CT AutoQA Lite™ Software
Model 49-802

- Fast automated CT analysis for routine QC or acceptance testing
- Generates easy to read results with hardcopy output
- Comprehensive trend analysis
- Can be configured with various vendor phantoms including the Catphan® Phantom (Models 424, 440, and 5001,2)
- DICOM® 3.0 compatible; DICOM storage class provider (SCP) application license provided

Processing features

- **Localizer and table incrementation accuracy** – can be evaluated from the slice width section when the ramps are paired at opposing angles. The slice width test outputs a parameter called Table Position Offset, which is an offset in the z-axis relative to the center of the opposing wire (or test section). Verification of the scanner table incrementation accuracy can be checked by incrementing the table by 30 mm and then returning the table to the starting position and scanning the slice width module. The reported table position offset values should be the same.

- **Noise and mean CT number** – is calculated from several regions of interest (ROI) positioned over a water/ uniformity phantom section. The number, size and location of these ROI’s are variable, but typically five are defined: one at the phantom center and the other four along the axes at the same radius covering a 15 x 15 pixel area.

- **Spatial resolution (MTF)** – The modulation transfer function (MTF) is calculated from the discrete Fourier transform of the average vertical and horizontal LSF’s of the point spread function from the bead or wire test section. The program reports the 50%, 10%, and 2% MTF cutoff values³.

- **CT linearity (sensitometry)** – mean CT values are calculated for each reference material in the phantom test section. The measured CT numbers for test materials are fit to the linear attenuation coefficients using a linear least squares for energies from 40 to 100 keV. The variance representing the lowest variance was designated as the scanner’s effective energy. The linear attenuation coefficients for this effective energy are used to determine the contrast scale from the calculated linearity slope⁴.

- **Pixel size** – test verifies the expected pixel size based on the display field of view and the reconstruction matrix size from the measured set of four calibration pins positioned at a known physical location as specified in the Catphan section CTP401.
Processing features (continued)

- **Slice thickness** – is determined from the average full-width at half-maximum (FWHM) of the CT number profile for each wire ramp. The expected slice width is compared with all four measured ramps values. A trigonometric conversion is calculated based on the known ramp angle to yield the slice width. This test provides information on the position of the phantom and the vertical and horizontal tilt values. A rotation of the phantom about an axis perpendicular to the ramps is also computed. Since there are two pairs of ramps orientated along the orthogonal directions, phantom rotations about both the vertical and horizontal axes can be estimated.

- **Uniformity** – vertical and horizontal profiles 10 pixels wide are generated and averaged through the phantom’s center. The fractional uniformity of the profile is calculated as the percentage of the pixels within an acceptable range determined by ± 2 times the central noise or ± 10 H, whichever is smaller.

- **Contrast detail (low contrast resolution)** – theoretical Contrast-Detail data is calculated based on the measured noise of the water/uniformity test section.

**Note:** Low contrast modules (CTP263 and CTP515) are not used in this measurement. This represents a conservative estimate of the minimum contrast level required such that a cylindrical object of a given diameter should be detected.

Result features

CT AutoQA Lite provides two database options for storage of test results. ‘Monitor Database’ is the first database option designated for constancy/monitoring and is linked to the Trend Analysis function. The ‘Service Database’ is the second data base option and is designed for more extensive service and/or acceptance testing data sets. If neither of these two options is appropriate, the user can select the option to not store results but only view results.

Specifications

**Minimum computer requirements** Pentium® processor, Microsoft® Windows® 95/NT®, CD-Rom, network connection using TCP/IP protocol, NIC

**Available model(s)**

49-802 CT AutoQA Lite Software

For additional information, please contact Radiation Management
Services business of Cardinal Health at 440.248.9300, fax: 440.349.2307, or e-mail: rmsinfo@cardinal.com; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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AAPM CT Performance Phantom
Model 76-410-4130

Introduction
The increasing use of computed tomography (CT) as a diagnostic tool creates the need for an efficient means of evaluating the performance of the CT scanners now in use. Recognizing this requirement, the American Association of Physicists in Medicine established the AAPM Task Force on CT Scanner Phantoms. Its goals are to define CT scanner performance and present practical methods of performance testing through the utilization of special phantoms. This phantom design is based on the guidelines presented in Report #1 of the Task Force and approved by the AAPM.

Applications
The modular AAPM CT Performance Phantom offers the CT user a single system with which to measure nine performance parameters. This phantom permits the routine standardization of alignment, beam width, spatial uniformity, linearity/contrast, spatial resolution, linespread, noise, size independence, and absorbed dose. All components of the phantom are housed in a compact, transparent tank which holds the system together in the correct orientation.

