Advanced Digital Imaging System Maintenance (Phase 3)

RADIOLOGICAL SERVICE TRAINING INSTITUTE

Introduction

Advanced R&F, & Digital FPD System Maintenance is a formal hands-on course that provides a comprehensive approach to servicing today's digital fluoroscopic, surgical C-Arms, cardiac, and vascular imaging systems. Emphasis is placed on system performance and image evaluation. Each sub-component of the imaging system is thoroughly analyzed, and methods of optimizing system performance are applied. Participants perform complete system alignment and calibration while evaluating each sub-component for its specific digital imaging performance. Participants also have the opportunity to troubleshoot all phases of the imaging system chain.

Prerequisites

To attend this course, the service professional must have good fundamental knowledge of radiological physics and procedures as taught by our Principles of Servicing Diagnostic X-Ray Systems (Phase 1) course, or two years equivalent experience.

Objectives

At the conclusion of this course, participants will be able to:

- Perform complete calibration on C-Arms and digital fluoroscopic imaging systems
- Perform complete calibration on various digital FPD (Flat Panel Detector) systems
- Evaluate overall performance of digital imaging system components
- Troubleshoot imaging problems on all components of the imaging chain
- Use proper test equipment, software, procedures, and phantoms to evaluate system performance
- Evaluate different methods for performing system ghosting and cloning procedures
- Determine and perform suitable ghosting and cloning procedures, as they pertain to specific systems

Course Outline

Day 1

- Introduction to Fluoroscopy and Digital Imaging
  - Image Quality Terminology
    - Detail Visibility
    - Contrast
    - Sharpness
    - Resolution
    - Dose vs Dose Rate
      - Dose/Frame
      - Continuous vs. Pulsed Fluoroscopy
      - Air Kerma, DAP, & patient dose reporting
    - Density/Intensity vs DEI
    - Exposure index and standardization of DEI
  - Digital Terminology
    - FOV
    - Matrix
    - GX
    - SNR/CNR/MTF
    - Binning
    - Zoom/Mag
  - Modes of Operation
    - Continuous/Pulsed
      - Gridded X-Ray tubes
    - Record/Fluoro
      - Singular or Serial
      - Dose levels
  - Integration time/mA relationship
    - Image noise issues
  - Advanced modalities overview
    - Digital fluoroscopy
    - C-Arms
    - IXR (Interventional X-Ray)
      - Cardiology
      - Angiography
  - Introduction to digital fluoroscopic imaging
  - Digital R&F image quality
- The X-ray beam
  - X-ray tube design & operation
    - Radiography
    - Fluoroscopy
    - C-Arm
    - Cardiac/Angio
  - Quantity and quality
  - Filtration
  - Grids and scatter
- FOV (Field of View) to matrix relationship
  - Zoom vs. Magnification
  - Resolution
- Dose vs. Noise
- Radiation entrance and exit doses
  - Max. "R"

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Hands-On Training Course
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- Half value layer
- Absorption characteristics
- Stabilized dose level

- **Lab Activities**
  - kV
  - Max. "R" calibration
  - HVL measurements
  - Central ray alignment
  - Shutter alignment
  - Focal spot measurements
  - Input radiation levels (FPD & I.I.)
  - Dose reporting accuracy

Day 2

- Advanced Clinical Applications
  - DSA, Roadmaps, 3D
- Cardiac Clinical Review
  - Catheter
  - Stent
  - Balloon
  - PICC
  - Run-Off
- Flat Panel Detectors
  - Radiography FPD's
    - Configurations
      - ☐ Fixed
      - ☐ Tethered
      - ☐ Wireless
    - Resolution
    - Contrast vs dynamic range
  - Fluoro FPD's
    - FPD construction
    - Quantum detection efficiency
    - Binning
- Image intensifiers
  - Functional overview
  - Conversion factor
  - Quantum detection efficiency
  - Contrast ratio
- Optical system
  - Image coupling methods
  - Collimating lenses & infinity focus
  - Focal length versus image size
- Lab Activities
  - Low contrast resolution eval
  - High contrast resolution eval
  - Electronic I.I. focus
  - Verify Input Radiation

Day 3

- Fluoroscopy Modes
  - Pulsed Fluoro
  - Continuous mA
- Capture Modes
  - Digital Record/CINE
  - Digital Fluoroscopy
- Brightness stabilization
  - kV, mA, and secondary switching
  - Light distributors and brightness pickup
  - Center scanning & shutter tracking
  - Stabilizer circuits
- Lab Activities
  - Light distributor alignment
  - Stabilized level adjustments
  - Center scan evaluation

Day 4

- Video stabilization (AGC)
  - Composite video
  - Video sampling
- Photospot
  - Circuit operation
  - Density/DEI/Dose regulation
    - Preshot (II systems)
- Lab Activities
  - Photospot DEI to Dose/Frame analysis
  - Input radiation adjustments
  - Auto dose validation testing

Day 5

- Cine radiology
  - Circuit operation
  - Focus and density runs
- System Backups
  - Types of backups
- Ghosting vs Cloning
  - Best practices
- Lab Activities
  - Overall system calibration
  - Perform system backups
  - Perform ghosting
  - Perform Cloning
  - Overall system troubleshooting

Day 6

- Introduction to television
  - Principles of television
  - CCD/FP Monitor synchronization
  - Scan rate conversions
  - Composite video
- Television system block diagram
  - Television camera block diagram
- Camera tube overview
- Lab Activities
  - Camera tube alignment
    - Beam current/alignment
  - System troubleshooting
    - Isolating camera from monitor
    - Isolating II from Camera
    - Isolating X-Ray system from Video chain

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Day 7

- Vertical and horizontal blanking and sync
  - Standard and circular blanking
  - Vertical/Horizontal sweep circuit operation
- Video chain
- CCD/CMOS Cameras
  - Functional overview
  - Video processing
  - Key characteristics of CCD/CMOS cameras
    - Resolution
    - Readout noise
    - Dark current
    - Non-uniformity
    - Dynamic range
    - Quantum efficiency
- Lab Activities
  - CCD measurements
  - CCD calibrations

Day 8

- Flat Panel Detectors
  - Construction
  - Theory
  - Video processing
- Key characteristics of Flat Panel detectors
  - Spatial resolution
  - Dynamic range
  - DQE
  - Evaluating performance
- Lab Activities
  - FPD measurements
  - FPD calibrations

Day 9

- Displays
  - Display classifications
  - Luminance/Illuminance
  - Test patterns
  - Evaluation testing
    - Geometry
    - Luminance
    - Uniformity
    - Resolution
    - Noise
- Monitor alignment
- Lab Activities
  - Monitor calibrations
    - Video display monitors
    - Review monitors
  - Video processing/distribution and monitor troubleshooting

Day 10

- System review
- Final exam
- Course evaluation

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