# ACR–AAPM TECHNICAL STANDARD FOR THE PERFORMANCE OF LOW-DOSE-RATE BRACHYTHERAPY PHYSICS



## 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 individuals with recognized expertise in medical physics, representing the American College of Radiology (ACR) and the American Association of Physicists in Medicine (AAPM).

Brachytherapy is a method of treatment in which a radionuclide is used to deliver radiation by interstitial, intracavitary, intraluminal, or surface application. There are a number of processes and sealed radioactive sources used to perform low-dose-rate (LDR) brachytherapy. This document is explicitly not intended to address

the use of remote afterloading devices commonly referred to as high-dose-rate or pulsed-dose-rate systems.

The practice of brachytherapy physics occurs under a variety of settings. The judgment of a Qualified Medical Physicist, in conjunction with a radiation oncologist (authorized user (AU)), should be used to apply these standards to individual practices. Also, radiation safety requirements must be in compliance with appropriate federal and state regulations.

## II. QUALITY MANAGEMENT

Quality Management (QM) is, "an overall management system that includes establishing quality policies and quality objectives, and processes to achieve quality objectives through quality planning, quality assurance (QA), quality control (QC), and quality improvement." [1].

## II. QUALITY MANAGEMENT

### A. Quality Management Team

The quality management team defines the individuals who are responsible for, and involved with, the technical aspects of clinical use of LDR brachytherapy systems. In general, the supervising physician is responsible for the overall quality and safety of the clinical operation of LDR brachytherapy systems. The Qualified Medical Physicist has responsibility and oversight for equipment testing protocols, methods, and criteria for action. As such, the quality management team should be led or overseen by the supervising physician with support from the Qualified Medical Physicist on equipment issues. Although different types of physicians (eg, radiologists and/or surgeons) may be involved in LDR brachytherapy, the participation of all physicians on a quality management team is likely unnecessary. At least 1 physician should participate on the quality management team so they may provide physician and end-user input to quality processes.

The quality management team should be in communication at regular intervals, (eg, quarterly, semiannually, or annually) to review issues, discuss upcoming activities, and perform general review of past QA and control results. In addition, such correspondence provides an opportunity to discuss any necessary updates to the quality management components discussed later in this section.

The quality management team should be the group responsible for providing the greatest input on purchasing decisions for new or replacement equipment and the associated accessory hardware and software. A consistent quality management approach to hardware and software simplifies the requirements associated with the ongoing QA and control measures.

As described in *Qualifications and Responsibilities of Personnel,* the Qualified Medical Physicist may be assisted in the collection of data, subject to all applicable regulations and relevant guidance. The Qualified Medical Physicist and the quality management team should define the required training and approval process for those individuals deemed qualified for assisting under the general supervision of the Qualified Medical Physicist. This technical standard recommends that all annual testing is performed either by or under the general supervision [2] of the Qualified Medical Physicist and all testing at more frequent intervals under the oversight or direction of the Qualified Medical Physicist.

## II. QUALITY MANAGEMENT

### B. Service Records

Equipment and relevant software calibrations should be performed as defined by the equipment manufacturer. Some manufacturers require calibrations to be performed by technologists or other clinical personnel, while other manufacturers describe calibrations as part of routine or corrective service. Similarly, some technical configurations may be required to be done by service engineers, especially at installation, while other configurations may be appropriately adjusted by technologists or medical physicists. For all equipment and relevant software, regular preventive maintenance and corrective service should be performed, documented, and records retained by a service engineer, following the maintenance schedule recommended by the manufacturer. Copies of all service records, including corrective actions, must be shared with, and retained by, the clinic providing patient care. The quality management team should, at minimum, have access to these records, and if sensible in the context of facility culture and operational practices, it may be best for the quality management team to keep and manage these records.

