



CT Manufacturer's Voluntary Commitment Regarding CT Dose

Updated list of dose management features

The CT manufacturers have worked through MITA to provide an updated list of available technologies implemented for dose reduction on CT scanners, in line with Commitment 2 of the *CT Manufacturer's Voluntary Commitment Regarding CT Dose*.

This following list has been updated and is still based on the MITA list¹, but contains only the COCIR CT manufacturers: General Electric Healthcare, Philips Healthcare, Siemens Healthcare and Toshiba Medical Systems. This list describes generic categories of features and is not intended to reflect marketing names or be updated to show the evolution of each of these specific features with respect to improvement in performance that all manufacturers continue to develop on an ongoing basis.

1. General Electric Healthcare

- Patient Protocol Selection Guidance
 - Color coded pediatric weight /age-based protocols, pediatric Featherlight (procedure based) protocols, and mA limited pediatric FOV protocols, to minimize technologist errors
 - Preloaded protocols for adults and for pediatric imaging organized by clinical indication to serve as a starting point for optimizing an institution's dose vs. IQ preferences
- Advanced Collimator Design
 - Real time beam tracking during all scanning to minimize beam collimation
 - Dynamic beam size collimation to reduce unused patient exposure at ends of helical scanning
- Automatic Tube Current Modulation (ATCM) and X-ray Initiation
 - Z-axis ATCM that automatically optimize the mA for smaller patient anatomy to achieve the desired image quality
 - X-Y ATCM to optimize the mA to account for changing patient habitus during a scan rotation to achieve the desired image quality
 - ECG initiated cardiac axial scanning to generate x-ray only during the desired heart phase, including irregular heartbeat avoidance. Avoids low pitch helical overlap
 - ECG guided ATCM for cardiac to allow full mA only during the desired heart phase
 - Contrast monitoring to initiate the CT exposure relative to contrast arrival

¹ MITA List of dose reduction features for the following CT manufacturers: GE Healthcare, Hitachi Medical Systems, NeuroLogica, Neusoft Medical Systems, Philips Healthcare, Siemens Medical Solutions, Toshiba America Medical Systems, March 2011, released on the 4th March 2011.



- Precise X-ray Field shaping
 - Internal tube collimation and stray electron collection devices to reduce off-focal radiation
 - Real time active source collimation to reduce unused x-rays
 - A variety of beam shaping filters optimally selected based on the patient scan field of view and intended application
- Dose Efficient Design
 - Helical algorithms that minimize helical overranging
 - High resolution detector pitch that maintains high geometric dose efficiency
 - High (98%) detector material efficiency
 - Low noise data acquisition electronics to preserve patient x-ray measurements under low signal conditions
 - Selectable kV imaging at 80, 100, 120 and 140 kV
 - Image Reconstruction methods
 - Adaptive reconstruction methods and filters to reduce noise and retain image features
 - Statistical iterative image reconstruction technique that models system statistics
 - Advanced model based iterative reconstruction technique that accurately models both system statistic and optics
- Dose reporting and Awareness
 - Dose display of predicted CTDI_{vol}, DLP and associated phantom size prior to and post scan initiation
 - Dose report image containing CTDI_{vol}, DLP and associated phantom size that can stay with patient images as a record
 - DICOM CT Dose structured reporting
 - Dose notification and alert features, in conformance with NEMA standard XR-25 (CT Dose Check)
 - HIPAA enabled access controls for system use and protocol management
- Training Opportunities
 - Online TiP TV training sessions
 - GE Healthcare Institute training opportunities
 - Dose symposium offerings
 - On-site applications support
 - Online learning and reference guides
 - Online Center live customer support
 - Applications call center
 - Image Gently training collaboration

2. Philips Healthcare

- Pediatric Protocols
 - A complete group of factory installed age- and weight-based pediatric protocols that provide for appropriately reduced dose and utilize 80 and 100 kVp tube voltages and lower tube-currents
 - Reduced dose for surview, or planning scans, compared to adult settings



