X-ray Quality Assurance Program

Radiation Health & Safety Manual

ALBERTA COLLEGE AND ASSOCIATION OF CHIROPRACTORS

Contents

Created January 2012 Revised August 3, 2021

Radiation Health and Safety Manual Overview

This manual has been created by the Alberta College and Association of Chiropractors (ACAC) to help chiropractors to meet the requirements of the ACAC Quality Assurance Program (QAP). Any questions or concerns about the information in this document should be directed to the ACAC's Radiation Health and Safety Program Administrator.

Why Quality Control?

There are three main reasons for establishing a Quality Assurance Program: dose, dollars and diagnosis. Dose to patients should be kept to a minimum. Maximizing diagnostic benefit does not have to come with increased dose. An appropriate Quality Assurance Program has been shown to reduce costs by 6 – 20% (Gray, Quality Control in Diagnostic Imaging, 1983). These savings may be more significant in medium to high volume facilities.

Quality Control – Digital Facilities

If you have a digital x-ray facility, you are required to submit to the ACAC a copy of the Manufacturer's Recommended Quality Assurance Program (MRQAP) at the time of your Quality Assurance Program (QAP) review. You should adhere to the MRQAP's recommendations and requirements, as it will be used to assist in evaluating that your facility' QAP meets requirements at the time of the review.

Generally, your digital QA will involve the use of an SMPTE or TG18-QC video monitor test pattern.

Submission materials will include:

- The Manufacturer's Recommended Quality Assurance Program (MRQAP)
- Form 1 – Patient X-ray Log
- Form 2 – Repeat Film Analysis

You will be expected to follow the manufacturer's recommended quality assurance procedures and upon request, submit proof of compliance (i.e., your logs of MRQAP activities) consistent with appropriate quality control.

The following can be used as a guide for your digital facility (pages 4 – 11).

Digital Quality Assurance Procedures

Area	Quality Assurance Procedure	Frequency
Electronic Display Device	Overall visual assessment - general image quality using SMPTE & TG18-QC test patterns	Daily
	Performance using test patterns – SMPTE, TG18-QC & BWH	Monthly
Image Receptor & Scanner	Visual Inspection of Cleanliness	Weekly
Laser Film Printer	Image quality using SMPTE & TG18-QC test patterns	Weekly & Monthly
System Tests	Response Function	Annual
	Exposure Index	Annual
	Dynamic Range	Annual
	Noise, Uniformity and Image Artifacts	Annual
	Digital Detector Residual Image	Annual

Daily

Overall Visual Assessment of Electronic Display Devices

The performance of electronic display devices used for interpretation of clinical images must be assessed. Displaying the image of a test pattern, an assessment must be made of the general image quality and for the presence of artifacts. The SMPTE or the TG18-QC test patterns can be used for this test and should be displayed using the software routinely used to display clinical images. It is recommended that the test pattern image be viewed from a distance of 30 cm from the front of the display device. The results of the assessment must be within established limits.

Monthly

Electronic Display Device Performance

The performance of all electronic display devices used to view images from digital systems, as well as those obtained through scanning of radiographic films, must be checked using a test pattern such as the SMPTE or a TG18 test pattern. For closed systems, where a suitable test pattern is not available on the system, a test pattern generator equipped with the appropriate test patterns must be utilized. Where a system does not have the capability to display an externally provided pattern, the manufacturer recommended quality control procedures must be followed.

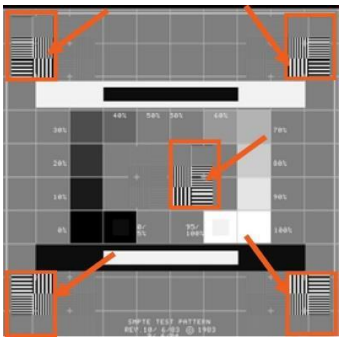
Electronic Display Device QA - Monthly

Initial each test to indicate that a successful evaluation was done for each video monitor in the facility. If a monitor fails the test, contact your service company for appropriate corrective action. Make a note of unusual occurrences, artifacts or maintenance required in the Comment section below.

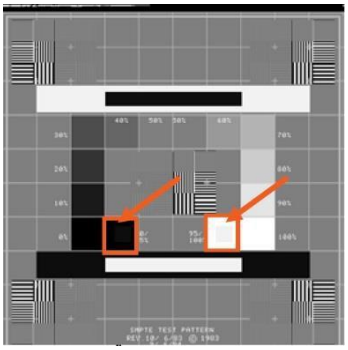
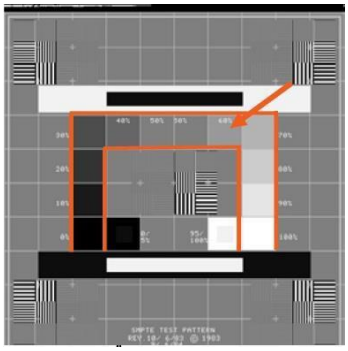
Indicate whether you are using either the SMPTE test pattern or the TG18-QC test pattern for the majority of the tests.

