

Training program for x-ray inspection non-film (RT-NF)

In the NDT training course the following knowledge will be educated.

Subject	Level 1	Level 2	Level 3
<i>Terms and abbreviations</i>	+	+	+
<i>Introduction to the non-film technique</i>	+	+	+
- What is the purpose of this inspection?	+	+	+
- How is it applied correctly?	+	+	+
- Difference between film-based and non-film techniques	+	+	+
<i>Basic physical principles</i>	+	+	+
- Properties of X rays and gamma rays	+	+	+
- Discovery of X rays	+	+	+
- Gamma radiation source	+	+	+
- Wave length of electromagnetic radiation and pertinent units	+	+	+
- Energy of electromagnetic radiation	+	+	+
- Properties of X rays and gamma rays	+	+	+
- Intensity, dose and dose output	+	+	+
- Electromagnetic waves	+	+	+
- Structure of the atoms	+	+	+
- Mechanisms of ionization	+	+	+
- Generation of X rays	+	+	+
- Intensity of radiation	+	+	+
- X ray spectrum	+	+	+
- Exposure rate coefficient	---	+	+
- Inverse square law	+	+	+
<i>The human eye</i>	+	+	+
- Anatomy	+	+	+
- How does seeing work?	+	+	+
- Light and dark adaptation	+	+	+
- Ametropia	+	+	+
- Eye tests	+	+	+
- Harmful effects of optical radiation on the eye	---	---	+
- Exposure limits and specifications	---	---	+
- Protective measures	---	---	+
- First aid measures	---	---	+
<i>Principle of radiographic inspection</i>	+	+	+
- General information	+	+	+
- Absorption behavior of different materials	+	+	+
- Examples of different material thicknesses	+	+	+
- Examples of different materials	+	+	+
- Examples of varying beam quality with the intensity unchanged	+	+	+
- X-ray inspection of solids	+	+	+
- Stray radiation	+	+	+
- Internal stray radiation	+	+	+
- Lateral stray radiation	+	+	+
- Detector scatter	+	+	+
<i>Geometric fundamentals of image generation</i>	+	+	+
- Geometric unsharpness U_q	+	+	+
- Image distortion	+	+	+
- The inverse square law	+	+	+

continued

Subject	Level 1	Level 2	Level 3
<i>Generation of X-rays</i>	+	+	+
- X-ray tubes	+	+	+
- Cathode	+	+	+
- Heating filament	+	+	+
- Anode	+	+	+
- Focus	+	+	+
- Focusing	+	+	+
- Ray exit window	+	+	+
- Determination of focus size	---	+	+
- Electric power supply	+	+	+
- Connection diagram of a monopolar tube	+	+	+
- Connection diagram of a bipolar tube	+	+	+
- Cooling	+	+	+
- Control unit	+	+	+
- Operation of X-ray units	+	+	+
- Current-voltage characteristic	+	+	+
<i>Basic principles of digital image processing</i>	+	+	+
- What does digital mean?	+	+	+
- Basic principles of a digital system	+	+	+
- Dual system	+	+	+
<i>Digital X-ray detectors</i>	+	+	+
- Image intensifier	+	+	+
- Structure and functionality	+	+	+
- Properties of image intensifiers	+	+	+
- Linearity and measuring/dynamic range	+	+	+
- Magnification	+	+	+
- Artefacts, distortion, vignetting	+	+	+
- Advantages and disadvantages of image intensifiers	+	+	+
- Scope of application of image amplifiers	+	+	+
- Verification of the long-term stability of image intensifiers	---	+	+
- Phosphor record films (CR: computed radiography)	+	+	+
- Structure and functionality	+	+	+
- Phosphor record films and scanners	+	+	+
Properties of phosphor record films	+	+	+
- Linearity and measuring/dynamic range	+	+	+
- Classification	---	+	+
- Wear and damage	+	+	+
- Use of cassettes and casings	+	+	+
- Artefacts	---	+	+
- Deletion of phosphor record films	---	+	+
- Scanning rate	---	+	+
- Advantages and disadvantages of phosphor record films	---	+	+
- Scope of application of phosphor record film systems	---	+	+
- Verification of the long-term stability of phosphor record films	---	+	+
- Checking of the scanner (distortion, jitter, blooming, shading)	---	+	+
- Digital matrix detectors (DR: digital radiography with DDA)	+	+	+
- Structure and functionality	+	+	+
- Portable detectors for mobile use	+	+	+
- Properties of DDAs	+	+	+
- Linearity and measuring/dynamic range	+	+	+
- Resolution	+	+	+
- Bit depth	+	+	+
- Basic spatial resolution SR_b	---	+	+
- Efficiency	---	+	+
- Frame rate	---	+	+
- Binning	---	+	+
- Image integration	+	+	+
- Calibration (offset/gain, bad pixel)	+	+	+
continued			

