

X-Ray Regulatory Guide for Medical Offices and Clinics

Introduction

Operating and safety procedures for x-ray offices are required by Wisconsin Administrative Code DHS 157.74 (Radiation Protection) and are to be developed by the person responsible for the radiation safety in each facility. The model procedures in this regulatory guide are generalized. Each facility must write procedures that are specific for their facility. By using the sections of this guide that apply, the facility may create a unique set of operating and safety procedures. Although other formats are acceptable, information contained in this guide must be included in the operating and safety procedures.

This guide is prepared for medical offices that have not developed their own radiation safety procedure manual. Most larger medical clinics have already developed safety manuals and should check the content their manuals to make certain they contain all the necessary information.

The pertinent sections of DHS 157 that apply to medical practice are: Subchapter I, III, VIII, X, XI, XII. Within Subchapter VIII, DHS 157.74, .75, .76(Fluoroscopy), 77, and .86. DHS 157.81 covers the requirements for submitting shielding plans for review when new facilities are being constructed and when existing radiology rooms are being modified.

The Code may be obtained from the DHS web site: <http://www.legis.state.wi.us/rsb/code/dhs/dhs157.pdf>

GUIDE FOR THE PREPARATION OF OPERATING AND SAFETY PROCEDURES FOR THE USE OF X-RAY DEVICES IN MEDICAL OFFICES AND CLINICS

I. Sample Operating and Safety Procedures

OPERATING AND SAFETY PROCEDURES FOR

(name of facility)_____

This guide establishes procedures that will minimize radiation exposure to patients and employees. They are provided to comply with regulations enforced by the Wisconsin Department of Health Services Radiation Protection Section. The regulations require that each x-ray facility be registered with the department and pay annual renewal fees.

A Radiation Safety Officer (RSO) must be designated. The RSO has the responsibility and authority for assuring safe radiation practices and serves as the contact person between this facility and the department. Direct all your questions or concerns on radiation safety to the RSO for this facility, (specify name)_____.

CHANGES IN REGISTRATION

If there are changes in the registration such as change of address or ownership, notice must be sent to the department within 30 days of the change. Change of ownership requires re-registration with full fees paid by the new owner. Addition of new equipment or the replacement of old equipment also needs to be reported. Changes to the registration information may be faxed to (608) 267-4799 or mailed to Division of Public Health, Radiation Protection Section, PO Box 2659, Madison WI 53701-2659.

A. Operator Safety

1. ***Training Requirements for Operators of X-ray Machines***

All operators of x-ray machines, including fluoroscopy, must be trained to operate the equipment safely, use proper technique charts, and be able to position the patient properly and to process the film properly. This includes physician operators of fluoroscopic equipment. Each person should be trained in the proper operating procedures for each x-ray machine they will operate. New staff needs to acknowledge receipt of this training by signing-off on the form on Appendix A or similar record.

2. ***Individual Radiation Monitoring Requirements DHS 157.22***

Any adult who is likely to receive a dose from occupational exposure to radiation in excess of 5 mSv (500 millirem) in a year must use an individual monitoring device. In an office setting where the doctor is the only x-ray machine operator, monitoring devices are not required. Devices may be required only if other employees in the facility are likely to be exposed to radiation as a routine part of their job.

If monitoring devices are worn, they shall be worn at the neck level or on the upper torso. If a protective apron is worn because the operator needs to be less than six feet from the tube or patient, the dosimeter needs to be worn at the collar outside the apron.

Wisconsin Administrative Code DHS 157.88 in Subchapter X discusses the requirements for notifying the employee of their monitoring results. Each employee who wears a monitor should be shown the monitor

report and acknowledge seeing the results by initialing the report by their name. Social security numbers do not need to be used for identifying each employee. An employee number may be used for identification.

