Principles of Servicing CT Systems

RADIOLOGICAL SERVICE TRAINING INSTITUTE

Introduction

Principles of Servicing Computed Tomography Systems is designed for the service professional transitioning in CT service. This multivendor CT course teaches the skills necessary to understand the CT system, become self-confident in working on the gantry, patient transport, detector assembly, DAS, SRU, X-ray control systems, and operator workstation sub-systems.

Special attention will be given to x-ray tube changes. Hands-on lab time is emphasized and makes up approximately 80% of the overall course content.

The program is divided into seven major areas:

- Basic CT principles
- Safety procedures
- System operation
- Verification of system specifications
- System calibration
- Software maintenance, Backup/restore
- Troubleshooting to major subsystems
- Preventive maintenance

Prerequisites

It is recommended completion of X-Ray Phase I & 2 or a service background and two-year associate degree in electronics or equivalent service experience.

Objectives

At the conclusion of this course, participants will:

- Have a thorough understanding of CT principles and image production
- Follow safety procedures for patients, physicians, and individuals
- Be able to load and backup system and diagnostic software
- Be able to completely operate the CT system including local operation
- Troubleshoot to the major subsystem level
- Change the X-ray tube, realign and recalibrate the X-ray generator
- Calibrate, replace, and align the hardware associated with the gantry and patient transport
- Troubleshoot gantry, patient transport and X-ray systems
- Troubleshoot the digital acquisition system and detector array
- Troubleshoot the scan reconstruction unit
- Troubleshoot the operator workstation
- Perform preventive maintenance

Course Outline

Day 1

- Introduction
  - Overview of CT
- CT principles
  - Matrix sizes
  - CT numbers
  - Window width and level
  - Slice thickness
  - Collimators
  - Back projection
- Simplified block diagram

Lab Activities

- Proper power up and power down procedures
- Location of E-stop/emergency off switches
- Measurement of power requirements
- X-ray tube warm up procedure
- Introduction to scanning software operation
- Pilot/scout scans
- Scanner parameter manipulation
- Patient transport operation

Day 2

- CT imaging principles
  - Air calibration-why needed
    - Pilot/scout scans
    - Normal scan
- System hardware overview & block diagrams

Lab Activities

- Power distribution block diagram
- X-ray system block diagram
- Gantry block diagram
- Patient transport block diagram
- Data acquisition block diagram
- Computer block diagram
- Major component locations
- Major signal flow
  - kV/mA
  - Detector data
  - Motor feedbacks

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Hands-On Training Course
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Day 3

- System Operation and Power Distribution
  - Systems operational parameters
    - Major system component identification
    - System controls
      - ☐ Safety
      - ☐ Interlocks
    - Patient registration/scheduling
    - Exam/technique settings
  - System architectures
    - System block diagrams
  - Power distribution
    - Power distribution diagrams
      - ☐ Main AC power
      - ☐ Sub-system AC power
      - ☐ DC power supplies
- Types and uses of phantoms
  - Spatial resolution
  - Contrast resolution
  - Linearity
  - CT numbers of water equal to zero
  - Slice thickness

Lab Activities

- Control system DC power supplies
- Gantry DC power supplies
  - Stationary
  - Rotating
- Table DC power supplies
- X-ray system DC power supplies
  - X-ray generator
  - X-ray tube rotor control
  - Collimator
- Detector/DAS area DC power supplies

Day 4

- Motor/Motion Controls and Position Indication
  - Motor verification and replacement
    - Gantry rotation
      - ☐ Axial speed control
      - ☐ Axial motor driver
      - ☐ Patient transport/table movement and indexing
        - Tabletop horizontal control
          - Speed control
          - Motor drivers
        - Table vertical travel
          - Speed control
          - Motor drive
    - Laser and light knife position indicators
      - Alignment

Lab Activities

- Motor/Motion Control & Positioning
  - Gantry rotation
    - Axial driver verification
    - Drive assembly mechanical adjustments
  - Patient transport
  - Laser/Light knife adjustments

Day 5

- X-ray system
  - X-ray generation
    - High voltage control
    - Filament controls
      - ☐ Filament drive
      - ☐ Position (Z control)
      - ☐ Z position detection
    - Rotor controller
    - Collimator controls
      - ☐ Pre-patient
      - ☐ Post-patient
    - Filter control
  - X-ray tube change
    - Tube selection
    - De-install/install issues
    - Required calibrations and alignments

Lab Activities

- X-ray tube change
  - De-install procedures
  - Installation procedures
- kV calibration
- mA calibration
- Z position alignment

Day 6

- Detector and DAS
- Detector architectures
  - Maintenance issues
  - Detector replacement
- DAS architectures
  - Pre-amp/channel boards
  - DAS control
  - Data convolution
- Data transmission
  - Fiber optics
  - Slip ring data transfers
    - ☐ Optical transmission
    - ☐ Brushes
    - ☐ RF transmitters

Lab Activities

- Pre-amp/Channel board verification
  - Detector output mapping

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- Pre-amp measurements
- Detector/DAS replacement
  - Removal procedures
  - Installation and alignment
- Data transfer verification
  - DAS data output
  - Data transfer through slip ring verification
  - Data to image processing verification

Day 7

- Image processing and handling
  - Front end processing
  - Temporary preprocessed data storage
  - Image reconstruction
  - Processed image handling
    - Image generation for display
    - Image storage
      - ☐ System disk
      - ☐ CD/DVD ROM
      - ☐ DICOM

Lab Activities

- Image reconstruction system testing
- Image reconstruction testing
  - Real time reconstruction
  - Retro-reconstruction
- Manage image files
  - DICOM setup

Day 8

- System control and Image Quality
  - System host computer
    - Field replaceable units
    - System hard drive
  - System to Gantry control
    - Stationary controls
    - Rotating controls
  - System to X-ray system control
    - X-ray generation
    - Collimation
  - System to image processing/handling
  - Image quality control tests

Lab Activities

- System control and Image Quality Labs
  - System control communications verification
  - System state back-up and restore

Day 9

- Software backups
  - Images
- Loading software onto a CT system
  - How to do a "cold" boot
  - Minimum diagnostics hardware
- Lab Activities
  - Verification of manufacturers' specification
    - Linearity
    - CT number
    - Spatial/contrast resolution
  - Software load
- Preventive maintenance
  - Weekly/Monthly/Quarterly
  - Required Equipment
- Troubleshooting
  - Subsystem troubleshooting
  - Patient support troubleshooting
  - X-Ray system troubleshooting
  - DAS troubleshooting
- Error Logs
- Diagnostics

Lab Activities

- Perform PM procedures
- System troubleshooting

Day 10

- Course review
- Final exam
- Course evaluation

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