ACR–AAPM TECHNICAL STANDARD FOR THE PERFORMANCE OF RADIATION ONCOLOGY PHYSICS FOR EXTERNAL-BEAM THERAPY

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care[1]. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the practitioner considering all the circumstances presented. Thus, an approach that differs from the guidance in this document, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in this document when, in the reasonable judgment of the practitioner, such course of action is indicated by variables such as the condition of the patient, limitations of available resources, or advances in knowledge or technology after publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document may consider documenting in the patient record information sufficient to explain the approach taken.

The practice of medicine involves the science, and the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to the guidance in this document will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The purpose of this document is to assist practitioners in achieving this objective.

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1 *Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, 831 N.W.2d 826 (Iowa 2013) Iowa Supreme Court refuses to find that the "ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures (Revised 2008)" sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.*

I. INTRODUCTION

This technical standard was revised collaboratively by the American College of Radiology (ACR) and the American Association of Physicists in Medicine (AAPM).

The success of treatment in radiation oncology depends on several factors, including delivery accuracy of absorbed doses to selected targets in both tumors and normal tissues. Because the practice of radiation oncology physics occurs in a variety of settings, the judgment of the Qualified Medical Physicist should be used to apply these standards to individual practices.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

Qualified Medical Physicist

A Qualified Medical Physicist is an individual who is competent to practice independently one or more of the subfields in medical physics. The American College of Radiology (ACR) considers certification, continuing education, and experience in the appropriate subfield(s) to demonstrate that an individual is competent to practice one or more of the subfields in medical physics and to be a Qualified Medical Physicist. The ACR strongly recommends that the individual be certified in the appropriate subfields by the American Board of Radiology (ABR), the Canadian College of Physics in Medicine, or by the American Board of Medical Physics (ABMP).

A Qualified Medical Physicist should meet the ACR Practice Guideline for Continuing Medical Education (CME). (ACR Resolution 17, 1996 – revised in 2012, Resolution 42) [1]

The appropriate subfield of medical physics for this standard is Therapeutic Medical Physics (including medical physics certification categories of Radiological Physics, Therapeutic Radiological Physics, and Radiation Oncology Physics).

In addition, the Qualified Medical Physicist must meet any qualifications imposed by the state and/or local radiation control agency to practice radiation oncology physics and/or to provide oversight of the establishment and conduct of the physics quality management program.

In addition to the language above, this technical standard pertains to 1) therapeutic applications of x-rays, gamma rays, and electrons; 2) the equipment associated with their production, use, measurement, and evaluation; 3) the quality of information and images resulting from their productions and use; and 4) the associated patient and personnel radiation safety issues.

In addition, a Qualified Medical Physicist must hold a professional medical physics license where required and should uphold the AAPM Code of Ethics (AAPM Professional Policy 24-D) [2].

For further information on credentialing, accountability, authority, and professional development, see the ACR's Guide to Professional Practice of Clinical Medical Physics [3].

III. RESPONSIBLITIES OF PERSONNEL

A. Responsibilities

Qualified Medical Physicists are engaged in the design, optimization, technical evaluation, and delivery of radiotherapy treatment plans. Qualified Medical Physicists are the only individuals qualified to perform and oversee the calibration of therapeutic radiation delivery systems (eg, linear accelerators). They are also responsible for radiation protection of patients and staff. Their role may include clinical, research, educational, and administrative duties. The responsibilities of the Qualified Medical Physicist must be recognized and supported by the medical director and as per AAPM Professional Policy 17 [4].

The Qualified Medical Physicist must participate in the specification, selection, acceptance, and commissioning of radiation-producing machines, accessories, and computerized treatment-planning systems. The Qualified Medical Physicist should also supervise arrangements for proper maintenance of this equipment and work with the manufacturer/agent to facilitate repairs. After repair, if necessary, the Qualified Medical Physicist will supervise any required tests after the repair of the equipment to ensure the proper performance of the treatment unit. The Qualified Medical Physicist will periodically evaluate all systems for continued utility, appropriateness, reliable performance, and condition and will make recommendations on a practical life span, obsolescence, and replacement.

