

# IMRT QUESTIONNAIRE & BENCHMARK

Institution: _____	Date: ____/____/____
Physicist: _____	e-mail: _____
Address: _____	
_____	
_____	
Telephone: _____	Fax: _____
Responsible Radiation Oncologist(s) _____	
Telephone: _____	e-mail: _____

This questionnaire and benchmark have been accepted by all of the NCI funded cooperative groups and Quality Assurance Offices as a minimum standard for an institution to be credentialed for use of IMRT in clinical trials. The benchmark is not site specific, i.e. it applies to IMRT treatment of all disease sites. The benchmark should be submitted to the appropriate Quality Assurance office, i.e. Quality Assurance Review Center ([www.QARC.org](http://www.QARC.org)), Radiation Therapy Oncology Group ([www.RTOG.org](http://www.RTOG.org)), or Radiological Physics Center (<http://rpc.mdanderson.org/rpc>).

Some cooperative groups may require that a specially designed phantom be planned and irradiated using IMRT as a part of the IMRT credentialing requirement for some or all of their IMRT protocols. For such cases the RPC has developed anthropomorphic (or geometric) phantoms to meet the specific requirements of the protocol. Institutions that have satisfactorily completed IMRT credentialing with an RPC phantom will not be required to complete this benchmark. Information concerning the RPC phantoms may be obtained from the RPC.

1. a. What treatment machine(s) do you use for IMRT treatments? \_\_\_\_\_

b. Photon energy(s)? \_\_\_\_\_

2 a. What form of IMRT do you use?

SMLC (step and shoot)

DMLC (sliding window)

Serial tomotherapy (MIMiC)

other \_\_\_\_\_

b. MLC/device used to deliver IMRT: vendor \_\_\_\_\_

\_\_\_\_\_ (#) leaves with \_\_\_\_\_ cm leaf width at isocenter

\_\_\_\_\_ Nomos MIMiC in \_\_\_\_\_ 1cm mode \_\_\_\_\_ 2cm mode

Other : \_\_\_\_\_

3. What is your IMRT planning system? \_\_\_\_\_ Version No. \_\_\_\_\_

4. Is your treatment planning system capable of transferring a patient's beams to a QA phantom for verification purposes?  yes  no

If no, how do you verify the dose distribution \_\_\_\_\_

---

---

---

5. What sites do you treat with IMRT?

head and neck

prostate

other (please specify) \_\_\_\_\_

6. If you treat head and neck (H&N) patients with IMRT:

a. The total number of H&N patients treated with IMRT at your institution is \_\_\_\_\_

b. Number of H&N patients treated with IMRT in the past 12 months at your institution \_\_\_\_\_

c. The usual fraction size is \_\_\_\_\_ cGy

d. The usual number of fractions is \_\_\_\_\_

e. How are your H&N patients immobilized for IMRT?

head-cup and mask

talon

foam-immobilization mold and mask

other \_\_\_\_\_

A bite block is routinely used  yes  no

f. What PTV margins do you usually use for H&N IMRT patients? \_\_\_\_\_mm

g. To what isodose line are IMRT treatments for H&N patients commonly prescribed (relative to maximum dose)?

95%

90%

85%

80%

other \_\_\_\_\_

h. How do you verify field positioning relative to the patient's anatomy?

orthogonal films

beam films using a jaw setting that encloses all segments

other (please be specific) \_\_\_\_\_

---

---

---

i. How frequently is position verification performed for H&N patients?

first treatment only

weekly

other \_\_\_\_\_

j. How do you verify that the field intensity patterns are delivered as planned?

7. If you treat prostate patients with IMRT:

a. The total number of prostate patients treated with IMRT at your institution is \_\_\_\_\_

b. Number of prostate patients treated with IMRT at your institution in past 12 months is \_\_\_\_\_

c. The usual fraction size is \_\_\_\_\_ cGy

d. The usual number of fractions is \_\_\_\_\_

e. How are your prostate patients immobilized for IMRT?

knee sponge only

thermoplastic cast

knee sponge and foot holder

foam-immobilization mold

other \_\_\_\_\_

f. What PTV margins do you usually use for prostate patients? \_\_\_\_\_mm

g. To what isodose line are IMRT treatments for prostate patients commonly prescribed (relative to maximum dose)?

