

RPC Lung Phantom

3D CRT / IMRT

Guidelines for *Planning and Irradiating* the RPC Lung Phantom.

Revised October 2013

The purpose of this test is to confirm that the dose distribution planned by each institution complies for the most part with the protocol and can be delivered by that institution.

The RPC requests that each institution keep the phantom for no more than 2 weeks. During this two-week period, the institution will image, plan, and irradiate the phantom and return it to the Radiological Physics Center (RPC). Thank you for your cooperation with this constraint.

This phantom has been designed and constructed by the RPC. The RPC phantom contains an imaging and dosimetric insert. The insert, which is part of the left lung, contains a centrally located GTV (3 cm x 5 cm). There are three orthogonal sheets of radiochromic film passing through the center of the target and two TLD capsules within 0.5 cm of the center of the target. The phantom also contains normal structures: the right lung, the heart, with one TLD capsule in its center, and the spinal cord, with one TLD in its center.

If you have any questions, please contact the appropriate person.

Billing : MDADL Staff (713) 792-3233 mdadl@mdanderson.org

Technical questions: Trang Nguyen (713) 745-8989 trangnguyen@mdanderson.org

Technical questions: Paola Alvarez (713) 745-8989 palvarez@mdanderson.org

DOSIMETRY INFORMATION TO BE SUBMITTED:

The following information is to be submitted to the RPC (include in the phantom shipping box):

- Original hard-copy of the plan and isodose distributions with correction for tissue heterogeneity in the sagittal, axial and coronal planes through the center of the target volume. Please ensure that each plane fills an entire page and that a scale is printed on the page.
- A completed **RPC Lung Phantom Institution Information** form.

The following information is to be submitted to the RPC:

Please follow the login URL:

<https://mdandersonorg.sharefile.com>

and the log in information below to submit the digital treatment planning data in DICOM format which include all CT slices with 3D composite dose, structure and plan file

Username: trangnguyen@mdanderson.org

Password: Phantom8989

- To create a new folder, select the **Add Folder** tab on the top right hand side of the screen. In the **folder name** box, enter your institution name, city and state then click **Create Folder**.
- Select the folder that you have created, then select **Upload Files** tab on the right hand side. Follow the instruction and upload your file.
- Please log out once you finish and inform the RPC by email trangnguyen@mdanderson.org.

DOSE PRESCRIPTION:

Only photon beams with nominal accelerating potential between 4 and 10 MV are allowed.

When static beams are used, a minimum of 7 non-opposing beams should be used. For arc rotation techniques, a minimum of 340 degrees should be utilized.

The prescribed dose to the phantom is 6 Gy. It should be delivered in 1 fraction with the following constraints:

- PTV:
 - CTV = GTV. PTV = GTV + 0.5 cm in axial plane + 1 cm in longitudinal plane.
 - Prescribed dose of 6 Gy to at least 95% of the PTV
 - Minimum dose of 5.4 Gy to at least 99% of the PTV,

- Hotspots must be manipulated to occur only within the PTV,
- Critical Normal Structures (spinal cord, heart, lungs):
 - Constraints over the normal structures are specified in the following table

Normal structure	Volume	Dose
Spinal Cord	Any point	≤ 5.0 Gy
Heart	< 33% total vol. < 66% total vol. < 100% total vol.	≤ 6.0 Gy ≤ 4.5 Gy ≤ 4.0 Gy
Whole Lung (Right & Left)	< 37% total vol.	< 2.0 Gy

IRRADIATING THE PHANTOM

- Material included in box for the phantom:
Lung Phantom, with 3 set of TLD capsules taped to the shell (2 on left side, 2 on right side and 2 on anterior side)
Dosimetric/Imaging insert
Rubber hose
Two acrylic cylinders containing TLD in one of the ends,
Motor driver
Motor to platform linkage
2D Reciprocating platform
Envelope with background film and TLD (hidden from your view; please don't try to find it)
Traditional RPC TLD block and irradiation table.
(Please irradiate this at the time you irradiate the phantom.)
- Material included in box for the reciprocating platform (If needed by institution):
Motor driver
Motor to platform linkage
2D Reciprocating platform

If reciprocating platform is not used, avoid procedures 7, 8, 10, 18, 20, 24

Procedures:

