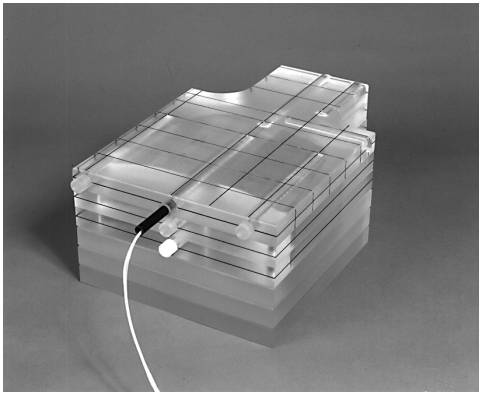
SeeDOS Product User Manual

IMRT Phantom



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General Precautions

Warnings and Cautions alert users to dangerous conditions that can occur if instructions in the manual are not obeyed. Warnings are conditions that can cause injury to the operator, while Cautions can cause damage to the equipment.

⚠ WARNING: Follow manufacturer's recommmended safety procedures for radioactive sources.

⚠ CAUTION: Do not drop or mishandle unit.

⚠ CAUTION: Refer all servicing to qualified individuals.

⚠ CAUTION: Proper use of this device depends on careful reading of all instructions and labels.

Features and Specifications

Dimensions:

Height (six slabs)	18.00 cm (7.09 in.)
Width (each slab)	30.00 cm (11.81 in.)
Length (each slab)	45.00 cm (17.72 in.)
Weight (six slabs)	22.7 kg (50.0 lbs)

Individual Components:

(2) Chamber Phantom Slab with 6 cavities for Ion Chamber placement
(2) Acrylic Phantom Slabs for build up thickness
(2) Lung Phantom Slabs with cavities for simulated lungs
(16) Solid Acrylic Plugs to fill unused Ion Chamber cavities
(1) Solid Acrylic Plug with cavity for Chamber of your choice
(1) Bone Equivalent Plug
(1) Lung equivalent insert set to fill lung phantom voids

Specifications are subject to change without notice.

Overview

The IMRT Phantom shown in Figure 1 is designed to provide feedback on complex treatment plans generated using 3D. This Phantom is especially applicable to IMRT and tomotherapy modalities. The phantom is designed to mimic a human torso. Multiple thicknesses allow measurements for different body sizes. Both film and ion chambers can be simultaneously irradiated for comparisons with the treatment planning system.

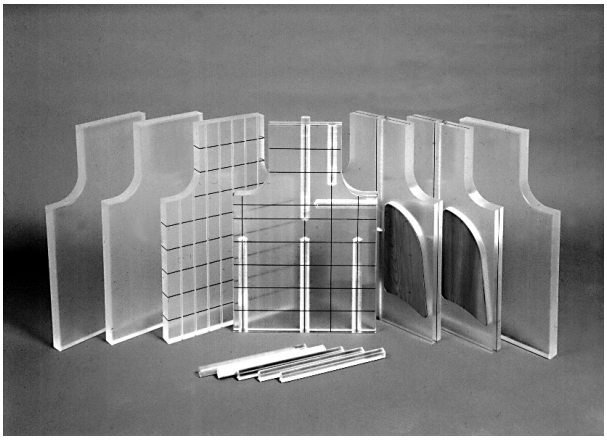

Figure 1: Photograph of IMRT Dose Phantom

The IMRT Phantom is easily used for dose verification by the following steps:

1. Select appropriate phantom configuration to resemble the clinical patient setup desired.

Each 3 cm acrylic slice can be added for a total thickness range of 3 to 18 cm. Two pieces are solid and are placed in position where no data is to be collected. Two of the pieces have a cavity resembling the shape of a lung and are to be used when a large tissue inhomogeneity may present a complication in a treatment. The final two pieces contain a number of cavities for an ionization chamber. The ion chamber can be positioned anywhere along the cavity. Unused cavities are filled with the solid acrylic rods. For commonly treated cases such as prostate, it is best to use a specified location for the chamber center as indicated by the scribe line. Place the lung inserts (set of four) into the simulated lung cavities and the bone equivalent plug into one of the ion chamber cavities, if desired.

