

# ***IMRT Phantoms***



**THORAX** MODEL 002LFC  
**PELVIC 3D** MODEL 002PRA  
**HEAD & TORSO** MODEL 002H9K  
**HEAD & NECK** MODEL 002HN



## USER GUIDE

# **CIRS**

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# **WELCOME**

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Congratulations on the purchase of your new phantom from CIRS. The CIRS line of IMRT phantoms were designed with the following objectives in mind:

- Approximate the human body in size, structure and tissue properties using known and fairly simple geometries
- Accommodate the wide variety of dosimeters necessary to perform thorough verification of the IMRT process
- Enable easy upgrades and custom configurations through a modular design system
- Provide a cost effective, user friendly and better designed alternative to existing phantoms on the market

We understand that you, the customer, are the expert when it comes to the use of our product. As you begin to use your new phantom we welcome and appreciate your feedback. While considerable time has gone into the design and manufacturing of these phantoms, we are committed to continuous quality improvements and providing the best possible product. Your advice is instrumental towards this end.

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# MODEL DESCRIPTIONS

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## All CIRS IMRT phantoms:

- Are made from proprietary tissue equivalent epoxy materials. Linear attenuations of the simulated tissues are within 1% of actual attenuation from 50 keV to 15 MeV. This allows for very accurate simulation from CT planning to treatment delivery. The phantoms are elliptical in shape and measure 20 cm thick to properly represent average patient size and proportion. The uniformity of shape also enhances accuracy of depth measurements.
- Accommodate standard Ready Pack™ films in a transverse orientation (other orientations available upon request).
- Incorporate a unique interchangeable rod design that enables chambers, diodes, MOSFET's and TLD's to be positioned in the same locations within the phantom for intercomparison of detectors. Depending on the model selected, your phantom may allow measurements to be taken inside or adjacent to semi-anthropomorphic lung and bone structures.
- Enable acquisition through planning process to treatment delivery
- Include CT to film fiducial markers allowing easy film registration supported by RIT 113.
- Include an alignment base and holding device that enables quick and easy set-up of multiple phantom sections while still allowing easy access and relocation of detectors.

### Additional features:

(optional in some models)

- Electron density reference plugs
- Radiochromic film stack for small volume distributions
- BANG™ gel cassette
- Carrying case

# MODEL DESCRIPTIONS

## Thorax

Model 002LFC



The 002LFC Thorax IMRT Phantom 30 cm wide x 30 cm long x 20 cm thick and includes lung and cylindrical spine. Allows measurements in mediastinum, lungs and spine. Up to 12 Ready Pack films can be positioned in the phantom.

### Model 002LFC Includes:

Qty	Description
1	Thorax section drilled to accommodate rod inserts
12	1 cm thorax sections
1	3 cm end section
1	Alignment base
1	Holding device
5	Water equivalent solid rod inserts
1	Bone equivalent solid rod insert
4	Lung equivalent solid rod inserts
1	Set of CT to film fiducial markers

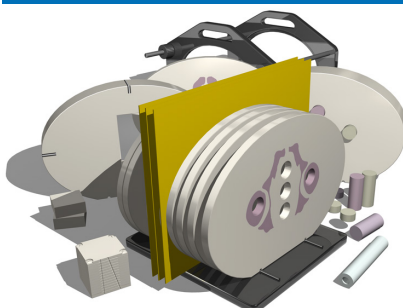
### Insert Options (purchased separately):

Qty	Description
1	Bone equivalent insert with ion chamber cavity (002RB-CVXX-XX)
1	Lung equivalent insert with ion chamber cavity (002RL-CVXX-XX)
1	Water equivalent insert with ion chamber cavity (002RW-CVXX-XX)

As described in Report of the Coordinated Research Project on Development of Procedures for Quality Assurance of Dosimetry Calculations in Radiotherapy - International Atomic Energy Agency (IAEA-TECDOC-1583)

## Pelvic

Model 002PRA



The 002PRA Pelvic 3D Phantom properly represents pelvic anatomy with a tissue equivalent three-dimensional skeleton. Five rod locations are available in the sensitive areas and up to ten Ready Pack films can be positioned within the pelvic region. Rectum balloon can also be represented by empty hole.

