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QUALITY CONTROL RECOMMENDATIONS FOR DIAGNOSTIC RADIOGRAPHY

VOLUME 1
DENTAL FACILITIES

July 2001

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CRCPD Publication 01-4

QUALITY CONTROL RECOMMENDATIONS FOR DIAGNOSTIC RADIOGRAPHY VOLUME 1: DENTAL FACILITIES

Prepared by CRCPD's
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ABSTRACT

Committee on Quality Assurance in Diagnostic X-ray, *Quality Control Recommendations for Diagnostic Radiography, Volume 1: Dental Facilities*, CRCPD Publication 01-4 (July 2001) (45pp).

This publication presents a template of a Quality Control Program for facilities using dental intraoral, panoramic, or cephalometric x-ray machines. The procedures included in this manual are one way to perform these tests. Applicable forms are provided and additional instructions may be found in the appendices.

FOREWORD

The Conference of Radiation Control Program Directors, Inc. (CRCPD) is an organization made up of the radiation control programs in each of the 50 states (except Wyoming, which has no radiation control program), the District of Columbia, and Puerto Rico, and of individuals, regardless of employer affiliation, with an interest in radiation protection. The primary purpose and goal of CRCPD is to assist its members in their efforts to protect the public, radiation worker, and patient from unnecessary radiation exposure. CRCPD also provides a forum for centralized communication on radiation protection matters between the states and the federal government, and between individual states.

One method of providing assistance to the states, as well as to other interested parties, is through technical and administrative publications. Most technical publications of CRCPD are written by various committees, task forces, or special working groups. Most administrative publications are written by the staff of the Office of Executive Director (OED).

This specific publication, *Quality Control Recommendations for Diagnostic Radiography, Volume 1: Dental Facilities*, is a guidance document for use by state x-ray inspectors and dental facilities with x-ray machines. No conclusions are included, and the implementation and use of the information contained in this document are solely the responsibility of the user.

Paul L. Schmidt

Chairperson
Conference of Radiation Control
Program Directors, Inc.

Dedicated in the memory of Debra Jackson and Joyce Zeisler.

PREFACE

The Conference of Radiation Control Program Directors, Inc. Committee on Quality Assurance in Diagnostic X-ray has compiled this manual to suggest a standard in quality control within a dental facility that uses radiation-producing machines for medical diagnosis. Separate volumes are available for podiatric facilities and facilities using radiography or fluoroscopy for other diagnostic purposes. State radiation control personnel are encouraged to share applicable information with facilities in need of establishing or improving their quality control program.

All state radiation control personnel are encouraged to promote quality assurance as a proven means to reduce exposure, increase and maintain diagnostic image quality, and limit health care costs. In many instances, state radiation control personnel are the primary source of such information and should offer assistance as necessary.

John P. Winston, Chairperson
Committee on Quality Assurance
in Diagnostic X-ray

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QUALITY CONTROL RECOMMENDATIONS FOR DIAGNOSTIC RADIOGRAPHY VOLUME 1: DENTAL FACILITIES

INTRODUCTION

The Conference of Radiation Control Program Directors, Inc. Committee on Quality Assurance in Diagnostic X-ray has compiled this manual to suggest a standard in quality control within each dental facility that uses radiation-producing machines for medical diagnosis. A **Quality Control (QC) Program** allows a facility with limited resources and personnel to monitor the basic components of the imaging process at a low cost through the use of simple, inexpensive tools and minimal staff time.

The **Quality Assurance (QA) Program** is a program designed by management to assure quality of a product or service. Such a program can have wide-ranging aspects, including customer feedback, employee empowerment, and quality control. **Quality control** involves specific actions designed to keep measurable aspects of the process involved in manufacturing a product or providing a service within specified limits. These actions typically involve measurement of a process variable, checking the measured value against a limit, and performing corrective action if the limit is exceeded. This document suggests such variables, methods for measurement, control limits, and in some cases corrective actions typically applied to control equipment performance in radiological imaging.

All medical facilities using x-ray equipment, from a simple intraoral dental unit to an image intensified special procedures system, will benefit from adopting a quality assurance program. An established program will monitor the imaging process from start to finish and reveal potential problems that may otherwise go unrecognized. The following concepts and procedures are what the Committee believes will provide a standard in program monitoring and may not meet the requirements of some state or federal regulations. Quality assurance in medical imaging is a rapidly evolving concept and each facility is encouraged to continually pursue ways to improve and expand its program.

This volume of Quality Control Recommendations has been written for facilities with dental x-ray machines. **Separate volumes are available for podiatric facilities and facilities using radiography or fluoroscopy for other diagnostic purposes.**

GETTING STARTED

The following sections present the basic test procedures and a suggested schedule for performing the tests. Each section is arranged with an objective for the test, suggested performance criteria, the frequency at which each test should be performed, equipment required to perform the test, instructions for performing each test, how to evaluate the results, and when corrective action should be taken. Several of the tests mention forms to be completed with test results. These forms are found in Appendix A. Alternative forms may be available from your film representative, service engineer, physicist, or other qualified expert. Appendix B includes detailed instructions on how to perform processor sensitometry. Appendix C contains the glossary, or definitions of terms used throughout this manual.

It is essential that one person at a given facility, the QA Coordinator, be in charge of maintaining the QA program and be allotted the time, equipment, and space necessary to carry out the duties that are required. The facility's **QA Coordinator** may choose to assign specific duties to other personnel, but should maintain oversight and realize that consistency is compromised when several people share the responsibility of carrying out these tasks. The QA Coordinator must ensure all the tasks are performed in a timely manner regardless of assigned staff availability (e.g., vacation or illness).

After each link (x-ray unit, developing system, screen-film combination, darkroom, etc.) in the imaging chain is optimized, a working QA program will flag the Coordinator when something goes awry. The Coordinator should review test results daily. If any test results fall outside established tolerances, **repeat the test to validate the results, then take corrective action**. The Coordinator must be capable of identifying problems and be allowed enough time to resolve them as they arise, or the QC program will not operate as designed.

Getting off to a good start is imperative. The QC program is based on planning and purchasing the proper equipment, then establishing a high standard of quality and maintaining it. The information provided should enable the Coordinator to set up and monitor the entire program. If a facility protocol is not available for a specific type of equipment (e.g., digital imaging systems), the manufacturer's recommendations should be followed. Establishing an open line of **communication** with representatives from the State Radiation Control Program and other technical experts will make it much easier to set a standard of which the facility can be proud.

In order to perform the QC tests outlined in this manual, an initial outlay of about $200 to $1,500, depending on the type of dental equipment in use, will be necessary. Minimal annual costs can be expected to keep your QA and QC programs running.

- Sensitometer (21 Step), approximately $700
- Densitometer, approximately $700
- Box of film (clinically used)
- Dental Radiographic and Normalizing Device, approximately $80
- Non-mercury thermometer, approximately $10
- Cleaning equipment for screens, cassettes and darkroom

This equipment may be purchased through your film, x-ray, or health physics equipment vendors.

Once you have become proficient at performing the tests the time spent will be minimal. Daily tests should take about 5 minutes to perform and should be done prior to the first patient image of the day. Monthly tests will add an additional 10 minutes to the daily tests. Quarterly tests will take about 45 minutes to perform. The semiannual test for darkroom fog should take no more than 5 minutes to perform and analyze. The annual tests and biennial tests completed by the qualified expert will probably take 1 to 2 hours to perform.

There are several sources from which a facility may locate a "qualified expert." The first place to contact is the Radiation Control Program in your state. Many state programs have an approval process for this type of individual and will provide lists of qualified experts in your area. If your state does not have such a list, a large, JCAHO approved hospital would have a "consultant" that they use who meets the suggested qualifications.