Records of employee exposure must be retained, even after the employee has left. Upon departure, each employee must receive a copy of their final monitoring report that shows their exposure for the entire employment period. The information on the periodic monitor report may be recorded on facility letterhead and include the phrase "This report is furnished to you under the provisions of Wisconsin Administrative Code, Chapter DHS 157, Radiation Protection. You should retain this report for future reference".

a. Individual monitoring devices must be worn at the unshielded location of the whole body likely to receive the highest exposure. When a protective apron is worn, the location of the individual monitoring device is typically at the neck (collar) [DHS 157.25(3)].

b. Additional individual monitoring devices used for monitoring the dose to the embryo/fetus of a declared pregnant woman must be located at the waist and under any protective apron being worn by the declared pregnant worker.

c. The individual monitoring device shall be assigned to and must be worn only by one individual.

d. When wearing a protective apron during fluoroscopy multiple individual monitoring devices may be worn. When multiple devices are worn, occupational doses shall be determined in accordance with DHS 157.25(3)(b)

e. If multiple individual monitoring devices are worn by a declared pregnant woman, dose to the embryo/fetus and the occupational dose to the woman shall be determined in accordance with DHS 157.25(3)(b).

f. Individual monitoring devices which are not being worn and the control monitoring device will be stored in an area that is away from rooms where radiation machines are in use. This is in/at (specify location).

g. (specify name) is responsible for the occupational dose records and exchanging the individual monitoring devices on - (specify exchange dates). The individual monitoring device readings (film badge reports) are located in/at (specify posting or records location)

_____.

h. If any employee's are working for another employer and receive an occupational dose, they shall report that dose to the RSO at each employer so that it can be included in their annual record of occupational dose. An employee working for a single employer and working at multiple sites must be assigned only one dosimeter, not one for each location. Employees are responsible for reporting their exposure from each job to each employer. The cumulative exposure from each job is the occupational exposure limit. No employee is allowed to receive more than 50 mSv (5 rem) in a calendar year from all employment during that year.

i. If any employee is pregnant or becomes pregnant, she may voluntarily inform the Radiation Safety Officer (RSO) or employer in writing of the pregnancy. If the RSO or employer is informed of the pregnancy, the employer must ensure that the dose to the embryo or fetus does not exceed 5 mSv (500 mrem) during the entire pregnancy and no more than 0.5 mSv (50 mrem) in any month. The dose to the monitoring device worn at the waist level is considered to be the fetal dose. Pregnant workers shall be monitored for radiation exposure. If the employee chooses to wear a leaded apron and have dosimetry, two monitors are recommended; one device will be worn at the neck and the second under the apron at the waist level. If an apron is not worn, only one monitor may be assigned and that shall be worn at the waist level.

If an employee does not declare their pregnancy in writing, for radiation safety purposes they are not considered to be pregnant and the 50 mSv (5 Rem) occupational exposure limit applies.

Top Ten Dosimeter Do's and Don'ts

- **DO WEAR IT** when working. It has no value in your locker or purse.
- **DON'T WEAR IT** when you are receiving x-rays for your own health care.
- **DON'T WEAR IT** away from the workplace.
- **DON'T WEAR IT** under your apron unless you are wearing two dosimeters. Leave your dosimeter in the same place every day when you leave work so you know where it is.
- **DO TURN IT IN** on time. Time gaps make analysis more difficult, less accurate and reduces legal and historical value of the reports.
- **DO PLACE** the control dosimeter in a radiation-safe area; the dose to the control is subtracted from each dosimeter and needs to be accurate.
- **DO REPORT LOST OR DAMAGED** dosimeters immediately. Prevent damage by not leaving your dosimeter in areas of high temperature such as your dashboard or in the clothes dryer.
- **DON'T PLACE** a dosimeter in an area for testing of stray radiation. Additional dosimeters can be assigned for testing.
- **DON'T SHARE** dosimeters; this is illegal. An average for a shared dosimeter is meaningless to each individual.
- **DON'T TAMPER** with your dosimeter or anyone else's. The reports are legal documents and are regarded as real exposures received. Tampering with dosimeters is grounds for dismissal.