## II. QUALITY MANAGEMENT

### C. Records of devices and tools

Quality management of imaging and LDR brachytherapy equipment requires accurate and complete installation records of the equipment. At a minimum, the quality management team should establish an asset management methodology to track location, manufacturer, model, date of manufacture, and unique identifier of all devices in their purview. The asset management system should serve as either the repository for, or link to, the permanent storage for quality performance records and reports.

In addition to the LDR brachytherapy system itself, the quality management team should maintain accurate records of the tools used to perform QC tests. These records should include tool description or type, manufacturer, model, date of manufacture, and unique identifier. The calibration, calibration schedule, and/or intercomparison history and schedule of the applicable tools should be kept with these records to ensure regulatory and policy compliance.

The quality management team should include a review of the asset management system as part of its regular meetings. Individual members of the team should be assigned specific data points of interest to oversee. The more detailed and automated the asset management system, the easier the delineation of the data for the quality management team members.

## II. QUALITY MANAGEMENT

### D. Policies

Effective quality management requires a comprehensive set of policies and guidelines to address all aspects of equipment performance. This subsection lists those aspects of LDR brachytherapy systems that should be included in such documentation.

1. Equipment calibration targets
2. Expectations for installation or configurations
3. Summary of QA and QC frequencies
4. Reporting of QA and QC results
5. Review of applicable regulatory and accreditation requirements
6. Requirements for postservice
7. Personnel roles
8. User/operator responsibilities

## II. QUALITY MANAGEMENT

### E. Reporting Structure for Issues

1. Incident Identification: Promptly identifies any issues or incidents during the LDR procedure. All team members (radiation oncologists, medical physicists, dosimetrists, radiologists, nurses, and technologists) are responsible for identifying and reporting any deviations, errors, or unexpected events.

2. Immediate Notification: Ensure critical issues are immediately communicated to relevant team members. Notify the radiation safety officer (RSO), lead radiation oncologist, and medical physicist immediately. Document the incident in the patient’s medical record and the incident reporting system. If the issue poses an immediate risk to patient safety, follow emergency protocols.

3. Incident Documentation: To maintain a detailed and accurate record of the issue. Using methodology that at a minimum includes the "5 Ws" (Who, What, Where, When, Why), complete an incident report entry in the incident learning system, including date and time of the issue (When), location that issue occurred (Where), description of the issue (What), individuals involved (Who), and impact on the patient and treatment (Why).

4. Root Cause Analysis: To determine the underlying causes of the issue and prevent recurrence. Assemble a multidisciplinary team to review the incident. Conduct a thorough investigation, including interviews with involved personnel and documentation review. Identify contributing factors and root causes, document findings, and recommend corrective actions. Follow a just culture and avoid blaming.

5. Corrective Actions: To implement measures that address the root causes and prevent future occurrences. Develop and implement a corrective action plan. Assign responsibilities and timelines for each action. Communicate the plan to all relevant staff. Monitor the implementation and effectiveness of corrective actions.

6. Reporting and Feedback: To ensure transparency and continuous improvement. Provide feedback to the involved team members and departments. Share lessons learned and best practices across the organization/Radiation Oncology community.

7. Continuous Monitoring: Use Plan Do Study Act or other Continuous Improvement methodologies to maintain vigilance and ensure ongoing compliance with safety protocols. Review incident reports and trends regularly. Conduct periodic audits and safety checks. Update procedures and training based on issue analysis and industry best practices.

## III. QUALITY ASSURANCE

### A. Introduction

The Quality Management Program refers to administrative policies, QA, QC measures, and consideration of quality improvement objectives that ensure consistent and safe fulfillment of the treatment prescription. The Qualified Medical Physicist is responsible for a QA program that maintains the records regarding appropriate description, calibration, and the current source strength to ensure the accurate delivery of the prescribed dose to the specified volume [3]. The complexity of brachytherapy procedures necessitates that comprehensive quality management includes treatment-related devices (planning and imaging systems, applicators, radioactive sources, and delivery systems) and the clinical process [4, 5]. The AAPM Task Group (TG) 100 report provides suggestions for increasing the effectiveness of quality and safety programs based on formal risk analysis methodology [6]. The Qualified Medical Physicist should work closely with the radiation oncologist and other members of the brachytherapy team to build consensus and to document the clinical workflow and resources for specific anatomical site and treatment modality combinations.