B. Personnel Requirements

A Qualified Medical Physicist must be available for each institution that uses therapeutic equipment. The Qualified Medical Physicist is typically on site when treatments are delivered and must be physically present for special external beam techniques. For further guidance, see the Radiation Oncology Practice Accreditation program requirements [5]. The number of Qualified Medical Physicists and support personnel must be appropriate for the types, levels of complexity, and volume of the external-beam services offered [6]. External-beam physics services generally include calibration of the radiation beams, safe and appropriate operation of the treatment units, continuing quality assurance, and medical physics support

(dosimetry, special physics consults etc) for the radiation oncologist when needed. This clinical support includes patient-specific dose measurements (if requested), monitoring of the custom block fabrication process or appropriate use of multileaf collimation (MLC), and responsibility for the technical accuracy of the computerized treatment plans, including patient data acquisition. Special external-beam treatment techniques require additional physics support at a level higher than that required for routine external-beam therapy.

Staffing requirements are required to provide services outside the scope of this standard, including brachytherapy, radiation safety, research, administration, and education and training programs [1,7]. Trainees with medical physics responsibilities must be supervised and their work reviewed by a Qualified Medical Physicist or their designee [7,8].

Commissioning of modern therapy systems is a critically important, time-consuming process. The technological complexity of modern systems requires a well-designed and carefully implemented series of steps for data collection, analysis, computer modeling, and validation on the specific system as installed. The Qualified Medical Physicist must determine the scope of work to be performed consistent with the clinical scope of service in the practice and the appropriate timeline for the work to ensure that all quality and safety aspects are afforded sufficient focus. In the event that the commissioning is performed by a physicist or physics group other than the institution medical physics staff, the institution's or on-site Qualified Medical Physicist must review the final results of the commissioning process and ensure they are in line with published commissioning standards. It is the responsibility of the institution's or on-site physicist to complete a subset of test to independently validate the results presented in the report. The Qualified Medical Physicist determines when the therapy system can commence clinical use and communicates to all clinical and administrative groups any possible limitations on the scope of use.

Physics support staff should be appropriately trained. Medical dosimetrists should be certified by the Medical Dosimetry Certification Board. In clinics where it is not always possible to have only certified dosimetrists, a Qualified Medical Physicist should provide appropriate supervision of uncertified dosimetrists. In-house therapy equipment service engineers and third-party service organizations should participate in the manufacturer's training program. Radiation therapists should either be certified in radiation therapy by the American Registry of Radiologic Technologists (ARRT) or be eligible for such certification.

Prior to the introduction of new treatment modalities, the systems administrator and the medical director should consult the Qualified Medical Physicist so that adjustments to staffing can be made for specialized procedures. Additionally, all staff who participate in the new treatment modality process, including physicians, dosimetrist, therapists, and physicists, should receive training/in-service prior to and at first use (proctoring) of clinical initiation. Documentation of this training is required. Issues related to several complex treatment techniques are dealt with in other technical standards and practice parameters [9-12].

IV. EQUIPMENT

The Qualified Medical Physicist must determine the need for, specify the requirements of, and have access to dosimetric and treatment-planning equipment including, but not limited to, the following:

1. Measurement instruments to calibrate all treatment equipment that includes, but is not limited to, the following:
    - Ionization chambers/electrometers used as local standards and/or used as field instruments.
    - Constancy check instruments, water-equivalent dosimetric phantoms, and other appropriate dosimetry equipment.
2. Computerized water-scanning systems with appropriate ionization chambers, diodes, and other measuring tools
3. Dosimetry quality assurance (QA) hardware and software, such as film densitometry systems or detector array systems
4. In vivo patient dose–measuring systems (eg, diodes, metal oxide silicon field effect transistors (MOSFET), thermoluminescence dosimeters (TLDs), or optically stimulated luminescence (OSL) dosimeters
5. Radiation protection measurement devices, such as appropriate survey meters and area monitors
6. Appropriate QA test tools for radiation therapy equipment, such as mechanical alignment tools, thermometers, and barometers

7. Imaging equipment QA tools [13,14]
8. Equipment to support special external-beam techniques (such as those listed in Section III.B)
9. Any additional equipment as needed to ensure that integration between devices is acceptable (ie, motion phantom for gated lung stereotactic body radiotherapy (SBRT)).

V. QUALITY MANAGEMENT PROGRAM

A. Introduction

Quality management (QM) in radiation oncology may be defined as those procedures that ensure a consistent and safe fulfillment of the dose prescription. The Qualified Medical Physicist is responsible for designing and implementing those aspects of the QM program that involve the use of the external-beam radiotherapy equipment. The Qualified Medical Physicist is also responsible for reviewing and approving the procedures followed by the radiation therapy and dosimetry staff in planning and delivering the prescribed dose.