3. Use of Protective Devices

a. Use protective devices, such as lead aprons, gloves, and shields, to reduce exposure to radiation and keep radiation exposure as low as reasonably achievable (ALARA). Protective devices must be used or provided in the following situations:

(i) when it is necessary for an individual other than the patient to remain in the room or hold a patient.

(ii) when it is necessary to protect other patients who cannot be moved out of the room (Examples: critical care areas, emergency rooms, or trauma units) or

(iii) when the gonads are in or within 5 centimeters of the x-ray beam, shields must be used unless the use of the shield interferes with the diagnostic procedure.

b. If fluoroscopic procedures are being performed, protective devices (lead drapes, hinged sliding panels) shall be in place to reduce the scatter radiation to the operator.

c. Protective gloves and aprons is/are stored in/at (specify location)_____.

d. Protective devices shall be checked annually for defects, such as holes, cracks, or tears. This check can be done by visually inspecting or feeling the protective devices or may also be done by x-raying these items. A record will be kept of this check [See Appendix C]. If a defect is found at the time of the annual check or on any other occasion, notify the RSO and remove the device from service until it can be repaired or replaced. Protective devices should be radiographed and the interpreting physician should review the films for defects in the devices.

4. Holding of patients and/or film

a. If a patient or film must be supported during a radiation procedure, use a mechanical holding device when circumstances permit. Mechanical devices cannot be routinely used during the following situations in this facility:

(1) (List Situations) _____

(2) _____

(3) _____

b. If it becomes necessary for an individual to hold a patient or film, the holder shall not be pregnant. They must wear protective devices, must be monitored and keep out of the direct beam.

5. Posting Notices, Instructions, and Reports to Workers

a. Employees must read the "Notice to Employees" sign posted in/at (specify location) _____. The "Notice to Employees" form can be printed from the DHS web site at: http://dhs.wisconsin.gov/dph_beh/BEH/notcemp.pdf. The form needs to be posted on an employee bulletin board or employee accessible area. This is located at _____.

b. The certificate of registration, issued annually at the time of registration renewal, the operating and safety procedures and any notices of violations involving radiological working conditions are located in/at (specify location's) _____.

c. Your rights and obligations as a radiation worker are found in DHS 157.88, a copy of which may be found at (specify location) _____.

6. Radiation Incident or Overexposure

If any person suspects there have been an excessive exposure or a radiation incident such as unintentional exposure of the x-ray machine operator or another employee, immediately notify the RSO who will then notify the department by calling (608) 267-4784 or by faxing the information to (608) 267-4799. The department will investigate the alleged incident.

B. Operation of the X-ray Machine

1. Ordering of X-ray Exams

No x-ray exams shall be taken unless ordered by a licensed practitioner, including nurse practitioner and physician assistant. This may be a verbal order so long as there is a corresponding entry into the patient chart or computer file.

2. Operator Location During Exposure

- a. The operator must be able to continuously view and communicate with the patient from a shielded position. The operator must also be able to see every entrance to the room from the operator position. If the doors cannot be viewed directly, mirrors or electronic surveillance may be installed to view doors from the operator position.
- b. During the exposure, the operator must be positioned so that the operator exposure is as low as reasonably achievable (ALARA) and/or a lead apron, gloves, or other shielding protects the operator.

3. Use of a Technique Chart

Technique charts are required for systems with adjustable techniques, such as kV, time and mA (x-ray tube current). Use of a technique chart aides in reducing the exposure to the operator and patient by providing a standard technique for a given machine regardless of the operator. Technique charts are displayed in the vicinity of the control panel of each x-ray machine.

Electronic technique charts programmed into the computer system that controls the x-ray machine are acceptable.

4. Restriction and Alignment of the Beam

The useful x-ray beam shall be restricted to the area of clinical interest. Use the centering and beam-limiting devices (collimator) provided on the x-ray machine. If the automatic collimator system fails, the RSO must be notified immediately and have the unit repaired. Automatic collimators must continue to function unless repair parts are no longer available. Units with apertures must have a means to center the x-ray beam to the image receptor or the area of clinical interest.

