ACR–AAPM TECHNICAL STANDARD FOR MEDICAL PHYSICS PERFORMANCE MONITORING OF SPECT/CT EQUIPMENT

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.

---

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).

Combined single-photon emission computed tomography - computed tomography (SPECT/CT) systems are designed to acquire sequential SPECT and CT datasets [1]. Some of these systems are capable of being used for diagnostic CT imaging alone, whereas others have CT capabilities that are intended solely for localization and

attenuation correction. In either case, a SPECT/CT system combines 2 medical imaging technologies: X-ray CT for anatomical imaging and attenuation correction and SPECT for radionuclide imaging. These systems have the advantages and the complexities of each subsystem while providing combined anatomic and functional information in the coregistered images.

All SPECT/CT imaging equipment must be tested on installation and evaluated at least annually by a Qualified Medical Physicist to ensure system performance is within the manufacturer's specifications and accepted performance standards. Additional, or more frequent, performance evaluation 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 evaluated, adherence to this technical standard will help to optimize image quality and ensure the accuracy of quantitative results in clinical procedures. Key points to consider are performance characteristics to be evaluated, estimated patient radiation dose, qualifications of personnel, and follow-up procedures.

The primary goal of SPECT/CT imaging is to produce highly accurate coregistered SPECT and CT images on the same platform. An equally important goal is to produce images with the lowest reasonable radiation dose consistent with the clinical use of the equipment and the information requirements of the examination [2]. The goal of this document is to establish performance standards for medical physics oversight of SPECT/CT imaging equipment.

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." [3]

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 SPECT/CT systems. In general, the supervising physician is responsible for the overall quality and safety of the clinical operation of SPECT/CT 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. The quality management team should also include at least one technologist who routinely operates SPECT/CT systems. At least one physician should participate on the quality management team so they may provide physician and end-user input to quality processes. Although different types of physicians (eg, radiologists and/or surgeons) may be involved in SPECT/CT imaging, the participation of all physicians on a quality management team is likely unnecessary.

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 QC 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 QC 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 [4] of the Qualified Medical Physicist, and all testing at more frequent intervals is 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 SPECT/CT equipment requires accurate and complete installation records of the equipment. At a minimum, the quality management team should establish or adopt an asset management methodology to track location, manufacturer, model, date of manufacture, and unique identifier of all SPECT/CT 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 SPECT/CT 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 SPECT/CT 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

The Qualified Medical Physicist must provide a written report of the findings of acceptance testing and performance evaluation to the professional(s) in charge of obtaining or providing necessary service to the

equipment and, if appropriate, to the responsible physician(s). Written reports must be provided in a timely manner consistent with the importance of any adverse findings.

If appropriate, the Qualified Medical Physicist should notify the facility to initiate the required service. The facility must complete corrective actions in a timely manner consistent with the importance of any adverse findings and pertinent regulations. The facility should retain service reports from competent service personnel as verification that the issue(s) were appropriately resolved.

A Qualified Medical Physicist may review the reports to confirm that the equipment is performing in a safe and acceptable fashion after the required service is performed or as required by federal, state, or local regulations.

If use of the equipment would pose a danger to life or health or potentially result in erroneous clinical findings, the Qualified Medical Physicist, in collaboration with the facility's Radiation Safety Officer and supervising physician, must take immediate action to either prevent equipment use or indicate in writing what limited studies can be performed safely using the equipment until the hazard is addressed. The quality management team should be notified of the hazard and of follow-up measures taken to eliminate the hazard.

III. QUALITY ASSURANCE

Quality assurance is, "a component of QM focused on providing confidence that quality requirements will be fulfilled; it includes all activities (planned, systematic, and practice-based activities) that demonstrate the level of quality achieved by the output of a process." [3]

III. QUALITY ASSURANCE

A. 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

B. 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." [3] Equipment performance must be evaluated on 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 [5]. The Qualified Medical Physicist should review these records at least annually and report any findings or recommendations to the quality management team.

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

A table that lists the recommended parameters to be evaluated during acceptance testing, performance evaluation, continuous QC for SPECT/CT equipment is presented in Appendix A. The parameters are written in

general terms, with additional guidance provided as applicable. The Qualified Medical Physicist responsible for acceptance testing may modify the table and the extent of the measurements depending on the designated use(s) of the SPECT/CT equipment.

IV. QUALITY CONTROL

A. Acceptance Testing

A Qualified Medical Physicist must conduct initial SPECT/CT equipment performance evaluation on 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 must be verified by appropriate personnel and informatics interoperability (eg, DICOM transfer) should be verified by appropriate personnel.