QC for brachytherapy sources includes maintaining an ongoing review for adherence to regulatory and licensing requirements. Accordingly, the Qualified Medical Physicist must develop, implement, supervise, and review the policies and procedures that encompass sealed sources and their use and maintain proper written documentation [7]. When these activities relate to radiation safety, they should be carried out in conjunction with the institutional RSO.

The Qualified Medical Physicist should institute a documented peer-review mechanism for the review of the brachytherapy physics program by a Qualified Medical Physicist with experience relevant to the scope of the program being reviewed. The review should be performed annually. When reviews are performed on a less frequent schedule, the time between reviews should not exceed 3 years or the next state or Nuclear Regulatory Commission inspection [8].

The Qualified Medical Physicist must ensure the spatial resolution, fidelity, applicator compatibility, and appropriate use of each imaging modality. Also, the Qualified Medical Physicist must ensure that proper acceptance testing and/or commissioning as well as a documented QA program are in place for each imaging modality before its clinical use.

## III. QUALITY ASSURANCE

### B. Sealed Sources

Because the radiological characteristics of encapsulated sources depend on their physical and chemical form, as

well as on the source encapsulation and the radioactivity distribution within the source, the Qualified Medical Physicist must take these factors into account to properly determine the dose distribution around the source.

Sealed sources with long half-lives (>6 months) must be labeled to distinguish sources that have the same radionuclide and capsule design but different source strengths.

1. Measurement of source strength

   Brachytherapy sources used in radiation oncology must have measurements of their source strength with traceability to national standards. The 1995 AAPM TG 43 report [9], its updated version published in 2004 [10], and supplements [11] should be consulted for dosimetry protocols of specific LDR sources employed for brachytherapy procedures. If new sources not included in the above references are to be used, other published measurements in peer-reviewed journals should be sought before using these sources.

   The Qualified Medical Physicist must establish acceptable limits of accuracy for source strength measurements as well as a course of action if the source strength does not fall within these limits.

   All sources containing radionuclides with a half-life greater than 6 months should have their source strength measured upon receipt. Autoradiographs must be performed on these sources before initial use to verify the uniformity of radioactivity spatial distribution for each source.

   For sources containing radionuclides with a half-life of less than 6 months, a random sample of sources from each manufacturer's lot number should have their source strength measured upon receipt. The quantities of sources to be assayed are described in the AAPM Report 98 [12].

   Source strength should be specified in terms of air kerma strength, not apparent activity, for all clinical aspects of the procedure, such as source ordering, source strength assays, and treatment planning [12]. The current source strengths of new sources must be entered into the treatment-planning system. An additional qualified individual should perform a check of the entered values.

2. Instrumentation

   For direct measurement of source strengths, a well ionization chamber with known axial response and an electrometer, as applicable, is recommended. The constancy of the well ionization chamber and electrometer must be verified upon receipt, after repair, before and after mailing for calibration, and before each use. For source calibrations, the well ionization chamber and electrometer must be calibrated at least every 2 years [7].

   An uncalibrated well ionization chamber may be used in conjunction with a source whose strength has been determined by an Accredited Dosimetry Calibration Laboratory or National Institute of Standards and Technology (NIST) by the replacement method to provide relative response for verifying source strength, describing batch variation, and confirming source identity according to strength. The sensitivity, linearity (if appropriate), and reproducibility of the instrument must be documented at least annually [12, 13].

3. Brachytherapy applicators and templates

   The Qualified Medical Physicist must determine the source location, the coincidence of dummy and active sources, and the location of shields for intracavitary applicators before initial use. Such applicators should be radiographically inspected annually and physically inspected before each use. For appropriate interstitial applicators, the coincidence of dummy and active sources must be verified before initial use.