5. Use of Fluoroscopic Machines

- a. Only a licensed practitioner or a trained operator assisting the practitioner with a procedure may operate fluoroscopic machines. A trained operator may operate the unit and position the patient only under the direct supervision of a licensed practitioner. Direct supervision means in the same room or by tele-radiography.
- b. Reset the 5-minute cumulative timing device before each fluoroscopic procedure. Fluoro times should be recorded in the patient record for each procedure.
- c. Users of x-ray machines with accessible beams, including users of special radiographic or fluoroscopic procedures, shall also receive instruction on:
 - Effects of machine technique attributes and usage on patient dose.
 - Source and intensity of scattered radiation.
 - Proper use of shielding.
 - Placement of dosimeters.
 - Proper use of special shielding devices for patients.
- d. Anyone within six feet of the fluoroscopic unit or within six feet of the patient during the exam shall wear a lead apron that is 0.5mm lead equivalent at 100 kV for conventional C-Arm units or stationary units. Anyone within three feet of a Mini C-arm unit shall wear protective aprons.

6. Patient Safety

Patient radiation safety practices include:

1. Using the lowest possible radiation exposure for each exam by using the fastest film speed and the shortest exposure time based on a technique chart
2. Avoiding repeat x-rays by setting the correct technique
3. Positioning the tube and film carefully
4. Provide gonad reproductive organ protection for patients of child bearing age unless the shield interferes with the exam

7. Film Processing [See Appendix B for sample record chart]

a. Unexposed film is stored (describe location and procedures for storage)_____

Unexposed film should be stored according to the film manufacturer instructions. This is usually in a temperature and humidity controlled location.

b. Films shall be developed by the time and temperature recommended by the x-ray film manufacturer.

These specifications are posted in/at (specify location)_____.

(This is usually near the processor in the darkroom)

(i) Check the temperature at the beginning of the workday using a thermometer that does not contain mercury. Do not process films unless the developer temperature is (specify temperature)_____.

(ii) Manual processing system temperature should be checked throughout the workday.

(iii) For automatic processors, run blank films through the processor at the beginning of the workday and perform the QC test prior to processing patient films or at least once a week.

c. Expiration dates on film and chemicals should be checked periodically. New film or chemicals should be rotated so the oldest are used first. Do not use films or chemicals after the expiration date. Pre-mixed developer has a shelf life of only 30 days and supplies must be used or discarded within 30 days of receipt.

d. Chemicals will be replaced by (specify name)_____ according to the manufacturer's or chemical supplier's recommended interval, which is (specify frequency)_____, or no longer than every one month.

e. Safe light(s) in the film processing/loading area is/are provided under these conditions and should not be changed without authorization from the RSO.

Safe light filter type _____ (GBX recommended for blue or green sensitive film)

Bulb wattage _____

Distance from work surfaces _____ (inches)_

f. If you see light leaks around doors, ceilings, or other openings in the darkroom, notify the RSO to have these light-leaks blocked.

8. Alternative Processing Systems

Users of daylight processing systems, laser printers, self-processing (Polaroid) film units, or other alternative processing systems shall develop procedures following manufacturer's recommendations for image/film processing quality control and machine maintenance.

9. Darkroom

The darkroom needs to be light tight and ventilated. Ventilation is especially important if the control panel is located in the darkroom. Corrosive fumes can destroy the electronics in the control panel unless the fumes are vented out of the building. If the control panel is located in the darkroom, other requirements for patient communication also apply.

Dust must be controlled in the darkroom. Ceiling panels in suspended ceilings can move up and down when the door is closed, releasing dust into the darkroom.