### Model 002PRA Includes:

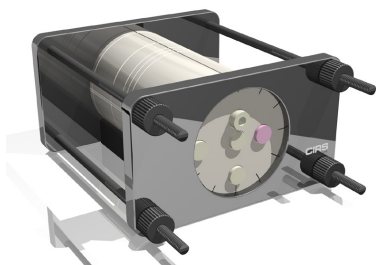
Qty	Description
1	5 cm tissue equivalent reference section for interchangeable ED inserts
10	1 cm thick contiguous 3D pelvic sections each drilled to accommodate rod inserts
1	Homogeneous section that accommodates 002FC or 002GC cassettes
1	Film stack for 3D reconstruction
5	Water equivalent rods, 2.5 cm dia. x 5 cm long
20	Bone equivalent solid disks, 2.5 cm dia. x 1 cm thick
30	Water equivalent solid disks, 2.5 cm dia. x 1 cm thick
1	Electron density reference plugs, set of 4 (lung, bone, muscle, adipose)
1	Alignment base
1	Holding device
1	Set of CT to film fiducial markers

### Insert Options (purchased separately):

Qty	Description
1	Bone equivalent insert with ion chamber cavity (002RB-CVXX-XX)
1	Water equivalent rod insert with ion chamber cavity (002RW-CVXX-XX)

# MODEL DESCRIPTIONS

## Head and Neck Model 002HN



The Head and Neck phantom approximates the average cranial diameter of 16 cm. A bone equivalent rod can simulate the c-spine and an empty hole can simulate the trachea. The phantom has film cassettes for radiographic or radiochromic film.

### Model 002HN Includes:

Qty	Description
1	Water equivalent homogeneous section drilled to accommodate rod inserts (15 cm)
2	Film slabs, 1 cm, film cavity 10x10 cm with a set of CT to film fiducial markers
1	Cavity slab, 6.4 cm, to accommodate Film Stack or Gel Cassette
1	Film Stack for small volume 3D image reconstruction
2	Spacer slabs, 1 cm
1	Spacer slab, 2 cm
1	End slab, 1 cm
1	End slab, ~1.6 cm
5	Water equivalent solid rod inserts
1	Bone equivalent solid rod insert
1	Alignment base
1	Holding device

### Insert Options (purchased separately):

Qty	Description
1	Bone equivalent insert with ion chamber cavity (002RB-CVXX-XX)
1	Water equivalent rod insert with ion chamber cavity (002RW-CVXX-XX)

## Head and Torso Model 002H9K



The H9K contains two rotating cylinders within the main phantom body. Each cylinder can receive standard CIRS interchangeable rods. By rotating the cylinders, the detectors can be positioned in the phantom at any location. The phantom can accommodate four films. The center cylinder can be removed from the body to simulate head and neck set-ups. A bone rod can be inserted to simulate c-spine and one hole can be left empty to simulate the trachea. Bone rods can also be inserted for assessment of heterogeneity correction.

### Model 002H9K Includes:

Qty	Description
1	Water equivalent homogeneous torso section torso section with cylindrical inserts (15 cm)
2	Spacer slabs, 2 cm
1	Spacer slab, 1 cm
1	Spacer slab, 10 cm
4	Water equivalent solid rod inserts
1	Bone equivalent solid rod insert
1	Set of CT to film fiducial markers
1	Alignment base
1	Holding device
	Coordinate Translation Program

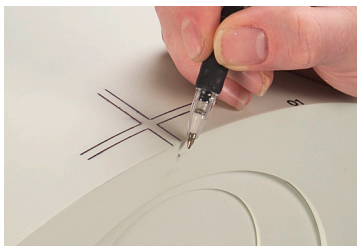
### Insert Options (purchased separately):

Qty	Description
1	Bone equivalent insert with ion chamber cavity (002RB-CVXX-XX)
1	Lung equivalent insert with ion chamber cavity (002RL-CVXX-XX)
1	Water equivalent insert with ion chamber cavity (002RW-CVXX-XX)

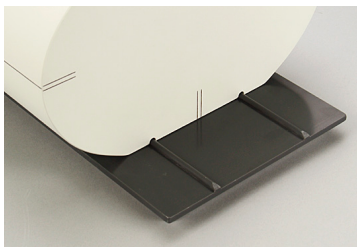
# PHANTOM ASSEMBLY

**1** Please inspect your shipping carton before unpacking. If there are any signs of damage to the carton do not accept the shipment. If the shipment has already been received, contact CIRS or your distributor immediately for instructions. A claim will most likely need to be filed with the shipping company and all evidence of carton damage will need to be retained for proof of claim

**2** Carefully unpack, visually inspect and inventory all items. Check your pack list to ensure you have accounted for all items in the shipment. Contact CIRS or your distributor immediately if any items are missing or damaged.



