Eighth Edition

Quality Resource Guide

Radiographic Quality Assurance for Film Imaging Systems

Author Acknowledgements

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Educational Objectives

Following this unit of instruction, the learner should be able to:

1. Recognize those factors that influence the quality of dental radiographs.
2. List the elements that should be considered in the design of a radiographic dark room.
3. Describe a method for detecting dark room light leaks and how they can be prevented.
4. Recognize the variables that influence the quality of a dental radiograph following manual or automatic processing and how to achieve optimal quality using either technique.
5. Demonstrate familiarity with how waste resulting from radiographic processing should be managed.
6. Recognize the optimal approach to film storage.

MetLife designates this activity for **1.0 continuing education credits** for the review of this Quality Resource Guide and successful completion of the post test.

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The content of this Guide is subject to change as new scientific information becomes available.

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Quality Assurance for the Darkroom

Dental radiographs are an important and necessary adjunct to clinical dentistry. Good diagnostic radiographs provide invaluable information to the dental health team members, which assists them in providing appropriate care. Ionizing radiation can also be harmful to both the patient and dental team member if used incorrectly or inappropriately. Thus, the primary goal of radiology is to produce a diagnostically acceptable image while keeping the exposure to the patient as low as reasonably achievable (ALARA). To achieve this goal, the dental team member must possess adequate knowledge in the areas of radiation biology, radiation protection and safety, and radiographic techniques This Guide provides basic information and useful resources on each of these areas.

A quality assurance program is an important means used by health professionals to assist them in rendering the best care possible to the patient. In dental radiography, quality assurance can assist in decreasing the dose to the patient and operator as well as providing a high-quality diagnostic images. This Guide will review industry recognized quality assurance standards for the darkroom and dental operatory.

Dark Room Design

The darkroom should have a layout that is conducive for efficient processing of radiographs while maintaining proper infection control procedures. Adequate counter space should allow for unwrapping film packets and mounting films on a film rack, if manual processing, or have adequate space to accommodate an automatic processor. The room must have hot and cold running water with drainage in order to maintain appropriate processing temperatures for the developer. Processing chemicals should be stored in a cool dry area. The floor should be kept clear of boxes, etc. to prevent accidental tripping while the lights are out. Racks or film dryers should be available to allow radiographs to adequately dry. Because unexposed film is extremely sensitive to heat, humidity and background radiation, care should be taken to store unexposed films properly. The room should be well ventilated to prevent chemical fume contamination, in addition to being regulated at a moderate temperature (50-70°F) with a 30 to 50 percent relative humidity level. Extreme humidity levels, high or low, can create conditions that cause moisture contamination or static electricity.

Light Leaks

The darkroom should be secured in a manner to prevent extraneous light from entering while processing. Areas that are common culprits include doorjambs, keyholes, openings around water pipes, and lighted buttons on a telephone. Doors that cannot be locked while processing can also be a source.

To test for light leaks, stand in the darkroom with all lights turned off (including safelights) and doors closed. Allow at least 1 to 2 minutes for your eyes to become adjusted to the dark. Light leaks will become visually evident. Doors should also be equipped with a lock or sign indicating “Processing in Progress.”

Safelights

Each darkroom should be equipped with safelights that must be used while film processing. The safelights should be mounted at least 4 feet from the work area. The safelight filter must provide adequate protection based on the film sensitivity. D-speed film must use at least an amber-colored filter such as Kodak ML2. F-speed and extraoral films require a red-colored filter such as the Kodak GBX. No more than a 15-watt bulb should be used for safelights directed at the work area.

To determine if the safelights are safe from causing film fog, each should be checked monthly. With the normal overhead lighting off, check the safety of the safelight by placing a coin on top of an opened unexposed film for 3 to 4 minutes. Then process the film using normal processing procedures. If an image of the coin (light circle) appears on the film, then the filter, bulb, or distance of the mounted safelight is not safe for processing. Filters may need replacement approximately every two years if used daily for 1 to 2 hours.

Automatic processors with daylight loaders should also be evaluated for effectiveness of the filter. If the processor is positioned under fluorescent lighting with an amber-colored filter, then film fogging may occur from the white light. With the filter in place, it may be tested in the same manner as the safelight by placing a coin on top of an opened unexposed film in the daylight loader. After 3 to 4 minutes, process the film in a normal manner. The appearance of a circular image will indicate inadequate filtering.