   Before first use, and periodically thereafter, needle-guiding templates should be checked for alignment and scaling between physical needle positions and the superimposed electronic grid generated by the ultrasound and treatment planning system [14].

4. Radiation safety

Radiation safety practices must be consistent with the institution's radioactive material license, license amendments, and existing regulations [15, 16]. Nevertheless, the Qualified Medical Physicist in conjunction with the RSO should be responsible for developing, overseeing, and documenting radiation safety procedures, including, but not limited to, the following:

a. Written procedures for ordering, receiving, returning, and/or disposing of radioactive materials and for performing patient and room surveys following source removal
b. Procedures for the safe handling, preparing, cleaning, sterilizing, and sorting of sources
c. Policies for personnel monitoring of radiation exposure
d. An inventory control program sufficient to identify the locations of all sealed sources at any time
e. Emergency procedures for leaking sources and loss of or dislodging of sources
f. Leak tests of inventoried long half-lived sources
g. Ensuring the security of all radioactive sealed sources, including procedures for the interdepartmental transport and retrieval of sources before and subsequent to implantation
h. Documentation and reporting of medical events in accordance with state or federal regulations
i. Determining and evaluating unsafe and risky procedures
j. Patients should be provided with written release instructions for radiation protection including, but not limited to, potential limitations on patient contact with minors and pregnant women. These instructions must be consistent with guidance of the ACR–ABS–ASTRO Practice Parameter for the Performance of Low-Dose-Rate Brachytherapy [17].

## III. QUALITY ASSURANCE

### C. Treatment Planning and Dosimetry

1. Computerized planning system

Computerized planning systems must undergo rigorous acceptance tests and commissioning to ensure that the dose-calculation algorithm properly converts the source strength and dosimetry parameters into the appropriate absorbed dose distribution, including dose-volume statistics, if available, and to ensure that hardware and software were installed properly [9-11, 15, 18]. Correction for decay of source strength must be made regularly to reflect change in source strength. The handling of image data and their use in dose calculations must also be verified for accuracy in comparison (where appropriate) with well-established methods of dose calculation (eg, nomograms or lookup tables). Model-based treatment planning system algorithms and the use of material heterogeneity corrections have increased the accuracy and complexity of brachytherapy dose calculations [18-20]. These new approaches need to be implemented with great care because current prescription and outcome data are based on the TG-43 formalism [11]. All users must receive proper training. An in-service program should be given for new users and, when appropriate, provided to all users following software releases. A written treatment-planning system QA program must be implemented and documented to ensure the accuracy of dose-calculation algorithms, software changes, hardware changes, and source data files [21, 22]. All training should be documented.

2. Treatment plan and review

For each brachytherapy procedure, a treatment plan and dosimetry report pertinent to the plan should be reviewed and completed by the Qualified Medical Physicist. The report should include, but is not limited to, the following items:

a. Patient name, identifier, and treatment site
b. Prescribed dose
c. Description of the source, the implant technique, and the source distribution pattern used
d. Total source strength, dose rate, and implant duration
e. Isodose distributions in appropriate planes

f. Dose-volume indices used to evaluate coverage of the target and the quality of the treatment plan along with dose constraints of tissue/organs at risk (OARs)

The treatment plan should be independently reviewed by the AU and a Qualified Medical Physicist or a designate not directly involved with generating the treatment plan [23]. This review may include, but is not limited to, ensuring that the:

a. Planned dose conforms to the prescription
b. Applicator type, implant geometry and applicator reconstruction, and source position(s) are reasonable
c. Radionuclide, source configuration and strength, source calculation model, date of implant, and implant duration are correct
d. Volumetric dose coverage of the target and dose constraints of tissue/OARs are satisfactory

3. Independent dose calculation

To validate the treatment plan, an additional dose calculation using an independent method from the treatment-planning system should be used. This validation should be consistent with the prescription, source position(s), and source strength. Consistency with prior practice, when applicable, should be checked using the target volume and total source strength to generate regression fits to dosimetric indices. This plan validation step should be completed before treatment initiation. There may be instances in which treatment plan validation may not fit with the implant workflow and may need to be delayed (ie, prostate seed implants, intraoperative implants, etc) until source placement is complete.