- Dedicated Infant Imaging Mode
 - Infant mode activates the infant beam shaping wedge and filter for increased dose efficiency
 - Separate infant mode calibrations optimize image quality for newborns and babies
 - Dedicated infant phantom utilized for infant calibration and protocol development
- Advanced Tube and Collimator Design
 - Dynamic x-ray beam collimation eliminates unnecessary and unused patient radiation exposure at the beginning and end of a helical scan
 - Adaptive collimation to automatically match prospective axial scan length to desired anatomical range
 - Tube housing elements to capture stray electrons and reduce off-focal radiation
- Automatic Tube-Current Modulation during Scanning
 - Automatic tube-current selection based on the surview or planning scan patient attenuation
 - Z-axis tube-current modulation based on surview patient attenuation
 - X-Y, or angular, tube-current modulation within each rotation of a helical scan
 - Simultaneous X-Y and Z tube-current modulation based on surview patient attenuation
 - Prospective ECG-triggered axial cardiac scans generate radiation only during desired heart phase
 - Automatic arrhythmia rejection algorithms that suspend x-ray emission during irregular heartbeats
 - ECG-triggered tube-current modulation for helical cardiac imaging modes
 - Injector integration to reduce the potential for rescans due to mistimed or suboptimal contrast
 - Z-focal-spot deflection to double sampling and prevent helical artifacts without an increase in dose
- Dose Efficient Detection
 - 99% efficient detector material that increases signal and image quality
 - Wide detector coverage with high geometric efficiency
 - Proprietary 2D antiscatter grids and scatter removal techniques for wider beam collimations increase image quality without a corresponding increase in dose
 - Low-noise data acquisition electronics preserve patient x-ray measurements at low-doses
 - Multiple beam-shaping wedges and filters to optimize the dose efficiency per protocol
 - Multiple flat-field filters to adjust x-ray beam quality (hardness) for a given diagnostic task
- Optimized Image Reconstruction
 - Advanced cone beam reconstruction algorithms
 - Iterative reconstruction technique provides dose reduction and maintains or improves image quality
- Dose Display and Recording
 - Predicted dose display of $CTDI_{vol}$ and DLP on console prior to acquisition
 - Actual $CTDI_{vol}$ and DLP recorded with patient images
 - DICOM dose structured report and IHE REM profile
 - Dose notification and alert features, in conformance with NEMA standard XR-25 (CT Dose Check)



- Training Opportunities

- Offsite customer application training at three convenient global locations
- On-site customer application training and support
 - On-site pediatric dose course
 - On-site ACR accreditation assistance and dose-management course
 - On-site dose reduction strategies course
- Remote dose management course
- Remote pediatric check-up course
- Brain perfusion course
- NetForum for up-to-date information sharing among customers and Philips
- Philips Online Learning Center
- Image Gently pediatric dose training collaboration
- CustomerCare solutions phone support

3. Siemens Healthcare

- Predefined Protocols for Adults and Children

- Predefined clinical protocols tailored to various body regions and procedures, which include available dose modulation options
- Dedicated protocols for pediatric patients, utilizing low tube voltage (as low as 70 kV) and mAs-settings. The X-ray exposure is automatically adapted to the child's size, weight, and age, substantially reducing patient dose
- Real-time topogram; manual interruption possible once desired anatomy has been imaged

- Dose Modulation Options

- Automated real-time tube current adjustment for best diagnostic image quality at lowest possible dose. Tube current is automatically adapted to patient size, to the attenuation of the patient's long axis and to the angular attenuation profile measured online for each single tube rotation
- Automated tube voltage adjustment, which automatically recommends the optimal tube voltage for each individual patient for each specific exam. Information gathered from the topogram is used to optimize tube voltage and current, so that a user-specified contrast-to-noise ratio is maintained, and thus optimal image quality and lowest dose are achieved
- Tailored ECG-gated dose modulation for various acquisition types, such as ECG-gated cardiac spiral for dose reduction outside the selectable heart phase. Prospective ECG-synchronized cardiac sequence scans allow for maximum dose savings
- Special scan modes for contrast bolus triggered data acquisition. It enables an optimum spiral scan start after contrast injection based on repetitive low dose monitoring scans



- Modulating the X-ray beam
 - Specially shaped X-ray exposure filters installed at the tube collimator reduce unnecessary dose at the peripheral FOV. Selection is based on scanned body region and patient size
 - Special dynamic tube collimator which prevents pre- and post-spiral overscanning
 - Unique X-ray tube utilizes two precisely alternating focal spots. This doubles scan information at each detector without a corresponding increase in dose and eliminates spiral artifacts in the daily clinical routine at any position within the scan field

- Dose Efficient X-ray Detection
 - Ultra fast ceramic detector material with ultra short afterglow, optimized for sub-second and multislice acquisition
 - High efficiency for low exposure requirements to enable best possible image quality with low patient dose

