

**New York State Department of Health
Bureau of Environmental Radiation Protection**

**Guide for Radiation Safety/Quality Assurance Programs
Computed Radiography**

INTRODUCTION

A. Purpose

This guide describes a model quality assurance program for the evaluation of Computed Radiography equipment as a part of a facility’s Radiation Safety/Quality Assurance Program. The Department of Health has developed this program to reduce radiation exposure to patients, optimize diagnostic image quality and foster facility involvement in the responsibility for Quality Assurance (QA). Facilities may adopt this program or they may develop their own program. Inquiries can be directed by email to berp@health.state.ny.us or by surface mail to:

**Bureau of Environmental Radiation Protection
New York State Dept of Health
547 River Street
Troy, N.Y. 12180.**

B. Limits and Standards

The American Association of Physicists in Medicine Report No. 93, “Acceptance Testing and Quality Control of Photostimulable Storage Phosphor Imaging Systems”, the online report OR-03 “Assessment of Display Performance for Medical Imaging Systems” and other references are the control limits and standards that are the basis of this guide. These documents can be found at www.aapm.org.

Equipment problems identified through the application of this guide should be corrected and documented expeditiously and shall be corrected, with appropriate documentation, within thirty (30) days of discovery.

C. Regulations/Authority

The statutory authority for regulations is found in the New York State Public Health Law, Section 225. The Radiation Safety/Quality Assurance requirements are outlined in Sections 16.5 and 16.23 of Part 16 of Chapter 1 of Title 10 (Health) of the Official Compilation of Codes, Rules and Regulations.

Radiation Safety/Quality Assurance Programs

A. **Radiation Safety/Quality Assurance Responsibility**

Responsibility for Computed Radiography Quality Assurance is a function of the size of the facility. Large facilities can absorb the responsibilities and structure for CR quality assurance into the existing committee responsible for overseeing diagnostic radiography. In smaller facilities, it is the responsibility of the physician who serves as the Radiation Safety Officer. The responsibility for CR equipment preventative maintenance/testing falls upon several different groups. Medical physicists, radiologic technologists, in-house engineering, and manufacturer service representatives are responsible for various aspects of equipment evaluation or performance. The QA responsibilities for each party shall be defined as a manual item.

B. **Records**

1. **Quality Assurance Manual**

Establish a manual that includes the following items:

- a. **a list of tests to be performed and the frequency of performance;**
- b. **a list identifying which individual or group will be doing each test;**
- c. **a written description of the procedure that will be used for each test;**
- d. **a list of all the variables which comprise the operating conditions for each test procedure;**
- e. **the acceptability limits for each test;**
- f. **a list of the equipment to be used for testing; and**
- g. **sample records to be used for each test.**

2. **Equipment Records**

Records will be maintained for each unit currently in operation and include:

- a. **the initial test results (acceptance testing and radiation safety survey as appropriate); and**
- b. **the CR exposure indicator numbers and image retakes rates. These results should be trended and kept for a period of three years.**

3. QC Records for Test Equipment

Records will be maintained and available for review for QC test equipment that requires calibration. QC records may be maintained in either a hardcopy or softcopy format, but must be available for review during inspections and whenever else they are needed.

C. Equipment Monitoring

Each facility will make or have made quality control tests to monitor equipment performance and maintain records of data collected. The tests performed will vary from manufacturer to manufacturer but must include those quality control checks specified by the manufacturer and be modeled after the program below. If, at the time of inspection, significant equipment malfunctions are found, the facility may be required to perform more frequent testing to ensure good diagnostic image quality.

This guide describes a basic Radiation Safety/Quality Assurance Program and represents only a portion of the Quality Control tests your facility may choose to perform as part of an individualized program. Facilities with equipment under warranty or service contract with an Original Equipment Manufacturer (OEM) or an Independent Service Organization (ISO) must follow the testing and preventive maintenance schedule required by the OEM or ISO to keep the warranty or contract valid. The OEM or ISO testing and maintenance schedule must be included in the manual. Facilities with equipment not under warranty or service contract must follow the testing frequency stated in this guide. Facilities must perform all the QC tests which the manufacturer supplied phantom will allow.

Appropriate quality control testing must be conducted whenever major maintenance or a change in equipment operation (software change) occurs.

1. Test Frequency – Daily

The technologist needs to check each patient image, softcopy and hardcopy, for artifacts. Artifacts may be caused by dust particles, scratches, lines, mechanical friction marks or other factors. If an artifact is found to be common to a particular Imaging Plate (IP), that plate shall be removed from service until the cause of the artifact is eliminated.

Softcopy images shall be evaluated on a radiologist's workstation and viewed over a range of window-level settings consistent with routine clinical practice.

All images must be quality controlled, verified and properly stored.

Maintain a record of image retakes including date and cause for future reference and review.