## III. QUALITY ASSURANCE

### D. Clinical Medical Physics Management

1. Source loading and placement
The Qualified Medical Physicist or Medical Dosimetrist should be available for consultation during applicator placement and loading. The prescribed loading of applicators must be independently confirmed and documented.

2. Source removal and radiation safety review
For a temporary implant, the Qualified Medical Physicist or Medical Dosimetrist must be available for consultation during source and applicator removal. The Qualified Medical Physicist, in conjunction with the RSO, should be responsible for developing, overseeing, and documenting the process/procedure for radiation safety review at the time of source removal.

## III. QUALITY ASSURANCE

### E. New Procedures

In conjunction with the medical director and/or the appropriate AU, the Qualified Medical Physicist must define basic standards of practice and develop a prudent course of action to determine the quality and safety of any new procedures before clinical initiation. New devices and applicators must be evaluated with respect to integrity, suitability for use with the radioactive sources, and effects on dose distributions. This evaluation must be prepared as a written report and distributed in accordance with institutional policy.

## III. QUALITY ASSURANCE

### F. Periodic Review of Settings/Protocols/Clinical Outputs

The Qualified Medical Physicist should review the routine QC results at least annually and report any findings or recommendations to the quality management team.

## III. QUALITY ASSURANCE

### G. Calibration of Measurement Devices/Tools

Measurement devices should be regularly calibrated or cross-referenced with calibrated devices to ensure the quality of their readings. The Qualified Medical Physicist should adhere to professional practice standards and must meet applicable regulatory requirements.

## IV. QUALITY CONTROL

Quality Control is, "a component of QM focused on the fulfillment of quality requirements; it includes activities that impose specific quality on a process; and entails the evaluation of actual operating performance characteristics of a device or system, comparing it to desired goals, and acting on the difference; QC works on the input to a process to ensure that important elements or parameters specific to the process are correct." [1].

Equipment performance must be evaluated upon installation and monitored at least annually by a Qualified Medical Physicist to ensure proper functioning within the defined performance standards. Additional or more frequent performance monitoring may be necessary in certain situations (eg, after major equipment maintenance). Although it is not possible to consider all variations of equipment performance to be monitored, adherence to this technical standard will help to optimize image quality and ensure the quality of equipment performance in clinical procedures. Key points to consider are performance characteristics to be monitored, estimated patient radiation dose, qualifications of personnel, and follow-up procedures.

A documented QC program with procedure manuals, records, and intervention results in either soft or hard copy should be maintained [24]. The Qualified Medical Physicist should review these records at least annually.

The QC activities described in this section are broadly separated into 3 categories: acceptance testing, annual equipment performance evaluation, and continuous QC.

### A. Acceptance Testing

A Qualified Medical Physicist must conduct initial LDR brachytherapy equipment performance evaluation upon installation of the equipment and after major upgrades. This evaluation should be more comprehensive than periodic evaluation and should be completed before clinical use.

Before the initial equipment performance evaluation, electrical safety and informatics connectivity (eg, DICOM transfer) must be verified by appropriate personnel.

Acceptance testing must include tests performed during the annual performance evaluation and may include additional tests such as an end-to-end test of complete workflow.

### B. Equipment Performance Evaluation

The performance of each LDR brachytherapy system must be evaluated at least annually.

### C. Continuous QC

A continuous QC program must be implemented for all LDR brachytherapy systems with the assistance of a Qualified Medical Physicist. The Qualified Medical Physicist should determine the test frequency and tolerances (in conjunction with manufacturer specifications).

## V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

### A. Qualified Medical Physicist

A Qualified Medical Physicist must carry out acceptance testing and performance evaluation of LDR brachytherapy systems.

