Q.A. Collectible

Sponsored by CRCPD's Committee on Quality Assurance in Diagnostic Radiology (H-7)

Processor Sensitometric Control

The importance of sensitometric processor quality control has become more evident over the last decade, and therefore several states are requiring facilities to perform this procedure on a daily basis. Such monitoring of processor performance can assist all facilities in consistently producing optimal images while reducing unnecessary radiation exposure. Studies have shown that processor variability is the single most important cause of retakes. This Collectible answers some basic questions on setting up an x-ray processor control program, and discusses the reasons why such monitoring is important.

Why is it important to monitor an x-ray film processor? Processor quality control ensures that the film processor is performing satisfactorily on a daily basis. This is vital for optimal diagnostic quality, reduced exposure to patients, and a minimum of repeat examinations. Offices performing automatic film processing need to use the correct chemicals and know the proper operating temperature for film processing to ensure quality radiographs. Processor quality control is becoming a recognized safety issue because it highlights and detects subtle changes which, undetected and uncorrected, could result in misdiagnosis due to poor quality, or repeat examinations resulting in unnecessary dose. Time, temperature, and chemical activity are the three processor variables that can affect film quality.

Does the radiology profession have a standard definition for Speed Index, Contrast Index, and Base + Fog? Generally, it has been recognized in the radiology profession that there are different techniques for determining Speed Index, Contrast Index, and Base + Fog. While the techniques differ from one source to another, the terms define the same measurements. Speed Index, or Mid-Density, is an indication of the processor-film-sensitometer combination speed. It is measured at the step on the sensitometric film with an optical density closest to 1.0 above base + fog (if the base + fog optical density is 0.18, speed is measured at the step having an optical density closest to 1.18). This step may be somewhere around step 11 on a 21-step sensitometric strip. Contrast Index, or Density Difference, gives an indication of the difference in density between different steps on the stepwedge, i.e., the film density difference resulting from exposure to two different light intensities. It is usually measured as the difference between those two steps on the sensitometric film that have optical densities closest to 0.25 above base + fog, and 2.00 above base + fog. Base + Fog is the optical density of the unexposed portion of the film after processing.

How does a sensitometer operate? A sensitometer is a light-producing instrument that consistently and accurately produces a step pattern of density on film. Some sensitometers provide for 21 steps, while others have a different number of steps (or light intensities).

How does a densitometer operate? This instrument measures the amount of light that passes through the film. If a densitometer reads 0.0 optical density, 100% of the light was transmitted. If the densitometer reads 1.0 optical density, 10% of the light was transmitted and 90% of the light was blocked by the film.

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How is a processor quality control program started? Facility personnel should take the following steps to begin a processor quality control program: make sure the processor has been cleaned, the chemistry is fresh, and the processor is operating at the recommended temperature, replenishment rate, and cycle time specified by the film manufacturer. Designate one box of film for processor quality control. First thing in the morning, take one piece of film from this designated box, expose it with a sensitometer in the darkroom, process the film, measure the appropriate steps with a densitometer, and record the data to determine Speed Index, Contrast Index, and Base + Fog. Repeat this procedure for five consecutive days. At the end of five days, the five daily measurements are averaged to determine the reference values (operating levels).

How are control limits established? The control limits are the boundaries within which measurements must be maintained. Once reference values are determined from the procedure above, facility personnel should daily take one piece of film from the box that has been designated for this purpose, expose it with the sensitometer, process the film, and evaluate it with the densitometer. Speed Index, Contrast Index, and Base + Fog measurements should then be determined and compared to reference values. Normally, the control limits for Speed and Contrast are $\pm$ 0.15 OD from the reference values. Some mammography requirements, however, have a more stringent $\pm$ 0.10 optical density control limit. Base + Fog usually has + 0.03 optical density control limit.

What happens if the test results are not within the established control limits? If the Speed Index or Contrast Index measurements exceed the control limits, the technologist should repeat the test. If the second test gives the same results as the first, the technologist should start troubleshooting for possible problems in the processor.

Why does the procedure require using film from the same box? Films used for sensitometric evaluations must be from the same box of film each day. The reason is that films are made in batches and there can be a slight difference from film batch to film batch. It is also recognized that humidity and temperature affect film that has been stored over time. When the box of film selected for the quality control test is almost empty, designate a new box and run comparison strips along with the final week's films taken from the original box in order to establish the appropriate reference values for the new box of film.

What is a processor control chart? A processor control chart is an important document, because when the data is plotted daily, it provides a historical trend of processor performance. The chart includes control limits and measurements for Speed Index, Contrast Index and Base + Fog. Any changes to the processor, such as changing developer temperature setting, changing chemicals, or cleaning the processor, should be documented on the chart.

What is the most important consideration when doing processor quality control? The key to good processor monitoring is consistency in human technique. Films should be inserted into the same side of the processor feed tray every time, in the same orientation. If a technologist processes single emulsion films with the emulsion side up, then the Q.C. film must always be processed in an identical manner. It is also important that processor quality control be done the same time every day. It is preferable that this test be performed in the morning before seeing patients, after the processor developer temperature has stabilized.

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Q.C. Chart

The following chart indicates possible causes of variances in sensitometric processor control results. State surveyors may wish to make this chart available to facilities performing this activity. When the plotted data on the processor control chart exceeds the control limits, the operator should investigate the cause of the problem. Below are the most common changes a technologist may detect:

Observation	**Possible Causes**
Increased Base + Fog	Developer temperature (too high) Improper safe lights (excessive wattage or inadequate filter) Improper storage Incorrect starter in developer Dirty rollers (If base + fog is measured over roller marks)
Decreased Contrast	Developer temperature (too high or too low) Depleted or contaminated developer Incorrectly mixed developer Incorrect replenishment rate Developer transit time set too short
Increased Contrast	Developer temperature (too high or too low) Incorrectly mixed developer Incorrect replenishment rate Developer transit time set too long
Decreased Speed	Developer temperature (too low) Developer depleted Incorrectly mixed developer Insufficient replenishment rate Developer over-diluted Contaminated developer Developer transit time set too low
Increased Speed	Developer temperature (too high) Contaminated developer No starter in fresh developer Incorrectly mixed developer Excessive replenishment rate Improper storage conditions Developer transit time set too long

It is recommended that your processor service dealership be notified if a problem occurs with the chemistry or the operation of the processor.

Chart and questions and answers from information provided by, and with permission from, X-Rite, Inc., Grandville, MI.

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