95%

90%

85%

80%

other \_\_\_\_\_

h. How do you verify field positioning relative to the patient's anatomy?

orthogonal films

beam films using a jaw setting that encloses all segments

other (please be specific) \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

i. How frequently is position verification performed for prostate patients?

first treatment only

weekly

other \_\_\_\_\_

j. How do you verify that the field intensity patterns are delivered as planned?

8. Other than prostate or H&N, what site do you most commonly treat with IMRT? \_\_\_\_\_

\_\_\_\_\_

a. The total number of patients treated to this site with IMRT at your institution is \_\_\_\_\_

b. The number of these patients treated with IMRT at your institution in past 12 months is \_\_\_\_\_

c. The usual fraction size is \_\_\_\_\_ cGy

d. The usual number of fractions is \_\_\_\_\_

e. How are patients immobilized for these treatments? \_\_\_\_\_  
\_\_\_\_\_

f. What PTV margins do you usually use for this site? \_\_\_\_\_ mm

g. To what isodose line are IMRT treatments for these patients commonly prescribed (relative to maximum dose)?

95%       90%       85%       80%       other \_\_\_\_\_  
\_\_\_\_\_

h. How do you verify field positioning relative to the patient's anatomy?

orthogonal films

beam films using a jaw setting that encloses all segments

other (please be specific) \_\_\_\_\_  
\_\_\_\_\_

i. How frequently is position verification performed for these patients?

first treatment only       weekly       other \_\_\_\_\_

j. How do you verify that the field intensity patterns are delivered as planned?

9. How do you verify that the treatment unit delivers the planned dose for individual patients?

a. Absolute dose

point(s) measurement with

ion chamber (chamber size \_\_\_\_\_ )

diode

TLD

XV film

EDR2 film

radiochromic film

Other: \_\_\_\_\_

b. Relative dose

isodose distribution with

XV film

EDR2 film

radiochromic film

Gel dosimetry

other \_\_\_\_\_

in \_\_\_\_\_ (#) axial planes

& in \_\_\_\_\_ (#) sagittal planes

& in \_\_\_\_\_ (#) coronal planes

c. Type of QA phantom:

anthropomorphic phantom Vendor: \_\_\_\_\_

geometric phantom: \_\_\_\_\_(material)

shape:  square  cylinder  other \_\_\_\_\_

size of phantom \_\_\_\_\_cm X \_\_\_\_\_cm X \_\_\_\_\_cm

d. For this measurement

the patient's beams are transferred to the QA phantom by the planning system.

the patient's beams are not transferred to the QA phantom in software, but an anthropomorphic phantom is used to simulate approximate patient geometry for dose measurements.

e. What agreement between planned and measured doses for individual patients is considered acceptable at your institution?

For absolute dose in target volume (high dose) region \_\_\_\_\_

For absolute dose in critical normal tissue region \_\_\_\_\_

For absolute dose in low dose region \_\_\_\_\_

For relative dose in high dose gradient region \_\_\_\_\_

For relative dose in low dose gradient region

in high dose region (target) \_\_\_\_\_

in low dose region \_\_\_\_\_

f. Are your monitor unit calculations checked by an independent program?

no  yes Vendor: \_\_\_\_\_

10. Are your IMRT treatments monitored by a record and verify system?

no  yes What system? \_\_\_\_\_

11. Treatment Machine Calibration

a. Calibration Protocol:  TG-21  TG-51 Other: \_\_\_\_\_

Frequency of calibration checks: \_\_\_\_\_

- b. RTOG institutions and institutions choosing to satisfy the benchmark requirement with an RPC phantom should submit the following items for all treatment machines/photon energies used for IMRT:
  - 1. A description of the procedures followed to verify the calibration of the treatment machine.
  - 2. Calibration report worksheet (TG-21/TG-51 or equivalent).
  - 3. Central axis depth dose information: table of TPR's, TMR's, TAR's, or percentage depth dose and output data used for clinical meter set calculations.

## IMRT BENCHMARK

An institution may become credentialed to use IMRT in clinical trials by either successfully completing this IMRT benchmark or by successfully completing an IMRT phantom irradiation. Unless a phantom measurement credentialing process is required by a specific protocol or by the NCI, the successful completion of the IMRT benchmark has been accepted by all of the NCI funded cooperative groups and Quality Assurance Offices as a minimum standard for an institution to be credentialed for use of IMRT in clinical trials. The benchmark is not site specific, i.e. it applies to IMRT treatment of all disease sites. If an institution successfully irradiates the IMRT Head and Neck phantom, this successful irradiation will satisfy the IMRT benchmark requirement. Guidelines for the RPC phantom credentialing process can be obtained from the RPC website (<http://rpc.mdanderson.org>).