**3** **IMPORTANT!** Your phantom may contain steel CT fiducial markers. Handle with care. They protrude from the phantom and they are sharp in order to produce a clean series of holes in your film which can later be referenced to your CT plan. They will damage the surface of other phantom sections with which they come in contact.



**4** Always use the alignment base to assemble the phantom but not for imaging and treatment. This will insure that the fiducials contact phantom surfaces in the same location every time. You can store your phantom with the cardboard provided or a spare ready pack envelope to protect the fiducials. Place the alignment base plate on a level surface. The two parallel male ridges should be facing upwards. Then place the contiguous sections of your phantom onto the base plate, aligning the groves with the ridges as shown.



**5** A holding device is provided with every phantom to enable quick set-up, adequate compression of the films and easy transport from the desktop to CT couch to treatment table. The holding device consists of 2 end plates, 4 threaded nylon rods and four threaded knobs.



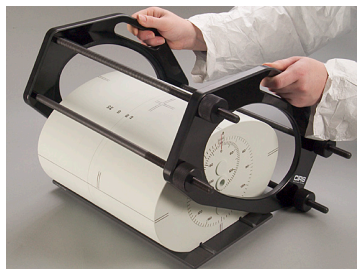
**6** Insert the short threaded end (approx.  $\frac{1}{2}$  " thread) into the end plate with the threaded holes.

## PHANTOM ASSEMBLY

**7** Position end plates with recessed edges facing inwards and handles facing up. The opposite end plate should travel over the long threaded ends of the four rods. Place knobs on the long threaded end of each rod.



**8** Position the holding device over the phantom as shown.



**9** Tighten the knobs in equal turns until the end plates meet the phantom. Visually inspect to ensure the recessed edges of the end plates are aligned with the outside contours of the phantom on both ends. Continue to tighten each knob in equal turns until hand tight. The phantom should be secure, but never overtightened while in use.



**10** The phantom can now be removed from the alignment base for scanning and treatment delivery. The end plates allow for easy access to the interchangeable rods so that detectors can be added or rearranged in the phantom without having to take it apart. When removing the films, however, it is recommended that the phantom be returned to the alignment base before loosening the knobs.

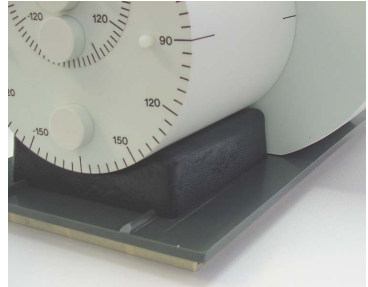


**NOTE:** Do not use the alignment base during verification procedures. It is not tissue equivalent and may adversely affect the results.



# PHANTOM ASSEMBLY - 002H9K HEAD/NECK SET UP

**1** Remove the 16 cm cylinder and place on the cradle on base alignment device. The cradle positions the head within the center of the head holding device.



**2** Taking the head holding device, align it with the 16 cm cylinder. Position the phantom holding device over phantom and tighten the knobs in equal turns until the end plates meet the phantom. Visually inspect to ensure the recessed edges of the end plates are aligned with the outside contours of the phantom on both ends. Continue to tighten each knob in equal turns until hand tight. (As shown in numbers 8 and 9).



**3** The phantom can now be removed from the alignment base and head cradle for scanning and treatment delivery. The end plates allow for easy access to the interchangeable rods. A bone rod can be inserted to simulate c-spine and one hole can be left empty to simulate the trachea. Detectors and rods can be added or arranged in the phantom without having to take it apart when removing the films, however, it is recommended that the phantom be returned to the alignment base before loosening the knobs.