Processing Technique

Manual Processing

The time/temperature method should be used for manual processing. Film emulsion contains certain properties that are activated only if the appropriate temperature and time are used. Thus, assessment of when the development process is completed should be accomplished by following the prescribed time/temperature guidelines and not by visual assessment. Ideally, radiographs are processed for 4½ minutes at 70° F. Films should then be agitated for 30 seconds in the rinse water, fixed for 2 to 4 minutes and then washed for 10 minutes or manufacturer’s guidelines. A time/temperature chart should be posted in the darkroom for easy reference.

The chemicals should be replenished daily. According to the manufacturer’s recommendations and radiographic workload, chemicals should be discarded appropriately (see Waste Management section) and new chemicals replaced. Records should be kept to track cleaning and chemical replacement.

Automatic Processing

The automatic processor requires minimal maintenance, but regular care is a must. If cared for according to manufacturer’s instructions, then consistent high-quality films will be produced. Components that should be cleaned or monitored regularly include the tanks, rollers, solution

levels, water reservoir, and temperature. The roller transport mechanism should be removed and cleaned according to instructions as well as the tanks that hold the chemicals. Water and chemical levels should be checked daily to replenish evaporated and depleted solutions.

The chemicals for the automatic processor differ from those used in manual processing because they are designed to process quickly at high temperatures. Thus, only chemicals designed for use in an automatic processor should be used. When replacing and replenishing chemicals, it is imperative to place the developer and fixer tanks in the correct order (developer first) in addition to containing the correct solution. Often the lid to the bottles and the corresponding chemical tanks are identical in color (*i.e.* bottle with the red lid should be poured into the red chemical container). The replacement and replenishment schedule will vary per office and is based on radiographic workload. For a normal workload (20 to 30 intraoral films/day), eight ounces of developer and fixer should be added to the existing processing solutions daily after draining approximately the same amount of used solutions. If over 30 films are developed per day, then an additional .25 oz/film should be replenished. Complete replacement of the chemicals is necessary periodically due to degradation as a result of oxidation. Based on a processing workload of 30 intraoral films per day, chemicals should be completely replaced at least every three to four weeks.

Automatic replenishment systems are available for some models of automatic processors. The ready-mixed developer and fixer solutions for these systems are attached by placing the tubing into the developer or fixer replenishment bottles. It is important to change the bottles before they become completely empty and to make sure the tubing does not become clogged. The frequency with which replenishment bottles need to be changed depends on the workload.

Specially designed developer and fixer chemistries are necessary for clinical situations that require immediate viewing of processed radiographs in 30 seconds. These rapid processing chemicals may be used with D and F speed films. After viewing, the films must be returned to the fixer for the full fixing time according to the manufacturer's instructions. Note that it is imperative that the appropriate processing chemistry be used for rapid processing.

Waste Management

The practitioner should become familiar with the requirements of the Resource Conservation and Recovery Act of 1976. This law provides, generally, that processing chemicals (processing effluent) and lead foil packing (waste solids) should be disposed of properly to keep a safe environment. These items should not be disposed of in the trash or in the drain unless treated. Based on the amount of waste produced, a variety of options are available to dental offices to safely eliminate the hazardous waste. Generally, a licensed waste hauler should recycle hazardous waste, such as the lead foil found

in the film packet. Lead recycling programs are also available. Local companies for lead or silver reclamation can be identified through an internet search. Terms that may be used are: "silver recycling", "lead recycling", "dental film recycling" or similar terms. Processing solutions that contain 5 mg/L or more of silver are also considered a hazardous waste. Silver estimation papers can be used to monitor silver content levels. These strips of paper will measure the amount of silver in the processing solutions. Management options such as silver reclaiming units should be used to remove silver from the fixer solution. In addition, some companies will buy scrap film for silver recovery. State and local regulations may vary, so it is recommended that each dental office check with their State Hazardous Waste Management Agencies and Water Pollution Control Agencies to determine if they comply.

Film Storage and Cassettes

Unexposed film should be stored in a cool dry area. Expiration dates should be monitored and the film with the nearest dates should be used first. Exposed films should be stored in a "Safe Area" to prevent double exposure. Extraoral film should be stored with the box on end to prevent artifacts from occurring due to pressure marks on the emulsion. Intensifying screens, located inside

Table 1 - Activities Performed by Office Personnel

This table provides a summary of quality assurance activities that current literature suggests dental personnel should perform on a daily or monthly basis.