The phantom consists of an 8.50 inch diameter acrylic tank containing a beam-width insert, a spatial resolution and linespread block, a high-contrast insert, and a means for inserting alignment pins and/or TLD holders. Additionally, a 0.25 inch thick Teflon® band, positioned at the base of the tank and concentric to the 8 inch internal diameter, simulates human bone. Attached to the base of the tank is a low-contrast section with resealable cavities (from 1 to 0.125 inch diameter) which can be filled with a diluted dextrose or other appropriate solution to provide a low-contrast media. The optional external resolution and noise ring slides snugly over the outside diameter of the tank, allowing whole-body scanner systems to be evaluated.

Features
This ONE phantom evaluates:
- Noise
- Spatial resolution
- Sensitivity (low contrast resolution)
- Absorbed dose
- Size dependence
- Contrast scale
- Slice thickness
- Alignment
- Linearity
- Beamwidth

- Meets guidelines in AAPM Report #1 for Performance Evaluation and QC of CT Scanners
- Single system measures nine performance parameters
Specifications

**Watertank**  Made of acrylic, 8.50 inch OD x 8 inch ID x 12.75 inch long. Resealable with fill and drain ports. Low-contrast detectability block is attached to base

**Linearity and contrast insert**  7.50 inch OD x 2.50 inch long. Contains 1 inch diameter contrast pins of polyethylene, acrylic, polycarbonate, polystyrene and nylon. Density values: polyethylene, 0.95 gm/cc; polystyrene, 1.05 gm/cc; nylon, 1.10 gm/cc; acrylic, 1.19 gm/cc; polycarbonate, 1.20 gm/cc

**NOTE:** The contrast pins in each AAPM CT Performance Phantom are identical in density to the contrast pins of similar material in every other Nuclear Associates’ CT Phantom. For example, the nylon pin in every CT Phantom we manufacture has the same density. This uniform density among all Nuclear Associates’ phantoms provides the user with a standard for comparing the performance of different scanners.

**Resolution insert**  7.50 inch OD x 2.50 inch long with 6 inch diameter solid acrylic block. In the Model 76-410-4130, the block has eight sets of five holes: 1.75, 1.5, 1.25, 1.00, .75, 0.61, 0.5, and 0.4 mm round. In the Model 76-410-4132, the block has nine sets of five holes: 1.75, 1.5, 1.25, 1.00, .75, 0.61, 0.5, 0.4, and 0.2 mm round. In both phantom inserts, the holes are spaced longitudinally on 5 mm centers and vertically on centers equal to twice the hole width. All cavities are filled with air. The 6 inch block is sectored 1.25 inch out on radius. The insert contains 0.014 inch stainless steel wire positioned longitudinally to the insert plates. The wire allows simple computation of linespread functions. A sectored 1.25 inch portion of the main 6 inch block permits an edge gradient to be measured.

**Beam width insert**  7.50 inch OD x 3.50 inch long. Contains three 0.020 x 1.00 inch aluminum strips angled at 45°, positioned on the center line and displayed vertically. A simple, direct calculation permits the accurate measurement of beam width. Adjacency is determined merely by a double exposure of two adjacent frames.

**Low-contrast extension**  8.50 inch OD x 2.75 inch long solid acrylic block. Has two each of the following 2.25 inch deep cavities: 1, 0.75, 0.50, 0.375, 0.25, and 0.125 inch diameter, spaced twice the appropriate diameter apart, one row of cavities on each side of the center line. Cavities with screw-locking sealing ports are easily filled with dextrose or sodium chloride solutions of various densities. The user may adjust densities to any value suitable for the scanner. Typically, 2% or 3% differentials in density between cavities are used.

**Alignment pin**  0.25 inch OD x 3 inch long aluminum with tapped hole, allowing pin to be secured to cover plate.

**TLD insert**  0.50 inch OD x 3.50 inch long polystyrene rod drilled 3 inch deep to accept TLD inserts. Resealable cavity. Tapped on other end to allow mounting to cover plate.

**External (whole-body) resolution and noise ring**  Annulus 12 inch OD x 8.50 inch ID x 2.50 inch long contains the same hole pattern as the Resolution Insert, at two locations 90° apart. Permits whole-body resolution and noise measurements when positioned on the main tank. Inner and outer resolution values are easily determined.

**CT-SSP insert**  The CT-SSP (Slice Sensitivity Profile) Point Response Phantom can be used as a stand-alone phantom or as an insert with the AAPM CT Performance Phantom. The AAPM CT Performance Phantom meets the guidelines in AAPM Report #1 for Performance Evaluation and QC of CT Scanners. The AAPM CT Performance Phantom is described in the report by the AAPM Task Force on CT Scanner Phantoms. The acrylic and closed-cell foam ball bearing size is 0.010 inch, diameter is 7.50 inch, width is 3.50 inch, and weight is 0.825 lb.