10. Quality Control

- a. Automatic wet chemistry film processing systems shall be tested for chemical activity daily before patient films are processed or at least once a week, whichever is shorter. If the facility processes less than one patient set of films a day, on average, then a step-wedge may be used. A sensitometer-only system may be used and successive films compared with a "master" without the aide of a densitometer. This procedure is less accurate than with a densitometer, however, and may not be able to detect a trend in chemistry changes before they become problematic.
- b. The processor quality control test shall consist of a density test using densitometer/sensitometer tools or, for facilities that process films less than once a day, a Pentrometer (step wedge) may be used, following the procedures described in **Appendix F**.
- c. Screens in the cassettes and the type of film must be compatible. Never use green sensitive film with blue light emitting screens or vice versa.
- d. Screens should be changed in the cassettes at least every five years and cassettes should be replaced if they become damaged, have light leaks or become warped. Screens age and lose their light-emitting ability and require higher radiation exposures.
- e. Screens in the cassettes must be cleaned with a special screen cleaner at least once a month or when dust artifacts are noted on the films, whichever is shorter. Follow the cleaner manufacturer's instructions for cleaning. Never use alcohol based cleaners and never put film into wet cassettes. This will ruin the screens.

APPENDIX A

SAMPLE RECORD FOR INSTRUCTION OF INDIVIDUALS IN OPERATING AND SAFETY PROCEDURES FOR

(name of facility)

These procedures have been made available to each individual who operates the x-ray equipment on the date(s) indicated.

(Signature of RSO)

(Date)

Equipment Operator Statement:

I have read these procedures and agree to abide by them.

(Signature of Equipment Operator) (Date)

(Signature of Equipment Operator) (Date)

(Signature of Equipment Operator) (Date)

(Signature of Equipment Operator) (Date)

(Signature of Equipment Operator) (Date)

(Signature of Equipment Operator) (Date)

APPENDIX B

SAMPLE DARKROOM REQUIREMENTS LOG FOR CALENDER YEAR

Automatic processor (Model # _____, Serial # _____) OR
Manual processing

Developer temperature _____

Chemicals replaced

(Manufacturer's or chemical supplier's recommendations or at least every 3 months)

(initials) _____ (date) _____

(initials) _____ (date) _____

(initials) _____ (date) _____

(initials) _____ (date) _____

Darkroom light leak tests performed (every 6 months)

(initials) _____ (date) _____

(initials) _____ (date) _____

Lighting checked in film processing/loading area:

filter type _____ (GBX recommended for blue or green sensitive film)

bulb wattage _____

distance from work surfaces _____ inches

(initials) _____ (date) _____

(initials) _____ (date) _____

Light leaks or related deficiencies noted

(initials) _____ (date) _____

(initials) _____ (date) _____

Corrections of light leaks or related deficiencies (or attach service/work orders)

(initials) _____ (date) _____

Appendix D

Densitometer and Sensitometer Suppliers

Wisconsin Administrative Code DHS 157.74(3) requires x-ray facilities to conduct processor testing prior to the processing of patient films on days when x-ray exams are performed. See Appendix F for the test procedures. The following lists of suppliers have equipment designed for testing processors to determine whether it is safe to process patient films. This list is not inclusive.

Cal-Ray, Inc

2895 Algoma Blvd
Oshkosh WI 54901
920-233-6946

info@calrayinc.com

Densonorm21E combination sensitometer and densitometer

ESECO

One ESECO Rd

Cushing OK 74023-9912

800-331-5904

<http://www.eseco-speedmaster.com/>

Speedmaster - SM-12 Pocket Pal Densitometer

Speed Light SL-2 Sensitometer

PT-11 Pentrometer (Step Wedge)

Fluke BioMedical

<http://www.flukebiomedical.com/rms/content/med-image/diag-image/index.asp?dvv=2Sales> and Service -

E-Mail sales@nucl.com)

Voice: 516.870.0100

Toll Free: 888.466.8257

Fax: 516.870.0140

07-417 Hand-Held, Dual-Color Sensitometer

07-443 Hand-Held Deluxe Digital Clamshell Densitometer,

M2 Industries (Aluminum step wedge only)

2212 Andrew Court

Bettendorf IA 52722

(563) 359-5362

Fax 563-445-3689

Paul Marietta

Reynolds X-Ray

608-244-2022

ESECO products

Superior Radiographics

4726 Pflaum Rd

Madison WI 53718

www.superiorrad.com

X-Rite Corporation

<http://www.xrite.com/>

X-Rite, Incorporated

3100 44th Street, S.W.

