RAD 220 QUALITY ASSURANCE FOR RADIOGRAPHERS

BASIC TESTS

• KVP TEST
• TIMER
• HALF VALUE LAYER
• RADIATION OUTPUT
• REPRODUCIBILITY
• RECIPROCITY
• LINEARITY

BASIC TESTS

• FOCAL SPOT SIZE
• FIELD LIGHT-X-RAY FIELD CONGRUENCY TEST
• ILLUMINATOR BULB BRIGHTNESS
• BEAM PERPENDICULARITY
KVP TEST

- WISCONSIN TEST CASSETTE
- DIGITAL KVP METER

WISCONSIN TEST CASSETTE

The test cassette produces a series of density columns on an exposed radiograph. For each kVp setting, two columns are created: a reference column and a test column.

The reference column has the same density. Find the density on the test column that most closely matches the density on the reference column.
WISCONSIN TEST CASSETTE

If an identical match is not found, then interpolation is necessary. The result determines the “step” that corresponds to the actual kVp used. The step is compared to a chart which indicates the actual kVp. The actual kVp must be within ±5% of the operating level kVp.
A much quicker method is to use a digital kVp meter. This is a dedicated device which will indicate the actual kVp used. The controls must be adjusted to specify if the proper phase (single, three-phase). The acceptance limit is the same.
KVP ACCURACY

Must always be tested before any output-related tests are done (filtration, repeatability, reciprocity, and linearity).

TIMER ACCURACY

Timer accuracy is performed in order to ensure accurate mAs values. This can be done using a manual “spinning top” method or with a digital meter.
SPINNING TOP TEST
The spinning test for single-phase equipment is a simple device which can be turned by hand prior to an exposure. The 1/10, 1/20, 1/30, and 1/40-second timer setting should be tested on single-phase equipment.

SPINNING TOP TEST
The acceptance limit for the timer settings is ±5%. For settings shorter than 1/100 seconds (10 ms) is ±20%

SPINNING TOP TEST
For three-phase and high-frequency generators, a SYNCHRONOUS SPINNING TOP device can be used. It has a rotating disk that is turned by a motor at 1 rps.
SPINNING TOP TEST
As with the manual spinning top, a radiograph of the synchronous disk is exposed. The degrees of arc recorded on the film can be used to calculate the actual exposure time.

EXAMPLE
A timer test on a three-phase generator is performed. If an exposure time of 1/40 second is used and the resulting arc is 60 degrees, is the timer working accurately?

ANSWER
A 1/40 second exposure should produce an arc equal to:
360 x 1/40 = 9 degrees. Therefore, 60 degrees means that the exposure is longer than 1/40 second.
FILTRATION CHECK
Whenever a new x-ray tube is installed or when the tube or collimator is serviced, a HVL test should be done. This is done to ensure that adequate filtration is present in the beam to reduce skin dose.

FILTRATION CHECK
The half value layer is NOT a direct measure of the amount of filtration in the tube housing. By definition, HVL is the amount of filtration necessary to reduce the exposure rate by 1/2.

FILTRATION CHECK
To perform the test, an exposure factor is selected at the appropriate kVp. For diagnostic tubes, use 80 kVp. A dose reading is obtained and recorded. Subsequent exposures are made with aluminum filters added to the beam.
FILTRATION CHECK

Each dose is recorded and a chart. Once the recorded dose falls to 1/2 the original rate, determine the half value layer. No less than 2.3 mm is acceptable.

FILTRATION CHECK

RADIATION OUTPUT

The purpose of this test is to provide a baseline exposure rate which can be used to measure changes from year-to-year as well as room-to-room comparisons on identical generators.
RADIATION OUTPUT

An exposure consisting of 80 kVp, 100 mA and 100 ms (.10 sec) is used. The output is recorded in mR/mAs. The year-to-year acceptance limit as well as room-to-room acceptance limit is ±10%.

REPRODUCIBILITY

A simple test which measures the ability of the x-ray generator to faithfully deliver the same output when the same exposure factors are used.
REPRODUCIBILITY

A kVp, mA and time factor is selected and an exposure made. A dosimeter records the output. A series of 5 separate exposures are made with the same factors. The output for each is recorded.

REPRODUCIBILITY

From the recorded output readings, the maximum and minimum readings are plugged into the following formula:

\[
\text{Reproducibility Variance} = \frac{mR_{\text{max}} - mR_{\text{min}}}{mR_{\text{max}} + mR_{\text{min}}} \times 100
\]

The reproducibility variance should be no more than 5%. This test is done annually and when the generator or tube are serviced.
This test measures the ability of the x-ray generator to produce the same output given the same kVp and mAs, but different mA and time settings.