QUALITY CONTROL MANUAL

A **QC Manual** should be created and reviewed at least annually. The manual should include the facility's objectives, QC instructions, QC results, and personnel responsibility. Items that should be included in a **QC Manual** are:

- A list of the tests to be performed and the frequency for each test, including acceptable test limits, test procedures, maintenance, and service records.
- A list of equipment to be used for testing.
- Policy and procedures for QC tests as well as for the facility.
- Sample forms.

Questions asked during a review might include:

- Is image quality maintained at the desired level?
- Is the x-ray technique chart up-to-date?
- Is the screen-film combination used still the best suited for our facility?
- Do all personnel meet required or established qualifications?
- Does any equipment need to be replaced?
- Do any QC procedures need to be changed or updated?
- Are personnel adequately performing assigned tasks?
- Is patient and personnel radiation exposure as low as reasonably achievable?
- Are all documents up-to-date and accurate?

RECOMMENDED QUALITY CONTROL TESTS FOR DENTAL FACILITIES

TEST	FREQUENCY	PROCEDURE
Dental System Constancy Test (Intraoral Only)	Daily, Prior to Developing Films and After Service	1
Processor QC (Extraoral)	Daily, Prior to Developing Films	2, Appendix B
Darkroom QC	Daily and Weekly	3
Viewboxes	Monthly	4
Visual Checklist	Quarterly and After Service	5
Repeat Analysis	Quarterly	6
Tube Head – Boom Stability	Quarterly	7
Film and Chemical Storage	Quarterly	8
Cassettes and Screens	Quarterly or Semiannually (As Needed)	9
Darkroom Fog	Semiannually*	10A or 10B
Lead Apron Check	Annually	11
Panoramic Field Alignment	Annually	12
Program Review	Annually	Form 6
Radiation Safety Survey	Every Two Years	Form 4

*Darkroom fog should be evaluated every time you change the filter, bulb, or film type, and at least every 6 months.

DENTAL SYSTEM CONSTANCY TEST
(Procedure 1)

OBJECTIVE:

To assure the processing and dental intraoral x-ray unit are operating consistently.

SUGGESTED PERFORMANCE CRITERIA:

After following the instructions on the Dental Radiographic Normalizing and Monitoring Device, the daily films should match one of the middle steps on the device (Steps 3-5).

FREQUENCY:

Daily, prior to processing patient films*
After service on the equipment

REQUIRED EQUIPMENT:

1. Dental Radiographic Normalizing and Monitoring Device
2. Film

STEPS:

1. The first time the procedure is performed, use new solutions for developing films.
2. Place device on a flat surface. Insert unexposed intraoral film under copper square.
3. Position the cone, centered on copper square and touching device.
4. Expose the test film using typical posterior bitewing technique factors.
5. Process the test film using normal techniques.
6. Insert dried test film into the film slot on the test tool.
7. Slide film strip until one of the density steps match the test film density.
8. If the test film is above or below the mid-density steps (Steps 3-5), adjust the x-ray timer settings and repeat Steps 1-7.
9. Record the technique factors used and the density setting matched by the film.
10. Using the techniques established in Step 9, repeat test daily and record results on the **Daily QC Checklist (Form 1)**. Daily test should be within one step of the first test film obtained following procedure Steps 1-9.

CORRECTIVE ACTION:

Refer to troubleshooting guide on the device. If problems persist after troubleshooting, contact x-ray service engineer.

* This test may be substituted for daily sensitometry until a facility is able to obtain such equipment.

Note: If your facility uses extraoral screen-film and you are doing daily sensitometry to monitor the film processor, it may not be necessary to complete this test daily, but the Dental Radiographic Normalizing and Monitoring Device can continue to be used at fixed intervals (e.g., monthly) to monitor the operation of the x-ray unit(s).

PROCESSOR QC (SENSITOMETRY)
(Procedure 2)

OBJECTIVE:

To determine if film processor is working optimally in **facilities producing radiographs other than intraoral**.

SUGGESTED PERFORMANCE CRITERIA:

± 0.15 optical density of the mid-density step
± 0.15 optical density of the density difference
+ 0.03 optical density of the base + fog level

FREQUENCY:

Daily, prior to processing patient films

REQUIRED EQUIPMENT:

1. Sensitometer*
2. Dedicated box of control film
3. Densitometer

STEPS**:

1. Expose the control film with the sensitometer.
2. Develop the film.
3. Determine the average optical density of the **mid-density** step and record on **Form B1** in Appendix B.
4. Determine the average optical **density difference** and record.
5. Measure the background optical density (base + fog) and record.
6. Verify that the measured values are within the suggested performance criteria.

CORRECTIVE ACTION:

The tests should be repeated if the values are outside the performance criteria. If, after repeating, the results are still out of limits, look for processing problems and contact the processor service supplier.

Notes:
1. In order to perform sensitometry, the current processing technique must be able to develop the QA film (due to the size of the QA film some dental facilities may not have the capability to process this type of film, therefore, sensitometry will not be possible at these sites).
2. The sensitometer and densitometer must be maintained and calibrated according to manufacturer recommendations.

* If asymmetric film is being used, a dual-sided sensitometer is necessary.

** For detailed instructions, chart and example, please see **Appendix B**.

DAILY AND WEEKLY DARKROOM QC
(Procedure 3)

OBJECTIVE:

Keep the darkroom clean and processing optimized.

FREQUENCY:

Daily - Check developer temperature
Daily - Check developer, rinse, fixer levels
Daily - Clean processor feed tray, counter tops
Weekly - Clean darkroom

REQUIRED EQUIPMENT:

1. Non-mercury thermometer
2. Mop
3. Non-abrasive, liquid cleaning solutions
4. Damp, lint-free cloths

STEPS:

Daily: If manual processing, developer temperature must be measured with non-mercury thermometer for correlation with the time-temperature chart.

If auto processing, measure the temperature with a non-mercury thermometer to verify that the developer is operating within the temperature range established by the manufacturer, and that the display, if applicable, is accurate. It may not be necessary to physically measure the temperature daily if the processor passes the daily QC test (Procedure 1).

Daily: If manual processing, replenish following the chemistry manufacturer guidelines. Replace rinse water.

If auto processing, follow the processor manufacturer recommendations regarding replenishment.

Daily: Clean processor feed tray and counter top.

Weekly: Damp mop darkroom floor. Clean counters, cabinets, and anywhere else dust may accumulate. Clean film hangers.

CORRECTIVE ACTION:

If automatic processor cannot be maintained at its optimal operating temperature, call processor service supplier.

VIEWBOXES
(Procedure 4)

OBJECTIVE:

To ensure viewboxes are clean and light levels are kept consistent throughout. A difference in luminance can create confusion and may effect accurate interpretations.

SUGGESTED PERFORMANCE CRITERIA:

Viewbox lights are the same "color" and luminance, and viewbox surfaces are kept clean.

FREQUENCY:

Monthly

REQUIRED EQUIPMENT:

Glass cleaning supplies

STEPS:

1. Clean surface of viewbox.
2. If a bulb or tube fails, it is best to replace all of them.
3. Record results on the **Monthly QC Checklist (Form 3)**

VISUAL CHECKLIST
(Procedure 5)

OBJECTIVE:

To assure that all components of the radiographic x-ray system (indicator lights, displays, and mechanical locks and detents) are working properly and that the mechanical rigidity and stability of the equipment is optimum.

SUGGESTED PERFORMANCE CRITERIA:

Each of the items listed in the **QC Visual Checklist (Form 2)** should pass or receive a check mark. Items not passing the visual check should be replaced or corrected as soon as possible.