Grandville, Michigan 49418 USA

Phone: 616-534-7663

Fax: 616-534-8960

X-Rite 331 Portable Transmission Densitometer

X-Rite 334 Portable Dual-Color Sensitometer

WARNING: Mention of a product, company or service does not constitute an endorsement by the Department of Health and Family Services but only serves to present information regarding the types of devices or services available to the user. Contact these vendors or your local x-ray service company or film supplier for further information.

Appendix E
Radiation Monitoring Suppliers

Radiation monitoring devices may be obtained from:

Global Dosimetry Service
800-251-3331

Landauer, Inc
800-323-8830

Quantum Products
800-359-9686

MP Biomedicals, LLC
(800) 633- 1352 Ext. 2336

WARNING: Mention of a product, company or service does not constitute an endorsement by the Department of Health Services but only serves to present information regarding the types of devices or services available to the user. Contact these vendors or your local x-ray service company or film supplier for further information.

Appendix F

Film processing test procedures

Automatic Film Processors

Processing conditions must be tested before processing patient films or at least once per week. The test consists of exposing film to a known intensity of light, processing the film and comparing the film to a known standard. Under-processed or over-processed films can lead to misdiagnosis, excessive patient exposure and increased operating costs. Properly exposed and processed films are required for proper patient care. Over exposing the patient to radiation and under processing the film is a serious problem. Hand processing systems do not need to be tested. There are too many variables to produce consistent test results.

There are two methods which may be used for this testing:

- A. Pentrometer/Step Wedge - May be used if you do not process patient films every day
- B. Sensitometer and/or densitometer - Should be used if you process patient films every day. This test is more sensitive and will detect changes more quickly.

Start with seasoned chemistry. To season the chemistry, put fresh chemistry into the processor and mix fresh chemistry for the replenishment tanks if provided. For small tabletop processors, operate the processor for two days to season the chemistry. For larger processors, operate the processor for five days. Seasoned chemistry is more stable than fresh chemistry and will give a more consistent test result. Seasoning requires about 5 14"x17" equivalent films for small processors and 25 for larger processors.

A. Pentrometer method

Tools needed

1. Pentrometer/Step Wedge, 11 steps. A pentrometer is a metal wedge with at least eleven steps cut into the metal. Each step is numbered with a lead number. The pentrometer method is less precise than the densitometer because it relies on "eyeball" comparisons of the density of the wedge.
1. Thermometer, digital or dial type. No mercury! If you have an old mercury thermometer, dispose of it at the next city or county "Clean Sweep". It is illegal to dispose of mercury containing devices in a landfill. If a mercury thermometer breaks in a processor, the processor will have to be replaced. The mercury binds to the silver halides in the film and ruins the film.
2. Densitometer for measuring light transmission through the film (preferred but not required)

This test method may be used but is not the preferred method. A densitometer should also be acquired to measure the base plus fog values to determine whether there are any light leaks in the darkroom. If inspection results by the department inspectors show that this method is ineffective, facilities will be required to obtain the test tools for the sensitometer/densitometer method.

To perform this test using seasoned chemistry, do the following:

1. Determine the proper exposure technique from the literature that came with the wedge. If no information came with the wedge, the technique will usually be about 70 kV at 3-5 mAs (100 mA, 1/30 or 1/20 sec) when the wedge is placed directly on the cassette and not in the buckey tray.
2. Always use the same cassette for making the exposure.
3. Always use the same distance from the x-ray tube to the cassette.
4. Place the wedge in the center of the cassette and expose.
5. Make sure the processor is up to temperature before processing the film.
6. Process the film according to the film manufacturer instructions. Always feed the film into the processor on the same side of the feed tray.
7. Reserve this first film as your "master" film and date it with the processing date. Cut the film in half down the length of the image of the step wedge.
8. Perform the test again the next time you are going to process patient films. Cut this film in half down the length of the wedge.
9. Place both films on a view box with the two cut edges together.
10. Align the top or bottom step of each image.
11. If the daily test image is off by more than one density step from the master image, either lighter or darker, make adjustments to the processor and perform the test again until the films match.
12. When the films match, the patient film may be processed.
13. **NEVER CHANGE THE TECHNIQUE TO MAKE THE FILMS LOOKS BETTER. THIS DEFEATS THE PURPOSE OF THE TEST!**