**Dimensions**  8.50 in Ø x 15.50 in (d) (21.59 x 39.37 cm)

**Weight**  17.25 lb (7.84 kg)

**Optional accessories**

- **External (Whole-Body) Resolution and Noise Ring** (Model 76-411)
- **CT-SSP Point Response Phantom** (Model 76-412)

**Available model(s)**

- **76-410-4130** AAPM CT Performance Phantom, with Resolution Insert (to 0.4 mm)
- **76-410-4132** AAPM CT Performance Phantom, with Resolution Insert (to 0.2 mm)

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA. Specifications are subject to change without notice. Teflon is a registered trademark of E. I. Du Pont de Nemours and Company.

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76-410-4130 ds rev 3 10 mar 03
CT Head and Body Dose Phantom
Model 76-414-4150

Introduction
These phantoms can be used with any computed tomography (CT) system designed to image both head and body. They can separate dose information for each. When performing dose profile measurements, the dose phantoms allow the user to collect information for the maximum, minimum and mid-range value of the nominal tomographic section thickness.

This essential phantom consists of two parts: a body phantom and a head phantom. Both are made of solid acrylic, 15 cm thick, with diameters of 32 cm and 16 cm, respectively. Each part contains five probe holes, one in the center and four around the perimeter, 90° apart and 1 cm from the edge. The inside diameter of the holes is 1.31 cm. Each part includes five acrylic rods for plugging all the holes in the phantom. A storage and carrying case is available as an option.

Applications
The CT Dose Phantoms were designed in accordance with the Food and Drug Administration’s performance standard for diagnostic x-ray systems, which includes regulations specifically applicable to CT systems (21 CFR 1020.33).

Allows the user to calculate:
- Computed Tomography Dose Index (CTDI)
- Dose profile
- Meets requirements of FDA Performance Standards

Specifications
Weight
- Body phantom: 32 lb (14.5 kg); Head phantom: 8 lb (3.6 kg)

Optional accessories
- Carrying Case (Model 89-414)
- CT Head Dose Phantom, with five plugs (Model 76-414)
- CT Body Dose Phantom, with five plugs (Model 76-415)

Available model(s)
- 76-414-4150 CT Head and Body Dose Phantom

CT Ion Chambers
Specifications
Detector type
- Vented air ion chamber

Volume
- 3.2 cc

Sensitive length
- 10.0 cm

Chamber material
- Polystyrene

Chamber inside diameter
- 6.4 mm

Chamber wall thickness
- 54 mg/cm²

Electrode material
- Aluminum

Sensitivity
- 10 R. cm/nC (nominal)

Standard calibration
- 100 kVCP, 5.5 mm Al HVL (NIST Tech. M100)

Energy response
- ± 5%, 1 mm Al to 10 mm Al HVL

Beam orientation
- Normal to chamber axis

Phantom adapter OD
- 1.27 ± 0.04 cm (0.50 ± 0.015 in)

Leakage current
- (300 V collection potential) less than 1013 A at 10 min polarization time, less than 1014 A at 2 hr polarization time

Intensity limits
- Continuous beam: 4.86 kR/min (1% recombination loss)
- Pulsed beam: 51.5 mR/pulse (1% recombination loss)

Maximum pulse repetition rate
- 3.3 kHz

Cable length
- 3 ft (0.9 m)

Weight
- 1 lb (0.46 kg)

Available model(s)
- 660-6: CT Ion Chamber, 3.2 cm³, with UHF termination: used with Victoreen Model 660 Electrometer
- 500-100: CT Ion Chamber, 3.2 cm³: used with Model 530 and (ATD) Model 35040 electrometers
- 500-200: CT Ion Chamber High Sensitivity, 10 cm³: used with Model 530, (ATD) Model 35040, and other electrometer/dosimeters
- 6000-100: CT Ion Chamber, 3.2 cm³: used with Victoreen Models 4000, 6000, 8000, and RAD-CHECK® PLUS

Available model(s) (continued)
- 6000-200: CT Ion Chamber High Sensitivity, 10 cm³, for multislice CT: used with Victoreen Models 4000, 6000, 8000, and RAD-CHECK PLUS

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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76-414-4150-ds rev 3 10 mar 03
Spiral/Helical CT Lesion Detectability Phantom  
Model 76-409