FREQUENCY:

1. Quarterly
2. After service or maintenance on the x-ray system

STEPS:

1. Cephalometric beam limiting device (BLD) insert in place and used.
   Determine if the unit has built-in collimation or if manual beam limiting devices are being used. Assure that the collimators are functioning correctly and smoothly. Determine that manual beam limiting devices are sufficient for blocking the beam. Assure that collimators or beam limiting devices are being utilized correctly for the area being radiographed.
2. Panoramic tube and film holder motion smoothness.
   Determine that during motion the tube and film holder moves smoothly without catches or interruptions.
3. Cone or cylinder secured to tube.
   Visually inspect the connection between the tube and the cone or cylinder. Determine the connection is secure and stable.
4. Tube or generator oil leakage.
   Visually inspect areas around tubes and generators for oil or abnormal collections of dust attaching to oil leaks.
5. Condition of cables and wires.
   All cables and wires should be inspected for frayed coverings, kinks, and should be free from catching on other objects.
6. Film artifacts.
   Examine exposed processed films closely to determine if artifacts are visible. Density variations, small specks from dust particles, fingerprints, water marks, and other artifacts should not be visible.
7. Cassettes and screens condition.
   Cassettes and screens should be cleaned regularly. Check screen condition for dust particles, scratches, and areas of discoloration. Assure screens are properly fitted and attached to cassettes (if applicable). Check cassette latches to make sure they are functioning properly and are not broken. Cassettes and screens should be replaced if necessary.

8. Film storage.
   Determine that film is stored in a cool, dry place, and is protected from exposure to stray radiation. Assure that film boxes that have been opened are stored in a light-tight container. Determine that film being stored has not expired; check the expiration dates. See Procedure 8.
9. Loaded cassette storage.
   Determine that loaded cassettes are stored in an area that is properly shielded from radiation to prevent exposure. They should be stored off the ground and kept free from dust.
10. Control panel indicators.
    Assure all control panel switches, lights, and meters are functioning correctly.
11. Technique chart.
    Make sure technique charts are available, current, and appropriate for all procedures normally performed.
12. Patient viewability.
    Check for the availability of a method to permit continuous observation of the patients during the x-ray exposures.
13. Exposure switch placement.
    Assure the exposure switches are mounted or exposure switch cables are long enough that operators are not exposed to unnecessary levels of scatter radiation during x-rays.
14. Lead aprons, gloves, collars, etc.
    Assure items are available and stored correctly without bends or folds. If abnormal areas are found, complete Procedure 11.

CORRECTIVE ACTION:

Missing items from the room should be replaced as soon as possible. Malfunctioning equipment should be reported to the x-ray service engineer for repair or replacement as soon as possible.

***Note**: Some of the items on the visual checklist are operator convenience features. However, many of the items are essential for patient safety and high quality diagnostic images. It may be necessary to add additional items to the list that are specific to particular equipment or procedures. These should be included on the checklist and in each evaluation.

REPEAT ANALYSIS
(Procedure 6)

OBJECTIVE:

To identify ways to minimize patient exposure and reduce costs by addressing higher than normal repeat rates.

SUGGESTED PERFORMANCE CRITERIA:

The criteria associated with repeating a film is subjective. There is no good way to determine what the repeat rate should be. Each facility should decide on its own, but should strive for a repeat rate of no greater than 5 to 7 %.

FREQUENCY:

1. ***Ongoing*** tracking of films
2. Perform analysis quarterly

STEPS:

1. Determine the reason for film repeat as compared to the categories listed on the data sheet.
2. Record these numbers on the **Repeat Analysis Form (Form 5).**
3. Determine the total number of repeated films and the total number of films exposed. The overall repeat rate is the total of repeated films divided by the total number of films exposed during the test period.
4. By dividing the number of repeats per category by the total number of repeated films, a facility can calculate the repeat rate per category.

CORRECTIVE ACTION:

The percentage of repeats should guide the facility to focus their efforts to those areas needing the most attention. For example, films that are too light or too dark may be due to processing problems, equipment problems that require repair or re-calibration, or technique charts may need updating.

DENTAL TUBE HEAD AND BOOM STABILITY TEST
(Procedure 7)

OBJECTIVE:

To assure the intraoral x-ray tube remains in the correct location.

SUGGESTED PERFORMANCE CRITERIA:

Tube does not drift out of position or oscillate.

FREQUENCY:

Quarterly

STEPS:

1. Position the tube as you would with a patient in the chair.
2. Watch for any movement after you have positioned it.
3. Check all typical tube positions.
4. Record your results on the **Quarterly QC Checklist (Form 3)**.

CORRECTIVE ACTION:

Perform appropriate maintenance. Contact x-ray service engineer if necessary.

FILM AND CHEMICAL STORAGE
(Procedure 8)

OBJECTIVE:

To assure film and chemistry quality are maintained and inventory is rotated on a first in, first out basis.

FREQUENCY:

Quarterly

STEPS:

1. Maintain inventory so first in is first out.
2. Maintain the temperature and humidity to manufacturer recommendations.
3. Follow the chemistry manufacturer guidelines for replacement and disposal.
4. Record results on the **Quarterly QC Visual Checklist (Form 2).**

CORRECTIVE ACTION:

If storage conditions exceed manufacturer recommendations, take the necessary steps to resolve the problem.

Note: Premixed replenisher should not be stored in the replenisher tanks for more than 2 weeks due to oxidation.

INTENSIFYING SCREEN CLEANING
(Procedure 9)

OBJECTIVE:

To assure that screens and cassettes are free of dust and dirt particles that may degrade image quality.

SUGGESTED PERFORMANCE CRITERIA:

Minimize artifacts on films from screens or cassettes.

FREQUENCY:

1. Quarterly or semiannually (depending on workload and amount of dust in the environment)
2. When a problem is noticed

REQUIRED EQUIPMENT:

1. Screen cleaner (as recommended by manufacturer)
2. Lint-free gauze pad or cloth, or camel's hair brush.
3. Canned air* (available from photographic supply store)

STEPS:

1. Visually inspect the condition of the intensifying screen.
2. Dust the screen with the camel's hair brush and canned air*.
3. If foreign material (e.g., dirt, developer solution) cannot be readily removed with the camel's hair brush, use liquid screen cleaner.
4. After cleaning with manufacturer approved cleaners, screens should be allowed to air-dry, standing vertically, before returning the cassette to use.
5. Record your results on the **Quarterly QC Checklist (Form 3)**.

CORRECTIVE ACTION:

If the screen shows signs of surface damage, cracking, fading, or discoloration, it should be evaluated for replacement.

*Assure that the canned air used to clean the screens is "clean" air. If the air contains moisture, oil, or other contaminants, you may be introducing artifacts or damaging the screen.

Note: Lack of humidity in the darkroom can lead to excessive dust in the cassettes and static artifacts on film. To remedy this situation, install a humidifier in the darkroom.

DARKROOM INTEGRITY OR FOG TEST FOR SCREEN-FILM UNITS (Procedure 10A)

OBJECTIVE:

To determine and minimize the amount of darkroom fog.

SUGGESTED PERFORMANCE CRITERIA:

An optical density increase of 0.05 or less.

FREQUENCY:

1. Semiannually, with each type of film used clinically
2. After bulb or filter replacement
3. After changing or adding types of film

REQUIRED EQUIPMENT:

1. Opaque material (manila folder)
2. Watch or timer
3. Attenuation block (aluminum step wedge, phantom, acrylic block) to create a medium optical density of about 1.0 on the film.
4. Densitometer

STEPS:

1. Load a cassette with film and place on a flat surface.
2. Center the attenuation block and expose the film using an x-ray technique that will result in an optical density of about 1.0 after the film is processed.
3. With the safelights on, place the exposed film on the work area in the darkroom. Cover half the film with opaque material, bisecting the latent image parallel to the long axis of the film.
4. Leave exposed film on the counter for 2 minutes, then process as usual.
5. While waiting 2 minutes for darkroom fog test, look for any sources of extraneous light. Any light leaks identified should be repaired as soon as possible.
6. Inspect the processed film. If there is no discernible delineation between the shielded and unshielded sides of the film, there is no fog problem.
7. If a line is evident, measure the optical densities of both sides of the line with the densitometer. If the density difference is greater than 0.05, corrective action should be taken.
8. Record results on the **Semiannual QC Checklist (Form 3)**.