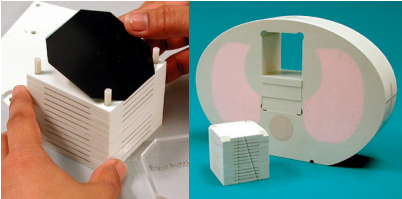


# USING DOSIMETERS WITH YOUR PHANTOM

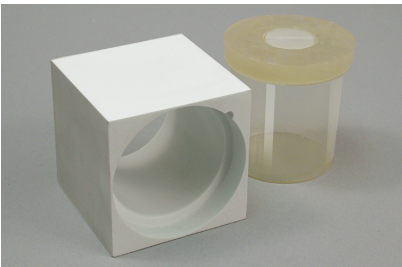
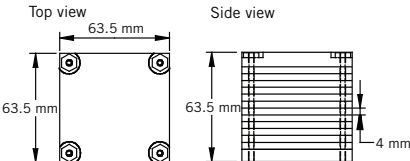
The CIRS line of IMRT phantoms are designed to accommodate a wide variety of dosimeters in the areas of greatest challenge for IMRT. When possible, the dosimeter holders have been made interchangeable to allow for inter-comparison of detectors and cost effective upgrades as new detectors become available. As with all CIRS phantoms, custom modifications to detector position or orientation can be made upon request. For a complete listing of available parts and model numbers refer to appendix.



**1** Ready-Pack™ films can be positioned in transverse orientation within the phantom. Depending on your model at least 1 and up to 13 films can be positioned 1 cm apart within the phantom. Note: Interchangeable rods are designed to allow for close positioning to at least one film plane. This enables a combination of the ion chamber and film measurement in one irradiation session affording time savings and film calibration.



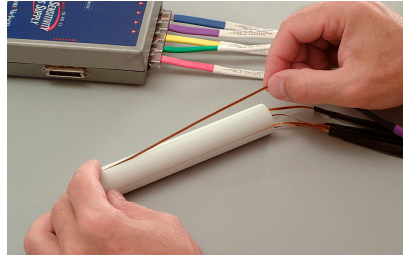
**2** Radio chromic film can be used with the Film Stack for small volume dose mapping (Model 002FC). Film can be cut by hand using the jig provided or you can purchase pre-cut GafChromic® films. The film stack measures 2.5x2.5x2.5" (63.5x63.5x63.5 mm) and accommodates 13 layers of film with 4 mm thick water equivalent spacers in between each film. Place one film between each spacer and assemble the stack. Use a razor blade to score the edges of the film using the groves along the side of the stack. This enables x, y and z orientation when viewing individual films. Place the film stack inside the Cavity Slab in any orientation preferred. Contact customer service to order complementary film samples cut to your specific phantom configuration.



**3** The Bang™ Gel Cassette (Model 002GC) is designed to be interchangeable with the Film Stack inside the cavity slab. Simply fill the disposable Barex™ container (max Ø 50 mm, height 63.5 mm) in accordance with gel supplier's instructions then place the container within the cassette and position as desired with the cavity slab.

# USING DOSIMETERS WITH YOUR PHANTOM

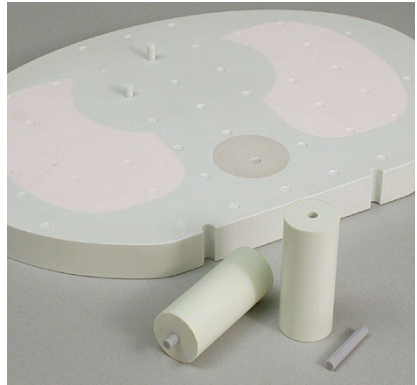
**4** The interchangeable rods measure 1" in diameter and 16 cm long. They are available in lung, bone and water equivalent material. Detector cavities are manufactured to allow the sensitive volume of the detector to be positioned 16 mm to the film plane and aligned with laser marks on the phantom body. This allows detector and film measurements to be taken in one irradiation session.



Cavity rods can be ordered to accommodate thimble chambers, diodes, MOSFET arrays or TLD's. (see appendix) Solid rods of the same tissue are provided to fill phantom cavities not in use.