Area or Type of Equipment	Quality Assurance Activity	Frequency
Clean darkroom	Trash, chemical spills, etc.	daily
Processor	Sensitometry, stepwedge images, spectroline, etc.	daily
Check view boxes	Replace bulbs as needed and keep view box plexiglas clean.	monthly
Clean screens/cassettes	Keep extraoral screens clean with damp clean cloth. Check for good contact between screen and film.	monthly

of the film cassette, should be handled carefully to prevent damage. In addition, cassettes should be cleaned and inspected monthly according to manufacturer's directions. After cleaning, an antistatic agent can be applied.

Quality Assurance for the Operatory

All x-ray equipment requires proper installation and calibration upon purchase. The National Council on Radiation Protection and Measurements and the American Academy of Oral and Maxillofacial Radiology have recommended that each of the following components be checked and calibrated on an annual basis. Although many of these tests can be performed and monitored by dental personnel, most are probably best done by a qualified technician with the proper equipment. Resources for detailed information on each specific test are provided in the resource list.[10]

Other Considerations for Quality Assurance

Film should be handled carefully during processing to prevent fingernail marks or scratching of the image prior to hardening and drying of the image. Handling the film by the edges will help prevent these errors from occurring. Films should also be rinsed properly to prevent yellowing of the image over time.

Patient shielding (thyroid and abdominal) should be evaluated to assess for cracks, tears, or ragged areas on a monthly basis. To prevent cracks, shields should be hung or laid flat when not in use.

Receptor holders that align the beam to the receptor should be checked for tightness of the aiming ring. After repeated sterilization, the aiming rings may become loose resulting in conecuts. These should be replaced when the rings are no longer tight on the positioning bar. Handheld x-ray unit devices are becoming more common in dental offices and community service sites. Because these devices are not stabilized on a stand or tripod, motion can be a problem resulting in image distortion. It is important that the operator stabilize the unit mid-body with the arm against the body.

Lastly, a quality assurance log should be kept for documentation of all procedures conducted in both the darkroom and operatory. The information on the log should include the procedure performed, date, results, and any corrective actions. It is also helpful to keep a retake log in order to track technique errors and determine education that is needed for the radiographer.

Table 2 - Tests Performed by Qualified Personnel

This table provides a summary of tests for x-ray equipment that current literature suggests should be performed on a yearly basis by qualified personnel.

Type of X-ray Equipment	Quality Control Test
X-ray output	Ionization chamber which measures the quantity of ionizing radiation in air.
Kilovoltage	Wisconsin test cassette (kVp meter) or kVp meter will measure the intensity of the beam.
Milliamperage (mA)	Unit with two mA settings uses reciprocity test. Units with one setting, invasive test by technician.
Timer	Brass Spinning Top
Collimator and Beam Alignment	Expose four #2 size films that are arranged in a cross pattern. Diameter of exposed area = 2.75 inches.
Tubehead stability	Visually observe drifting of tubehead.
Filtration	Half-value layer (HVL). Using dosimeter, determine initial exposure value. Continue to add thicknesses of aluminum (Al) filters until the initial dose is halved. Plot curve using dose readings and added Al thicknesses.