Acceptance testing and/or commissioning must include tests performed during the annual performance evaluation and, additionally, should include evaluation of the following items:

1. Compliance with local regulatory requirements
2. Compliance with special contractual terms
3. Compliance with manufacturer's specifications

IV. QUALITY CONTROL

B. Equipment Performance Evaluation

The performance of each SPECT/CT system must be evaluated at least annually.

If a major component is replaced or repaired, a Qualified Medical Physicist should, in a timely manner, evaluate the need for performance testing of the SPECT/CT. The scope of the evaluation should be determined by the Qualified Medical Physicist based on the type of component that was replaced or repaired.

IV. QUALITY CONTROL

B. Equipment Performance Evaluation

1. SPECT

The performance evaluation of the SPECT subsystem should be based on the ACR–AAPM Technical Standard for Nuclear Medical Physics Performance Monitoring of Gamma Cameras [6]. For systems with pixelated detectors and/or unique detector geometry (ie dedicated cardiac systems), there may be substantial differences in the performance evaluation that the Qualified Medical Physicist and quality management team should consider. Similar manufacturer-specific performance measurements may be substituted. All required calibration procedures described by the manufacturer for SPECT cameras should be completed before to an equipment performance evaluation. This may include the calibration of the uniformity correction, center of rotation, and head alignment for multihead SPECT cameras.

IV. QUALITY CONTROL

B. Equipment Performance Evaluation

2. CT

The performance evaluation of the CT components should be based on the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment [7].

Hybrid systems may incorporate CT components not found in conventional rotational CT systems, such as a very low-power X-ray tube, a rotational cone beam system with a flat-panel X-ray detector, or a photon-counting gamma detector system. Consequently, some of the performance measurements identified in the technical standard may not apply to them. Similar manufacturer-specific performance measurements may be substituted.

IV. QUALITY CONTROL

B. Equipment Performance Evaluation

3. SPECT/CT in Combination

The performance of the combined system should be monitored at least annually by a Qualified Medical Physicist. There are some testing procedures that evaluate the effectiveness of both systems simultaneously or how one subsystem performs to enhance the other.

IV. QUALITY CONTROL

B. Equipment Performance Evaluation

4. Radiation Output or Dosimetry

Radiation output or dosimetry

a. CT
   i. The Qualified Medical Physicist should measure the CT dose indices (eg, CTDIvol, CTDIfreeair) or other established CT dose metrics. For nonconventional CT, refer to the manufacturer's dose measurement procedure.
   ii. Review protocols to include age and weight considerations. If pediatric patients are scanned with the system, then pediatric protocols should also be reviewed.
   iii. Report CT dose indices or other established CT dose metrics for representative examinations [8].
   iv. The Qualified Medical Physicist should also review dose reporting requirements and dose alert availability and setup.
   v. CT dose levels should be compared with appropriate guidelines or recommendations when available. See the ACR–AAPM–SPR Practice Parameter for Diagnostic Reference Levels and Achievable Doses in Medical X-Ray Imaging [9]. The dose from low-dose CT protocols for attenuation correction and image registration may be one-third or lower than that of standard reference levels.

b. SPECT
   i. The Qualified Medical Physicist should ensure a table listing radiopharmaceuticals and typical administered activities for all procedures commonly performed at the facility is available as described in the ACR–AAPM Technical Standard for Nuclear Medical Physics Performance Monitoring of Gamma Cameras [6].
   ii. Within the table, separate values for patient age, size, and sex should be tabulated when applicable.
   iii. The table should be reviewed by the Qualified Medical Physicist at least annually and updated when any of the following occur: 1) addition of new procedures and/or radiopharmaceuticals, 2) change in radiopharmaceutical dosage schedules, 3) change in route of administration, and 4) availability of more accurate dosimetric data

IV. QUALITY CONTROL

C. Continuous Quality Control

A continuous QC program must be implemented for all SPECT/CT 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). The program should be consistent with the recommendations of the ACR–ACNM–SNMMI–SPR Practice Parameter for the Use of Radiopharmaceuticals in Diagnostic Procedures [10], ACR–AAPM Technical Standard for Nuclear Medical Physics Performance Monitoring of Gamma Cameras [6], and the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment [7, 11].

The Qualified Medical Physicist should periodically monitor the results of the QC program. If measured values of QC parameters fall outside the control limits, the Qualified Medical Physicist should initiate appropriate investigative or corrective actions. The Qualified Medical Physicist should be available to assist in recommending corrective actions for unresolved problems.