Video Monitor Identification	Video Monitor Setting & Test Pattern	0%-5% contrast	95%-100% contrast	Grey steps	Alpha-numerics	Resolution (centre)	Resolution (corners)	Distortion	BWH Grey Scale

Electronic Display Device QA with SMPTE Test Pattern – Monthly

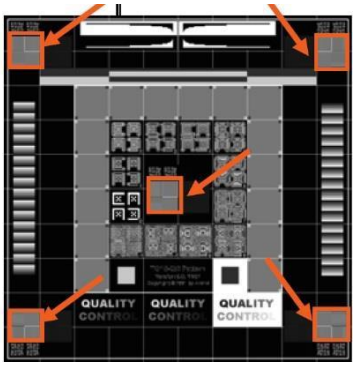
QA Test:	Video Monitor QA with SMPTE Test Pattern
Equipment needed:	Digital image file of the SMPTE1 Test Pattern
Limit of Acceptability:	No areas of distortion or damage. Track degradation of resolution, contrast and brightness
Procedure:	• Each video monitor in the facility should be tested • It is preferable to load the test pattern using the x-ray imaging software. If this is not feasible, load the test pattern onto the screen by using an available application (for Microsoft Windows systems: Paint or Microsoft Picture and Imaging, or Adobe Photoshop, etc.) • If you are not able to load/import the .gif file, try another file format **Before you start the assessment:** • Position the monitor to minimize reflections on the screen from ceiling lights, lamps or other illuminators • Set the room (ambient) light low • Warm up the monitor for 30 minutes prior to testing • Load the test pattern with the software application as specified on the *Video Monitor QA Chart* • Adjust the monitor settings, if required, as specified on the *Video Monitor QA Chart.* This may include: (a) window level and width, (b) contrast, (c) brightness, (d) vertical or horizontal size • Centre the test pattern in the active area of the monitor. Ensure all borders of the test pattern are visible The following tests have been adapted from the tutorials developed by the Department of Radiology, Brigham and Women's Hospital, Harvard Medical School[2]. Perform the following tests:
	**1. Resolution** • The high contrast bar patterns in the test image should be distinct as a pattern of black and white pairs • In each corner of the image, as well as in the centre, inspect the 6 squares filled with varying widths of alternating black and white horizontal and vertical lines (these are referred to as high contrast line-pair images). Refer to the diagram with arrows to indicate the regions of interest • Verify that the high contrast line-pair images at the centre and corners of the SMPTE pattern are distinguishable. You should be able to differentiate all the lines, from wide to narrow, both horizontal and vertical • Record the results on the Video Monitor QA Chart *Continued on next page*

[1] Test Pattern RP-133, The Society of Motion Picture and Television Engineers, 595 West Hartsdale Ave., White Plains, NY

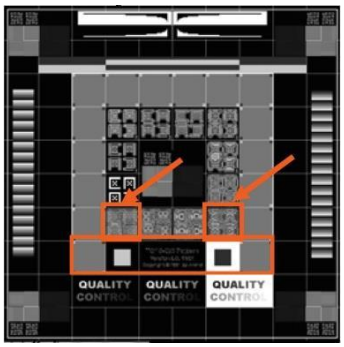
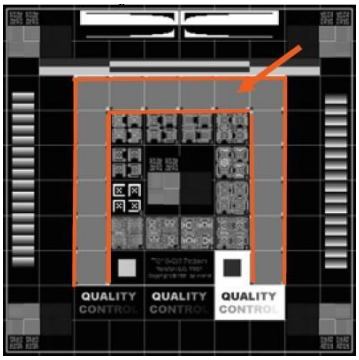
QA Test:	Video Monitor QA with SMPTE Test Pattern, continued
	**2. Contrast & Brightness** • The contrast and brightness of the monitor is adequately set if the 5% squares at both ends of the grey scale are visible • The grey scale is shown as a series of squares in the centre of the image that range from black (0%) to white (100%) in a semi-rectangle • The 0% and 100% squares (see arrows on image at left) each contain smaller squares within them that represent signal level steps of 5% and 95% respectively • You should be able to visually differentiate the inner square from the larger square that contains it • Verify that the 0%-5% contrast is visible • Verify that the 95%-100% contrast is visible • Record the results on the Video Monitor QA Chart
	**3. Grey Steps & Alphanumerics** • The grey scale is shown as a series of squares in the centre of the image that range from black (0%) to white (100%) in a semi-rectangle • Verify that each step from 0% to 100% is distinguishable from the adjacent ones • Verify that the alphanumeric characters that appear on the pattern are sharp and in focus. For example, examine the "%" signs that label the steps of the grey scale • Record the results on the Video Monitor QA Chart
	4. Geometric Distortion • Assess the general appearance of the test pattern • Verify that all lines appear straight and continuous without curvature or waviness • Verify that the pattern is square • Verify that there are no blurred areas or regions that flicker • Record the results on the Video Monitor QA Chart

[2] Visual Perception Laboratory, Video Monitor Test Pattern Tutorials, Brigham and Women's Hospital Department of Radiology, Harvard Medical School, BrighamRAD at http://brighamrad.harvard.edu/research/topics/vispercep/tutorial.html, 1997.

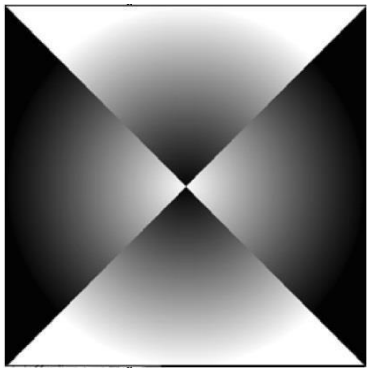
Electronic Display Device QA with TG18-QC Test Pattern – Monthly