References

1. Nuclear Associates, New York, NY. 1-888-466-8257. (Aluminum Stepwedge)
2 http://www.xrayfilmsrecycling.com/B.W. Recycling Inc. 2011.
3 Kodak Lead Recycling Program. Kodak Customer Imaging Environmental Support Services (CIESS) at 1-716-477-3194.
4 Cone Instruments. Solon, Ohio. 1-800-321-6964.
5 American Academy of Oral and Maxillofacial Radiology. Recommendations for Quality Assurance in Dental Radiography.
6 Mallya SM and Lam E. White and Pharoah's Oral Radiology: Principles and Interpretation, 8th Ed. Elsevier Inc., St. Louis, Missouri. 2019. Chapters 5 and 16.
7 Eastman Kodak Co. Guidelines for Prescribing Dental Radiographs. Publication No. N-80.
8 Eastman Kodak Co. Waste Management Guidelines. Publication No. N-417.
9 Eastman Kodak Co. Quality Assurance in Dental Radiography. Publication No. N-416.
10 Eastman Kodak Co. Quality Control Tests for Dental Radiography. Publication No. ME-504A1.
11 Eastman Kodak Co. Kodak Silver Estimating Test Papers. Cat. No. 196 5466.
12 Eastman Kodak Health Sciences. Dental Radiography Series Distribution List. 1-800-233-1650.
13 Kantor ML, Zeichner SJ, Valachovic RW, Reiskin AB. Efficacy of dental radio¬graphic practices: options for image receptors, examination selection, and patient selection. JADA, 1989. 119(8):259-68.
14 Mauriello SM, Overman VO, Platin E. Radiographic Imaging for the Dental Team. JB Lippincott Co. 1995.
15 National Council on Radiation Protection and Measurements, Quality Assurance for Diagnostic Imaging Equipment. Report No. 99, Bethesda, MD, 1988.16. Platin E, Matteson SR. Quality Assurance for Dental Imaging. Rochester, NY: Eastman Kodak, 1992.
16 Ponce AZ, Ponce ML. The X¬ray Checker: Basic Radiographic Quality Assurance. Clin Prev Dent. 1984. 6(2):27-9.
17 Brass Spinning Top. Picker, Charlotte, N.C. 1-800-635-9729.
18 Evaluation of a new F speed dental x-ray film. The effect of processing solu¬tions and a comparison with D and E speed films. TT Farman and AG Farman. Dentomaxillofacial Radiology, Vol 29, Issue 1 41-45, Copyright © 2000 by British Institute of Radiology.
19 Dental Radiography: Doses and Film speed. FDA. Center for Devices and Radiological Health. https://www.fda.gov/radiation-emitting-products/nationwide-evaluation-x-ray-trends-next/dental-radiography-doses-and-film-speed (April 27, 2006).
20 Dental Radiographic Examinations: Recommendations for Patient Selection and Limiting Radiation Exposure. American Dental Association, Council on Scientific Affairs and US Department of Health and Human Services, Public Health Service, Food and Drug Administration, 2012. https://www.ada.org/-/media/project/ada-organization/ada/ada-org/files/resources/research/oral-health-topics/dental_radiographic_examinations_2012.pdf

POST-TEST

Internet Users: This page is intended to assist you in fast and accurate testing when completing the "Online Exam." We suggest reviewing the questions and then circling your answers on this page prior to completing the online exam.

(1.0 CE Credit Contact Hour) Please circle the correct answer. 70% equals passing grade.

1. **When using a manual processing system, films in the developer should be placed in the fixer:**
   a. when an image can be seen.
   b. after 1 minute.
   c. according to the time/temperature chart.
   d. based on the temperature of the fixer.

2. **The red colored safelight filter is a required filter to use with all EXCEPT:**
   a. D-speed film
   b. F-speed film
   c. Extraoral film

3. **Replenishment of the processing chemicals is recommended based on all of the following EXCEPT:**
   a. light film images (depleted chemicals)
   b. low processing solution levels
   c. high volume processing of radiographs
   d. need to shorten the development time

4. **Although the lead foil packaging should not be discarded in the trash, it is acceptable to dispose of processing effluent in the sink drain.**
   a. True
   b. False

5. **According to the Quality Assurance recommendations:**
   a. the darkroom should be cleaned daily.
   b. the viewboxes should be cleaned daily.
   c. the processor should be monitored monthly.
   d. the extraoral film cassettes and screens should be cleaned daily.

6. **Chemicals for automatic processors are different from manual processing chemicals because they:**
   a. process at higher temperatures.
   b. are not used in a dark room setting.
   c. are designed for use with fast speed films.
   d. the chemicals are the same for automatic and manual processing.

7. **A primary purpose of a quality assurance program is to:**
   a. maximize the effectiveness of processing chemicals
   b. minimize workplace errors
   c. produce quality images
   d. track technique errors

8. **A retake log is effective in determining:**
   a. processing errors.
   b. darkroom errors.
   c. technique errors.
   d. educational needs.

9. **Film scratches and fingernail artifacts are best avoided by:**
   a. Rinsing the film thoroughly to remove processing chemicals.
   b. Air drying film a minimum of four hours.
   c. Handling film by the edges during processing.
   d. Avoiding technique errors.

10. **The coin (penny) test is an appropriate quality assurance test used for evaluating the:**
    a. safelight
    b. viewboxes
    c. film cassette
    d. processor

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