A Qualified Medical Physicist is an individual who is competent to practice independently in 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 subfield(s) by the American Board of Radiology (ABR), the Canadian College of Physicists in Medicine (CCPM), the American Board of Science in Nuclear Medicine (ABSNM), or the American Board of Medical Physics (ABMP).

A Qualified Medical Physicist should meet the ACR Practice Parameter for Continuing Medical Education (CME) [25].

The appropriate subfield of medical physics for this standard is Therapeutic Medical Physics. (ACR Resolution 17, adopted in 1996 – revised in 2008, 2012, 2022, Resolution 41f)
The Qualified Medical Physicist is responsible for the test protocols, test methods, and acceptability criteria. The Qualified Medical Physicist may be assisted by properly trained individuals in obtaining data in accordance with applicable regulations and relevant guidance (eg, AAPM medical physics practice guideline 7.a [26]). Medical physics students, medical physics residents, and medical physicists-in-training may assist the Qualified Medical Physicist based on their training and at the discretion of the Qualified Medical Physicist [27]. These individuals must be properly trained and approved by the Qualified Medical Physicist such that they have knowledge about the techniques of performing tests, functions and limitations of the equipment and test instruments, reasons for the tests, and the importance of the test results. The assisting individual shall be under the general supervision[2] of the Qualified Medical Physicist during all surveys. The Qualified Medical Physicist is responsible for all surveys and must review, interpret, and approve all data as well as provide a signed report with conclusions and recommendations [2].
In addition, the Qualified Medical Physicist must meet all 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.

Where required, the Qualified Medical Physicist must have a license to practice therapeutic medical physics. Similarly, depending on the bylaws of the relevant hospital/institution, the credentials and delineated privileges for the Qualified Medical Physicist should be confirmed through the medical staff membership process in the appropriate category because clinical brachytherapy physics involves direct contact with patients and access to their hospital records.

Regulatory agencies may define requirements for an Authorized Medical Physicist for practice covered in this technical standard. It is assumed in this technical standard that the Qualified Medical Physicist meets all requirements of an Authorized Medical Physicist within the relevant jurisdiction(s) of their practice.

The Qualified Medical Physicist is responsible for maintaining complete and accurate records required by regulatory agencies and accrediting bodies. Records documenting the results and frequency of QA checks, QC measures, corrective actions.

B. Physician
For physician qualifications related to LDR brachytherapy systems, see the ACR–ABS–ASTRO Practice Parameter for the Performance of Low-Dose-Rate Brachytherapy [17].

C. Medical Dosimetrist

Certification by the Medical Dosimetrist Certification Board is recommended. The Medical Dosimetrist activities should be performed under the supervision of the Qualified Medical Physicist.

D. Radiation Therapist

The Radiation Therapist must fulfill applicable state licensing requirements and should have American Registry of Radiologic Technologists (ARRT) certification in radiation therapy.

E. Medical Physicist Assistant

A Medical Physicist Assistant is an individual who has the necessary didactic education and practical medical physics knowledge to work under the supervision and responsibility of a Qualified Medical Physicist [26, 28]. As outlined in AAPM medical physics practice guideline 7.a, a Medical Physicist Assistant is an individual who is not a Qualified Medical Physicist but extends to a Qualified Medical Physicist through a formal chain of authority [26]. The Medical Physicist Assistant is likely to be a valuable member of the quality management team and make the feasibility of a robust quality management program much easier.

[2] For the purposes of this standard, general supervision means all procedures are performed under a Qualified Medical Physicist's overall direction and control. The Qualified Medical Physicist's presence is not required during the procedure but must be available by phone to provide assistance and direction if needed. The training of the personnel who perform the procedure and the maintenance of the necessary equipment and supplies are the responsibility of the Qualified Medical Physicist.