2. Test Frequency - Quarterly

- a. Evaluate a 10% sampling of a random assortment of plates for dark noise following the manufacturer's instructions. Dark noise is the residual signals from background radiation or other sources on an unexposed cassette. If widespread failures are noted then the entire inventory will be evaluated. The exposure indicator numbers (e.g., S value, exposure index, or IgM, etc.) are documented and retained for future reference and review.**
- b. Make a QC phantom image using a phantom that is designed by the original equipment manufacturer and implement the suggested testing protocol. If a manufacturer's phantom is not available, use an appropriate phantom that includes gray scale patterns and a spatial resolution test pattern. Perform qualitative and quantitative analysis of the test image for:
 - 1. resolution,**
 - 2. contrast/noise,**
 - 3. laser jitter, and**
 - 4. exposure indicator accuracy.****

Document findings and store acquired data for future use and review.

- c. Verify the calibration of the photostimuable storage phosphor (PSP) workstations. If the system is capable, this can be accomplished by using a SMPTE video test pattern, the methodology of AAPM TG-18 for monitor quality control, or a comprehensive phantom image that includes gray scale patterns and a spatial resolution pattern.**
- d. Visually inspect and clean all cassettes and imaging plates with methods that are approved by the equipment manufacturer. All plates should be erased before being placed back into service. The cleaning frequency is based upon the particular environment that the plate is used in. Cleaning more or less frequently may be necessary should environmental conditions warrant.**
- e. Review the image retake rate and determine the causes of unacceptable PSP images. Document findings and maintain records of review.**
- f. Review the QC exposure indicator database. Determine the cause of under/overexposures, implement corrective action and generate a quarterly report that can be reviewed by the Radiation Safety Committee or RSO. The incident exposures on the IPs should be tracked to analyze any trends and in particular "dose or CR creep" as there is an optimal level of exposure for each type of exam that is performed.**

3. Test frequency - Annually

a. IP Dark Noise

Each IP must be erased with the full erasure cycle. The hard and soft images for each IP should be clear, uniform and artifact free. Corrective action for any artifacts, density shading or non-uniformities must be made prior to performing other tests.

b. Imaging Plate Linearity and Sensitivity

Verify the response of selected IPs to several different levels of radiation exposure (e.g., 0.1, 1, and 10 mR). Measure the optical density or pixel value to determine linearity. At the same time, the manufacturer's method of establishing an estimate of the incident exposure on the plate can be verified when the incident exposure is measured with a calibrated radiation detector. If a calibrated radiation detector is not available on-site, evaluate linearity and sensitivity by using appropriate technique factors obtained from a medical physicist.

c. System Linearity and Sensitivity

This is accomplished by a uniform exposure of several plates of each size dimension over a range of exposures, for example 0.1, 1.0, 10 mR (this must be measured with a calibrated ionization chamber) using a standard kV (e.g., 80 kVp) and added filtration, if recommended by the manufacturer, (e.g., 1 mm Cu). Use an extended SID of 180 cm to minimize the heel effect. Using a standard display, the resultant images should have a constant image density across the field of view. Hardcopy images should be within 0.5 OD of the target OD. The measured exposures to the IP as determined by the CR system exposure index, S-number or DgN value, should agree to within 20% over the three orders of magnitude of incident exposure.

d. Image Quality

Uniformity is evaluated by selecting several different sizes of ISP and then exposing them to the same quantity of radiation (approximately 1 mR) and processing the plates with a standardized image acquisition and processing routine. Compare the resultant images for any type of artifacts.

e. Uniformity and Reproducibility

Compare the OD or pixel value from similar images acquired in step 3d above for uniformity of response and reproducibility.

f. Image Geometric Uniformity and Spatial Resolution

A test object such as a line-pair resolution phantom or other device is imaged in each of the 4 quadrants of the IP with minimum magnification using a standard acquisition protocol and a reasonable incident exposure (1 mR). Verification of pixel calibration and pixel dimensions along the rows (x-dimension) and columns (y-dimension) is performed for each quadrant. The results should be within 5% of one another. A resolution test pattern appropriate for the system (e.g., 1-5 lp/mm) is then placed centrally with a 45 degree orientation along the x-axis and a second resolution test pattern is placed in one of the outer quadrants with orientation along the laser scan lines. The IP is then exposed to a moderate incident exposure (e.g., 50 kVp and 5 mAs at 180 cm with no filtration). Process the IP and determine the limiting resolution in both the horizontal and vertical directions. The measured resolution should be within 10% of the theoretical resolution based upon the sampling frequency of the imaging plate as specified by the manufacturer.

g. Artifacts

Each IP should be evaluated for artifacts using a uniform attenuator (such as acrylic or copper). Artifacts should be evaluated using either softcopy or hardcopy with sufficiently narrow windows to demonstrate clinically significant artifacts.