- Incorporates clinically-relevant lesion shape (spherical) and size
- Provides clinically-relevant absolute HU values for soft tissue
- Provides a clinically-relevant HU differential (i.e. tumors have a slightly lower HU than background)

Features
- Designed for use on all conventional and spiral (helical) CT scanners
- Compact, rugged
- Features three cylindrical reference plugs made of the same material as the spherical lesions
- Valid for x-ray energies from 80 to 140 kVp
- Background Hounsfield Units (HU) approximate liver tissue
- Contains clinically-relevant sphere sizes of 2.4, 3.2, 4.0, 4.8, 6.3, and 9.5 mm in diameter
- Spheres are 5, 10, and 20 HU below background HU
- Carrying case is designed for use as a phantom support during scanning procedure

Applications
The phantom is designed to permit complete testing of low contrast lesion detection when various scan or image reconstruction parameters are varied. These include: collimation, pitch, reconstructed field of view, reconstruction algorithm, z-axis (patient’s long axis) interpolators, kVp, mA, and rotation time. This lesion detectability testing can be applied to protocols designed for imaging of the liver, spleen, pancreas, kidneys, and adrenal glands. It can also be used for mass detection in the brain.

Specifications
Note: The CT Lesion Detectability Phantom is a tissue-equivalent test object that consists of an 18 cm diameter right circular cylinder with a CT value of 50 HU at 120 kVp. Within the phantom is an 18 cm diameter, 4 cm deep right circular void in which a soft-tissue-equivalent disk (containing low contrast spheres) can be placed. The cylindrical void is in a plane containing the z-axis of the scanner. The soft-tissue-equivalent disk also has a background CT value of 50 HU Embedded within the disk are three sets of simulated spherical lesions. One set is 5 HU below background, a second set is 10 HU below background, and the last set is 20 HU below background. Each set contains one sphere each of the following diameters: 2.4, 3.2, 4.0, 4.8, 6.3, and 9.5 mm. These diameters were chosen to encompass the full range of clinically significant lesions. The disk can also be placed at the end of the phantom when axial scanning detectability testing is desired

Low-contrast sphere diameters 2.4, 3.2, 4.0, 4.8, 6.3, and 9.5 mm
Disk dimensions 18 cm Ø x 4 cm thick
Phantom dimensions 20 cm long x 18 cm Ø
Weight 11.9 lb (5.4 kg)
Available model(s) 76-409 Spiral/Helical CT Lesion Detectability Phantom
Mini CT QC Phantom
Model 76-430

Introduction
This highly versatile phantom is designed for routine monitoring of the consistency of all the major parameters of computed tomography (CT) image quality and radiation dose. Its unique, compact design allows for unparalleled portability, easy set up and reliable parameter determinations. It is perfect for use by physicists, technologists and service engineers.

Applications
The disc section consists of a 1 inch thick Lucite® disc with a 6 inch diameter. The six large holes are for the placement of inserts for evaluation of CT number consistency and evaluation of image resolution. The four small holes are for inserting an ion chamber at different locations within the phantom. Lucite inserts are provided to fill the four small holes, when necessary. The disc section is attached to a rectangular acrylic bar containing a thin copper wire embedded along a central groove. This section of the phantom is used to evaluate laser beam alignment and accuracy of slice thickness, slice spacing, slice contiguity, and pilot scan to transverse (longitudinal) scan correspondence. This is achieved by exposing a non-screen film (such as Flex Film Cassettes, listed below) placed underneath the phantom, and making several cuts while the phantom is advanced along the gantry in a pre-programmed manner.

Specifications

Dimensions
6 inch Ø, 1 inch thick, with six 1.125 inch through-holes and four 0.50 inch through-holes

Lucite disk
The Lucite disk is attached to the side of the base by two removable nylon, slotted screws

Inserts
Phantom is supplied with seven inserts for 1.125 inch holes; 1 each of: Plastic Water®, bone-equivalent, polystyrene, polycarbonate, polyethylene, nylon, and one acrylic high-contrast resolution insert

Lucite base
11.94 inch long x 1.81 inch wide x 0.69 inch thick, with copper wire (approximately 0.020 inch) fixed into a 0.020 inch deep groove centered on the base

Weight
3 lb (1.36 kg)

Optional accessories

Low Contrast Resolution Insert (Model 76-430-1000): designed for determining the CT unit’s ability to detect slight differences in contrast. Two materials with very similar CT numbers are incorporated into the low contrast resolution insert to assess the low contrast detection capability of the unit.