QA Test:	Video Monitor QA with TG18-QC Test Pattern
Equipment needed:	Digital image file of the TG18-QC3 Test Pattern
Limit of Acceptability:	No areas of distortion or damage. Track degradation of resolution, contrast and brightness
Procedure:	• Each video monitor in the facility should be tested • It is preferable to load the test pattern using the x-ray imaging software. If this is not feasible, load the test pattern onto the screen by using an available application (for Microsoft Windows systems: Paint or Microsoft Picture and Imaging, or Adobe Photoshop, etc.) • If you are not able to load/import the .gif file, try another file format **Before you start the assessment:** • Position the monitor to minimize reflections on the screen from ceiling lights, lamps or other illuminators • Set the room (ambient) light low • Warm up the monitor for 30 minutes prior to testing • Load the test pattern with the software application as specified on the *Video Monitor QA Chart* • Adjust the monitor settings, if required, as specified on the *Video Monitor QA Chart.* This may include: (a) window level and width, (b) contrast, (c) brightness, (d) vertical or horizontal size • Centre the test pattern in the active area of the monitor. Ensure all borders of the test pattern are visible The following tests have been adapted from the American Association of Physicists in Medicine, On-line Report No. 033. Perform the following tests:
	**1. Resolution** • The high contrast bar patterns in the test image should be distinct as a pattern of black and white pairs • In each corner of the image, as well as in the centre, inspect the 4 squares filled with varying widths of alternating black and white horizontal and vertical lines (these are referred to as high contrast line-pair images). Refer to the diagram with arrows to indicate the regions of interest • Verify that the high contrast line-pair images at the centre and corners of the TG18-QC pattern are distinguishable. You should be able to differentiate all the lines, from wide to narrow, both horizontal and vertical • Record the results on the *Video Monitor QA Chart* *Continued on next page*

[3] Test Pattern TG18-QC, American Association of Physicists in Medicine, AAPM On-Line Report No. 03

QA Test:	Video Monitor QA with TG18-QC Test Pattern, continued
	**2. Contrast & Brightness** • The contrast and brightness of the monitor is adequately set if the 5% squares at both ends of the grey scale are visible • The grey scale is shown as a series of 16 squares around the centre of the image that range from black (0%) to white (100%) in a semi-rectangle • The 0% and 100% squares (see arrows on image at left) each contain smaller squares within them that represent signal level steps of 5% and 95% respectively • You should be able to visually differentiate the inner square from the larger square that contains it • Verify that the 0%-5% contrast is visible • Verify that the 95%-100% contrast is visible • Verify that the contrast detail "QUALITY CONTROL" letters are visible and distinct in the three boxes below the grey scale squares • Record the results on the *Video Monitor QA Chart*
	**3. Grey Steps & Alphanumerics** • The grey scale is shown as a series of 16 squares in the centre of the image that range from black (0%) to white (100%) in a semi-rectangle • Verify that each step is distinguishable from the adjacent ones • Verify that the alphanumeric characters that appear on the pattern are sharp and in focus • Record the results on the *Video Monitor QA Chart*
	4. Geometric Distortion • Assess the general appearance of the test pattern • Verify that all lines appear straight and continuous without curvature or waviness • Verify that the ramp bars appear continuous without any contour lines • Verify that the pattern is square • Verify that there are no blurred areas or regions that flicker • Record the results on the *Video Monitor QA Chart*

Q Electronic Display Device A with BWH Test Pattern - Monthly

QA Test:	Q Electronic Display Device A with BWH Test Pattern
Equipment needed:	Digital image file of the BWH[4] Test Pattern
Limit of Acceptability:	Assess the range of grey levels available on your workstation
Procedure: 	• Each video monitor in the facility should be tested • It is preferable to load the test pattern using the x-ray imaging software. If this is not feasible, load the test pattern onto the screen by using an available application (for Microsoft Windows systems: Paint or Microsoft Picture and Imaging, or Adobe Photoshop, etc) • If you are not able to load/import the .gif file, try another file format Before you start the assessment: • Position the monitor to minimize reflections on the screen from ceiling lights, lamps or other illuminators • Set the room (ambient) light low • Warm up the monitor for 30 minutes prior to testing • Load the test pattern with the software application as specified on the *Video Monitor QA Chart* • Adjust the monitor settings, if required, as specified on the *Video Monitor QA Chart.* This may include: (a) window level and width, (b) contrast, (c) brightness, (d) vertical or horizontal size • Centre the test pattern in the active area of the monitor. Ensure all borders of the test pattern are visible The following test has been adapted from the image and tutorial developed by the Department of Radiology, Brigham and Women's Hospital, Harvard Medical School[4]. • The test pattern should appear as a continuous grey scale image from the center of the pattern • No concentric ring-like features should be present. If such features are present, your system is displaying at less than optimal quality • Record the results on the *Video Monitor QA Chart*

[4] Visual Perception Laboratory, Video Monitor Test Pattern Tutorials, Brigham and Women's Hospital Department of Radiology, Harvard Medical School, BrighamRAD at http://brighamrad.harvard.edu/research/topics/vispercep/tutorial.html, 1997.

Weekly, Monthly and Annual Digital QA Procedures

Visual Inspection of Cleanliness of Imaging Systems – Weekly
Imaging systems **must** be inspected for dust and dirt on or near the image reception area where they may negatively affect image quality. The image receptors for direct-capture systems **must** be kept clean of dust, dirt and other items which may come into contact with them. Laser scanning digitizers **must** also be checked for cleanliness.

Laser Film Printer Operation – Weekly & Monthly
The quality of images obtained from the laser film printer **must** be checked. Depending on the system, this may or may not require using pre-established window and level settings on the display. Ensure that the viewbox used to assess printed films has sufficient luminance. The SMPTE, TG18-QC and TG18-PQC test patterns should be used. A hardcopy image of the test pattern **must** meet the following criteria:

i) the 5% patch **must** be just visible inside of the 0% patch,
ii) the 95% patch **must** be just visible inside the 100% patch,
iii) the optical density of various patches (for example 0%, 10%, 40% and 90%) **must** be within acceptable limits from the established baseline values, for the particular film used at the facility.
iv) no geometrical distortion greater than ± 1 mm,
v) no artifacts upon visual inspection.