QM of radiation therapy equipment is primarily an ongoing evaluation of functional performance characteristics. Accordingly, the Qualified Medical Physicist must develop, supervise, and implement effective hazard mitigation methods that encompass the QA of radiation therapy equipment [15,16]. The policy and procedure review may include the use of risk-based tools such as failure modes and effects analysis (FMEA) or a radiation oncology incident learning system (RO-ILs) [17-20].

B. General Protocol Outline

The goal of the QM program for external-beam radiation therapy equipment is to ensure that the performance characteristics defined by physical parameters and established during commissioning of the equipment remain within acceptable limits. Policies and procedures must be established by the Qualified Medical Physicist to verify that all equipment meets the manufacturer's specifications and to establish baseline performance values for new or refurbished equipment or for equipment following major repair. Once a baseline standard has been established, a protocol for periodic QA tests may be developed for monitoring the baseline performance values. The protocol for QA tests should recommend the equipment to be used, the frequency of measurement, techniques to be followed, suggested performance criteria, action levels, and routes of notification. QA test procedures should be able to measure parameter changes smaller than tolerance or action levels. The Qualified Medical Physicist should refer to the current AAPM guidelines and documents to develop their QM program [21].

A written summary of physics activities, along with the results of the evaluation, should be documented and presented to the medical director and senior institutional administrator annually. This written summary should be incorporated into the institution's overall QM program.

C. Specific Protocols

It is recommended that relevant AAPM Medical Physics Practice Guidelines, Task Group reports, and ACR–AAPM technical standards be used to determine the types of testing and procedures that should accompany commissioning and initialization of any new technique involved in the delivery of external-beam radiotherapy. Testing functionality and compatibility integration of multiple vendor components into the external-beam delivery pathway should be fully examined and tested prior to patient treatment.

1. Measurement equipment

   A program must be in place to ensure the accuracy and precision of measurement equipment used for calibration and constancy checks of treatment machines and instruments used for patient dosimetry. The program must have documented procedures for instrument calibration to ensure traceability to accredited calibration facilities and to affirm instrument precision and accuracy. Redundancy in dose calibration equipment is recommended to ensure that instruments are holding their calibration. This can be achieved by cross calibrations or the use of the appropriate long-lived radioactive source. It is recommended that both a local standard and a field dosimetry system be maintained and routinely compared.

2. Treatment machines

   Protocols for calibrating treatment machines must follow those protocols currently published by the AAPM and adhere to state and federal guidelines.

   After the treatment machine has been commissioned and prior to clinical use, an independent verification of the output of each photon and electron beam must be performed to verify that the treatment unit calibration is consistent with national standards. In subsequent years, there must be an independent check of each photon beam annually and each electron beam biennially or more frequently per regulatory requirements. The independent check must be performed by either:

   a. A Qualified Medical Physicist who did not perform the commissioning/annual output calibration, using a dosimetry system other than the one that was used during the commissioning/annual output calibration (this dosimetry system must also have calibration factors traceable to an accredited dosimetry calibration laboratory); or
   b. An independent dosimetry service designed to measure doses within an uncertainty of 5%.

3. Radiotherapy simulators and imaging equipment

   Procedures for establishing and maintaining the imaging equipment used in planning radiation therapy treatment planning (eg, computed tomography (CT), magnetic resonance (MR), positron emission tomography (PET), PET/CT scanners, and other radiography equipment) should be an integral part of a QM program. The Qualified Medical Physicist must be aware of the factors that affect image quality as well as the effect of image distortions on treatment planning. The medical physicist should ensure that those elements of imaging equipment quality control directly relevant to radiation oncology planning are carried out at an appropriate frequency and the measured CT dose index is within 20% of the displayed CT dose index [22].

   Every effort should be made to acquire patient data through digital imaging techniques. If deemed appropriate by the radiation oncologist, manual techniques may be used. All data used in the dose-distribution calculation and implementation process should be reviewed by a member of the physics staff for appropriateness prior to its use in computation. The spatial linearity (in 3 dimensions) of CT or other digital images used for planning should be verified by test imaging of appropriate phantoms having fixed fiducials and/or known external dimensions.