- Fill the phantom with water:
 - Thread the rubber hose into the filler hole placed on the base of the phantom.
 - Fill slowly with water (the rubber hose stretches over most faucets). There is a breathing hole on the phantom, make sure it is open, to allow the pressure to release. You may need to jiggle the phantom to release air trapped inside the cavity.
 - Remove hose and replace acrylic screw.
- Allow the phantom to sit with water in it for 10 min. to check for leaks.
- Look in the insert space and check for water leakage. If you find any water call the RPC. If not, proceed to the next step.
- Position the insert. Make sure that the insert is in its correct position by making small rotations of the insert around its central axis. When it is in the correct position it will **lock** in place by an indentation at the base of the insert.
- Position the acrylic cylinder labeled "spinal cord cylinder" in the hole labeled "spinal cord". You will see a TLD capsule in the cavity closed with a screw. The end with the TLD should be inserted first.
- Position the acrylic cylinder labeled "heart cylinder" in the hole labeled "heart". You will see a TLD capsule in the cavity closed with a screw. The end with the TLD should be inserted first.
- Assemble the 2D reciprocating platform and motor drive system per the attached instructions. Do this on the CT couch so that the phantom and the platform can be imaged.
- The motor driver for the platform will have been programmed to simulate the manner in which your institution instructs its patients to breathe during the 4D CT.
- Position and CT the phantom as you would a patient. **You may wish to scan with 1.5 mm slices especially near the target to better identify the TLD capsules.** NOTE: There are TLD on the external shell of the phantom to give us an estimate of the CT dose to the target.
- Turn on the motor drive and acquire your CT images for treatment planning. Turn off motor driver once CT process is completed. Disassemble the reciprocating platform.
- Remove insert from the phantom during planning process. Store insert in a dry place. **REMOVE WATER FROM PHANTOM.** Store insert and phantom where they will not be irradiate.
- Segment the phantom images contouring the skin, lungs, heart, spinal cord and PTV. Note that the CTV = GTV. PTV = GTV + 0.5 cm in axial plane + 1 cm in longitudinal plane. Also contour all the 4 TLD volumes. Please use the following names for these contours:
 - PTV_TLD_sup for the superior TLD in the target,
 - PTV_TLD_inf for the inferior TLD in the target,
 - HEART_TLD for TLD in the heart
 - CORD_TLD for the TLD in the spinal cord
 - The dimensions of the TLD volume are approximately 10 mm long by 2 mm diameter
 - The outside dimensions of the TLD capsules are 15 mm long by 4 mm diameter; the TLD axis is normal to the axial plane. (The capsules and the TLD should be visible on CT image)
- Plan the treatment as specified in the DOSE PRESCRIPTION above.
- Repeat steps 1 and 2.
- Look in the insert space and check for water leakage. If you find any water call the RPC. If not, follow the instructions in step 5 to position the insert again and proceed to the next step.
- Perform your customary QA of the plan prior to irradiating the phantom.
- Irradiate the RPC TLD block according to the instructions provided.
- Assemble the 2D reciprocating platform and motor drive system per the attached instructions. Do this on the treatment machine couch so that the phantom and the platform can be irradiated.
- Position the phantom as you would a protocol patient. Try to avoid positioning the axial film at the abutment of adjacent MLC leaves or adjacent arcs. Abutting fields or leaves on the film may increase the uncertainty of the measurement.
- Turn on the motor drive.
- Perform all the verification needed to confirm the final position of the phantom.

22. **REMOVE THE TLD CAPSULES LOCATED ON THE EXTERNAL SHELL.** Put them into the designated container.
23. Irradiate the phantom with the developed plan.
24. Turn off the motor drive and put each part of the motion table into its shipping box.
25. Remove the insert and place it in the box.
26. Remove the acrylic cylinders from holes and place them in the box.
27. Please verify that there is no water in the insert space. If you find any water call the RPC.
28. Remove the screw on the base of the phantom and drain the water from the phantom.
29. Put the empty phantom in the box.
30. Make sure that the container with the external TLD's and the rubber hose are in the box.
31. Include the dosimetry data discussed above. Complete the attached forms. Be sure to include the scale used on the images coming from your TPS.
32. Return the complete package to the RPC.

RPC Lung Phantom Institution Information

(Original to RPC)

Institution: _____

Address: _____

Person performing irradiation: _____

Person to receive report: _____

Oncologist to receive report: _____

Person to call in case of questions: _____

Phone Number: _____ Fax Number: _____

Email address: _____

Treatment Unit:

Manufacturer: _____ Model: _____

In-house specification: _____ Serial Number: _____

Photon Energy Nom _____ (MV) IR (TMR 20/TMR 10): _____ %dd(10)_x _____

Technique used: 3D-CRT: _____ IMRT: _____

If IMRT, Intensity Modulation Device:

___ MIMIC ___ Multileaf Collimator ___ Solid Attenuator Modulation

If IMRT, IMRT Technique:

☐ Segmental (step and shoot) MLC ☐ Dynamic MLC ☐ Intensity Modulated Arc Therapy (IMAT)

☐ Rapid Arc ☐ TomoTherapy ☐ VMAT Other: _____

Please enclose original copies of your treatment plans. Include the coronal, axial and sagittal planes through the target center. Include scaling factors for each plane. FTP the digital treatment planning data.

Treatment Planning System:

Manufacturer: _____ Model: _____

Software: _____ Version Number: _____

Algorithm used for dose calculation: _____

Total number of MU's: _____ Total number of segments: _____

Method to Account for Respiratory Induced Target Motion(If applicable):

Please describe your method:

Please enclose original copies of your treatment plans. Include the coronal, axial and sagittal planes through the target center. Include scaling factors for each plane. FTP the digital treatment planning data.