Each time you change the chemistry in the processor, the master film **must** be recreated. Some small processors may require new chemistry every two weeks. The purpose of the "master" film is to give a comparison value for each new batch of chemistry.

B. Sensitometer/densitometer method

1. A sensitometer is a device designed to expose one or both surfaces of the film to a preset light source, imprinting an image of graduated density steps on the film.
2. A densitometer is a device designed to pass light through the processed film and measure the intensity of the light as it passes through the graduated density steps on the processed film.
3. By charting the density of specified steps, the operator can determine whether the processor has changed since the last test. If the processor has changed by more than an acceptable amount, usually one step on a 21-step sensitometer or 0.15 density, then a determination of the cause of the change needs to be made before patient films can be processed. A processor must be within control specifications established by the test procedure before patient films are processed.
4. Establishing a correct baseline is critical to the proper testing. The following steps can be used to establish your baseline charts:
 - a. **Needed tools:**
 1. Thermometer. This should be a non-mercury thermometer, either electronic or dial type capable of determining temperature of the developer to within 0.5 degree F. A common fever thermometer can be obtained at any variety store and will be accurate so long as the temperature of the developer is over 90 degrees. These have sufficient range and accuracy to be used for testing the processor developer temperature. Thermometers in processors are seldom accurate or consistent. You need to verify the actual temperature and make adjustments accordingly.

2. A simulated light source (sensitometer) that is capable of exposing the film using either blue or green light.
 3. A densitometer to measure density of the film.
 4. Quality control (QC) film. This box of film should be used exclusively for quality control. It must be the same *type* of film you use for your patient exams. If you routinely use only 14X17 film, the QC film may be 8X10 so long as it is the same type of film. Also, film is either blue sensitive or green sensitive, depending on the type of screens you use in your cassettes. You must use film that is compatible with your screens for proper exposure. If you do not know what screens you have, contact your x-ray service supplier.
 5. Processor quality control charts. These charts are useful tools for graphically plotting the QC values and determining trends or out of control values. Charts generally come with the QC kits and a sample is attached to this packet. One is attached to this packet.
- b. The sensitometer is used to expose your test film.
1. Set the “blue/green” switch to the type of film you are using. If you do not know whether the film is blue or green sensitive, check with your film vendor. In the darkroom with the lights off, insert the edge of the film into the slot on the sensitometer. Some are a “clam shell” design and you press the top down onto the film to activate the light source. Rotate the film 180 degrees and expose the opposite edge of the film.
 2. Some films are more sensitive on one side of the film and exposing opposite sides will invalidate the results. If you turn the film over and expose the ends of the film rather than the long edges, if one side of the film differs significantly from the other. Always use the same side to measure the density. You can choose the high reading side or the low reading side but you must be consistent. You must always use the same side of the film for testing. Always orient the film box the same way when removing the film. Mark one side to the box with a heavy marker and always keep that side up or down when removing the film from the box.
 3. Process the film by placing the film on the feed tray. Always place the film on the same side of the feed tray and always have the same side of the film facing up. Sensitometry films must be processed each day for five days to establish your “Aim Points”.
 4. When the film comes out of the processor, measure the density as follows:
 - a. Measure the density of the steps numbers 8 to 14 on each of the exposed strips on each film. Record the values and average the value for each film at each density step.
 - b. Add the five daily values for each film on each step and divide by five to obtain the average for all five days.
 - c. Determine which step will be used for the speed or Mid Density (MD) value by selecting the step that is closest to a density value of 1.20 but not less than 1.10. This can be over 1.20. Plot this point on the chart at the MD line and write this value on the chart.
 - d. Next, select the density steps that will be used to determine the contrast or Density Difference (DD) value. Select the density step with a value of not more than 2.20. Then, select the density step with a value of not less than 0.45. Subtract the lower value from the higher value to determine the DD. Record the density step numbers and the density difference on the chart on the line that represents the operating level for contrast.
 - e. Measure the base plus fog value by measuring the density in an unexposed portion of the film. If this value exceeds 0.23, you may have a darkroom fog problem with light leaks or improper safe lights.
 - f. Establish control limits for speed (MD) contrast (DD) and base plus fog. For the MD and DD values, the range should be +/- 0.20 density and for base plus fog should be no greater than 0.03.
 - g. Developer temperature can also be plotted on the charts. (See attached chart for sample)