4. External-beam dose distributions and associated coordinate systems

   Independent systems involved in the treatment simulation, planning, and delivery process may have different image characteristics and coordinate systems. Faithful data transfer and coordinate translation must be achieved, and this process must be routinely tested. One method to test the data chain is via an end-to-end test, which may contain some or all of the following components:

   a. Simulation, including CT scanning of a dosimetry phantom
   b. Phantom image data transfer to the treatment-planning system
   c. Creation of a treatment plan with variables such as independent jaws, wedging, blocking, noncoplanar beams, or other techniques at the discretion of the medical physicist
   d. Calculation, monitor unit verification, and transfer of the plan to the record-and-verify system or treatment unit, in the custom of the clinic
   e. Treatment of the dosimetry phantom with dosimeter(s) in place
   f. Analysis of dose measured compared with that predicted by the planning system
   g. In each of the imaging systems (simulation and planning), a check of spatial fidelity, Hounsfield unit (HU) value, and beam geometry (size, source skin distance [SSD], etc) against nominal values
   h. Should MRI-based imaging methods be used in the treatment planning dose calculation, commissioning of the method into the external-beam treatment workflow should be documented and shown to have equivalent accuracy to CT-based dose calculation.
   i. Alternative methods of completely testing the image/data chain may be devised by the medical physicist.

5. Treatment-planning computer systems

The treatment-planning computer model must be verified using beam data measured under the supervision of the Qualified Medical Physicist on the same treatment unit for which the model will be applied for patient planning. Reference beam data provided by the manufacturer may be used if it is within acceptable agreement with the measured dataset as determined by the Qualified Medical Physicist. Treatment-planning computer systems must undergo rigorous acceptance tests and commissioning to ensure that the calculated output satisfactorily agrees with measured beam data for a series of test cases and to ensure that the hardware and software were installed properly. (See the ACR-ARS Practice Parameter for 3D Conformal External Beam Radiation Therapy [23-25].)

All users must receive initial and annual documented training by the Qualified Medical Physicist or manufacturer. In addition, documented training should be given to all new users. Software releases should be reviewed and documented by impacted parties.

Treatment-planning systems must be tested to ensure that they meet the published specifications of the system. All features of the system that are used in clinical practice must be tested. Both central-axis and off-axis beam characteristics at specific points should be tested for various field sizes to confirm the spatial accuracy of the dose display. Studies must be performed to test all types of external-beam planning used at the site. The limitations/uncertainties of the dose-calculation algorithm(s) must be reviewed, documented, and made available to all clinical personnel at the time of commissioning.

If the treatment-planning system is used to define beam apertures, then this function should be tested along with margin tools used to define the planning target volume.

In many treatment-planning systems, the dose can be displayed in terms of absolute dose or relative dose. The exact method of dose display must be consistent with the treatment-planning approach that is used clinically. The user must confirm that the relative dose distribution is as described in the system manual. The absolute dose calculation must be confirmed by measurements under normal conditions in radiation fields of various sizes [26].

If dose-volume histograms are used in the analysis of the plan, their validity must be checked. Various dose distributions can be calculated whose characteristics are known. The dose and volume results from the dose-volume histogram can be checked against the known values.

Periodic tests (eg, standard plans) must be performed routinely and after any major service or software change to ensure the accuracy of the monitor unit and/or dose-calculation algorithms, to ensure that any software changes or updates (including editing of beam data files) were implemented correctly and have not corrupted the beam data, to ensure that any hardware changes were installed properly, and to verify that the system performance is consistent with its initial commissioning.

6. End-to-end testing
   It is recommended that end-to-end testing procedures be designed and implemented for the purpose of systematic and random error reduction. The end-to-end test procedures should include use of phantoms. These phantoms should enable a test of entire patient treatment procedures, including imaging, treatment planning, plan export from the planning system to the treatment unit, and finally the treatment delivery. It is recommended that these types of tests be performed annually and as part of the commissioning of new treatment procedures [27].

7. Electrical, mechanical, and radiation safety
   A documented program must be implemented to assess potential safety hazards and to check the integrity of mechanical and electrical patient care devices. This program should include, but should not be limited to, the following:
   - Periodic inspections of patient dose-monitoring devices

- Treatment machines (including the proper operation of LINAC vault doors and interlock safety devices such as door pressure sensors or motion detectors)
- Simulators (including the patient support assembly)
- Accessories to these machines, including MLC systems, treatment couches, imaging systems, immobilization devices, and beam attenuators [28]
- Use of emergency procedures for machine shutdown by the staff
- The radiation protection program must be designed to cover all treatment and imaging equipment and be consistent with state and federal regulations.