In addition, regular preventive maintenance should be performed and documented by an equipment service engineer following the recommendations of the equipment vendor.

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A Qualified Medical Physicist must conduct acceptance testing and performance monitoring of SPECT/CT equipment.

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 subfield(s) by the American Board of Radiology (ABR), the Canadian College of Physics 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) [12].

The appropriate subfield of medical physics for this standard is Diagnostic or Nuclear Medical Physics. (ACR Resolution 17, adopted in 1996 – revised in 2008, 2012, 2022, Resolution 41f)
Medical physicists who are board-certified in an area limited to X-ray imaging or nuclear medicine imaging are expected to obtain additional training and directed experience according to the ACR technical standards and practice parameters before representing themselves as qualified to evaluate hybrid systems [13, 14].

The Qualified Medical Physicist must be familiar with the principles of imaging physics and radiation protection; the guidelines of the National Council on Radiation Protection and Measurements (NCRP); laws and regulations pertaining to the use of the equipment being tested; the function, clinical uses, and performance specifications of the imaging equipment; and the calibration processes and limitations of the instruments and techniques used for testing performance.

The Qualified Medical Physicist is responsible for:

1. The design of the overall program of performance monitoring (including the selection of specific methods for acceptance testing and QC testing)
2. Documentation of program goals, policies, and procedures related to performance monitoring
3. Documentation of the results of all performance measurements
4. Communication of any findings or recommendations to the quality management team.
5. Review and approval of all measurements performed by other designated personnel

The Qualified Medical Physicist may be assisted by properly trained individuals in obtaining data. These individuals must be approved by the Qualified Medical Physicist in the techniques of performing tests, the function and limitations of the imaging equipment and test instruments, the reasons for the tests, and the importance of the test results. The Qualified Medical Physicist is responsible for and must review, interpret, and approve all data and must provide a signed report with conclusions.

VI. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, non-physician radiology providers, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, "as low as reasonably achievable" (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Facilities and their responsible staff should consult with the radiation safety officer to ensure that there are policies and procedures for the safe handling and administration of radiopharmaceuticals in accordance with ALARA principles. These policies and procedures must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by applicable state, local, or other relevant regulatory agencies and accrediting bodies, as appropriate. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol, using body habitus or other customized method when such guidance is available.
Nationally developed guidelines, such as the ACR's Appropriateness Criteria®, should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org). These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

VII. RADIATION SHIELDING CONSIDERATIONS

Consideration must be given to radiation shielding requirements for SPECT/CT facility design. A Qualified Medical Physicist should evaluate shielding requirements for all areas where radiopharmaceuticals or radioactive materials and wastes are prepared, used, or stored. An evaluation must be performed any time there is a change to the equipment in the room, a change of the physical layout of the immediate area, or when significant alterations to work processes occur.

The presence of the CT component may add additional shielding requirements not typically encountered in a nuclear imaging suite; therefore, special attention must be given to these requirements. A Qualified Medical Physicist should be consulted early in facility design planning stages so that shielding requirements can be determined and structural design issues resulting from the use of appropriate amounts of shielding can be assessed. The NCRP Report no.147 [15] should be used as a reference in determining CT-specific shielding requirements.

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).

ACKNOWLEDGEMENTS

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.

Writing Committee – members represent their societies in the initial and final revision of this practice parameter

ACR
Grice, Jared V DMP, Chair
Amurao, Maxwell MBA, PhD

AAPM
Graves, Stephen A PhD
Kasraie, Nima PhD

Bevins, Nicholas PhD
Mawlawi, Osama PhD
Nye, Jonathon A PhD
Shuman, Jillian DMP
Thompson, Emily A PhD
Nelson, Jeffrey MHP

Committee on Practice Parameters and Technical Standards – Medical Physics
(ACR Committee responsible for sponsoring the draft through the process)

Keenan, Mary Ann DMP, Chair
Bevins, Nicholas PhD
Carver, Diana E PhD
Grice, Jared V DMP
Mawlawi, Osama PhD
Rubinstein, Ashley E PhD
Tarver, Russell B MS
Berns, Eric A PhD
Buckey, Courtney R PhD
Dieguez Gonzalez, Ana MS
Gros, Sebastien PhD
Pacella, Matthew A MS
Schofield, Deborah L PhD

Committee on Practice Parameters and Technical Standards
(ACR Committee responsible for sponsoring the draft through the process)