Response Function – Annually
For digital X-ray imaging systems, the response function of the detector should be assessed. The manufacturer specified relationship between the system response (mean pixel value in a standard region of interest) and exposure to the image receptor, over a range of tube loadings, should be confirmed to be within established limits. The manufacturer's recommended testing procedure should be followed.

Exposure Index – Annually
For digital X-ray imaging systems, the accuracy and reproducibility of the exposure index, as a function of the dose to the image receptor, must be evaluated. The manufacturer's recommended testing procedure must be followed and the results must be within established limits.

Dynamic Range – Annually
For digital systems, the dynamic range is a measure of the maximum difference in attenuation that the system can simultaneously image, without loss of information due to saturation of pixels. A test object consisting of an attenuating plate terminated with a step wedge of 12 steps should be used. The number of non saturated steps or the thickness of the smallest non saturated step should be within established limits.

Noise, Uniformity and Image Artifacts – Annually
An assessment must be made of noise, uniformity and image artifacts. The Signal-to-Noise Ratio (SNR) should be calculated by measuring the mean pixel value and standard deviation in a region of interest within the image. The standard deviation of signal values should be determined for three different locations, at the centre, at the top, and at the side of the image. The size of the region of interest should equal approximately 10% of the area of the phantom. The test should be done using homogeneous phantoms having thicknesses representative of patient thickness. The measured noise value must be within established limits. The uniformity of the signal across the different regions of interest at the periphery and the centre of the phantom must be within established limits. Images must be assessed to ensure that unacceptable artifacts are not present.

Digital Detector Residual Image – Annually
There must not be any visible residual image from a previous exposure. The manufacturer's recommended test procedure should be followed.

Quality Control – Film-based Facilities

Follow the daily, weekly, monthly, quarterly and yearly procedures as set out in Safety Code 35, and your QAP will meet review standards when you are flagged for a random review. To meet QAP standards, you will need to use the forms below in conjunction with these procedures.

Safety Code 35 can be accessed here:

http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code_35-securite/index-eng.php#sc3

Quality Assurance Program Checklists & Forms

	Applies to	
Checklists	**Digital Facility**	**Film-based Facility**
Film-based X-ray Facility Checklists (weekly, monthly, quarterly and annual)	No	**Yes**
Digital X-ray Facility Checklists (weekly, monthly, quarterly and annual)	**Yes**	No
Forms The following forms are required for adherence to the QAP. These forms must be filled out and maintained in your clinic. They will be requested at the time of your QAP review.		
Form 1 – Patient X-ray Log	**Yes**	**Yes**
Form 2 – Repeat Analysis	**Yes**	**Yes**
Form 3 – Densitometry Graph	No	**Yes**
Form 4 – Processor Quality Control Chart	No	**Yes**
Form 5 – Entry of Sensitometry & Densitometry Values	No	**Yes**
Form 6 – Quality Control Test Tool Chart*	No	**Yes***

*See the *Quality Control Test Tool Manual* on page 28 for further details on this tool. Form 6 can be used in place of forms 3, 4 & 5 if you have the test tool. If films start to come out poorly, however, you may need to replace your chemistry and temporarily return to regular sensitometry and densitometry until you determine the cause of the problem.

Digital X-ray Facility Checklists

Perform the following daily, weekly, monthly, quarterly and annual procedures as per the checklists below to ensure that your Quality Assurance Program meets the requirements of Safety Code 35 and the ACAC's Radiation Health and Safety Program.

Daily (CR/DR)

	Equipment warm-up
	Meters operation – check for proper function
	Equipment Conditions – visual inspection
	Overall visual assessment of electronic display devices

Weekly (CR/DR)

	Visual inspection of cleanliness of imaging systems
	Viewboxes condition

Monthly (CR/DR)

	Retake analysis • Review Form 2 – Retake Analysis for trends and indications
	Electronic display device performance – use a test pattern for evaluation of electronic display device performance (ex. SMPTE, TG18-QC, TG18-PQC)

Quarterly (CR/DR)

	Collimator mechanical function – check for smooth operation of collimator leaves
	Interlocks

Annually (CR/DR)

	Integrity of protective equipment (gonad shield, lead apron, gloves, etc.)

Film-based X-ray Facility Checklists

Perform the following daily, weekly, monthly, quarterly and annual procedures as per the checklists below to ensure that your Quality Assurance Program meets the requirements of Safety Code 35 and the ACAC's Radiation Health and Safety Program.

Daily (Film)

	Equipment warm-up
	Meters operation – check for proper function
	Equipment Conditions – visual inspection
	Darkroom cleanliness
	Film processor function • Complete Forms 3 – Densitometry Graph, Form 4 – Processor Quality Control Chart, and Form 5 – Daily Entry of Sensitometry/Densitometry Values • OR, complete only Form 6 if you have the X-ray Quality Control Test Tool

Weekly (Film)

	Visual inspection of cleanliness of imaging systems
	Viewboxes condition

Monthly (Film)

	Cassette, screen, and imaging plate cleaning
	Darkroom temperature and humidity conditions
	Darkroom light conditions
	Film processor operation i. The accuracy of the processor temperature display must be checked against a non-mercury thermometer. The processor developer temperature should be accurate to within 0.5°C. ii. The replenishment rate must be compared with the manufacturers' recommended baseline level for the particular processor and film type, for the given number of films processed daily and for the method of processing. iii. All processing solutions should be changed and processor solution tanks cleaned. iv. Fixer retention tests should be performed to ensure fixer is adequately removed from processed films according to established baseline levels.
	Retake analysis • Review Form 2 – Retake Analysis for trends and indications

Quarterly (Film)

	Collimator mechanical function – check for smooth operation of collimator leaves
	Interlocks

Annually (Film)

	Safelight test
	Film/screen contact
	Integrity of protective equipment (gonad shield, lead apron, gloves, etc.)