This benchmark is not applicable to Cyberknife units. Cyberknife users must complete the head and neck phantom irradiation.

Whichever credentialing pathway an institution chooses, i.e. the RPC phantom irradiation or this benchmark, the institution must complete the credentialing process following the chosen pathway. Institutions unable to pass the RPC phantom test will not be considered for credentialing using the benchmark; likewise institutions unable to pass the benchmark test will not be considered for credentialing with the RPC phantom.

Once you have been credentialed for IMRT, your institution will not need to repeat the credentialing steps unless there is a change in IMRT planning system (not version number) or delivery technique (such as dynamic arc or tomotherapy) or a protocol specifically requires additional IMRT credentialing. If there is any question about your credentialing status the institution should contact the appropriate quality assurance office. See Table 1.

When completed, this benchmark should be submitted to the appropriate Quality Assurance office, i.e. Quality Assurance Review Center (<http://www.QARC.org>), or Radiological Physics Center (<http://rpc.mdanderson.org>) for review (see Table 1).

	Submit Benchmark to	
	QARC	RPC
Group members	COG	RTOG
	ECOG	NSABP
	SWOG	NCCTG
	ACOSOG	GOG
	CALGB	
	PBTC	

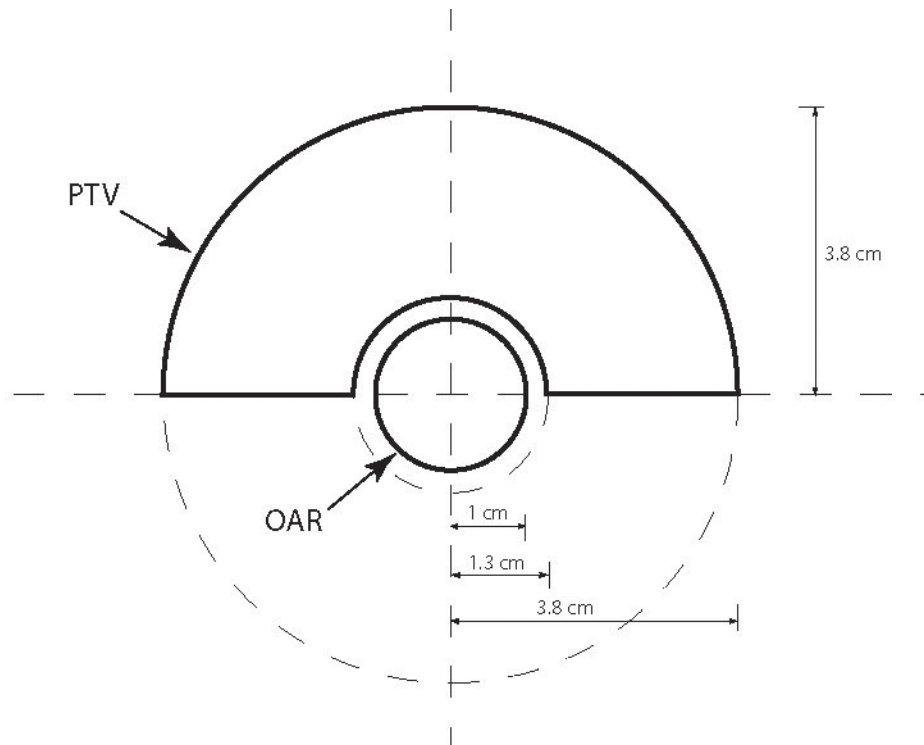
Table 1. Benchmark submission route for members of each of the cooperative study groups.



**BENCHMARK CASE:****Patient Data Selection:**

For the IMRT benchmark case, a planning CT scan in the head region or in the pelvic region from your institution shall be used. The image data set shall extend at least 10 cm superiorly/inferiorly with slice thickness no greater than 3 mm. The geometry of the target volume (PTV) and the organ at risk (OAR) is described below and shown in figure 1. The benchmark case must be planned with a planning system that is capable of transferring a patient's beams to a QA phantom. In addition to the treatment planning exercise, measurements with the QA phantom are required. If your planning system does not have this capability, contact the appropriate QA office for guidance (see Table 1).