A set of five exposures are made. mR/mAs readings are made for each exposure. From this data, the average mR/mAs is determined. The maximum and minimum mR/mAs values are also identified.

The mR/mAs values are then plugged into the following formula:

Reciprocity Variance = \[
\left( \frac{mR / mAs_{\text{max}} - mR / mAs_{\text{min}}}{mR / mAs_{\text{average}}} \right) \div 2 \times 100
\]
**RECIPROCITY**

The reciprocity variance should be no more than 10%. This test is done on an annual basis.

**LINEARITY**

Is a test of the mA and timer to determine the proportionality of output given increasing exposure factors (mA or time). The assumption is that if the exposure factor tested doubles, the radiation output should also double.

**mA LINEARITY**

To test mA linearity, the mA is increased while the other factors are held constant. A series of 5 exposures are made and the mR/mAs readings taken. For example, the 25, 50, 100, 200 and 400 mA stations are tested.
TIMER LINEARITY
A series of 5 exposures are made with changes in the timer (e.g., .05, .10, .20, .40, .80 sec) with the other factors held constant. The mR/mAs readings are taken and then plugged into the formula used for reciprocity variance.

LINEARITY
The linearity variance should not exceed 10%. This test is done on an annual basis.

TESTS OF FOCAL SPOT SIZE
With use, the focal spot will increase in size due to constant heating and cooling of the filament. This is called BLOOMING and impacts the effective focal spot and consequent recorded detail.
FOCAL SPOT SIZE
- PINHOLE CAMERA
- STAR RESOLUTION TOOL
- FOCAL SPOT TEST TOOL (RMI)

PINHOLE CAMERA
This test produces the effective focal spot on radiographic film. Allowing for an “ENLARGEMENT FACTOR,” the measurement taken off of the film determines the dimensions of the effective focal spot.

STAR TEST PATTERN
A disk with radiating bars is used to produce a radiographic image. To determine effective focal spot size, the magnification factor must be known (image size/object size).
Measurements off of the radiographic image of the star are taken lengthwise and crosswise. Along with the magnification factor, the measurements are put into the formula:
Focal spot size in mm = $\theta D/(M-1)$
STAR TEST PATTERN

In the formula,

\[ \frac{\theta D}{(M-1)} \]

\( \theta \) is the spoke angle of the pattern in radians (degrees x \( \pi/180 \)). Acceptance limits for both the pinhole camera and star test pattern tests are based on NEMA standards...
WHY RADIANS MEASURE?

• DEGREE MEASURE IS SOMEWHAT ARBITRARY (WHY IS A CIRCLE EQUIVALENT TO 360° AND NOT 400° OR 750°?)
• SCIENTIFIC & ENGINEERING CALCULATIONS BASED ON DEGREES ARE LESS ACCURATE THAN THOSE USING RADIANS (THINK FRACTIONS VERSUS DECIMALS)

WHAT IS A RADIUS

A radian is an angle formed between two radii when the length of said radii equals its connecting arc…
In math we learned that a circle is equivalent to $360^\circ$. We also learned that the circumference of a circle is equal to $2\pi r$. Therefore, $2\pi r = 360^\circ$. Assuming that $r = 1$, $2\pi = 360^\circ$.

- If $2\pi = 360$ degrees, then 1 degree = $2\pi/360$, or $\pi/180$.
- If $2\pi = 360$ degrees then 1 radian = $360/2\pi$, or $180/\pi$.
- 1 radian = $180/\pi = 57.3^\circ$
NEMA ACCEPTANCE LIMITS

• LESS THAN 0.8 MM = 50% OF NOMINAL
• 0.8 MM - 1.5 MM = 40% OF NOMINAL
• 1.6 MM OR GREATER = 30% OF NOMINAL

FOCAL SPOT TEST TOOL

A less accurate, but reliable test of effective focal spot size, produces an image of a resolution test pattern (not the effective focal spot). A ceramic cylinder with an embedded pattern is used...

RMI RESOLUTION TEST PATTERN

![Diagram: SOD = 18" SID = 24" Non-screen film or fine detail cassette]
FOCAL SPOT TEST TOOL

Using a 24” SID, an exposure is made of the test pattern using magnification factor of 4/3. Look for the smallest test pattern where all three parallel bars are distinct. Compare result with the accompanying chart. Tests of smaller focal spots require larger magnification factor.