A. Availability

A Qualified Medical Physicist must be available for continuing medical physics consultation for patients and for consultation with the radiation oncologist and to provide advice or direction to staff.

The Qualified Medical Physicist should be present to review and/or supervise complicated simulations as well as treatment setups and to communicate specific requirements directly.

It is preferable to have a Qualified Medical Physicist on-site and available on a daily basis. Practices without a full-time Qualified Medical Physicist must have regular on-site physics support to meet the clinical activity needs of the practice and be at the level of industry safety standards for staffing [5,29]. The requirements for full-time equivalent coverage may increase with the complexity of the practice. In addition, state or local regulatory requirements must be met.

Procedures must be established to meet clinic needs for periods when a Qualified Medical Physicist is not immediately available on-site, including standard procedures and covering physicists. The Qualified Medical Physicist must review, as soon as possible, all dosimetric and physics activities that occurred during their absence. Authority to perform specific clinical medical physics duties must be delegated by the Qualified Medical Physicist to each member of the physics staff in accordance with their training and competence. The radiation oncologist must be informed of the clinical activities authorized for each member and/or the locum tenens Qualified Medical Physicist.

B. Supervision

1. For clinical activities requiring supervision by a Qualified Medical Physicist, the various levels of supervision are described below. Each level of supervision is defined in AAPM Professional Policy 18-B:
    a. General — The procedure is performed under a Qualified Medical Physicist's overall direction and control. The Qualified Medical Physicist's presence is not required during the performance of the procedure, but they must be available by phone to provide assistance and direction if needed. Under General Supervision, the training of the personnel who actually perform the procedure and the maintenance of the necessary equipment and supplies is the responsibility of the Qualified Medical Physicist.
    b. Direct — A Qualified Medical Physicist must exercise General Supervision and be present in the facility and immediately available to furnish assistance and direction throughout the performance of the procedure. Direct Supervision does not require that the Qualified Medical Physicist must be present in the room when the procedure is being performed.
    c. Personal — A Qualified Medical Physicist must exercise General Supervision and be present in the room during the performance of the procedure. QA of the external-beam process. For specific instructions on the process of radiation therapy see the ACR–ARS Practice Parameter for Radiation Oncology.

C. Medical physics initial chart review protocol

At minimum, the physics review must include a review of the following:

1. Patient diagnosis
2. Any previous treatments the patient received
3. Implantable devices

4. Simulation instructions
5. Dose prescription
    a. A written or electronic and dated prescription for the medical use of radiation should be made for each treatment course. The prescription should be signed or approved electronically by a board-certified radiation oncologist or qualified physician who restricts their practice to radiation oncology.

       For specific required imaging to be used, see the ACR–AAPM Technical Standard for Medical Physics Performance of Image-Guided Radiation Therapy (IGRT) [13].

6. External-beam dose distributions
   Under the direction of a board-certified radiation oncologist or qualified physician who restricts their practice to radiation oncology, external-beam dose distributions must be generated by the Qualified Medical Physicist or dosimetrist. The physician must review all dose distributions prior to the patient starting treatment. Cumulative dose distributions should be generated as appropriate and reviewed by the physician prior to treatment delivery. Documentation of this review must be included in the patient's treatment chart.
7. Treatment plan review
    a. The treatment plan and any modifications to the treatment plan data that are transferred to a radiation treatment delivery system must be reviewed and approved by the Qualified Medical Physicist. For situations in which the Qualified Medical Physicist creates the treatment plan, it is preferable for a second Qualified Medical Physicist or dosimetrist to review the treatment plan. The dosimetrist must be specifically trained in treatment plan review. Documentation of training should be maintained and updated for any changes in the plan review process.
    b. A Qualified Medical Physicist should review the treatment plan prior to patient treatment.
    c. For an emergency treatment that occurs after regular clinical treatment hours, on the weekend, or on a holiday, the institution should have procedures in place such that the plan and/or calculations are checked by a Qualified Medical Physicist within 1 business day after treatment delivery.
    d. The Qualified Medical Physicist must review and verify the parameters that are used to describe the radiation beam or beams used in the treatment plan. These parameters must reflect the intent of the prescription. They include the target/source-to-patient skin distance (SSD or TSD), gantry and collimator angle, field size, a description of the beam aperture or MLC pattern(s) when shaped fields are used, the identification of wedges or a compensator if such are used, the relative beam weight or normalization, and all treatment couch parameters.
    e. Verify appropriateness of target volumes (may include gross target volumes (GTVs), clinical target volume (CTVs), planning target volume (PTVs), internal target volumes (ITVs) (per the International Commission on Radiation Units [ICRU]-50, ICRU-62, and ICRU-070), and normal structures.
    f. The Qualified Medical Physicist should ensure that the graphical dose distribution is consistent with the dose prescription and verify dose calculation parameters and the accuracy of dosimetric results.
    g. Each practice must have a written procedure that defines how to calculate the monitor units or treatment time for all treatments. Such calculations must be based on measured dosimetric parameters. Tables of these dosimetric parameters in either paper or electronic form must be compiled and be readily accessible to the physics staff.
    h. All treatment-planning system calculations of monitor units or treatment times must be verified by an independent monitor unit calculation system. This independent calculation is to be performed by a trained member of the physics team (dosimetrist or Qualified Medical Physicist) and checked by the Qualified Medical Physicist. If treatment-planning system calculations of monitor units or treatment times were originally prepared by a Qualified Medical Physicist, it may be rechecked by the same individual using a different calculation method.
    i. For patient-specific QA that involves verifying plan data and delivery accuracy, such as IMRT,