CORRECTIVE ACTION:

Repeat the test with the safelight off. If the results remain the same, the problem may be caused by a light leak or extraneous light. If the fog level disappears, the fog was due to the safelight and remedial action must be taken to correct the problem.

POSSIBLE SOURCES OF DARKROOM FOG:

Safelight filters (old or compromised)
Safelight housing
Safelight too close to work area
Light bulb of incorrect wattage or type
Ancillary indicator lights on processor
Timers
Radios
Fluorescent light afterglow
Light leaks
Suspended ceilings
Any place there is a hole cut in the wall
Excessive ambient light through the tinted viewing windows of daylight loading systems

DARKROOM INTEGRITY OR FOG TEST
INTRAORAL ONLY (WITHOUT DENSITOMETER*)
(Procedure 10B)

OBJECTIVE:

To determine and minimize the amount of darkroom fog.

SUGGESTED PERFORMANCE CRITERIA:

To maintain no visible difference in density between the shielded and unshielded sides of the fog test film. With no defined density differences present the use of a densitometer is unnecessary.

FREQUENCY:

1. Semiannually, for each type of film used clinically
2. After bulb or filter replacement
3. After changing or adding types of film

REQUIRED EQUIPMENT:

1. Opaque material (manila folder)
2. Watch or timer
3. Dental radiographic normalizing and monitoring device or attenuation block (aluminum step wedge, phantom, acrylic block) to create a medium optical density of about 1.0 on the film.

STEPS:

1. Set up intraoral film and attenuation block or normalization device.
2. Expose the film so that the background density will produce a medium optical density.
3. With the safelights on, remove exposed film from its light tight covering and place the exposed film on the work area in the darkroom. Cover half the film with opaque material, bisecting the latent image parallel to the long axis of the film. For a daylight processor, place film under the tinted viewing window in the glove box.
4. Leave exposed film on the counter for 2 minutes, then process as usual.
5. While waiting 2 minutes for darkroom fog test, look for any sources of extraneous light; any light leaks identified should be repaired as soon as possible.
6. Inspect the processed film. If there is no discernible delineation between the shielded and unshielded sides of the film, there is no fog problem.
7. If a line is evident, repeat the test to determine the source of darkroom fog. A test film, which shows no delineation between the shielded and unshielded sides, must be obtained to assure the source of the darkroom fog has been resolved.
8. Record results on the **Semiannual QC Checklist (Form 3).**

CORRECTIVE ACTION:

Repeat the test with the safelight off. If the results remain the same, a light leak or extraneous light may be the cause of the problem. If the fog level disappears, the fog was due to the safelight and remedial action must be taken to correct the problem.

POSSIBLE SOURCES OF DARKROOM FOG:

Safelight filters (old or compromised)
Safelight housing
Safelight too close to work area
Light bulb of incorrect wattage or type
Ancillary indicator lights on processor
Timers
Radios
Fluorescent light afterglow
Light leaks
Suspended ceilings
Any place there is a hole cut in the wall.
Excessive ambient light through the tinted viewing windows of daylight loading systems

* This procedure is designed for facilities that are only taking intraoral x-rays. Facilities using screen-film should follow Procedure 10A.

LEAD APRON, GLOVE, GONADAL, AND THYROID SHIELD INTEGRITY CHECK
(Procedure 11)

OBJECTIVE:

To assure that the lead aprons, gloves, gonadal shields, and thyroid collars provide optimal protection when positioned appropriately.

SUGGESTED PERFORMANCE CRITERIA:

No breaks in lead lining of protective garments.

FREQUENCY:

Annually

REQUIRED EQUIPMENT:

Lead aprons, gloves, gonadal, and thyroid shields

STEPS:

Option 1: If an image intensified fluoroscopy unit is available, this is the preferred way to inspect the aprons, gloves, and collars:

1. Lay out the item to be checked on the table
2. Examine the entire item using the fluoroscope
3. Record results on the **Annual QC Checklist (Form 4)**

Option 2: If an image intensified fluoroscopy unit is not available:

1. Closely inspect each item for kinks and irregularities
2. Take a radiograph of suspect areas
3. Process the film and look for breaks in the lead lining
4. Record results on the **Annual QC Checklist (Form 4)**

CORRECTIVE ACTION:

Any item displaying breaks in the lead lining should be replaced.

Note: Lead aprons should never be folded. Cracks in the lead lining can develop at the fold, reducing the useful life of the apron.

PANORAMIC SLIT ALIGNMENT TEST
(Procedure 12)

OBJECTIVE:

To assure that the radiation field is in proper alignment with the slit on the panoramic unit image receptor.

SUGGESTED PERFORMANCE CRITERIA:

Opening on the x-ray tube is in alignment with the opening in the image receptor.

FREQUENCY:

1. Annually
2. After service or maintenance on the x-ray system

REQUIRED EQUIPMENT:

Dental intraoral (or other individually wrapped) film

STEPS:

1. Tape film packets to the top and bottom of the slit on the image receptor. See **Figure 1** for set-up.
2. Mark the position of the slit on the film packets with a ballpoint pen. (Press hard).
3. Expose the film.
4. Develop the film.
5. Observe if the exposed portion of the film is in alignment with the demarcation caused by the use of the pen in Step 2.
6. Record results on the **Annual QC Checklist (Form 4)**

CORRECTIVE ACTION:

Malfunctioning equipment should be reported to the x-ray service engineer for repair as soon as possible.

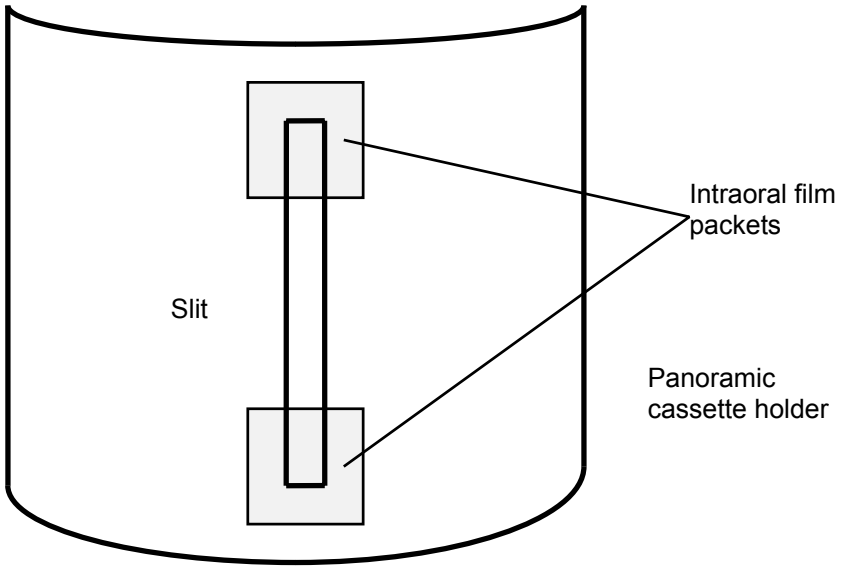

Figure 1. **Determining the Alignment of the Radiation Field to the Slit on the Image Receptor.**

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APPENDIX A

FORMS AND CHECKLISTS

The following forms and checklists may be reproduced as necessary to aid in maintaining your quality control program:

- ✓ *Quality Control Program Contact Sheet*
  A form designed to be completed, posted in the QC work area, and used as a quick reference.

- ✓ *Daily Quality Control Checklist (Dental Form 1)*
  Is a daily checklist to ensure that Procedures 1, 2, and 3 are completed.

- ✓ *Quarterly Quality Control Visual Checklist (Dental Form 2)*
  This checklist should be completed every calendar quarter as described in Procedure 5.

- ✓ *Monthly, Quarterly, and Semiannually Quality Control Checklist (Dental Form 3)*
  Is a checklist for Procedures 4, 6, 7, 9, and 10.