Patient X-ray Log

Form 1

Use for every film taken. For each patient, record each view and the associated factors. The “Quality” column is used to indicate that a retake is needed.

Date	Patient Name	View	cm.	kVp	mA	Time	Quality

Repeat Film Analysis Form 2

Record every time you have a repeat film. Analyze your reshoots monthly to determine which problems are consistent.

Month and year:							
#	**Patient identifier**	**Study date**	**Over-exposed**	**Under-exposed**	**Positioning**	**Scratches**	**Artifacts, collimation, other technical factors**
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Densitometry Graph

Form 3

Complete each day x-ray used, prior to exposure. This form is not necessary if you are using the X-ray Quality Control Test Tool (see Form 6).

Density baseline (day 1)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____

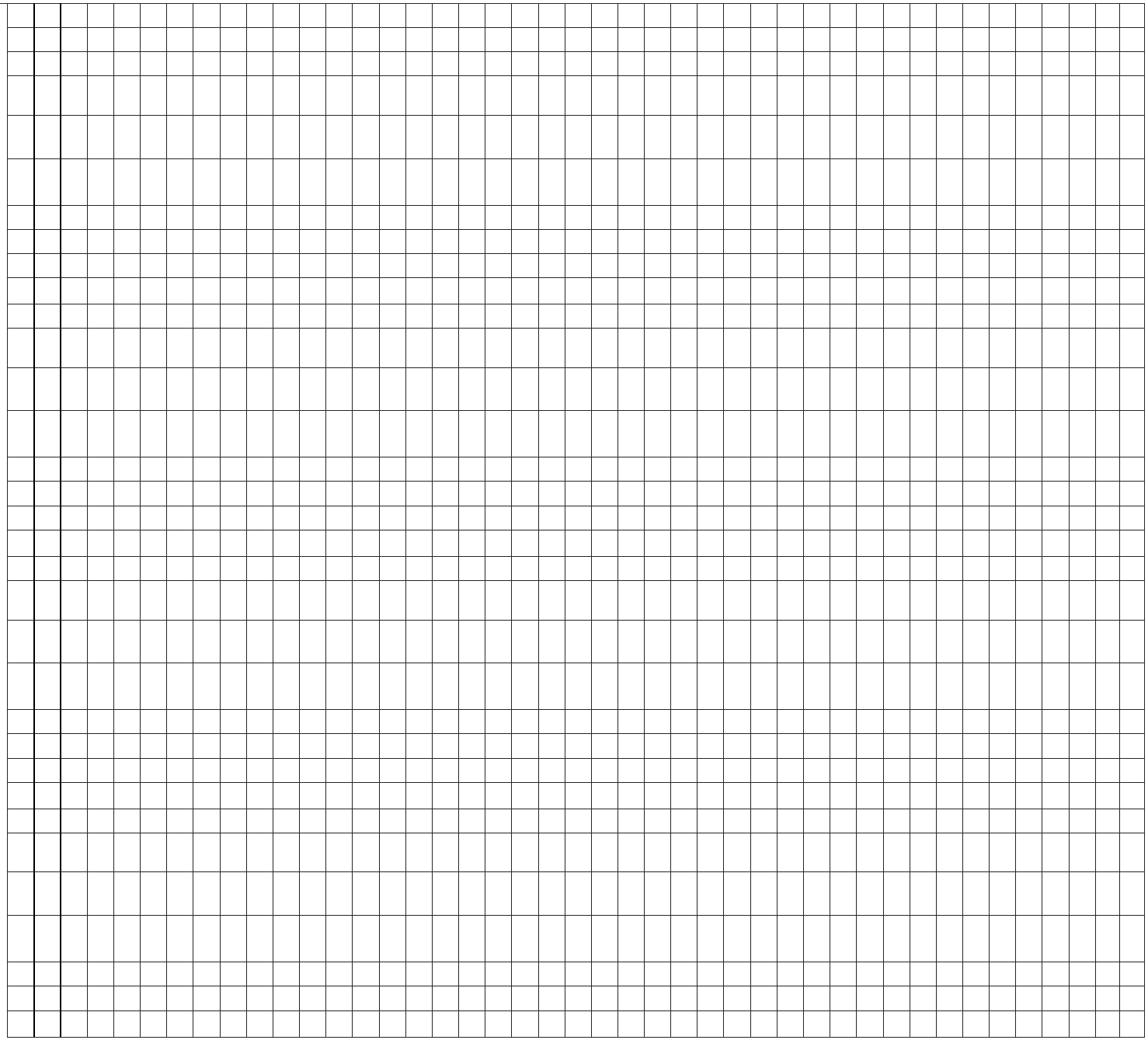
Processor: _____

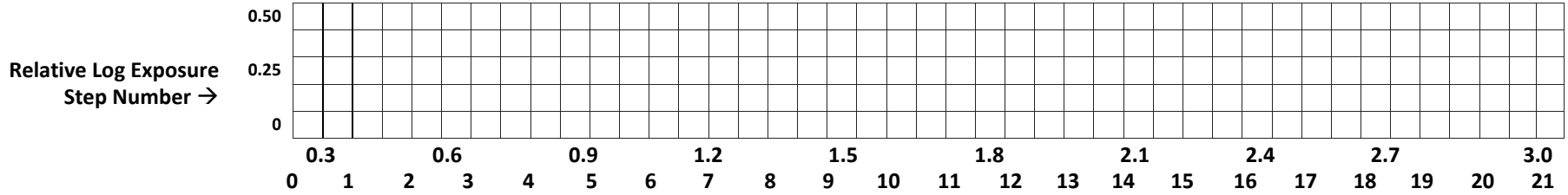
Date: _____

Chemistry: _____

Speed: _____

Contrast: _____




Relative Log Exposure
Step Number →
0.50
0.25
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Processor Quality Control Chart — Form 4