Treatment of Phantom:

Date of Irradiation: _____

Dose specified is to: ☐ Muscle ☐ Water

Indicate the dose delivered to the TLD as determined by your treatment planning computer

TLD	Mean Dose (Gy)	Min. Dose (Gy)	Max. Dose (Gy)
PTV_TLD_sup			
PTV_TLD_inf			
HEART_TLD			
CORD_TLD			

Results of the QA: _____

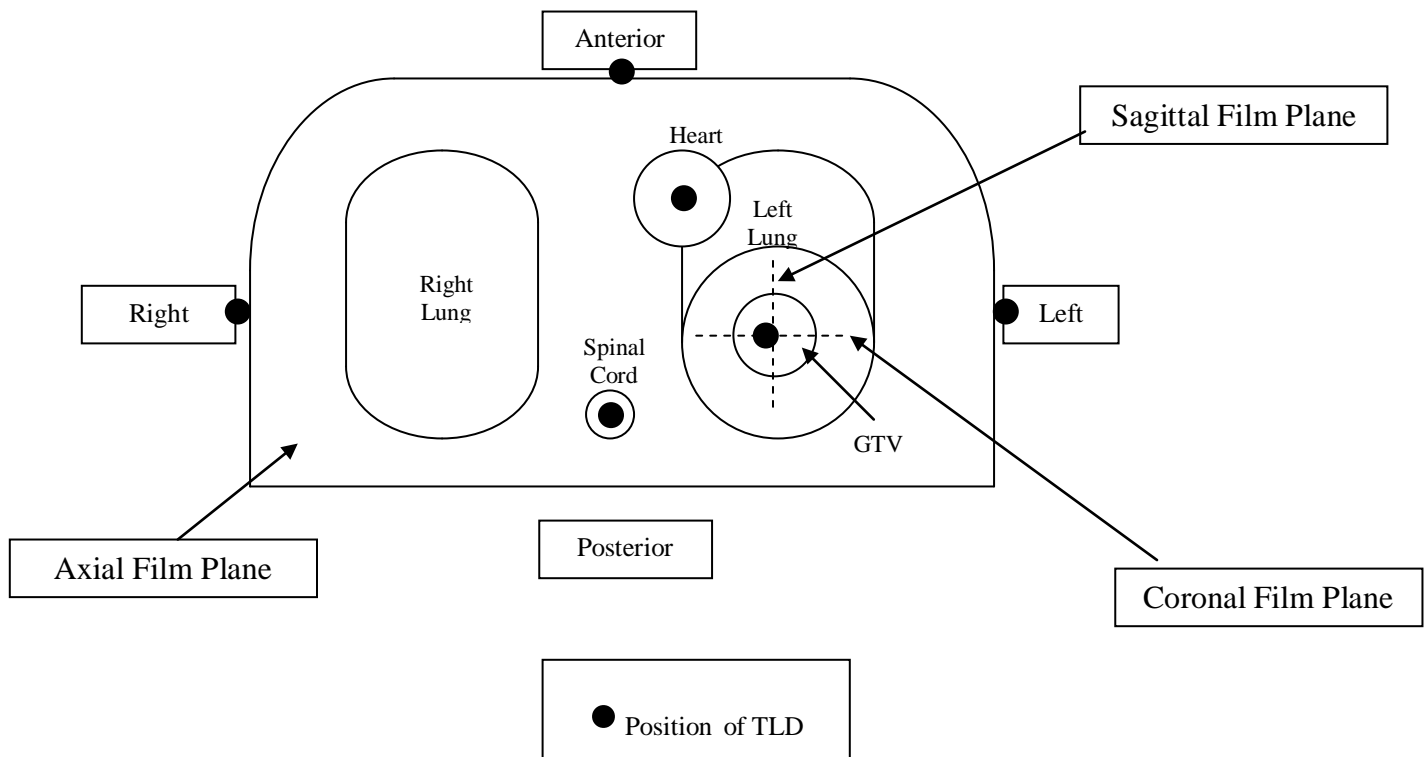
Did you adjust the MU based on these results?_____If so, how much?_____

Attach copies of the treatment plan including slices in the sagittal, axial and coronal film planes.

Comments: _____

For Office Use Only	TLD Batch B11	Film Batch EBT2 07301301	Phantom ID # L-	Code	Date Sent	Date Rec'd QA
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This is a cross sectional view of the phantom.



Note: Please ignore all markings on the external shell of the phantom, use your own system to position the phantom and remove when done.

Note:

1. You need to deliver 6.0 Gy to the PTV in 1 fraction. Total dose to the PTV 6.0 Gy
2. If utilizing reciprocating platform, please take it into account during planning.

*Good Luck from the
Phantom team @ RPC*