- ✓ *Annually and Biennially Quality Control Checklist (Dental Form 4)*
  Is a checklist for Procedures 11 and 12, and the routine survey by the qualified expert.

- ✓ *Repeat Analysis Form (Dental Form 5)*
  Is used for the ongoing tracking of repeat films and to calculate the repeat rate, following Procedure 6. An example form is included.

- ✓ *Annual Quality Control Review Form (Dental Form 6)*
  Is designed to be used as an aid during the annual review of the QA program.

Note: In addition to the forms in Appendix A, there are two forms in Appendix B:

X-Ray Processing Control Chart *(Form B-1)*
Cross-over Worksheet *(Form B-2)*

QUALITY CONTROL PROGRAM CONTACT SHEET

	NAME AND ADDRESS	PHONE
Doctor Responsible for QA	_____	_____
QA Coordinator	_____	_____
State Radiation Control Program	_____	_____
Medical Physicist or Qualified Expert	_____	_____
X-ray Machine(s) Technical Representative	_____	_____
Film Processor Technical Representative	_____	_____
X-ray Film and Intensifying Screens Technical Representative	_____	_____
Service Engineer	_____	_____
Radiation Safety Officer	_____	_____

Current as of: _____

DAILY
QUALITY CONTROL CHECKLIST
(Dental Form 1)

Facility: _____ Month: _____ Year: _____

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Initials																															
Processor QC																															
System Constancy																															
Darkroom Cleanliness																															

Comments (Date problems noted and identified, corrective action taken):

_____
_____
_____
_____
_____
_____

Pass = P Fail = F Does Not Apply = NA

QUARTERLY
QUALITY CONTROL VISUAL CHECKLIST
(Dental Form 2)

Year(s): _____ Facility: _____

Calendar Quarter (1st, 2nd, 3rd,4th)								
Date								
Initials								
1. Ceph BLD Insert in Place and Used								
2. Pan Tube and Film Holder Motion Smoothness								
3. Cone or Cylinder Secured to Tube								
4. Tube or Generator Oil Leakage								
5. Condition of Cables and Wires								
6. Film Artifacts								
7. Cassettes and Screens Condition								
8. Film Storage								
9. Loaded Cassette Storage								
10. Control Panel Indicators								
11. Technique Chart								
12. Patient Viewability								
13. Exposure Switch Placement								
14. Lead Aprons, Gloves, Collars, Etc.								

Each x-ray unit should be evaluated and any failures noted above should be described in detail in the Remarks section.

Remarks (Date problems noted and identified, corrective action taken):

_____
_____
_____
_____
_____

Pass = P Fail = F Does Not Apply = NA

MONTHLY, QUARTERLY, AND SEMIANNUALLY QUALITY CONTROL CHECKLIST (Dental Form 3)

Year: _____ Facility: _____

Date												
Initials												
Viewboxes												
Repeat Analysis												
Tube Head and Boom Stability												
Screen and Cassette Cleanliness												
Darkroom Fog												

Remarks (Explain problems identified and corrective action taken):

_____
_____
_____
_____
_____

Pass = P Fail = F Does Not Apply = NA

ANNUALLY AND BIENNIALLY
QUALITY CONTROL CHECKLIST
(Dental Form 4)

Year: _____ Facility: _____

Date			*Qualified Expert* Survey Date	
			Collimation	
Lead Aprons, Collars, Etc., Test			Half-value Layer	
Pan Slit Alignment			Focal Spot (at Installation Only)	
			Timer Accuracy and Reproducibility	
			kVp Accuracy and Reproducibility	
			mA Linearity	
			Exposure Reproducibility	
			ESE Evaluation	
			Technique Chart Evaluation	

Remarks (Explain problems identified and corrective action taken):

_____
_____
_____
_____
_____

If preferred, one form may be used for the entire facility. The biennial qualified expert report for each unit, as well as documentation on the corrective action taken on identified problems, should be maintained along with this checklist.

Pass = P Fail = F Does Not Apply = NA

REPEAT ANALYSIS FORM
(Dental Form 5)

From: _____ To: _____

Facility: _____

Cause	Number of Films	Percentage of Repeats
1. Positioning		
2. Patient Motion		
3. Light Films		
4. Dark Films		
5. Black Films		
6. Static		
7. Fog		
8. Incorrect Patient ID		
9. Double Exposure		
10. Miscellaneous (?)		
11. Good Films (No Apparent Problem)		
12. Clear Film		

	Total	
Repeats (1-12)		%

Total Film Used _____

EXAMPLE REPEAT ANALYSIS FORM

From: __1/1/99__ To: __3/31/99__

Facility: __*Hometown Dental*____

Cause	Number of Films	Percentage of Repeats
1. Positioning *1111111*	*7*	*19%*
2. Patient Motion *111111111*	*9*	*24%*
3. Light Films *111*	*3*	*8%*
4. Dark Films *1111111111111*	*13*	*35%*
5. Black Films	-	-
6. Static *1*	*1*	*2.7%*
7. Fog *11*	*2*	*5.4%*
8. Incorrect Patient ID *11*	*2*	*5.4%*
9. Double Exposure	-	-
10. Miscellaneous (?)	-	-
11. Good Films (No Apparent Problem)	-	-
12. Clear Film	-	-

	Total	
Repeats (1-12)	*37*	*5.3%*

Total Film Used ___*694*_____

37 total repeats / 694 total film used = 0.053 or 5.3%
7 total positioning problems / 37 total repeats = 0.19 or 19%.

ANNUAL QUALITY CONTROL REVIEW FORM
(Dental Form 6)

Facility Name: QC Coordinator: ___

Date of Review: Year Reviewed:

Attendees:

- Is image quality being maintained at the desired level?
- What is the facility repeat rate? Are changes addressed when necessary?
- Is the x-ray technique chart up-to-date?
- Is the screen-film combination still the best for the facility? Are the screens over 15 years old? If so, consider replacing them.
- Do all personnel meet required or established qualifications?
- Based on QC trends (variations or inconsistencies on QC charts), do any procedures, practices, or equipment need to be modified?
- Do any QC procedures need to be changed or updated?
- Are personnel adequately performing assigned tasks?
- Is patient and personnel radiation exposure as low as reasonably achievable as compared to national data?

APPENDIX B

PROCESSOR QUALITY CONTROL

OBJECTIVE:

To confirm and verify that the film processor-chemical system is working in a consistent manner according to pre-established specifications (manufacturer's specifications).

FREQUENCY:

Daily, prior to processing patient films

REQUIRED EQUIPMENT:

1. Sensitometer
2. Densitometer
3. Fresh box of control film
4. Control chart
5. Non-mercury clinical digital fever thermometer, accurate to at least ± 0.5°F.

PROCEDURES:

A. Establishment of Processor Quality Control Operating Levels

This procedure is carried out when the quality control program is initiated or when a significant change is made in imaging procedures, i.e., different film, chemicals, or processing conditions.

B. Daily Processor Quality Control

This procedure is carried out daily at the beginning of the work day before processing any patient films but after processor warm-up. This procedure ensures consistent film quality through consistent film processing.

C. Control Film Cross-Over

This procedure is carried out whenever a new box of film is opened for QC purposes. Radiographic film is produced in batches and it may be necessary to adjust baselines based on slight variations in film between batches.

Procedure A: Establishment of Processor Quality Control Operating Levels

1. Select a fresh box of film of the same type used clinically, and reserve this box for QC purposes only. (Note emulsion number on quality control chart.)
2. Drain the chemicals from the processor and thoroughly flush the racks and tanks with water.
3. Drain the replenisher tanks and refill with fresh replenisher.
4. Fill the fixer tank with fixer solution.
5. Once again flush the developer tank with water.
6. Fill the developer tank about one-half full with developer solution and add the specified amount of developer starter solution. Add sufficient developer solution to fill developer tank.