Caplin, Drew M MD, Chair

Amurao, Maxwell MBA, PhD, Chair, Commission on Medical Physics
Larson, David B MBA, MD, Chair, Commission on Quality and Safety

Comments Reconciliation Committee

Edmonson, Heidi A PhD - CSC, Chair
Bevins, Nicholas PhD
Graves, Stephen A PhD
Kasraie, Nima PhD
Larson, David B MBA, MD
Nelson, Jeffrey MHP
Pacella, Matthew A MS
Thompson, Emily A PhD
Amurao, Maxwell MBA, PhD
Caplin, Drew M MD
Grice, Jared V DMP
Keenan, Mary Ann DMP
Mawlawi, Osama PhD
Nye, Jonathon A PhD
Shuman, Jillian DMP

REFERENCES

1. O'ConnorMichael KMKDepartment of Nuclear Medicine, Mayo Clinic, Rochester, MN 55905, USA. mkoconnor@mayo.edu, KempBrad JBJ. Single-photon emission computed tomography/computed tomography: basic instrumentation and innovations. Semin Nucl Med 36:258-66, .
2. Delbeke D, Coleman RE, Guiberteau MJ, et al. Procedure Guideline for SPECT/CT Imaging 1.0. J Nucl Med. 2006 Jul;47(7):1227-34.
3. Amurao M, Gress DA, Keenan MA, Halvorsen PH, Nye JA, Mahesh M. Quality management, quality assurance, and quality control in medical physics. Journal of Applied Clinical Medical Physics. 24(3):e13885, 2023 Mar.
4. American Association of Physicists in Medicine. AP 125-A Statement on the description of involvement of Medical Physicists in clinical procedures. Available at: https://www.aapm.org/org/policies/details.asp?id=2561. .
5. American Association of Physicists in Medicine. AAPM Task Group 270 - Display Quality Assurance. Available at: https://www.aapm.org/pubs/reports/RPT_270.pdf. .
6. American College of Radiology. ACR–AAPM Technical Standard for Nuclear Medical Physics Performance Monitoring of Gamma Cameras. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=196+&releaseId=2
7. American College of Radiology. ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance

Monitoring of Computed Tomography (CT) Equipment. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=131+&releaseId=2
8. American Association of Physicists in Medicine. The measurement, reporting, and management of radiation dose in CT. AAPM Report No. 96; 2008. Available at: http://www.aapm.org/pubs/reports/rpt_96.pdf.
9. American College of Radiology. ACR–AAPM–SPR Practice Parameter for Diagnostic Reference Levels and Achievable Doses in Medical X-Ray Imaging. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=16+&releaseId=2
10. American College of Radiology. ACR–ACNM–SNMMI–SPR Practice Parameter for the Use of Radiopharmaceuticals in Diagnostic Procedures. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=171+&releaseId=2
11. Dillon C, Breeden III W, Clements J, et al.. Computed Tomography Quality Control Manual: American College of Radiology; 2017. https://www.acr.org/-/media/ACR/Files/Clinical-Resources/QC-Manuals/CT_QCManual.pdf.
12. American College of Radiology. ACR Practice Parameter for Continuing Medical Education. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=130+&releaseId=2
13. American College of Radiology. ACR accreditation computed tomography program requirements. Available at: https://www.acraccreditation.org/modalities/ct.
14. American College of Radiology. ACR accreditation nuclear medicine and PET program requirements. Available at: https://www.acraccreditation.org/modalities/nuclear-medicine-and-pet.
15. National Council on Radiation Protection and Measurements. Structural Shielding Design for Medical X-Ray Imaging Facilities. NCRP 147. Bethesda, Md 2004.
16. Halama J, Graham D, Harkness BA, et al. Halama et al. Acceptance Testing and Annual Physics Survey Recommendations for Gamma Camera, SPECT, and SPECT/CT Systems. The Report of AAPM Task Group 177.
17. Samei EE, Bakalyar DD, Boedeker KK, et al. Performance evaluation of computed tomography systems: Summary of AAPM Task Group 233. Med Phys 46:e735-e756, .
18. McCollough CH, Zink FE. Performance evaluation of a multi-slice CT system. Med Phys. 1999 Nov;26(11):2223-30.
19. ImPACT. Information leaflet No. 1, CT scanner accpetance testing. Version 1.02. Available at: http://www.impactscan.org/download/acceptancetesting.pdf.

*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.