**5** Upon customer request any section of the phantom that is  $\leq 2.5$  cm thick can be drilled with through holes that are 5 mm in diameter and run completely through the section. Each through hole comes with a tissue equivalent plug which is inserted at the factory. These plugs can be removed using the plastic push rod provided. (Push through from downside of slab). For best fit, it is advised to replace each plug to its original hole as supplied by the manufacturer.



Alternately, short rods for TLD (model 002SPH) can be used to position detectors in the same location as interchangeable rods.

Through hole plugs can be cut to length to achieve appropriate TLD placement. They are not cut in advance to account for the variance and thickness of different detectors. Additional replacement plugs are available.

When loading detectors, place the bottom half of the plugs into their appropriate positions first. Gently place each detector into its appropriate hole. Check to make sure each detector is positioned correctly within the hole before inserting the top-covering plug. Be sure the length of the top plug takes into account the thickness of the detector before pushing the plug flush to the top surface. Failure to do so may result in damage to the detector.

## LASER ALIGNMENT MARKS

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All IMRT phantoms are clearly marked on the top, ends and sides with laser alignment guides to enable reproducible and accurate positioning of the phantom for CT scanning and treatment planning system verification. Cross hairs are also present at the top and side of the phantom for proper alignment with ISO center if the detectors placed there in.

## ACCESSORIES

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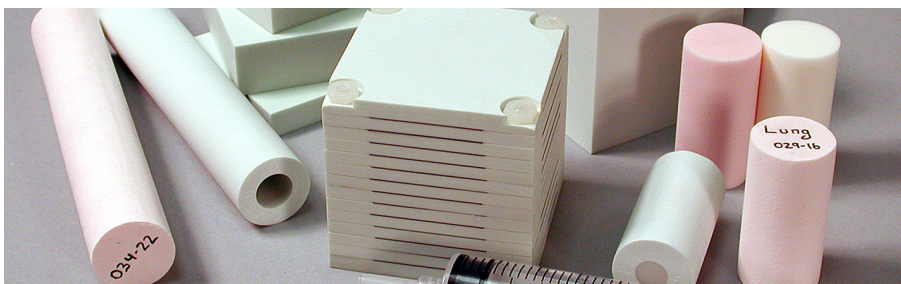


The materials used to construct your phantom can also be used for electron density calibration. See appendix for electron density data. Additional reference plugs are also available. They also measure 1" in diameter and can be positioned in any phantom hole.



Breasts attachments can be added to any phantom model. The attachments are made from a 50% adipose/ 50% glandular tissue composition. They approximate an average breast size (350cc) and shape. They are drilled to accommodate TLD arrays in 20 mm grid spacing. They can be specially manufactured to accommodate other detectors upon customer request. **IMPORTANT:** Do not over tighten the nylon screws. Too much torque may result in damage the threaded holes in the phantom.

# PART NUMBERS AND DESCRIPTIONS



## Single Breast Attachment (Part No. 002BR)

Single breast attachment 350 cc, 50/50 glandular/adipose ratio with TLD holes Ø5 mm, 20x20 mm grid spacing with tissue equivalent plugs.

## Film Stack (Part No. 002FC)

Film stack 2.5x2.5x2.5" (63.5x63.5x63.5 mm) for 3D image reconstruction using 13 layers of X-Ray or GafChromic® film with 4 mm thick tissue equivalent spacers between each film. Contact customer service to order complementary film samples cut to your specific phantom configuration.

## Gel Dosimetry Cassette (Part No. 002GC)

Gel dosimetry cassette has the same outside dimensions as the Model 002FC film cassette. It receives a disposable Barex™ cylinder (max Ø 50 mm, height 63.5 mm) that can be filled with BANG™ or other dosimetry gel.

## Sections (Part No. 002LH5, 002LCV, 002PCV)

Special sections for homogeneous, thorax and pelvic region to accommodate Model 002FC film stack and Model 002GC Gel Cassette. Three water-equivalent spacers are included to allow use of cassette in six different positions inside the phantom section. Spacers thickness is 20, 20 and 10 mm. Extra solid blocks to replace the cassette are included.