Complete daily. Plot numbers from Form 3 – Densitometry Graph on this sheet. Record Date, Contrast, Speed, Base + Fog, Time.
This form is not necessary if you are using the X-ray Quality Control Tool (see Form 6).

Month and year:																																
Performed By:																																
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**
Dev. Temp.																																
CONTRAST	**Normal**																															
SPEED	**Normal**																															
BASE + FOG	**0.25**																															
	0.20																															
	0.15																															

Date	**Remarks / Action Taken**

Daily Entry of Sensitometry/Densitometry Values Form 5

Perform daily/each day films are taken. This form is not necessary if you are using the X-ray Quality Control Test Tool (see Form 6).

Month and year:																																
Performed By:																																
Date		**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**
B + F																																
Step	**1**																															
	2																															
	3																															
	4																															
	5																															
	6																															
	7																															
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	18																															
	19																															
	20																															
	21																															
Time																																
# of Days																																
Temp.																																

Quality Control Test Tool Chart

Form 6

Complete each day x-ray is used, prior to exposure.

Film Step Number																															
Step Number	+3																														
	+2																														
	+1																														
	0																														
	-1																														
	-2																														
	-3																														

Film Processing Information																															
Developer Temp. & Time																															

Exposure Timer Setting																															
mA, seconds mA, impulses mAs																															

Date of the Quality Control Test																															
Y/M/D																															

Diagnostic Imaging Requirements

It is the position of the Alberta College and Association of Chiropractors (ACAC) that collaboration between the medical and chiropractic health professions is in the best interest of Albertans. The best interests of the patient should always be held paramount in administering and accessing imaging services.

The ACAC supports its members in the utilization of diagnostic imaging procedures that are consistent with the scope of practice for chiropractors in Alberta. It is appropriate for a chiropractor to order any flat-plate, non-contrast study involving any osseous structure(s) of the human anatomy. The primary use of diagnostic imaging is in support of differential diagnosis.

Given a patient's presenting complaint and the presence of significant objective findings, indications for diagnostic imaging study might include:

- objective or subjective biomechanical/kinesthetic aberrancy
- historic event (e.g. trauma/injury)
- history of arthritide
- malignant disease
- regional infection or persistent/unremitting symptomatology

Other factors and findings indicating the necessity for diagnostic imaging evaluation may include:

- positive orthopaedic/neurologic patterns
- deformity
- suspicious familial predilections
- uncertain palpatory indicators

Within the chiropractic diagnostic imaging lexicon, it is also appropriate to procure investigative radiographs in order to preclude potential treatment contraindications. These may include: the determination of atlanto-axial instability (i.e. the Down's syndrome patient or the rheumatoid arthritic patient) or a significant degree of spondylitis osteoarthritica/degenerative joint disease (e.g. an aging patient or previously injured patient).

More sophisticated or specialized imaging studies, such as MRI, are also appropriate when the technical considerations for these imaging modalities are determined in consultation with the medical diagnostic imaging facility.

The ACAC acknowledges that children are particularly sensitive to the untoward effects of ionizing radiation. It is the position of the ACAC that it would be considered appropriate and clinically prudent in certain situations to order radiographs for the investigation of trauma, significant biomechanical abnormality or instability. Diagnostic imaging investigation may also be prudent even in the absence of a manifest structural and/or developmental indicator or disease when such a condition is suspected (e.g. juvenile idiopathic scoliosis or a degenerative joint/connective tissue syndrome).

In the case of a recognized or suspected pathology or other significant diagnostic imaging finding, the ACAC asserts that the professional responsibility for reporting/referral rests with the practitioner who requisitions the imaging study. It is expected that chiropractors will communicate, in a timely fashion, any significant diagnostic imaging findings to the patient's primary attending physician. This will be undertaken with due consideration for patient consent and privacy.

Requirements

In addition to adherence to federal and provincial legislation, chiropractors will adhere to the following requirements as set by the Alberta College and Association of Chiropractors (ACAC).

Registration of Equipment

All owners of diagnostic imaging equipment will register their equipment with the ACAC as per the ACAC Administrative Policies.

Film Review

All facility owners will participate in the ACAC Radiation Health and Safety Program film review when requested. The review will consist of requests for radiographic studies, and the log sheets and quality assurance wedge strips for the period in which the radiographs were taken. Facility owners are responsible for ensuring that the recommendations of the ACAC Radiation Health and Safety Program are implemented.

Quality Assurance Program

Each facility owner must have a quality assurance program (QAP) that is in compliance with the ACAC Radiation Health and Safety Program. The QAP must require a test be performed each day that a radiograph is to be taken to ensure the radiographic imaging system is functioning optimally. Clinic staff members may be trained to perform quality assurance tests; however, the registered owner remains responsible for the program.

Gonadal Shielding

Gonad and breast shielding will be available for patients of both sexes. There is no requirement to use gonadal shielding, unless the patient requests shielding after you have informed them of the recommendation to not use the shielding.