Lightweight, compact, and extremely portable
Ideal for field service use
Used with any CT scanner, for measurement and analysis of all major CT scanner functions and radiation dose
Makes inhomogeneity corrections in radiation oncology

Accurately evaluates:
Laser beam alignment
Slice thickness, spacing, and contiguity
Table movement
CT numbers and noise level
CT number uniformity
Relative radiation dose
Video monitor and image processing equipment
Scout and axial scan correspondence
High contrast resolution
Low contrast resolution (with optional insert)

Optional accessories (continued)
Flex Film Cassette, 10 x 12 in (Model 07-800-1012)

Available model(s)
76-430 Mini CT QC Phantom, includes seven inserts
76-430-5555 Mini CT QC Phantom Kit, includes phantom, seven standard inserts, all seven optional inserts, teflon-bone semi-ring, and carry case

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.
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76-430 ds rev 2 10 feb 03
Interventional Triple-Modality 3-D Abdominal Phantom
Nuclear Associates Model 84-357

Introduction
This anthropomorphic phantom is made from proprietary materials which accurately mimic human tissues under magnetic resonance imaging (MRI), ultrasound, and computed tomography (CT). It is designed for image-guided interventional procedures.

Applications
The phantom contains simulated lungs, liver, hepatic vessels, ribs, vertebra, kidneys, abdominal aorta, inferior vena cava, muscle fat and interstitial tissues. Embedded within the lung and liver are simulated lesions available in a range of sizes and relative contrasts.

Each phantom is protected by a fat-equivalent urethane membrane and ABS end-caps. These features make the phantom durable enough for extended scanning sessions and enable insertion of various surgical instruments, as needed.

Specifications
Material Zerdine®, urethane, epoxy, and ABS
Dimensions 28 (w) x 12.5 (d) x 20 cm (h)
Weight 12 lb (5.5 kg)
Available model(s)
84-357 Interventional Triple-Modality 3-D Abdominal Phantom

Needle not included

Features
- Improve performance of freehand abdominal biopsies
- Test new equipment
- Validate automated biopsy systems
- Demonstrate CT, ultrasound, and MRI scan techniques
- Optimize imaging protocols

**CT Spiral Phantom**
**Model 76-432**

**Introduction**
The accurate indexing capability and exceptional image quality of the computed tomography (CT) scanners not only guarantee the object’s location and its size and shape, but also improve the diagnosis accuracy. The index and performance parameters of the CT scanners cannot be confirmed without objects of known specifications. The CT Spiral Phantom from Nuclear Associates provides specific details necessary to confirm the integrity of both conventional and spiral scanning. What makes the phantom unique is that it allows the user to visually evaluate all test results in their image displays.

**Applications**
The phantom consists of five Lucite® plates of different sizes, all affixed to a flat rectangular base. Specific hole patterns are drilled on each side of these plates. When imaging, the holes within the x-ray field will appear in the phantom images. By the hole appearance, both index and performance parameters can be confirmed qualitatively and quantitatively.

**This versatile phantom can be used by:**

**End users, to:**
- Set up baseline standards for future reference
- Verify scanner performance in the acceptance test
- Assist in routine equipment quality control testing
- Evaluate vendor-supported imaging protocols
- Customize image parameters for special applications

**CT manufacturers, to:**
- Evaluate equipment hardware design
- Improve imaging software
- Facilitate equipment installation, calibration, and preventive maintenance

**Research laboratories, for:**
- Testing image reconstruction algorithms and interpolation approaches

**Regulatory agencies, to:**
- Set up the standards for CT scanners, and measure their compliance

*Designed by Jung T. Ho, Ph.D., Department of Radiology, LAC+USC Medical Center, Los Angeles, California 90033.

**Features**
Parameters that can be confirmed by the phantom, based on the hole appearance in the phantom images include:

### Index parameters
- Light localizer orientation
- Light localizer and image slice congruence
- Slice thickness accuracy
- Gantry inclination
- Couch index accuracy
- Ruler (angle and distance) accuracy

### Performance parameters
- Slice geometric uniformity
- Image geometric distortion
- Image slice overlap
- Slice thickness change by pitch factor and image interpolation
- Noise level of imaging protocols

**Specifications**

**Material** Lucite

**Plate dimensions** 10 x 10 cm, 15 x 15 cm, 20 x 20 cm, 25 x 25 cm

**Phantom dimensions** 25 (w) x 20 (d) x 25 cm (h)

**Weight** 7.18 lb (8.2 kg)

**Available model(s)**
- 76-432 CT Spiral Phantom, with Bubble Level

For additional information, please contact Cardinal Health, Radiation Management Services customer service at 440.248.9300, 800.850.4608, or fax: 440.349.2307; located at 6045 Cochran Road, Cleveland, Ohio 44139-3303, USA.

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