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Radiographic Quality Assurance for Film Imaging Systems

THIRD EDITION

Author Acknowledgements

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METLIFE QUALITY RESOURCE GUIDE EDUCATIONAL OBJECTIVES

Topic: Radiographic Quality Assurance 3rd Edition

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

1. Recognize those factors which 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.

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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 to provide 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 film while keeping the exposure to the patient as low as reasonably achievable (ALARA). In order to achieve this standard, the dental team member must possess adequate knowledge in the areas of radiation biology, radiation protection and safety, radiographic techniques, and quality assurance procedures. These guides provide basic information and useful resources for the dental practitioner 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 film. This Quality Resource Guide will review industry recognized quality assurance standards for the darkroom and dental operatory.

Darkroom 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 films are extremely sensitive to heat, humidity and background radiation, care should be taken to store films properly. The room should be well ventilated to prevent chemical fume contamination, in addition to being regulated at a moderate temperature ($50\text{-}70^0$ 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 can not be locked while processing can also be a danger.

To test for light leaks, stand in the darkroom with all lights turned off (including safelights) and doors closed. Allow at least 1-2 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 ML-2. E-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 film for 3-4 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 12 hours.

Automatic processors with daylight loaders should also be evaluated for safety 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 film in the daylight loader. After 3-4 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 4.5 minutes at 70^0 F. Films should then be agitated for 30 seconds in the rinse water, fixed for 2-4 minutes and then washed for 10 minutes or manufactuer's guidelines.

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 that 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 times 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 (20-30 intraoral films/day), eight ounces of developer and fixer should be added to the existing processing solutions on a daily basis 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, E and F speed film. 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. Processing solutions that contain 5 mg/L or more of silver are also considered a hazardous waste. Silver Estimating 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 are in compliance.

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 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]

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 viewboxes	Replace bulbs as needed and keep viewbox plexiglas clean.	Monthly
Clean screens/cassettes	Keep extroral screens clean with damp clean cloth. Check for good contact between screen and film.	Monthly
Perform safelight test	Use penny test to check safelights. With safelights on, place penny on opened film for 3-4 minutes. Process. Coin image indicates light leak.	Monthly

Resources

1. Nuclear Associates, New York, NY. 1-888-466-8257. (Aluminum Stepwedge)
2. Kodak Lead Recycling Program. Kodak Customer Imaging Environmental Support Services (CIESS) at 1-716-477-3194.
3. Kodak Dental Products. 1997 Catalog and Reference Guide, Eastman Kodak Company. 1-800-933-8031.
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. Bushong SC. Radiologic Science for the Technologists, 5th ed. St. Louis: CV Mosby, 1993.
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 radiographic 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.
17. Ponce AZ, Ponce ML. The X-ray Checker: Basic Radiographic Quality Assurance. Clin Prev Dent. 1984. 6(2):27-9.
18. Brass Spinning Top. Picker, Charlotte, N.C. 1-800-635-9729.
19. Evaluation of a new F speed dental x-ray film. The effect of processing solutions 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.
20. Dental Radiography: Doses and Film speed. FDA. Center for Devices and Radiological Health. http://www.fda.gov/cdrh/radhealth/dentalradio.html (April 27, 2006).

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.

POST TEST - RADIOGRAPHIC QUALITY ASSURANCE FOR FILM IMAGING SYSTEMS 3RD EDITION

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

1) The red colored safelight filter is a required filter to use with all except:

A) D-speed film
B) E-speed film
C) F-speed film
D) Extraoral film

2) When using a manual processing system, films in the developer should be placed in the fixer when an image can be visually seen.

A) True
B) False

3) 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

4) Processing chemicals should not be replenished daily because:

A) it contaminates the solutions.
B) it will over-process (accelerate) the film development.
C) it wastes good chemical solutions.
D) the original statement is false.

5) The coin (penny) test is an appropriate quality assurance test used for evaluating the:

A) safelight
B) viewboxes
C) film cassette
D) processing chemicals

6) The best method for evaluating safelights in the darkroom is to place a coin on top of an opened film for three to four minutes. Then, after normal processing, inspect the film for the coin image.

A) True
B) False

7) 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.

8) Quality assurance components for the darkroom that should be monitored regularly include:

A) preventing light leaks.
B) adequately filtered safelights.
C) use of the time/temperature method.
D) safe disposal of film and processing waste products.
E) All of the above

9) The ALARA principle states that the exposure dose should be kept as low as reasonably achievable.

A) True
B) False

10) Viewboxes should be cleaned on a yearly basis.

A) True
B) False

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Date of Birth: _____ Email: _____

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Preferred Dentist Program ID Number: _____ ❑ Check Box If Not A PDP Member

AGD Mastership: ❑ Yes ❑ No

AGD Fellowship: ❑ Yes ❑ No Date: _____

Please Check One: ❑ General Practitioner ❑ Specialist ❑ Dental Hygienist ❑ Other

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PARTICIPANT EVALUATION: RADIOGRAPHIC QUALITY ASSURANCE FOR FILM IMAGING SYSTEMS 3RD EDITION

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