2. Scan the Phantom setup with CT.

Arrange the assembled IMRT Phantom on the CT table with the ion chamber in position. Scan as much of the phantom as possible ensuring that the entire length of the active area of the chamber is included. Export the scanned phantom to the treatment planning system and proceed to contour the active area of the chamber.

3. Position the phantom on the treatment unit.

Position the assembled IMRT Phantom on the treatment table placing isocenter in the middle of the desired chamber volume. The semitransparent acrylic is ideal for localization as the surface SSD may be easily read and at the same time the exact location of the chamber may be viewed with respect to the localization lasers. The scribe marks on the side of

the phantom can be used for rapid isocenter placement. Place a piece of ready pack V type film at the appropriate level(s) where a coronal dose distribution is to be measured.

4. Import the fluence pattern from the original treatment plan on the computer.

For most planning systems that use dynamic multileaf collimators this is a standard feature and will copy the exact fluence pattern from one field to another. After each fluence pattern is copied onto the phantom plan, calculate the dose. If dose to a particular point off the central axis is desired, then a separate contour will be needed and can be placed inside one of the cavities. Next, place fields around the phantom in the same manner they were used in the patient plan. This involves selecting the fields with the same gantry, collimator and jaw settings.

Dose distributions on the phantom can be measured by placing a piece of ready pack verification film between the acrylic slabs. If a high degree of correlation is desired, a small steel ball may be inserted in one of the cavities to provide a point of reference. The absolute dose to the chamber center may be calculated using the dose volume histogram utility available on most planning systems. If no such utility is available, the average dose may be computed by simply measuring the point dose on the planning system with a number of points and taking the average. If the dose volume histogram does not show a steep gradient at the expected dose level, then the chamber is either too big for the given field or in a region where the dose is changing rapidly and should not be used for an absolute measurement. If the exact location of the steel spheres is desired, make certain the film is pre-irradiated using an open field that covers the steel localization spheres embedded in the phantom. Pre-irradiation is

is acceptable since the film will only be used to show relative dose, not absolute dose. If one desires to have no irradiation in the area of the film to be analyzed, then simply pre-irradiate the film using two exposures with the jaws collimated up such that only a thin strip approximately 1 cm wide is used to irradiate the section with the steel spheres.

5. Irradiate the phantom

Irradiate the phantom delivering the dose just as onewould if a patient were on the treatment table. Deliver approximately 50 cGy to the chamber. This will allow simultaneous irradiation of the chamber and film with the same beams. As the charge is accumulating on the chamber for each field, record the amount of charge accrued for each beam if possible. This is useful if a significant deviation is found between the measured and expected dose.

6. Compare results from Phantom dosimetry with the original plan.

Using the appropriate calibration factors, convert the accumulated charge into an effective dose. This conversion is done via the TG 21 protocol using the correction factors for an acrylic phantom. To assist with this task, Table 1 provides correction factors that include all the corrections needed to be applied to acrylic phantom readings to convert to the equivalent doses in water.

•Example (see TG 21 for definitions of terms):

Using data measured for a given field at a depth of 10 cm:

M = 2.13 nC = Measured charge for a given monitor setting

N_{gas} =4.663 x 10^9 L/ρ = 1.063 $P_{T,P}$ = 1.022

P_{repl} = 1.000 P_{ion} =1.000

Use the equation:

Dose in water = $M * N_{gas} * L/\rho * P_{T,P} * P_{repl} * P_{ion} * P_{phan}$

$D_w = 2.13 * 4.663 * 1.063 * 1.022 * 1.000 * 1.000 * 1.034$

D_w = 11.16 cGy

where P_{phan} is given in Table 1 for 6X at 10 cm deep.

Table 1 is a ratio of charge measured in water to charge measured in acrylic at the same depth for a given number of monitor units. If your machine is not a 6X or 18X then you will need to measure these values or use the TG 21 procedure. The ratio in Table 1 is for a 10 x 10 cm reference field. The dependence of this ratio on field size is a second order effect which is estimated to be less than 0.5%, and can thus be neglected.