## Tissue Equivalent Rods (Part No. 002SPH)

Short water equivalent rods for TLD (set of 5). Each rod is 50 mm long by 25.4 mm (1") Outside Diameter. Inside hole Ø 5 mm with water-equivalent plugs 25 mm long. Rods are also available in other tissues and lengths.

## Fiducial Markers (Part No. 002CTF)

CT to film fiducial markers. Stainless steel, 1 mm diameter. Set of five for singular film interface. Fiducials at each phantom to film interface allow for very precise film to plan registration.

## Electron Density Plugs (Part No. 002ED)

Set of 4 (lung, bone, muscle and adipose) plugs. (See Appendix)

## Carrying Cases

Foam lined with built-in casters.

**Part No. 9501:** Case for Models 002H9K, 002LFC and 002PRA when ordered with corresponding Cavity Slab (002HCV, 002LCV, 002PCV)

**Part No. 9502:** Case for 002H9K, 002LFC and 002PRA without Cavity Slab

**Part No. 9503:** Case for Model 002HN



### Rods with Ion Chamber Cavities

Rods with detector cavities are recommended for purchase with each phantom. See specific phantom description for details. The rods are 1" in diameter and are 16 cm long. They are available in water, bone or lung equivalent material. Should your chamber or detector not be listed below, contact Customer Service for assistance.

**002RW-CVXX-XX** 16 cm long water equivalent insert with cavity (see below)

**002RB-CVXX-XX** 16 cm long bone equivalent rod with cavity (see below)

**002RL-CVXX-XX** 16 cm long lung equivalent insert with cavity (see below)

## Chamber Cavities for CIRS Dosimetric Phantoms

CIRS does offer a variety of dose phantoms that accommodate the most common ionization chambers. Also available are solid plugs to fill cavities not in use. When ordering a phantom for use with an ionization chamber, specify the exact chamber you are using (CVXX-XX). If your chamber or detector is not listed below, CIRS will need the actual chamber or engineering prints from the chamber manufacturer in order to quote for a custom cavity.

Manufacturers Model #	CIRS CV #
<b>Applied Engineering</b>	
C110	CV51-0
C134	CV50-3
<b>Attix</b>	
449	CV51-6
<b>Capintec</b>	
PR-05	CV53-5
PR-05P	CV53-5
PR-06C	CV50-7
PR-06G (w/ cap)	CV50-6
PR-06G	CV52-6
PS-033	CV50-8
<b>Exradin</b>	
A1/T1	CV54-5
A1SL, MR	CV53-1
A2/ P2/ T2	CV53-9

<b>Exradin (cont)</b>	
A10	CV54-9
A10 w/ cap	CV52-9
A11/ P11/ T11	CV51-2
A12, MR	CV51-3
A12S, MR	CV55-3
A14/ T14	CV54-4
A14P	CV54-6
A14SL	CV52-8
A16	CV54-0
A18	CV51-1E
A19, MR	CV50-1
A26, MR	CV57-4
A28, MR	CV57-0
W1 Scintillator	CV56-9
<b>Far West</b>	
IC18	CV56-1

<b>Manufacturers Model #</b>	<b>CIRS CV #</b>
<b>Fluke/ Invision/ Victoreen</b>	
30-344	CV51-1C
107325	CV50-1
580-006-WP	CV50-1
550-6A	CV52-4
X-10	CV52-3
<b>Multidata</b>	
233642	CV51-1C
233643	CV51-1C
<b>Nuclear Enterprise</b>	
2505/3A	CV50-1
2515/3A	CV51-7
2533/2533A	CV51-1A
2571/2571A	CV50-1
2577	CV51-7
2581/2581A	CV50-1
2611A	CV52-2
<b>Philips</b>	
60003	CV53-7
Diamond Detector	CV53-7
<b>PTW</b>	
23323	CV51-1D
23331	CV52-0
23332	CV54-8
23333	CV50-1
23333 w/ cap	CV51-4
23342	CV51-9
23343	CV50-3
23344	CV56-8
233641	CV51-1B
30000	CV50-1
30001	CV50-1
30001 w/cap	CV50-2
30002	CV50-1
30002 w/cap	CV50-2
30004	CV50-1
30004 w/cap	CV50-2
30006	CV50-1
30009	CV55-7
30010	CV50-1
30011	CV50-1