## VI. TREATMENT CONSIDERATIONS/SPECIFICATIONS OF THE PROCEDURE

A. Planning

Brachytherapy treatment planning should include, at a minimum, the determination of the appropriate isodose distribution. A consistent means of specifying and documenting administered activity must be in place. Treatment-planning specifications should include, at a minimum, a description of technique and applicator, radionuclide, source strength(s), anatomical description of target volume, dose-to-target volume, dose to reference points and/or OAR volumes, and the dose distribution. In the planning process, image-based volumetric computerized treatment-planning algorithms that provide a means to conform the dose distribution to the target and minimize the dose to OARs should be used. The time-dose pattern, anatomical description of the target volume, dose to the target volume, and volumetric dose statistics should be determined if 3-D patient imaging information is used. Prior and/or planned external beam and brachytherapy doses that overlap with the current LDR plan should be considered during the LDR planning to target volumes, and OARs should also be documented with every treatment plan.

1. Imaging

a. Image-guided applicator/source localization: Image-guided procedures are the standard of care. Imaging modalities such as fluoroscopy, MRI, CT, and ultrasound are used to achieve high-quality delivery of brachytherapy [29-34].
b. Localization images: The position of all intracavitary, intraluminal, and interstitial implants must be verified before treatment, as applicable, with appropriate medical imaging modalities. It is preferred that images be acquired with the patient in the treatment position. The responsible radiation oncologist should be present with the Qualified Medical Physicist or dosimetry personnel during applicator localization. Before treatment initiation, the localization images should be approved by the responsible radiation oncologists.

B. Delivery

Details of Delivery are included in the III Quality Assurance section.

C. Dosimetry

Postimplant dosimetry should be performed via verification imaging at a time interval specific to the

radionuclide that has been implanted.

D. Verification

The position of all intracavitary, intraluminal, and interstitial implants must also be verified after treatment, as applicable, with appropriate medical imaging modalities. Furthermore, all sources must be accounted for as either implanted in the patient or stored for radioactive waste at the end of the procedure.

## VII. RESOURCES

A. Personnel Requirements

Active brachytherapy programs require physics and support personnel beyond that required for external beam therapy because of the uniqueness and relative complexity of each case. As a special procedure, LDR brachytherapy requires a significant time commitment by the Qualified Medical Physicist to develop and maintain high standards for quality procedures, as well as to provide documentation to comply with regulatory agencies. Consequently, these commitments should be included when budgeting personnel requirements.

B. Equipment Needs

Each facility must have access to instrumentation to independently verify the source strength provided by the manufacturer. This should be done with a well ionization chamber and electrometer or other suitable instrument with a source strength measurement directly traceable to the NIST [15]. The AAPM has provided guidelines to verify the source calibration [7, 12].

Calibrated survey instruments that are appropriate in energy response and range for the sources used must be available for use at all times [15]. A backup survey meter with current calibration should be readily available in case of primary instrument failure or unavailability.

The facility must have instrumentation to perform periodic sealed-source leak testing or arrange to have this service provided.

Appropriate local shielding, storage facilities, transportation containers, manipulation devices, and storage containers for emergency use must also be available.

A computerized treatment planning system for volumetric image reconstruction or processing CT, ultrasound, MRI, etc), applicator reconstruction, and isodose computation should be available to calculate point doses, generate isodose distributions, and compute dose-volume statistics.

Proper maintenance, calibration, QC, and update of the equipment must be carried out under the supervision of the Qualified Medical Physicist.

## VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *ACR Position Statement on Quality Control and Improvement, Safety, Infection Control, and Patient Education* on the ACR website (https://www.acr.org/Advocacy-and-Economics/ACR-PositionStatements/Quality-Control-and-Improvement).

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*Practice parameters and technical standards that are collaborative with only radiation oncology societies (ACR Resolution 8, 2010) or are collaborative with the American Association of Physics in Medicine (ACR Resolution 54, 2015) are approved by the ACR Council Steering Committee (CSC) and the ACR Board of Chancellors (BOC) and will not go through the ACR Council. The effective date for these CSC/BOC documents is the first day of the month following a 60-day period that begins on the date the document was approved.

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