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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

Revised 2007 (Resolution 14)*

ACR TECHNICAL STANDARD FOR DIAGNOSTIC MEDICAL PHYSICS PERFORMANCE MONITORING OF COMPUTED TOMOGRAPHY (CT) EQUIPMENT

PREAMBLE

These standards are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these standards 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 physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the standards, 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 the standards when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the standards. However, a practitioner who employs an approach substantially different from these standards is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also 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 these standards 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 sole purpose of these standards is to assist practitioners in achieving this objective.

I. INTRODUCTION

All computed tomography (CT) equipment shall be evaluated upon installation and subsequently monitored at least annually or more often if required by state or local regulatory agencies, by a Qualified Medical Physicist to ensure that it is functioning properly. Additional or more frequent performance monitoring may be necessary after any service that may change the radiation exposure to patients or personnel, or the image quality.

Although it is not possible to consider all possible variations of equipment performance to be monitored, adherence to this standard will assist in maximizing image quality and in reducing patient radiation dose. Key points to consider are: performance characteristics to be monitored, patient radiation dose, qualifications of personnel, and follow-up procedures.

II. GOALS

The goals are to produce the highest quality diagnostic image at the lowest reasonable dose consistent with the clinical use of the equipment and the information requirement of the examination, and to establish performance standards.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

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 and continuing education and experience in the appropriate subfield(s) to demonstrate that an individual is competent to practice in one or more of the subfields in medical physics and to be a Qualified Medical Physicist. The ACR 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, or for MRI, by the American Board of Medical Physics (ABMP) in magnetic resonance imaging physics.

The appropriate subfields of medical physics for this standard are Diagnostic Radiological Physics and Radiological Physics.

A Qualified Medical Physicist should meet the [ACR Practice Guideline for Continuing Medical Education \(CME\)](#). (ACR Resolution 17, 1996 – revised in 2008, Resolution 7)

The medical physicist must be familiar with:

1. Principles of imaging physics and of radiation protection.
2. The guidelines of the National Council on Radiation Protection and Measurements (NCRP).
3. Laws and regulations pertaining to the performance of the equipment being tested.
4. The function, clinical uses, and performance specifications of the imaging equipment.
5. Calibration processes and limitations of the instruments used for testing performance.

The medical physicist may be assisted by properly trained individuals in obtaining data. These individuals must be approved by the medical physicist in the techniques of performing tests, the function and limitations of the imaging equipment and test instruments, the reason for the tests, and the importance of the test results. The medical physicist is responsible for and must be present during initial and annual surveys and must review, interpret, and approve all data as well as provide a signed report of conclusions.

IV. PERFORMANCE CHARACTERISTICS TO BE MONITORED

A. Characteristics to be Monitored Annually

Performance monitoring must be performed on each CT unit at least annually. This evaluation should include, but not be limited to, the following:

1. Alignment light accuracy
2. Alignment of table to gantry
3. Table/gantry tilt
4. Slice localization from scanned projection radiograph (localization image)
5. Table incrementation accuracy
6. Slice thickness
7. Image quality
 - a. High-contrast (spatial) resolution
 - b. Low-contrast sensitivity and resolution
 - c. Image uniformity
 - d. Noise
 - e. Artifact evaluation
8. CT number accuracy, linearity, and homogeneity
9. Display devices
 - a. Image display monitor(s)
 - b. Hard-copy display unit(s), if available
10. Dosimetry
 - a. CT dose index (CTDI)
 - b. Patient radiation dose for representative examinations
11. Safety evaluation
 - a. Visual inspection
 - b. Work load assessment
 - c. Scatter and stray radiation measurements (if work load and other related parameters have changed since acceptance testing or if CT fluoroscopy is routinely performed)
 - d. Audible/visual signals
 - e. Posting requirements
12. Other tests as required by state or local regulations.

B. Monitoring Required after Replacement or Repair of a Major Component

If a major component such as an X-ray tube or detector assembly is replaced or repaired, a medical physicist should verify the performance of the CT unit. The evaluation should be determined by the medical physicist based on the type of component that was replaced or repaired.

C. Patient Radiation Dose

Patient radiation dose for CT equipment shall be evaluated at least annually. Measurements of CTDI values of commonly used imaging protocols, or of other dosimetric metrics, should be performed and compared to

the vendor's displayed values. Tables of patient radiation absorbed dose for representative examinations (e.g., head, thorax, abdomen, and pelvis) shall be prepared and supplied to the facility. These results shall be compared with appropriate guidelines or recommendations when they are available.

V. QUALITY CONTROL PROGRAM

A continuous quality control (QC) program shall be established for all CT units with the assistance of a medical physicist. The medical physicist should determine the frequency of each test and who should perform each test based on the facility and CT usage. An on-site radiologic technologist shall be identified to be responsible for conducting routine QC.

The QC program should include, but not be limited to, the following:

1. Alignment light accuracy
2. Slice thickness
3. Image quality
 - a. High-contrast (spatial) resolution
 - b. Low-contrast sensitivity and resolution
 - c. Image uniformity
 - d. Noise
 - e. Artifact evaluation
4. CT number accuracy and homogeneity
5. Digital display fidelity

The results of the QC program shall be monitored annually by the medical physicist. If measured values of QC parameters fall outside the control limits, the physicist shall initiate appropriate investigative or corrective actions. A medical physicist should be available to assist in prescribing corrective actions for unresolved problems.

VI. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, radiologic technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as "as low as reasonably achievable (ALARA)."

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active; if not, manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Periodically, radiation exposures should be measured and patient radiation doses estimated by a

medical physicist in accordance with the appropriate ACR Technical Standard. (ACR Resolution 17, adopted in 2006 – revised in 2009, Resolution 11)

VII. ACCEPTANCE TESTING

Initial performance testing shall be performed upon installation and should be completed before clinical use. This testing shall be more comprehensive than periodic performance and compliance testing and should be consistent with current acceptance testing practices.

VIII. FOLLOW-UP PROCEDURES AND WRITTEN SURVEY REPORTS

The medical physicist shall report the findings to the physician(s), to the responsible professional(s) in charge of obtaining or providing necessary service to the equipment, and, in the case of the consulting physicist(s), to the representative of the hiring party, and, if appropriate, initiate the required service. Action shall be taken immediately by verbal communication if there is imminent danger to patients or staff using the equipment due to unsafe conditions. Written survey reports shall be provided in a timely manner consistent with the importance of any adverse findings.

ACKNOWLEDGEMENTS

This guideline was revised according to the process described under the heading *The Process for Developing ACR Practice Guidelines and Technical Standards* on the ACR web page (<http://www.acr.org/guidelines>) by the ACR Guidelines and Standards Committee of the Commission on Medical Physics.

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Suggested Reading (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

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*Guidelines and standards are published annually with an effective date of October 1 in the year in which amended, revised or approved by the ACR Council. For guidelines and standards published before 1999, the effective date was January 1 following the year in which the guideline or standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Standard

1998 (Resolution 14)
Revised 2002 (Resolution 21)
Amended 2006 (Resolution 16g, 17)
Revised 2007 (Resolution 14)
Amended 2009 (Resolution 11)