- Optimized Image Reconstruction
 - Spiral reconstruction algorithms that maintain high-quality imaging at any scanning speed
 - Advanced cone beam reconstruction algorithms for elimination of cone beam artifacts
 - Projection data and image based adaptive filtering algorithms to reduce image noise while preserving resolution
 - Advanced iterative reconstruction algorithms improving image quality and allowing for further dose savings

- Dose Information
 - Dose information is displayed on the user interface prior to scanning for the selected scan parameters. Parameter changes are reflected in real-time
 - Dose notification and alert features, in conformance with NEMA standard XR-25 (CT Dose Check)
 - Full dose information of individual scans as well as complete patient exam are automatically stored with the patient's images, both as a DICOM image as well as a DICOM Structured Report. The new DICOM standard, Dose SR, contains comprehensive data for each irradiation event, the accumulated dose and information about the context of the exposure. The data is provided in electronic format that can be sent to any system which receives, stores or processes dose information, such as conventional PACS or workstations

- Educational Opportunities
 - On-Site Clinical Education Support
 - Optimize CARE CT, an innovative consulting service which helps to optimize user's scan protocols and achieve the right dose for routine CT exams
 - Training and Development Centers located in various locations in the United States, Europe and Asia
 - Uptime Applications and Education Phone Support
 - Siemens Remote Assist to help if questions arise
 - Siemens Remote Training to regularly keep customer up-to-date



- Reference Guides as part of the equipment, Workshops and Fellowships
- Siemens Medical Academy web based Educational Material
- Dedicated web site: www.siemens.com/low-dose
- Brochure: "Guide to Low Dose"
- Consulting offer Optimize CARE CT – a comprehensive dose optimization program also including workflow and general staff education

4. Toshiba Medical Systems

- Default Pediatric Protocol Settings
 - Default age- and weight-based pediatric protocols tailored to pediatric anatomy
 - Automatic activation of pediatric protocol selection based on entered age
 - Variety of kVp options
- Dose Modulation Options
 - 3-dimensional mA modulation is available in the z and xy dimensions, tailoring the dose based on the patient's own size and composition. The user is able to specify a target level of image quality and constrain the minimum and maximum mA used
 - ECG gated to limit exposure during non-desired phases of the heart cycle
 - Prospective ECG gating that shuts X-rays off during non-desired phases of the heart cycle
 - Contrast bolus tracking technology controls start of X-ray exposure based on real-time measured contrast concentration
 - Variable Helical Pitch alters table speed during acquisition to avoid unnecessary low pitches in combination studies
- Beam Shaping
 - Anode grounded tube design and electron collection aperture to minimize off-focal radiation
 - Small bowtie filter to shape X-ray beam for pediatric patients
 - Dose Reduction wedge to maximally attenuate low energy X-rays
- Dose Efficient Design
 - Highly efficient detector material to maximize signal and low contrast detectability
 - Thin septa to reduce scattered radiation while maintaining geometric efficiency
 - Efficient acquisition system (including highly shielded electronics and stealth paint on the inside of the gantry) to minimize electronic noise and ensure accurate patient x-ray signal under low dose conditions
 - Active Collimation to reduce overranging with helical scans
- Image Reconstruction and Post-processing
 - Projection based adaptive algorithm to reduce noise and streak artifacts in areas with low photon counts
 - Image based adaptive filters to reduce image noise and mottle while preserving resolution and edge information
 - Iterative noise reduction algorithms



- Variety of reconstruction methods to optimize resolution and dose
- Dose reporting
 - Prospective feedback on prescribed dose values for a protocol prior to scanning
 - Detailed dose summary of complete patient exam that is retained with the patient's images
 - Dose notification and alert features, in conformance with NEMA standard XR-25 (CT Dose Check)
 - IHE REM profile DICOM structured report
- Training Opportunities
 - Toshiba Training Academy and Education Center
 - Three phase customer education including 1) didactic and practical training at the Education Center, 2) onsite training, and 3) follow-up onsite training after the customer has some direct experience
 - ToshibaLearningCenter.com provides resources on all courses, physician training, and continuing education courses
 - e-training resources on dose, safety, product info, books and articles
 - On-site applications support as well as InTouch Center phone support

Note:

1. *Not all dose reduction features are available on all products*
2. *Certain features are offered as purchasable options*
3. *Not all dose reduction features can be employed at the same time or for all scan types*
4. *Training and education support processes may differ depending on the region*