The geometry of the target volume (PTV) and organ at risk (OAR) is shown below. The primary organ at risk (OAR) is a central (midplane) cylinder 2.0 cm in diameter which extends at least 5 cm caudad/cephalad. The planning target volume (PTV) to be treated is a half annulus 2.5 cm wide that has the same center as the OAR and surrounds the cylinder by 180 degrees. It too shall extend at least 5 cm caudad/cephalad. There shall be a 3 mm separation of the PTV and OAR. In other words, the annulus has an inner radius of 1.3 cm and an outer radius of 3.8 cm.



For “step and shoot” and “sliding window” techniques the treatment plan shall consist of beams from at least 4 and not more than 9 gantry angles. Tomotherapy and other dynamic arc treatments (e.g. RapidArc and VMAT) shall be delivered in the usual clinical manner. All beams shall be coplanar in the plane of the axial slices; i.e. the patient’s longitudinal axis must be parallel to the gantry’s rotational axis.

### **Desired Dose Distribution:**

The aim of the plan is to deliver the prescribed dose of 200 cGy per fraction to 100% of the PTV and not more than 120 cGy (60% of the prescribed dose) to 5% of the organ at risk (OAR). The constraint on the organ at risk has priority over the target volume coverage. That is, the constraint of no more than 60% of the prescribed dose to 5% of the OAR *shall* be achieved. To accomplish the OAR constraint, target volume (PTV) coverage may be sacrificed slightly, if necessary, as long as the acceptability criteria below are satisfied. The maximum dose to any point within the irradiated volume should be no more than 120% of the prescribed dose. The constraint on maximum dose is also of lower priority than the constraint on the organ at risk and so may be sacrificed slightly if necessary provided that the point of maximum dose is within the PTV.

### **Dose Calculations:**

Dose distributions shall be calculated on every axial slice through the PTV and OAR. Isodose distributions shall be in absolute dose. Dose volume histograms for the PTV and the OAR shall be calculated. In addition, a DVH for “unspecified tissue” shall be calculated. Unspecified tissue is defined as tissue contained within the skin, but which is not otherwise contained within delineated structures.

An IMRT benchmark will be judged to be acceptable if it satisfies the following criteria:

1. 95% of the PTV must receive at least 95% of the prescribed dose (i.e.190 cGy).
2. No more than 5% of the PTV shall receive a dose greater than 115% (230 cGy) of the prescribed dose.
3. No more than 5% of the OAR shall receive greater than 60% (120 cGy) of the prescribed dose.

### **Dose Verification:**

The absolute dose and dose distribution shall be verified by the institution by transferring the calculated dose distribution to the institution’s QA phantom. The geometry of the QA verification delivery shall be the same geometry that is used clinically for patient IMRT QA. Similarly, the decision to measure and analyze fields individually or cumulatively shall be determined by the institution’s usual practice for routine patient QA. The dose distribution in the QA phantom shall be measured in at least one plane. The measured plane(s) shall correspond to plane(s) calculated in the planning software.

**Material to be Submitted:**

**Institutions must submit the IMRT plan electronically in DICOM RT or RTOG format (by sFTP or on CD). For QARC submissions, instructions can be found on the QARC website ([www.QARC.org](http://www.QARC.org)). For RPC submissions, instructions may be found on the ATC website (<http://atc.wustl.edu/>). If digital submission is not possible, please contact the appropriate QA center.**

**Verification Dosimetry**

1. Measured isodose distributions, on the same scale and displaying the same values as the calculated dose distributions for the verification geometry, shall be provided, preferably overlaid. Identification of the QA phantom plane and correspondence of the measured dose distribution with the calculated dose distribution must be explicit.
2. A complete description of the equipment used to measure the dose (e.g. diode array, ion chamber array, film) and the method, including software, used to compare the calculated with the measured isodose distributions must be included.
3. A detailed description of your verification procedures for absolute dose, including your acceptance criteria, must be submitted. Measurements performed with an absolute dosimeter shall be described in detail and the results for this case reported.

*Please return completed forms and supporting documents to the appropriate QA office:*

Physics Division  
**Quality Assurance Review Center**  
272 West Exchange Street, Suite 101  
Providence, RI 02903-1025  
Phone: (401) 454-4301  
FAX: (401) 454-4683  
Email: [Physics@QARC.org](mailto:Physics@QARC.org)

**Radiological Physics Center**  
8060 El Rio St.  
Houston, TX 77054  
Phone: (713)745-8989  
FAX: (713) 794-1364  
Email: [RPC@mdanderson.org](mailto:RPC@mdanderson.org)