refer to the requirements (see the ACR Practice Parameter for Intensity Modulated Radiation Therapy [IMRT] [11]). Documentation of this review and verification must be included in the patient's treatment record.

j. Verify that the treatment isocenter matches the simulated isocenter. If shifts were performed, verify that these are documented in the patient's record correctly.
k. Review the dose volume histogram for critical/normal structure doses.
l. Review digitally reconstructed radiographs for MLC position accuracy.
m. Review IGRT instructions prescribed by the physician for completeness (modality, frequency, match structures, etc).
n. If record and verify systems are used, the Qualified Medical Physicist must verify that the treatment plan and related data have been transferred properly.

8. Day 1 treatment verification
    a. Follow specific Day 1 verification methods, isocenter verification, patient SSD measurements, etc.
    b. A radiation therapy technologist or radiation oncologist should verify that the patient setup on the treatment machine is in accordance with the treatment plan prior to the first fraction of a course of treatment and prior to treatment for any changes to the initial treatment plan.
    c. Clinical staff should obtain clarification before beginning a patient's treatment if any element of the prescription or other record is confusing, ambiguous, erroneous, or suspected of being erroneous.
9. Medical physics weekly chart review protocol

    The Qualified Medical Physicist must develop a weekly chart review protocol for reviewing each patient's treatment records. The review must assess accuracy of information as well as completeness and clarity of the record. The chart review must be conducted at least once every 5 fractions. If the site employs more than one Qualified Medical Physicist, this review should be rotated amongst the physicists so that more than one Qualified Medical Physicist reviews the chart throughout the treatment course.

    There may be challenges in accomplishing weekly physicist chart review for hypofractionated treatments delivered over less than six days. The main problem is that these courses may receive a weekly chart review only after a substantial fraction of the prescription has been delivered. This is not ideal, so approaches should be developed to address this. If a treatment course is five fractions or less, the institution should consider developing a process to ensure that at least one weekly chart review is conducted during the course of treatment, ideally near the beginning of the course. For a single fraction treatment, the institution should have procedures in place such that the chart is checked by a Qualified Medical Physicist soon after treatment delivery.

    At minimum, the physics review must include a review of the following:
    a. Treatment prescription and approval. Any deviation from the radiotherapy prescription should be reported in a timely manner to the responsible radiation oncologist so that corrective action can be taken.
    b. Daily treatment doses and cumulative doses
    c. Isodose distributions and monitor unit (time) calculations
    d. SSD accuracy
    e. Special dose calculations and measurements including in-vivo measurements
    f. Review of new or modified treatment fields
10. Final check – Completion of treatment chart review
11. At the completion (end) of treatment (EOT), the Qualified Medical Physicist must review the entire chart to affirm the fulfillment of the initial and/or revised prescribed dose. This review must be performed within 1 week of EOT and documented in the treatment record. Any deviations from the physician treatment plan or radiotherapy prescription must be documented and promptly brought to the attention of the attending radiation oncologist.

D. Chart rounds

The Qualified Medical Physicist should participate in weekly department-wide chart rounds to ensure the fulfillment of the prescription and review any changes in dose, patient setup(s), and simulation and port films.