Develop the film and scan using film dosimetry software. The film may indicate a maximum dose that is higher or lower than what is given on the plan by up to 20% based on variations of film, temperature, processor conditions, etc. This deviation should not present a problem since the relative dose distribution on film compared with the treatment plan is of interest. Once the film is digitized, compare the location of selected isodose lines with that from the planning system. Any significant deviation should be investigated.

7. Other measurements

Point doses can be measured off axis using the optional TLD/Diode/MOSFET Phantom, REF 70608. If a point dose such as spinal cord is needed this can be accomplished by inserting the TLD/Diode/MOSFET Phantom in the approximate position above or below the desired isocenter. Once the exact location is determined from the patient plan, a small lead marker may be placed into one of the multiple slots and taped in place. The lead marker will appear when the phantom is

scanned by the CT and the image imported into the planning system. A diode dosimeter or TLD may be placed in the location and irradiated along with the film and chamber. This will give an accurate point dose in a high gradient region without affecting the overall measurement.

Table 1. Values of P_{phant} for 6X and 18X photons for various depths for a 10 cm X 10 cm field

Depth in cm	**6X Correction Factor, P_{phant}**	**18X Correction Factor, P_{phant}**
1.50	0.996	N/A
2.00	0.998	N/A
3.00	1.003	N/A
3.50	1.005	1.003
4.00	1.007	1.004
5.00	1.012	1.008
6.00	1.016	1.011
7.00	1.020	1.014
8.00	1.025	1.017
9.00	1.029	1.020
10.00	1.034	1.023
11.00	1.038	1.026
12.00	1.043	1.029
13.00	1.047	1.032
14.00	1.051	1.035
15.00	1.056	1.038
16.00	1.060	1.041
17.00	1.065	1.044
18.00	1.069	1.046
19.00	1.074	1.049
20.00	1.078	1.051
21.00	1.082	1.054
22.00	1.087	1.057
23.00	1.091	1.059
24.00	1.096	1.062
25.00	1.100	1.064

Recommended Exradin Ionization Chambers

General Chamber Specifications

For informational purposes, the specifications for most chambers useful for this application are given below.

Humidity: 10-80%, non-condensing
Temperature: -15 to 50° C
Nominal Collection Efficiency: 100%
Maximum Polarizing Potential: Greater than 1000 V
Normal Polarizing Potential: 300V
Nominal Inherent Leakage Currents: 10^{-15} A
Cable: 50 Ω, 29 pF/ft, 2 m long
Connector: Triaxial BNC Plug, 2-Lug Male (shell of chamber is common with connector body)

The Exradin chamber models given in the table below are normally used for IMRT applications. The specifications for each chamber are listed below.

Model Specifications

	Collecting Volume (cm^3)	Nominal Calibration Factor (R/nC)	Centroid of Collecting Volume (mm from tip of chamber)	Collector Diameter (mm)	Outside Diameter of Shell Collecting Volume (mm)	Wall Thickness (mm)	Shell, Collector,& Guard Material
Model A1	0.056	60	4.0	1.0	6.0	1.0	C552
Model A1SL	0.056	60	4.1	1.0	6.25	1.1	C552
Model A14	0.009	365	2.0	1.5	6.0	1.0	C552
Model A14SL	0.009	365	2.1	1.5	6.25	1.1	C552
Model A12	0.65	5	12.9	1.0	7.1	0.5	C552

Maintenance

Exterior cleaning of the device can be done with a soft brush and a cloth. Gently brush all surfaces to remove dirt and dust. Remove any remaining dirt with a cloth slightly dampened with a solution of mild detergent and water or a liquid disinfecting agent.

Service

There are no serviceable parts on the IMRT Phantom.

Bibliography

1. "A protocol for the determination of absorbed dose from high energy photon and electron beam." TG21 Med. Phys 10:(6) 741-771 (1983)

Table 1 courtesy of John Kordomenous, Ph.D., Advanced Radiotherapy Consulting, South Bend, IN.