All facilities will have available lead aprons for shielding abdomens on all studies that are not primarily exposing the abdominal area of patients.

Minimum Study and Film Size

The following are considered minimum requirements for radiographing the area listed. The chiropractor may wish to exceed these requirements and take additional views. However, these additional views must be *additional to* and not *instead of* the required views listed below.

Shoulders	Minimum two views: • internal rotation • external rotation Minimum film size of 8” x 10”
Upper arm, elbow, forearm, wrist, hand, fingers, knee, ankle, foot, calcaneus, toes	Minimum two views at right angles to each other Film size as required
Acromio-clavicular	Minimum two views, both A-P: • one view without weights • one view with weights
Clavicle	Minimum two views: • one A-P • one oblique
Hip	Minimum two views: • one A-P • one frog leg Minimum film size of 8” x 10”
Cervical Spine	Minimum three views: • A-P open mouth • A-P lower cervical • Lateral cervical Minimum film size of 8” x 10”, or 10” x 12”
Cervico-thoracic Combination	This is not a recommended series
Thoracic spine	Minimum two views: • A-P or PA lateral at right angles to each other Minimum film size 7” x 17” or 14” x 17” if significant scoliosis or kyphosis is present

Minimum Study and Film Size, Continued

Lumbar spine	Minimum of two views: • A-P or PA and lateral at right angles to each other Minimum film size 7” x 17” **Patients over 55 years of age:** Minimum film size is 14” x 17”, with the collimated image to be 12” x 17”
Lumbo-pelvic combination	Minimum two views at right angles to each other Minimum film size 14” x 17” A-P and 7” x 17” lateral **Patients over 55 years of age:** Minimum film size is 14” x 17”, with the collimated image to be 12” x 17”
Ribs, A-P, lateral and obliques	Minimum two views at right angles to each other Minimum film size 11” x 14”
Skull	Minimum two views at right angles to each other Minimum film size 10” x 12”
Chest	Minimum two views: • PA and lateral at right angles to each other • Minimum film size 14” x 17”
Other Views	As generally accepted
Miscellaneous	• When two views are taken on the same piece of film, lead sheeting or its equivalent must be used to protect the film from scatter during exposures • Motion studies and structural analysis studies may be taken alone when previous films of diagnostic quality have been reviewed (such diagnostic studies are to be no more than three months old) • Radiographs will be taken of the area of primary complaint • Further views in the case of those practitioners who practice special techniques are acceptable; however, the area of primary complaint must be radiographed. If the symptoms of the primary complaint are radicular in nature, then the area directly responsible must be radiographed • If a patient is sent for radiographs of the area of primary complaint, and those radiographs are reviewed by the chiropractor in question, then the practitioner may restrict the radiographic examination to the area that will be treated

The Radiographic Image

Collimation

Evidence of collimation must be present on all films. This will correspond to the area of diagnostic concern. Both horizontal and vertical collimation margins must be present.

Patient Placement

Patients will be appropriately positioned in relation to the study being performed.

Protection of the Eyes

Due to the radio-sensitivity of the eyes, the patient's eyes will be specifically excluded from the field of radiation unless this area is required for the study in question.

Corresponding A-P and Lateral Studies

The A-P or P-A and lateral radiographs will cover the same area. An A-P 14" x 17" and a lateral 8" x 10" are not acceptable. Two views of the same size at right angles is the requirement.

Patient Identification

Films must be marked with the patient's name or identification, patient birth date, date of study, and facility (facility name and address). This will be done with photo imprinting at the time of exposure.

Right and Left Markers

Films must be marked at the time of exposure with right and or left markers. Lateral exposures will be marked with the side of the patient closest to the film.

Upright or Recumbent Markers

Upright or recumbent position indicators should be used.

Gonad Shields

Gonadal shielding and the recommendation for usage are adapting to align with the Canadian Association of Medical Radiation Technologists and the Canadian Association of Radiologists. Standard use of gonadal shielding is no longer recommended for the following reasons:

- Patients receive 20-25 times less radiation today.
- Our bodies are unique. Shielding can easily be misplaced.
- Poorly placed shielding can impact the quality of the x-ray and cause the procedure to be repeated.
- In 70 years of research, no studies have proven harmful effects of x-rays on reproductive organs or the fetus.

Practitioners must inform patients of the recommendations and the reasoning why gonadal shielding is no longer being used. Further to the recommendation, patients may still choose to use gonadal shielding. This is an informed consent discussion and should be noted in the clinical record.

The Ten Day Rule

Female patients of childbearing potential will not have the abdomen exposed to ionizing radiation unless it is within the first ten days since the start of last menstruation. Emergency situations may require exceptions to this standard. Women who are abstaining from sex, or on birth control medication may be exempted from this rule as long as the risks are clearly explained to the patient in advance of the study.

Optimum k.v.p. techniques

Radiographs will be exposed at the highest k.v.p. that is consistent with high quality radiographs. As a guide, the following are considered optimum by the ACAC:

Optimum k.v.p. Techniques		
Cervical	A-P open mouth	80 k.v.p.
	A-P lower cervical	70 k.v.p.
	Lateral cervical	70 k.v.p.
Thoracic	A-P	85 k.v.p.
	Lateral	90 k.v.p.
Lumbar	A-P	85 k.v.p.
	Lateral	90 k.v.p.
Extremities		55 k.v.p.
Skull	A-P	80 – 90 k.v.p.
Knee	All views	55 – 65 k.v.p.
Shoulders	All views	70 – 80 k.v.p.

Practitioners wishing to vary from the above by more than 5 per cent must have prior approval from the ACAC Radiation Health and Safety Program Administrator.