E. Morbidity and Mortality Round
See the ACR–ARS Practice Parameter for Radiation Oncology [30].

Collaborative Committee – members represent their societies in the initial and final revision of this technical standard

ACR	AAPM
Matthew A. Pacella, MS, FACR, Co-Chair	Joseph Hanley, PhD
Christopher J. Watchman, PhD, Co-Chair	Koren S. Smith, MS
Debbie L. Schofield, MS	Malorie R. Veres, MS

Committee on Practice Parameters and Technical Standards – Medical Physics

(ACR Committee responsible for sponsoring the draft through the process)

Maxwell R. Amurao, PhD, MBA, Chair	Ralph P. Lieto, MS, FACR
Mary Ann Keenan, DMP, Vice Chair	Lijun Ma, PhD, FAAPM
Priscilla F. Butler, MS, FACR	Tariq A. Mian, PhD, FACR
Heidi A. Edmonson, PhD	Anshuman Panda, PhD
Samuel A. Einstein, PhD	Douglas E. Pfeiffer, MS, FACR
Per H. Halvorsen, MS, FACR	Premavathy Rassiah, PhD
Loretta M. Johnson, PhD	Thomas G. Ruckdeschel, MS

Mahadevappa Mahesh, MS, PhD, FACR, Chair, Commission on Medical Physics
Jacqueline Anne Bello, MD, FACR, Chair, Commission on Quality and Safety
Mary S. Newell, MD, FACR, Chair, Committee on Practice Parameters and Technical Standards

Comments Reconciliation Committee

David Youmans, MD, FACR, Chair	Janaki Krishnamoorthy, PhD
K. Elizabeth Hawk, MD, MS, PhD, Co-Chair	Mahadevappa Mahesh, MS, PhD, FACR
Maxwell R. Amurao, PhD, MBA	Alexander Markovic, MSc
Jacqueline Anne Bello, MD, FACR	Mary S. Newell, MD, FACR
Richard Duszak Jr., MD, FACR	Zoubir Ouhib, MS, FACR
Robert G. Gandy, MS	Matthew A. Pacella, MS, FACR
Steven J. Goetsch, PhD	Ben H. Robison, MS
Per H. Halvorsen, MS, FACR	Debbie L. Schofield, MS
Joseph Hanley, PhD	Koren S. Smith, MS
Steven C. Harrell, MS	Malorie R. Veres, MS
Annie Hsu, PhD	Christopher J. Watchman, PhD
Mary Ann Keenan, DMP	Gerald A. White Jr., MS, FACR
Amy L. Kotsenas, MD, FACR	Richard Y. Wu, MS

*Practice parameters and technical standards are published annually with an effect date of October 1 in the year in which amended, revised, or approved by the ACR Council. For practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Technical Standard
2004 (Resolution 19)

Amended 2006 (Resolution 16g)
Revised 2010 (Resolution 7)
Revised 2015 (Resolution 52)
Revised 2020 (CSC/BOC)
Amended 2023 (Resolution 2c)

VI. NEW PROCEDURES

The practice of radiation oncology often involves the implementation of new procedures and technologies. When these are being considered, the Qualified Medical Physicist must participate along with team members of the medical and administrative areas. The Qualified Medical Physicist should undertake a systematic literature review, make site visits, confer with colleagues familiar with the new procedure or equipment, and otherwise obtain factual information for use in planning, acquisition, and implementation. Such information may include clinical application, impacts on workflows, equipment, staffing, and space utilization.

The Qualified Medical Physicist must accept and commission any new treatment procedure, technique, accessory, or new treatment technology, and they must be received/accepted, commissioned, and released prior to clinical use. In the case of a product (hardware, software, or device) the commissioning must include safety testing and verification that the system or device meets the manufacturer's performance standards. Commissioning will also include institution of a QA program to demonstrate the consistent safety and performance of the system or device. Documentation of the acceptance, commissioning, and QA program development must be on-site and available for review.

The QA program associated with any new procedure should be periodically reviewed and updated.

For more information on image-guided radiation therapy, see the ACR–AAPM Technical Standard for Medical Physics Performance Monitoring of Image-Guided Radiation Therapy (IGRT) and the ACR–ARS Practice Parameter for Image-Guided Radiation Therapy (IGRT) [13,31].

