thickness | beam direction geometric distortion increase in wall thickness |
| | Imaged thickness range Number of exposures | Imaged thickness range Thickness ranges for x- and gamma rays Number of exposures | Imaged thickness range Thickness ranges for x- and gamma rays Number of exposures vs. distortion angle |
| | | | |
| 4.0 | 4.0 Design and Operation of X-ray Machines | 4.0 Design and Operation of X-ray Machines | 4.0 Design and Operation of X-ray Machines |
| Equipment | Stationary systems, mobile unit | Additional to level 1: | Additional to level 2 |
| | | | |



AFRICAN NDT CENTRE

COURSE CURRICULUM RADIOGRAPHIC TESTING LEVEL 1, 2 and 3

Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 6 of 10

| Tubes glass- and metal-ceramic tube Design of tubes standard tube rod anode tube short anode tube Cooling: Gas, water, oil Focal spot High voltage, max. current Exposure time Diaphragm | inherent filtering pre-filtering Devices for special applications micro focus tubes enlargement technique radioscopy Linac Construction Field of application Typical dates | beam opening characteristics x-ray flash devices rod anode devices micro focus devices high voltage devices Line focus tubes Rotary anode tubes |
|---|--|---|
| Safety circuit Operation instructions 4.1 Design and Operation of Gamma ray Devices container, shielding class: P, M type: A, B (transportation) source holder and source capsule Enclosed radioactive material manipulation device connections accessory remote control collimation fittings Operation instructions Reference to national requirements and safety regulations | 4.1 Design and Operation of Gamma ray Devices Additional to level 1: crawler for pipelines special device for testing of heat exchanger tubes | 4.1 Design and Operation of Gamma ray Devices Same as level 2 |



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 7 of 10

| | 4.2 Accessories for radiographic testing equipment lead tape measure holding magnets lead screens shielding rubber bands etc. radiation protection equipment | | |
|--------------------------------|---|--|--|
| 5.0 Information prior the Test | 5.0 Written procedures are given information about the test object Object dimensions Test class of standard Equipment to be used Exposure arrangement Extent of testing (20 % inspection) marking | 5.0 Information about the test object Identification or designation Material, dimensions, isometrics number of parts field of application kind of manufacture catalogue of defects Test conditions accessibility infrastructure particular test conditions Applicable standards Overview Standards assigned to the test object Preparation of written instructions | 5.0 Information about the test object and national requirements Additional to level 2: Selection of standards for specific testing Applications European standards Application standards overview purpose technical contents and systematic Product specific standards for special industrial sectors for welding for casting for pipes pressurised equipment directive ISO standards |



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 8 of 10

| | | | American standards: overview ASME-Code overview ASTM-Standards |
|-------------|--|--|--|
| 6.0 Testing | Reference blocks : design, production, storage. Operating conditions : Excitation frequency and if necessary auxiliary frequencies Probe speed, probe clearance, probe vibration and centring Calibration curves Settings : data acquisition procedure/instructions | Reference blocks: design, production, storage. Probe: selection, as a result of the information in 5.0, Operating conditions as a result of the information in 5.0: Excitation frequency and if necessary auxiliary frequencies Probe speed, probe clearance, probe vibration and centring Calibration curves Settings: data acquisition procedure | Reference blocks: design, production, storage. Probe: selection or design, as a result of the information in 5.0, Operating conditions as a result of the information in 5.0: Excitation frequency and if necessary auxiliary frequencies Probe speed, probe clearance, probe vibration and centring Calibration curves Settings: data acquisition procedure |



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 9 of 10

| 7.0 | 7.0 Evaluation | 7.0 Evaluation. | 7.0 Evaluation. |
|-----------------------------|--------------------|---|---|
| Evaluation And Reporting | NOT APPLICABLE | Characterisation of the indications : single frequency analysis, multifrequency analysis, data analysis procedure | Characterisation of the indications : single frequency analysis, multifrequency analysis, data analysis procedure |
| | 7.1 Reporting | 7.1 Reporting | 7.1 Reporting |
| | Examination report | Reporting level Examination report | Reporting level Examination report |
| 8.0 Assessment | NOT APPLICABLE | Acceptance criteria Codes, standards | Acceptance criteria Significance of discontinuities Codes, standards |



Doc No : CC-RT Issue : 2

Date : 01.07.2024 Page : 10 of 10

| 9.0 Quality aspects | 9.0 Personnel qualification (according to EN ISO 9712) Equipment verification | 9.0 Personnel qualification (according to EN ISO 9712) Equipment verification Written instructions Traceability of documents | 9.0 Personnel qualification (according to EN ISO 9712) Equipment verification Format of working procedures, Traceability of documents Other NDT qualification and certification systems A review of applicable NDT application and product standards |
|------------------------|---|--|---|
| 10.0 Developments | NOT APPLICABLE | General information | Array probes Pulsed eddy currents Non inductive techniques : Magneto-Optical Imaging, SQUID, Giant magneto resistance, Imaging Modelling |