Subject	Level 1	Level 2	Level 3
- Artefacts (image lag, ghosting, bad pixel, blooming, ...)	---	+	+
- Radiation tolerance of electronics	---	+	+
- Advantages and disadvantages of DDA	+	+	+
- Scope of application of DDA	+	+	+
Verification of the long-term stability of DDA as per ASTM E2737	---	+	+
<i>Computed tomography</i>	+	+	+
- Structure and functionality	+	+	+
<i>Digital image processing</i>	+	+	+
- Bit/byte	+	+	+
- Pixel/voxel	+	+	+
- Bit depth	+	+	+
- Hardware	+	+	+
- Computer	+	+	+
- Monitor (types, resolution, color presentation, bit depth)	+	+	+
- Brightness and contrast	+	+	+
- Calibration	---	+	+
- Test images	---	+	+
- Checking of monitors	---	+	+
Software	+	+	+
- Image description	+	+	+
- Histogram	+	+	+
- Average and standard deviation	---	+	+
- Image invert	+	+	+
- Grey scale representation	+	+	+
- Window width / level	+	+	+
- Look up table (LUT)	+	+	+
- Threshold	+	+	+
- Histogram equalization	+	+	+
- False color display	+	+	+
- Analysis	+	+	+
- Line profile	+	+	+
- Region of interest (ROI)	+	+	+
- Statistics tools	+	+	+
- Filter	+	+	+
- Convolution	---	+	+
- Median filter	---	+	+
- Low-pass filter	+	+	+
- High-pass filter	+	+	+
- Band-pass filter	---	+	+
- Sharpness filter	---	+	+
- Pseudo plastic filter	---	+	+
- Edge extraction filter	---	+	+
- Arithmetical image operations	+	+	+
- Addition	+	+	+
- Subtraction	+	+	+
- Division	+	+	+
- Multiplication	+	+	+
- Image average	+	+	+
- Binarization	+	+	+
- Archiving	---	+	+
- Digital media (CD, DVD, magnetic tape)	---	+	+
- Redundant array of independent disks (RAID)	---	+	+
- Central archive	---	+	+
- Image formats (jpeg, tiff, Diconde, bmp, ...)	---	+	+
- Compression of images	---	+	+
- Recopying of image data	---	+	+

continued

Subject	Level 1	Level 2	Level 3
<i>Determination of image quality</i>	+	+	+
- Measurement of image quality	+	+	+
- Signal-to-noise ratio (SNR)	+	+	+
- Standard signal-to-noise ratio (SNR _n)	+	+	+
- Basic spatial resolution (SR _b)	+	+	+
- Image unsharpness (U _m)	+	+	+
- Modulation transfer function (MTF)	---	---	+
- Contrast-to-noise ratio (CNR)	---	+	+
- Contrast sensitivity	---	+	+
- Geometric increase	+	+	+
- Compensation principles	---	---	+
<i>Image quality indicators</i>	+	+	+
- Hole penetrameter	+	+	+
- Hole penetrameter as per ASTM E 1025	---	+	+
- Hole penetrameter as per ASTM E 1742	+	+	+
- Pratt & Whitney TAMs (<u>T</u> ool <u>A</u> erospace <u>M</u> anuals)	+	+	+
- Adjusting washers, blocks, step wedges	+	+	+
- Wire penetrameters	+	+	+
- Wire penetrameter as per DIN EN ISO 19232	+	+	+
- Wire penetrameter as per ASTM E 747	---	+	+
<i>Definition of X-ray inspection procedure</i>	+	+	+
- X-ray beam angle	+	+	+
- Selection of image quality indicators	+	+	+
- Arrangement of image quality indicators	+	+	+
- Exposure techniques	+	+	+
- Welded joints on tubes	+	+	+
- Welded joints on sheet	+	+	+
- Inspection of castings	+	+	+
<i>Evaluation</i>	---	+	+
- Causes of defects	---	+	+
- Defects caused during the manufacture of blanks	---	+	+
- Defects caused by processing and machining	---	+	+
- Defects occurring in operation	---	+	+
- Manifestation of defects	---	+	+
- Types and causes of indications	+	+	+
- Assessment of indications	---	+	+
- Definition of inspection characteristics	---	+	+
- Acceptance limits	---	+	+
- Assessment aids	---	+	+
- Identification marking	+	+	+
- Assessment of castings	---	+	+
<i>Documentation</i>	+	+	+
- Data sheet / inspection instructions	+	+	+
- Inspection report	---	+	+
<i>Radioactive sources</i>	+	+	+
- Radioactivity	+	+	+
- Natural radioactive elements	---	+	+
- Artificial radioactivity	---	+	+
- Advantages of sources of artificial radioactivity	---	+	+
- Disadvantages when using radioisotopes	---	+	+
- Units	---	+	+
- Activity	---	+	+
- Ion dose	---	+	+
- Energy dose	---	+	+
- Equivalent dose (personal dose)	---	+	+

continued

Subject	Level 1	Level 2	Level 3
- Half life of a radioactive element	---	+	+
- Half value layer	+	+	+
<i>Protection against radiation during X-ray inspection</i>	+	+	+
- Dose and dose output	+	+	+
- X-ray quality	+	+	+
- X-ray ordinance	+	+	+
- Basic requirements	+	+	+
- Maximum permissible X-ray dose	+	+	+
- Basic principles of protection against radiation	+	+	+
- Other important topics	+	+	+
- Measurement of radiation	---	+	+
- Pocket dosimeter	---	+	+
- Film dosimeter	---	+	+
- Ionization chamber	+	+	+
- Radiation-counter tube	---	+	+
- Screening	---	+	+
<i>Other NDT methods</i>	---	+	+
- Penetrant inspection	---	+	+
- Ultrasonic inspection	---	+	+
- Eddy-current inspection	---	+	+
- Thermography	---	+	+
- Magnetic particle inspection	---	+	+
- Visual inspection	---	+	+
<i>Requirements on inspection personnel</i>	+	+	+
- Eye test	+	+	+
- Qualification	+	+	+
- Training times, experience	+	+	+
<i>Occupational safety and health, environmental protection</i>	+	+	+
- Workplace (ambient light, cleanliness)	+	+	+
- Ambient conditions for detectors (temperature, humidity)	+	+	+
<i>Standards, specifications and guidelines</i>	+	+	+

+ subitem of the level
 --- no item of the level



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