Once the chart has been established, each test film must be plotted before the patient films are processed for that day. If the processor is "out of control", determine the cause and correct the problems before processing the patient film. This may require adjusting the temperature or adding fresh chemistry. Small tabletop processors are more prone to fluctuations than larger models.

Write the date of each test on the chart. QC films need to be processed only on days when patient films are being processed or at least once per week even if patient films are not processed.

Processor Maintenance

The chemistry should be drained from the processor according to the processor manufacturers' instructions or at least once a month.

The roller racks should be removed and cleaned at the time of chemistry change.

Fresh chemistry should be mixed and the processor refilled.

Fresh replenisher should be mixed as needed. The replenisher tanks should never be allowed to run dry.

Chemistry filters in the processor must be changed according the processor manufacturers' schedule.

Check the owners' manual to see if the manufacturer recommends removing the lid of the processor at night to prevent contamination from condensation dripping from the lid.

HAND PROCESSING

Offices using hand processing techniques are not required to test the developer activity but it is strongly suggested that they do.

Tools Needed (if performed)

Step wedge

Thermometer

Timer

Hand processing chemistry should be changed at least every three months and the developer should never turn green or smell of ammonia. The chemistry tanks are deeper, hold more chemistry, operate at a lower temperature and the developer has less oxidation than automatic processors.

Some films are not suitable for hand processing because it requires the constant flexing achieved by the roller transport systems in automatic processors. Be certain that the film you purchase is compatible with hand processing.

You must have a thermometer to measure the developer temperature and process the film according to a time/temperature chart. You must have a timer in the darkroom to time the development of the x-ray. "Sight" developing is not permitted. Sight developing leads to inconsistency and higher patient exposures.

It is difficult to obtain consistent step wedge tests using hand-processing methods. The film will have to be processed precisely each time with careful attention to the developer temperature. The test results will differ greatly from automatic processor results and may not reflect the actual condition of the developer.

Hand Film Processing Time and Temperature Chart

The temperature of each solution shall be maintained within the range of 60 °F to 80 °F (16 °C to 27 °C). Film shall be developed in accordance with the time-temperature relationships specified by the film manufacturer or, in the absence of such recommendations by the film manufacturer, with the following time temperature chart:

TIME-TEMPERATURE CHART

Thermometer Reading Minimum Immersion Time in the Developer

°C	°F	minutes
26.7	80	2
26.1	79	2
25.6	78	2 ½
25.0	77	2 ½
24.4	76	3
23.9	75	3
23.3	74	3 ½
22.8	73	3 ½
22.2	72	4
21.7	71	4
21.1	70	4 ½
20.6	69	4 ½
20.0	68	5
19.4	67	5 ½
18.9	66	5 ½
18.3	65	6
17.8	64	6 ½
17.2	63	7
16.7	62	8
16.1	61	8 ½
15.6	60	9 ½

The non-mercury thermometer shall indicate the actual temperature of the developer to within +/- 0.5 °F

The timer shall signal the passage of a preset time as short as two minutes.

Film should be rinsed between the developer and fixer.

Immersion time in the fixer is usually twice that of the developer

A minimum of 15 minutes in flowing water is required for proper washing