7. Set the solution temperature controls at the temperatures specified in the film manufacturer's written literature.
8. Set the developer and fixer replenishment rates as specified by the film manufacturer.
9. After the developer temperature has stabilized, check the temperature of the developer solution with a thermometer and assure that the processor is operating at the temperature specified by the film manufacturer. Clean the thermometer stem of developer solution after each use.
10. Using a sensitometer, expose and process a sensitometric strip. Repeat this exposure and processing once each day for 5 consecutive days.

    Note: Before processing sensitometric strips, be sure that the:
    - Developer temperature is correct;
    - Sensitometric strip is processed with the less-exposed end being fed into the processor first;
    - Sensitometric strip is processed on the same side of the processor, and it is inserted on the same side of the processor feed tray each time;
    - Sensitometric strip is processed with the emulsion in the same orientation (for single emulsion films); and
    - Delay between exposure and processing is similar each day to avoid any latent image changes that may occur with time.

11. Read and record the densities of each step of the sensitometric strip using the densitometer, including an area of processed film that has not been exposed. Measure the densities of the steps in the center of each step.
12. Determine the average of the densities for each step using the densities from the same step of the five strips done on five consecutive days.
13. Determine which step has an average density closest to 1.20. Record this optical density and corresponding step number as the mid-density (MD) step on the control chart **(Form B-1**). (This step is often referred to as the speed point, speed index, or speed step.) The mid-density is a measure of how dark the films will be. Underprocessing will produce films that are too light.
14. Determine which step has a density closest to, but less than, 2.20 and record this step number as the high-density (HD) step on the control chart **(Form B-1)**. Next, determine which step has a density closest to but not less than 0.45 and record this step number as the low-density (LD) step on the control chart. The difference in densities between these two steps (HD minus LD) should be designated as the density difference (DD). The density difference is a measure of the contrast provided on the film that can be affected by processing conditions. Underprocessing can reduce contrast.

    Note*:* The density difference determined by this method is to be used only to assess consistency of film and processing. It is not appropriate for comparing different film types or for comparing film types processed at different facilities.

15. Determine the average of the densities from the unexposed area of the five strips. This density will be recorded on the control chart (**Form B-1**) as the base-plus-fog level (B+F) of the film.
16. Confirm that the numerical values of the MD, DD, and B+F you recorded on the center line of the appropriate areas of the control chart are correct.

17. See **Figure B-1** and the following section entitled "Suggested Performance Criteria" for examples and further information.

Procedure B: Daily Processor Quality Control

1. Expose and immediately process a sensitometric strip. Before processing sensitometric strips be sure that the:
   - Developer temperature is correct,
   - Sensitometric strip is processed with the less-exposed end fed into the processor first,
   - Sensitometric strip is processed on the same side of the processor, i.e., it is inserted on the same side of the processor feed tray each time, and
   - Delay between exposure and processing is similar each day to avoid any latent image changes that may occur with time.
2. Read the densities of the three indicated steps and the base-plus-fog.
3. Plot the mid-density (MD), the density difference (DD), and the base-plus-fog (B+F) level on the control chart.
4. Determine if any of the data points exceed the control limits.
5. Circle the out-of-control data points, correct the cause of the problem and repeat the test, note the cause of the problem in the "Remarks" section of the control chart, and plot the in-control data point(s).
6. Determine if there are any trends (3 or more data points moving in the same direction) in the MD, DD or B+F. If trends are present but the data points have not yet exceeded the control limits, patient films may be processed. However, it will be necessary to determine the cause of the trend and to monitor the processor closely to assure that the control limits are not exceeded.

Procedure C: Control Film Cross-Over

1. While you still have at least 5 sheets of the old QC film remaining, select a new box of film for processor quality control.
2. Assure that the processor is in control.
3. Expose and immediately process 5 sensitometric strips each from the old and new boxes of film.
4. Determine the average of the steps previously identified for processor quality control for MD, DD, and B+F from the 5 films from the old box and from the 5 films from the new box. **See Form B-2**.
5. Determine the difference in the average values between the new and old boxes of film, as shown in the example in **Figure B-2.**
6. Adjust the old operating levels for MD, DD, and B+F by this difference to establish the new operating levels. This is accomplished by adding the difference (new-old), including the sign, to the old operating level. If the difference (new-old) is positive, the new operating level is increased. If the difference (new-old) is negative, the new operating level is decreased.

7. Record the new operating levels with their new control limits on a new control chart. Record the complete emulsion number of the new box of film on the new processor control chart. If the new box of film produces step densities that are so different from the old that the monitored steps are no longer the best choices, then new operating levels need to be established. (The best choices are the step with densities greater than or equal to 0.45 for the low-density step, closest to 1.20 for the mid-density step and closest to but less than 2.20 for the high-density step.)
8. Make a notation on the control chart in the remarks section of the date and that a cross-over was performed.

PRECAUTIONS:

It is desirable that sensitometric strips be exposed and processed and the data evaluated before clinical films are processed each day. If problems are detected, corrective action must be taken before clinical films are processed under less than optimal conditions.

The use of sensitometric strips exposed more than an hour or two before use is not acceptable because these strips may be less sensitive to changes in the processor than freshly exposed strips. In addition, as noted above, the sensitometric strip must be evaluated before clinical films are processed. Reading of the sensitometric strips and evaluating the results hours or days after the strip has been processed do not provide adequate quality control. Many clinical films may be improperly processed before the results are available. In order to maintain good QC of the processor, it is essential to read the densities of the sensitometric control strips with a calibrated densitometer. Visual comparison of the steps of the control strips is not adequate.

As indicated above, each sensitometric strip must be processed on the same side of the processor and fed into the processor with the less-exposed (low density) end of the strip leading. This reduces variation in the results and avoids development artifacts.

Radiographic film is produced in batches. Consequently, there may be slight variations in the characteristics of film between batches. In addition, film aging and storage conditions can affect the sensitometric characteristics of the film. Whenever a new box of film is opened for QC purposes, it is necessary to perform a "cross-over" with the old film. That is, the purpose of running the daily sensitometric strip is to test the processing and not the film, so if the new batch of film is darker (a higher optical density) under exactly the same processing conditions, then one must adjust the operating levels (MD and DD) to the values measured for the new film. The "cross-over" should be carried out only with a processor with seasoned chemistry. Expose and process, at the same time, 5 sensitometric strips each from the old and new boxes of film. Determine the average of each of the 3 indicated steps and of the base-plus-fog for the old film and for the new film. The operating level on the control chart should be adjusted to the new levels for MD and DD. For example, if the MD operating level for the old film was 1.30 and the new film has an optical density 0.1 higher than the old film, simply change the number on the control chart from 1.30 to 1.40. If the B+F of the new film exceeds the B+F of the old film by more than 0.02, the cause for this increase should be investigated.

It is essential to assure that developer temperature is within ±0.5ºF of the temperature specified by the film manufacturer. Quality control must also be performed on the densitometer, sensitometer, and thermometer themselves, to ensure their proper calibration. Manufacturer recommendations for quality control on these instruments should be followed, where available.

Do not use previously-processed film as "clean-up" film for the processor, since this can contaminate the developer.