<b>PTW (Cont.)</b>	
30012	CV50-1
30013	CV50-1
30015	CV52-0
31002	CV51-1C
31003	CV51-1B
31005	CV51-1C
31006	CV51-8
31009	CV55-0
31010	CV51-1C
31011	CV51-1C
31013	CV51-1B
31014	CV51-8
31015	CV55-0
31016	CV55-1
31018	CV56-0
34001	CV50-4
34013	CV55-5
34045	CV54-9
34070	CV56-7
60008	CV55-4
60012	CV55-4
60016	CV56-6
60017	CV56-4
60018	CV58-0
60019	CV57-1
<b>RADCAL</b>	
10x5-0.6	CV55-2
10x5-3CT	CV55-2
<b>Sun Nuclear</b>	
1118 Edge Detector	CV56-2
SNC 125c	CV57-2
SNC 350p	CV57-3
<b>Thompson Neilson/ Best Medical Canada</b>	
MOSFET Cavity (5 locations)	CV53-8
MOSFET Cavity (Single location)	CV57-5
MOSFET Cavity (Single location****)	Model 680
MOSFET Cavity (Single location)	Model 70X-4
MOSFET Cavity (Single location)	Model 008A-05

Manufacturers Model #	CIRS CV #
<b>IBA/ Scanditronix/ Welhofer</b>	
999702 DEB012-XXX Diode	CV54-7
CC01	CV53-3
CC04	CV53-6
CC08	CV53-2
CC13	CV53-2
DS31 Roos	CV53-0
FC23	CV54-2
FC65	CV52-7
FC65-G	CV50-1
FC65-P	CV50-1
IC04	CV53-6

**When ordering specify part number and cavity code**

Example: 002RW-501 (16 cm long rod to accommodate farmer-type chamber)

IC10	CV53-2
IC15	CV52-5
IC28	CV54-2
IC3	CV52-1
IC69	CV50-2
IC70 w/cap	CV52-7
IC70	CV50-1
NACP	CV59-9
PPC-04	CV53-6
PPC-05	CV50-3
PPC-05 w/cap	CV56-5
PPC40 Roos	CV53-0
PS-31 Roos	CV53-0
RFD-3G Reference Field Detector	CV55-9
SFD 3G Stereotactic	CV55-8

\* Standard Imaging models may have various prefixes. Cavity code is independent of this prefix.

## USE OF THE PHANTOM

Most any IMRT phantom QA process will include, scanning the phantom on CT, importing the resulting scan data to the Treatment Planning System, create treatment plan to phantom scans, treating the phantom and examining the resultant output data. However IMRT QA and dose verification is a complicated process. There are many different opinions regarding the choice of detectors, QA processes and interpretation of results. Engineers and physicists at CIRS are available to answer specific questions regarding the materials, design and technical specifications of the phantom. Specific questions regarding various detectors and IMRT QA issues should be directed toward the appropriate manufacturers of those detectors and experts in the field.

### Commissioning of Radiotherapy Treatment Planning Systems: Testing for Typical External Beam Treatment Techniques

The following are IAEA clinical test cases recommended during commissioning, using the IMRT phantom Model 002LFC (*refer to the IAEA-TECDOC-1583 for instructions*):

Case 1: Verification of digitized contour – non-dosimetric test

Case 2: Verification/determination of CT numbers to relative electron density conversion in the RTPS

To meet the IAEA requirement in Case 1, copy the phantom face using your standard office copier or contact CIRS for a 1:1 digital image (provide file format when requesting image).

## HANDLING AND CARE OF YOUR PHANTOM

Your phantom is manufactured from epoxy resin. Various other chemicals and fillers have been added to the resin using a proprietary tissue simulation technology. See appendix for simulation data. As with most other epoxy plastics, your phantom may discolor slightly over time. This process can be accelerated by direct exposure to sunlight or extreme temperatures. It is recommended that when not in use, the phantom be stored in a dark, fully climatized storage area.

Epoxy is quite durable, but can still be damaged if it is dropped on a hard surface so handle with care! The phantom slabs should be stacked on a flat surface for storage, or stored on the holder without any tension from the front and back panels. Most phantoms can be easily repaired, and if damaged contact CIRS.