VIII. DOCUMENTATION

The Qualified Medical Physicist is responsible for documenting, at a minimum, the following:

1. Procedures for instrument calibration and periodic instrument constancy checks
2. Procedures to verify the manufacturer's specifications and to establish baseline performance values for radiation therapy equipment
3. QM programs for radiation therapy equipment, simulators, treatment-planning systems, and monitor unit calculation algorithms
4. Monitor units (time) calculation procedures and protocols
5. Physics chart check protocol for reviewing treatment delivery
6. Procedures for checking the mechanical and electrical integrity of patient care devices
7. Radiation protection program as it pertains to radiation oncology
8. Calculations related to patient dosimetry and/or physics measurements when such needs arise or per clinicians' requests
9. Consultations requested by the radiation oncologist
10. Commissioning of new systems and/or equipment introduced into the clinic
11. Response to vendor safety notices
12. Equipment repair log and QA prior to returning to service

Collaborative Committee – members represent their societies in the initial and final revision of this technical standard

ACR	AAPM
Matthew A. Pacella, MS, FACR, Co-Chair	Joseph Hanley, PhD
Christopher J. Watchman, PhD, Co-Chair	Koren S. Smith, MS
Debbie L. Schofield, MS	Malorie R. Veres, MS

Committee on Practice Parameters and Technical Standards – Medical Physics

(ACR Committee responsible for sponsoring the draft through the process)

Maxwell R. Amurao, PhD, MBA, Chair	Ralph P. Lieto, MS, FACR

Committee on Practice Parameters and Technical Standards – Medical Physics

(ACR Committee responsible for sponsoring the draft through the process)

Mary Ann Keenan, DMP, Vice Chair
Priscilla F. Butler, MS, FACR
Heidi A. Edmonson, PhD
Samuel A. Einstein, PhD
Per H. Halvorsen, MS, FACR
Loretta M. Johnson, PhD
Lijun Ma, PhD, FAAPM
Tariq A. Mian, PhD, FACR
Anshuman Panda, PhD
Douglas E. Pfeiffer, MS, FACR
Premavathy Rassiah, PhD
Thomas G. Ruckdeschel, MS

Mahadevappa Mahesh, MS, PhD, FACR, Chair, Commission on Medical Physics
Jacqueline Anne Bello, MD, FACR, Chair, Commission on Quality and Safety
Mary S. Newell, MD, FACR, Chair, Committee on Practice Parameters and Technical Standards

Comments Reconciliation Committee

David Youmans, MD, FACR, Chair
K. Elizabeth Hawk, MD, MS, PhD, Co-Chair
Maxwell R. Amurao, PhD, MBA
Jacqueline Anne Bello, MD, FACR
Richard Duszak Jr., MD, FACR
Robert G. Gandy, MS
Steven J. Goetsch, PhD
Per H. Halvorsen, MS, FACR
Joseph Hanley, PhD
Steven C. Harrell, MS
Annie Hsu, PhD
Mary Ann Keenan, DMP
Amy L. Kotsenas, MD, FACR
Janaki Krishnamoorthy, PhD
Mahadevappa Mahesh, MS, PhD, FACR
Alexander Markovic, MSc
Mary S. Newell, MD, FACR
Zoubir Ouhib, MS, FACR
Matthew A. Pacella, MS, FACR
Ben H. Robison, MS
Debbie L. Schofield, MS
Koren S. Smith, MS
Malorie R. Veres, MS
Christopher J. Watchman, PhD
Gerald A. White Jr., MS, FACR
Richard Y. Wu, MS

ACKNOWLEDGEMENTS

*As of May 2015, all practice parameters and technical standards that are collaborative with only the American Association of Physics in Medicine are approved by the ACR Council Steering Committee and the ACR Board of Chancellors and will not go through the ACR Council (ACR Resolution 54, 2015). The effective date is the first day of the month following a 60-day period that begins on the date the document was approved.

Development Chronology for this Technical Standard

2004 (Resolution 19)
Amended 2006 (Resolution 16g)
Revised 2010 (Resolution 7)
Revised 2015 (Resolution 52)
Revised 2020 (CSC/BOC)
Amended 2023 (Resolution 2c)

This technical standard was revised according to the process described under the heading *The Process for Developing ACR Practice Parameters and Technical Standards* on the ACR website (https://www.acr.org/Clinical-Resources/Practice-Parameters-and-Technical-Standards) by the Committee on Practice Parameters and Technical Standards – Medical Physics of the ACR Commission on Medical Physics, in collaboration with the AAPM.

*Practice parameters and technical standards are published annually with an effect date of October 1 in the year in which amended, revised, or approved by the ACR Council. For practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

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IX. PEER REVIEW

See the ACR–ASTRO Practice Parameter for Radiation Oncology [30].

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