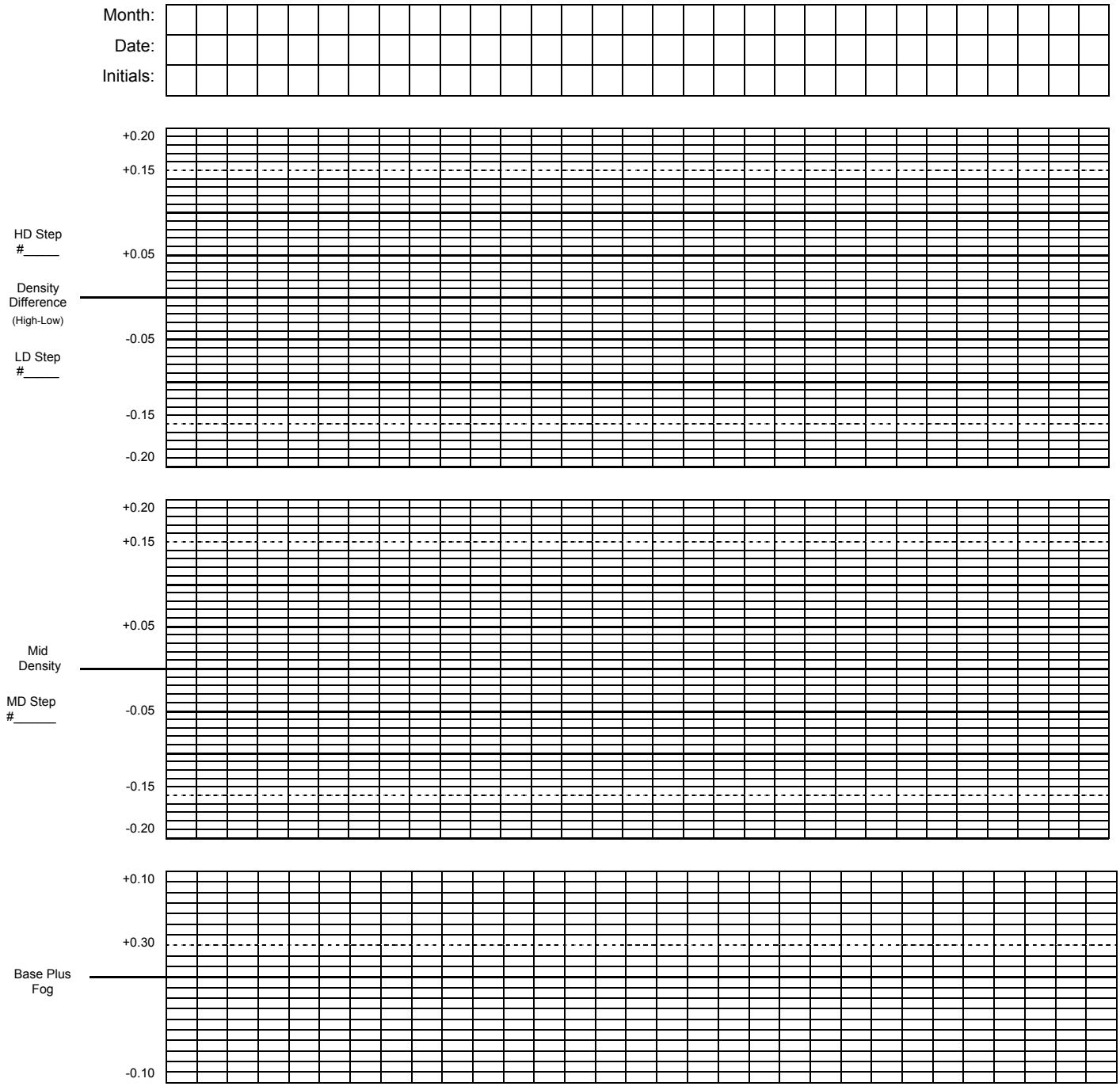
SUGGESTED PERFORMANCE CRITERIA AND CORRECTIVE ACTION:

If the MD and DD are within ±0.15 of their respective operating levels, and the B+F is within ±0.03 of its operating level, the processor is in control, and no further action is required. If the MD or DD exceeds the control limit of ±0.15, the source of the problem should be determined and corrected before clinical films are processed. Likewise, if the B+F exceeds +0.05, corrective action should be taken before clinical films are processed.

If a change in the mid-density, density difference, or base-plus-fog exceeds the suggested performance criteria, it will be necessary to determine the source or sources of this change (temperature, chemistry, replenishment, etc.) and the problem(s) should be corrected. In addition, the out-of-control data point should be circled, the cause of the problem noted in the "Remarks" section of the control chart, and the in-control data point plotted. See **Figure B-1**.

X-RAY PROCESSING CONTROL CHART
FORM B-1

Processor: _____ Film: _____
Emulsion # _____ Month _____ Yr. _____



REPLENISHMENT RATE

Date	Developer	Fixer

TEMPERATURE

Date	Developer	Wash

REMARKS

Date	Action

Date	Action

X-RAY PROCESSING CONTROL CHART

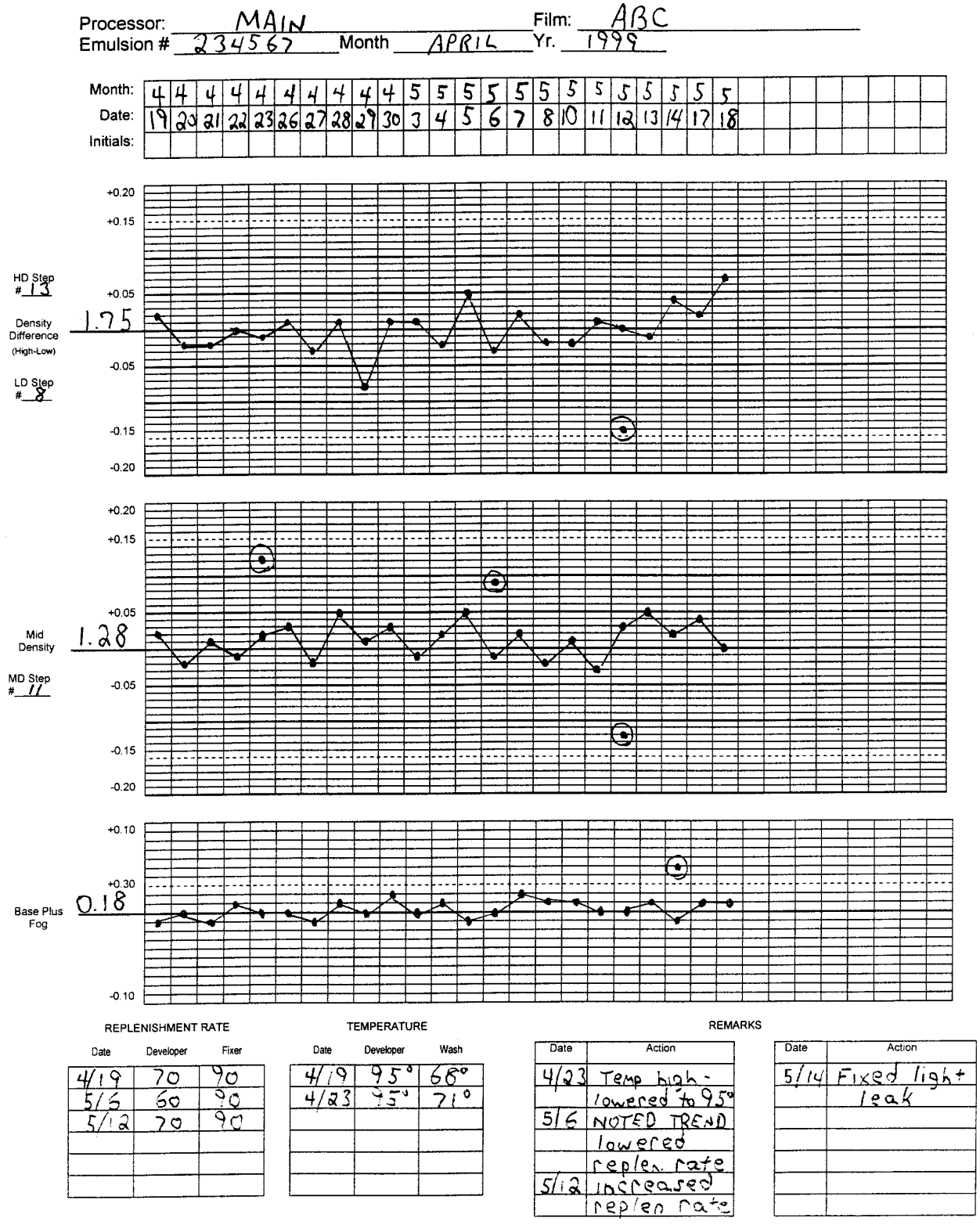


Figure B1. X-ray Processing Control Chart Example

CROSS-OVER WORKSHEET
FORM B-2

New Emulsion #					Old Emulsion #				
Film #	Low Density (LD) Step#___	Mid Density (MD) Step#___	High Density (HD) Step#___	B + F	Film #	Low Density (LD) Step#___	Mid Density (MD) Step#___	High Density (HD) Step#___	B + F
1					1				
2					2				
3					3				
4					4				
5					5				
Average					Average				
Average Density Difference (DD = HD - LD)					Average Density Difference (DD = HD - LD)				