# APPENDIX

## Ratios of IMRT Materials <sup>(1) (2)</sup>

### Linear attenuation coefficients to reference tissues

En, MeV	Plastic Water-DT to H <sub>2</sub> O Ratio, %	Average Bone to Ref <sup>1</sup> Ratio, %	Lung (inhale) to Ref <sup>2</sup> Ratio, %
0.05	100.8	100.00	100.3
0.06	100.5	99.96	101.1
0.08	100.3	99.91	101.9
0.10	100.2	99.88	102.2
0.15	100.1	99.86	102.5
0.20	100.1	99.84	102.5
0.40	100.1	99.84	102.7
0.60	100.1	99.83	102.6
0.80	100.1	99.84	102.7
1.00	100.1	99.83	102.7
1.50	100.1	99.84	102.7
2.00	100.1	99.84	102.6
4.00	100.0	99.87	102.1
6.00	99.8	99.93	101.6
8.00	99.7	99.95	101.2
10.0	99.6	100.03	100.7
15.0	99.2	100.06	100.0
20.0	99.1	100.13	102.7
El. density	100.1	99.83	102.7
Density	1.039 g/cm <sup>3</sup>	1.60 g/cm <sup>3</sup>	0.21 g/cm <sup>3</sup>

1. ICRP 23, Report of the Task Group on Reference Man (1975).

2. Woodard, H.Q., White, D.R., The Composition of Body Tissues, The British Journal of Radiology (1986) 59: 1209-1219.

### Electron Density Reference Inserts

Composition	Density	Electron Density per cc x 10 <sup>23</sup>	Electron Density Relative to H <sub>2</sub> O
Lung	0.21	0.69	0.207
Bone	1.60	5.03	1.506
Muscle	1.06	3.48	1.042
Adipose	0.96	3.17	0.949

# WARRANTY

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All standard CIRS products and accessories are warranted by CIRS against defects in material and workmanship for a period as specified below. During the warranty period, the manufacturer will repair or, at its option, replace, at no charge, a product containing such defect provided it is returned, transportation prepaid, to the manufacturer. Products repaired in warranty will be returned transportation prepaid.

There are no warranties, expressed or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description on the face hereof. This expressed warranty excludes coverage of, and does not provide relief for, incidental or consequential damages of any kind or nature, including but not limited to loss of use, loss of sales or inconvenience. The exclusive remedy of the purchaser is limited to repair, recalibration, or replacement of the product at manufacturer's option.

This warranty does not apply if the product, as determined by the manufacturer, is defective because of normal wear, accident, misuse, or modification.

## Non-Warranty Service

If repairs or replacement not covered by this warranty are required, a repair estimate will be submitted for approval before proceeding with said repair or replacement.

## Returns

If you are not satisfied with your purchase for any reason, please contact your local distributor prior to returning the product. If you purchased your product direct through CIRS, call Customer Service at 800-617-1177, email [rma@cirsinc.com](mailto:rma@cirsinc.com), or fax an RMA request form to 757-857-0523. CIRS staff will attempt to remedy the issue via phone or email as soon as possible. If unable to correct the problem, a return material authorization (RMA) number will be issued. Non-standard or "customized" products may not be returned for refund or exchange unless such product is deemed by CIRS not to comply with documented order specifications. You must return the product to CIRS within 30 calendar days of the issuance of the RMA. All returns should be packed in the original cases and or packaging and must include any accessories, manuals and documentation that shipped with the product. The RMA number must be clearly indicated on the outside of each returned package. CIRS recommends that you use a carrier that offers shipment tracking for all returns and insure the full value of your package so that you are completely protected if the shipment is lost or damaged in transit. If you choose not to use a carrier that offers tracking or insure the product, you will be responsible for any loss or damage to the product during shipping. CIRS will not be responsible for lost or damaged return shipments. Return freight and insurance is to be pre-paid.

## With RMA number, items may be returned to:

CIRS  
Receiving  
900 Asbury Ave,  
Norfolk, Virginia, 23513 USA

Product	Warranty Period
002 IMRT Phantoms	60 Months



# **CIRS**

**COMPUTERIZED IMAGING  
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