Development Chronology for this Technical Standard
2009 (Resolution 6)
Revised 2014 (Resolution 35)
Revised 2019 (CSC/BOC)
Amended 2023 (Resolution 2c, 2d)
Revised 2025 (CSC/BOC)- Effective Date, August 1st, 2025

Appendix A

SPECT/CT Equipment Evaluation Parameters

The recommended parameters to be evaluated are listed below, with designations for acceptance testing, performance evaluation, and quality control.

Parameter	Acceptance Testing	Equipment Performance Evaluation	Continuous Quality Control	Comments, Details, and Other Considerations
Evaluation of radiation shielding [15]	Y	Y	N	Including but not limited to verification of shielding

				documentation, confirmation of shielding integrity, scatter and stray radiation measurements, posting requirements, and workload assessment to identify changes in use since acceptance.
Mechanical and system safety evaluation	Y	Y	Y*	All mechanical parts move smoothly, without obstructions. Visual and audible signals functional. Unit is mechanically stable. All electrical wiring is secured as designed and undamaged. All system protective coverings are intact. System interlocks and emergency power switches are operational.
Verification of electrical safety and interoperability	Y*	N	N	
Compliance with all terms and line items of the purchase agreement or contract	Y*	N	N	If the documentation is available to the Qualified Medical Physicist
Compliance with manufacturer's relevant imaging and safety performance specifications	Y	Y		If applicable
Manufacturer-recommended	Y	Y	Y	If applicable.

calibration and quality control procedures not otherwise described				
Review of Continuous QC	Y	Y	N/A	At acceptance continuous QC should be established.
Diagnostic and modality display monitor(s) performance assessment [5]	Y	Y	Y*	When available to the physicist this may include hardcopy printers. If used for primary interpretation: viewing conditions, illuminance and monitor cleanliness.
Tests required by all pertinent regulations.	Y	Y	Y	
Planar and SPECT Subsystem (as applicable to the design of the scanner)				
Intrinsic Uniformity	Y	Y	Y*	
System Uniformity with all Commonly Used Collimators	Y	Y	Y	Use the single most commonly used collimator for continuous quality control
Intrinsic or System Spatial Resolution/Linearity	Y	Y	Y	For continuous quality control, the most commonly used low-energy collimator should be tested.
System Sensitivity	Y	Y	N	Including count rate per unit activity and interdetector variability
Energy Resolution	Y	Y	N	
Multiple Energy Window Registration	Y	Y	N	Only necessary if multi-energy windows are used for imaging.
Count Rate Performance	Y	Y	N	Deadtime determination or measured maximum count

				rate
Center of Rotation	Y*			
Overall System Performance for SPECT Image Quality	Y	Y	Y	Uniformity, Contrast and Spatial Resolution should be performed quarterly as a part of continuous quality control
Other tests as described in AAPM Report 177 [16]	Y*	Y*	Y*	
Computed Tomography Subsystem (As applicable to the design of the scanner)				
Review of clinical protocols	Y	Y	N	Special review should be done for pediatric protocols for age and weight considerations where pediatric patients are scanned.
Scout Prescription and alignment light accuracy	Y	Y	N	
Image Thickness	Y*	Y*	N	Not necessary for modern multi-slice systems. May be valuable for some single slice based CT systems.
Table Increment Accuracy	Y	Y	N	
Radiation Beam Width	Y	Y	N	
Low Contrast Performance	Y	Y	N	
Spatial Resolution	Y	Y	N	
CT Number Accuracy	Y	Y	Y	For Continuous QC, water only is sufficient. Multiple materials are necessary for acceptance and performance evaluation.
CT Uniformity/Artifact Evaluation	Y	Y	Y*	
Radiation Output and Dosimetry	Y	Y	N	Measurement of

				CT dose indices ((eg, CTDIvol, CTDIfreeair) or other established CT dose metrics and comparison to indicated values and established reference levels
Other tests as described in AAPM Report 233 [17] and other publications [18, 19]	Y*	Y*	Y*	
Specific tests for SPECT/CT in combination				
CT to SPECT Co-Registration	Y	Y	Y*	Specially designed phantoms are scanned on both SPECT and CT subsystems. The evaluation should also be performed after any major changes that might affect co-registration [2].
Total system SPECT/CT performance	Y	Y	N	A SPECT image quality phantom acquired with a typical clinical protocol including CT. The protocol may include CT attenuation correction, scatter correction, and iterative reconstruction algorithms. This may be the same phantom used for overall SPECT system performance.

Revised 2025 (CSC/BOC)				

*These tests are optional.