MD difference between old and new film (New MD - Old MD)	
DD difference between old and new film (New DD - Old DD)	
B+F difference between old and new film (New - Old)	

	MD	DD	B + F
Old operating levels			
Difference between new and old film			
New operating levels			

New Emulsion #		*24578*			Old Emulsion #		*23456*		
Film #	Low Density (LD) Step#10	Mid Density (MD) Step#11	High Density (HD) Step#13	B + F	Film #	Low Density (LD) Step#10	Mid Density (MD) Step#11	High Density (HD) Step#13	B + F
1	*0.49*	*1.25*	*2.39*	*0.18*	1	*0.46*	*1.27*	*2.33*	*0.17*
2	*0.50*	*1.23*	*2.43*	*0.18*	2	*0.48*	*1.30*	*2.30*	*0.17*
3	*0.49*	*1.26*	*2.40*	*0.17*	3	*0.46*	*1.27*	*2.28*	*0.18*
4	*0.53*	*1.28*	*2.41*	*0.18*	4	*0.48*	*1.28*	*2.32*	*0.17*
5	*0.49*	*1.28*	*2.43*	*0.18*	5	*0.47*	*1.31*	*2.35*	*0.18*
Average	*0.50*	*1.26*	*2.41*	*0.18*	Average	*0.47*	*1.29*	*2.31*	*0.17*
Average Density Difference (DD = HD - LD)				*1.91*	Average Density Difference (DD = HD - LD)				*1.84*

MD difference between old and new film (New MD - Old MD)	*-0.03*
DD difference between old and new film (New DD - Old DD)	*+0.07*
B+F difference between old and new film (New - Old)	*+0.01*

	MD	DD	B + F
Old operating levels	*1.34*	*1.9*	*0.17*
Difference between new and old film	*-0.03*	*+0.07*	*+0.01*
New operating levels	*1.31*	*1.97*	*0.18*

Figure B-2. Cross-over Worksheet Example.

APPENDIX C

GLOSSARY

Aluminum equivalent means material affording the same attenuation as a thickness of aluminum (type 1100 alloy).

Automatic exposure control (AEC), also called a phototimer, means a device that automatically controls one or more technique factors to deliver a required quantity of radiation.

Beam-limiting device, also called a collimator, diaphragm or cone, means a device that provides a means to restrict the dimensions of the useful x-ray field.

Beam quality. See half-value layer (HVL).

Cassette holder, sometimes called a "Bucky," means a device, other than a spot-film device, that positions an x-ray film cassette during an x-ray exposure.

Control panel means that part of the x-ray control upon which are mounted the switches, knobs, push buttons, and other hardware necessary for manually setting the technique factors.

Collimator. See beam-limiting device.

Dose means the absorbed dose as defined by the International Commission on Radiation Units and Measurements.

Exposure is the amount of ionizing radiation (in air) produced by the x-ray machine.

Exposure reproducibility is a measure of the x-ray machine's ability to have a consistent output at a preselected technique.

Focal spot is the source of the x-rays on the anode in the x-ray tube.

Half-value layer (HVL), also referred to as beam quality, means the thickness of specified material that attenuates the intensity of the radiation beam to one-half of its original value.

Image receptor means any device, such as a fluorescent screen, radiographic film, solid-state detector, which transforms incident x-ray photons either into a visible image or into another form that can be made into a visible image by further transformations. In those cases where means are provided to preselect a portion of the image receptor, term "image receptor" shall mean the preselected portion of the device (e.g., spot film devices).

Image receptor support means that part of the x-ray system designed to support the image receptor during an examination.

kVp is the peak kilovoltage applied to the x-ray tube.

Light field is produced by a light source in the collimator (or beam limiting device) and indicates the location and size of the x-ray field.

Phototimer. See automatic exposure control.

Primary protective barrier is the material, excluding filters, placed in the primary beam to reduce the radiation exposure for protection purposes.

Qualified expert is an individual having the knowledge, training, and experience to measure ionizing radiation, evaluate safety techniques, and advise regarding radiation protection needs and medical quality assurance programs. A *qualified medical physicist* will meet the requirements of a *qualified expert*.

Qualified medical physicist is an individual who is competent to practice independently. This individual demonstrates competence through certification in radiological or diagnostic radiological physics and continuing education in relevant areas.

Quality administration procedures are those management actions intended to guarantee that monitoring techniques are properly performed and evaluated and that necessary corrective measures are taken in response to monitoring results. These procedures provide the organizational framework for the quality assurance program.

Quality assurance means the planned and systematic actions that provide adequate confidence that a diagnostic x-ray facility will produce consistently high quality images with minimum exposure of the patients and healing arts personnel. The determination of what constitutes high quality will be made by the facility producing the images. Quality assurance actions include both "quality control" techniques and "quality administration" procedures.

Quality assurance program is an organized entity designed to provide "quality assurance" for a diagnostic radiology facility. The nature and extent of this program will vary with the size and type of the facility, the type of examinations conducted, and other factors.

Quality control techniques are techniques used in the monitoring or testing and maintenance of the components of an x-ray system. The quality control techniques thus are concerned directly with the equipment.

Repeat films are those patient films that had to be repeated and resulted in additional exposure to the patient.

Source is the focal spot of the x-ray tube.

Source-to-Image-Distance (SID) means the distance from the source to the image receptor.

Technique factor(s) means kilovoltage (kVp), time (seconds or pulses), current (mA), or the product of time and current (mAs).

Useful beam means the radiation that passes through the tube housing port and the aperture of the beam-limiting device when the exposure switch or timer is activated.

Variable-aperture beam-limiting device, also called an adjustable collimator, is a beam-limiting device that has the capacity for adjustment of the x-ray field size at a given SID.

X-ray control is a device that controls input power to the x-ray high voltage generator and/or the x-ray tube. It includes equipment such as timers, phototimers, automatic brightness stabilizers, and similar devices that control the technique factors of an x-ray exposure.

X-ray field. See useful beam.

X-ray service engineer is a person whose knowledge, training, and experience qualify them to repair x-ray equipment.

X-ray tube is any electron tube that is designed for the conversion of electrical energy into x-ray energy.

CRCPD'S MISSION: A PARTNERSHIP DEDICATED TO RADIATION PROTECTION.

The Conference of Radiation Control Program Directors, Inc. (CRCPD) is a nonprofit organization made up of individuals in state and local government who regulate and control the use of radiation sources, and of individuals, regardless of employer affiliation, who have expressed an interest in radiation protection. CRCPD was formed in 1968.

The objectives and purposes of the organization are: to promote radiological health in all aspects and phases, to encourage and promote cooperative enforcement programs with federal agencies and between related enforcement agencies within each state, to encourage the interchange of experience among radiation control programs, to collect and make accessible to the membership of the CRCPD such information and data as might be of assistance to them in the proper fulfillment of their duties, to promote and foster uniformity of radiation control laws and regulation, to encourage and support programs that will contribute to radiation control for all, to assist the membership in their technical work and development, and to exercise leadership with radiation control professionals and consumers in radiation control development and action.

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