Notice: *We welcome your evaluation of this manual. Your comments and suggestions help us improve our publications.*

Parts and Accessories List

70608	TLD/Diode/MOSFET Phantom Slab
50062	Additional Acrylic Phantom Slab
30613	Additional Solid Acrylic Plugs
Custom	Custom cavity drilled in 30613 for any Ion Chamber
70611	Exradin A1/A14 plug
70615	Exradin A1SL/A14SL plug
70612	Exradin A12 plug
70614	PTW 3000 series plug
92705	A1 Exradin Miniature Shonka Thimble Chamber, 0.056 cc
92722	A1 Exradin Slim Line Miniature Shonka Thimble Chamber, 0.056 cc
92711	A14 Exradin MicroChamber, 0.009cc
92723	A14 Exradin Slim Line MicroChamber, 0.009cc
92700	A12 Exradin Waterproof Farmer Type Chamber, 0.6 cc

Customer Responsibility

This product and its components will perform properly and reliably only when operated and maintained in accordance with the instructions contained in this manual and accompanying labels. A defective device should not be used. Parts which may be broken or missing or are clearly worn, distorted or contaminated should be replaced immediately with genuine replacement parts manufactured by or made available from Standard Imaging Inc.

Caution: Federal law in the U.S.A. and Canada restricts the sale, distribution or use of this device to, by or on the order of a licensed medical practitioner. The use of this device should be restricted to the supervision of a qualified medical physicist. Measurement of high activity radioactive sources is potentially hazardous and should be performed by qualified personnel.

Should repair or replacement of this device become necessary after the warranty period, the customer should seek advice from Standard Imaging Inc. prior to such repair or replacement. If this device is in need of repair, it should not be used until all repairs have been made and the product is functioning properly and ready for use. After repair, the chamber may need to be calibrated. The owner of this device has sole responsibility for any malfunction resulting from abuse, improper use or maintenance, or repair by anyone other than Standard Imaging Inc.

Warranty

Standard Imaging, Inc. sells this product under the warranty herein set forth. The warranty is extended only to the buyer purchasing the product directly from Standard Imaging, Inc. or as a new product from an authorized dealer or distributor of Standard Imaging, Inc.

For a period of twenty-four (24) months for well chambers and twelve (12) months for all other Standard Imaging, Inc. products from the date of original delivery to the purchaser or a distributor, this product is warranted against functional defects in materials and workmanship, provided it is properly operated under conditions of normal use, and that repairs and replacements are made in accordance herewith. The foregoing warranty shall not apply if the product has been dissembled, altered or repaired other than by Standard Imaging, Inc. or if the product has been subject to abuse, misuse, negligence or accident.

Standard Imaging's sole and exclusive obligation and the purchaser's sole and exclusive remedy under the above warranties are limited to repairing or replacing free of charge, at Standard Imaging's option, a product: (1) which contains a defect covered by the above warranties; (2) which are reported to Standard Imaging, Inc. not later than seven (7) days after the expiration date of the 12 or 24 month warranty period; (3) which are returned to Standard Imaging promptly after discovery of the defect; and (4) which are found to be defective upon Standard Imaging's examination. Transportation charges are the buyer's responsibility. This warranty extends to every part of the product except fuses, batteries, or glass breakage. Standard Imaging, Inc. shall not be otherwise liable for any damages, including but not limited to, incidental damages, consequential damages, or special damages. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

This warranty is in lieu of all other warranties, express or implied, whether statutory or otherwise, including any implied warranty of fitness for a particular purpose. In no event shall Standard Imaging, Inc. be liable for any incidental or consequential damages resulting from the use, misuse or abuse of the product or caused by any defect, failure or malfunction of the product, whether a claim of such damages is based upon the warranty, contract, negligence, or otherwise.

This warranty represents the current standard warranty of Standard Imaging, Inc. Please refer to the labeling or instruction manual of your Standard Imaging, Inc. product for any warranty conditions unique to the product.

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