Patient Artifacts

All earrings and piercings (that can reasonably be removed) and undergarments (including plastic and thick elastic garments such as pantyhose) should be removed prior to radiographic examination.

Technique Charts

Each film based radiographic facility will develop, or have developed, suitable technique charts. Such charts will be displayed in the control booth and used in conjunction with calipers. Technique charts will be up-to-date and accurate.

Log Book

Each radiographic facility must maintain an x-ray exposure log book. The log book will contain the patient's name, gender, measured thickness for each view, factors used for each view, date and quality of the resulting radiograph.

Full Spine Radiography

The ACAC recognizes that there are times when a single exposure A-P or PA spinal radiograph accompanied by related lateral sectional films may be desired in the assessment of inter-dependent spinal disrelationships, scoliosis, and multiple site symptom complexes. The ACAC encourages its members to take sectional views whenever possible and to avoid using full spine films as routine.

Full Spine Views Are to be the Exception

Full spine radiography is to be the exception rather than the rule. The ACAC encourages its practitioners to utilize techniques that do not require the use of full spine radiography.

If full spine films are taken, the procedure must adhere to the following directives:

1. **Patient Clothing Restrictions**: Remove necklaces, earrings, dentures, hairpins, eyeglasses, and all clothing above and below the waist except underwear that does not have thick elastic. Patients will be provided with a gown when street clothes are to be removed.
2. **Gonad and Breast Shielding:** Gonad and breast shielding will be available for patients of both sexes. There is no requirement to use gonadal shielding, unless the patient requests shielding after you have informed them of the recommendation to not use the shielding.
3. **The Ten Day Rule:** Employment of the ten day rule regarding menstrual cycle will be followed.
4. **Collimation:** The eyes will be outside the area exposed, and collimation will be to subject size. Collimation margins will be visible on all sides of the film.
5. **P-A Scoliosis Studies:** The radiation to the gonads and breasts is significantly reduced by using P-A procedures. In scoliosis studies where repeat radiographs are usually required, P-A positioning will be employed.
6. **Focal Film Distance:** A minimum 72" focal film distance will be employed.
7. **Film Screen Combinations:** A minimum 400 speed film screen combination will be used. For repeat scoliosis films, an 800 speed system is recommended.
    a. Split screen cassettes are not acceptable.
    b. Gradient screens are not acceptable.
8. **Filters:** In-beam compensating filters will be used to reduce the amount of radiation that is received by the thinner body parts.
9. **Radiographic Factors:** Radiographic factors consistent with minimum patient exposure will be employed. An optimum k.v.p. technique of 90 k.v.p. should be used. Any technique that uses k.v.p. less than 80 is not acceptable.
10. **Relevant Sectional Views:** The A-P full spine radiograph will be accompanied by relevant lateral radiographs. A single A-P film is not acceptable.
11. **Single A-P or P-A Scoliosis Studies**: Single A-P or P-A scoliosis studies are acceptable as follow-up studies if taken within three months, and the patient is a child of child bearing potential.
12. **Patient Size Restriction:** If the patient measures more than 27 cm. A-P, then the patient will be radiographed in sections.
13. **Lateral Full Spine Radiographs**: Lateral full spine radiographs are **not** acceptable.

Advanced Imaging Modalities

All proposals for non-conventional diagnostic imaging facilities must receive prior approval of the ACAC Radiation Health and Safety Program Administrator.

X-ray Quality Control Test Tool and Manual

If you would like to obtain a Quality Control Test Tool, contact the Administrator of the Radiation Health and Safety Program at the ACAC.

*(**Note:** The following is reproduced from the hard copy X-Ray Quality Control Test Tool Manual (pages 28-35) so that members can understand what this tool can offer. Therefore, page number references from pages 28-35 refer specifically to the printed manual and not to this document, the Radiation Health and Safety Manual.)*

This manual is for use with the Quality Control Test Tool, which can be used in place of traditional computation of speed, contrast, base plus fog, maximum density via densitometry and sensitometry.

This tool can be obtained from the ACAC office. Please contact the ACAC for further information on how to obtain your X-ray Quality Control Test Tool.

Preamble

Since mid-1994, the Radiation Protection Bureau has distributed over 250 X-Ray QC Test Tool kits. These are currently in use at remote medical x-ray facilities (health centres and small hospitals) located across Canada, including Northwest Territories and the Yukon. The QC kits are also being used successfully at other small x-ray facilities such as in penitentiaries and in private chiropractic and veterinary clinics.

The adoption and use of this quality control procedure, using the X-Ray QC Test Tool, provides the users with a simple non-invasive method to check the status of their imaging systems and maintain image quality. This is especially important for x-ray facilities where the workload is low or the x-ray system has not been used for an extended period. When significant deterioration of image quality has occurred, the procedure will assist the user to determine whether it is related to an imaging system problem or to an operator error. From this, with the help of some technical support, the required changes can be made to bring the system back to the previously established operating level.

Where this method of quality control has been implemented, requests for technical assistance have decreased. Also, the x-ray operators are now able to provide factual information regarding their imaging equipment problems when requesting technical assistance. The use of the test tool has also made it possible to quickly assist x-ray operators in establishing an accurate patient loading factors chart. This quality control method has increased their confidence in their ability to produce good quality radiograms and this is reflected in a significant decrease in the number of repeated films.

Acknowledgements

The authors with to thank Captain B. Ruests, Sergeant C. Martel and the 1993-94 Medical X-ray Technology Students who participated from the National Defence Medical Centre, Mr. C. Lavoie and Mr. P. Dvorak of the Radiation Protection Bureau, Ms. J. Rothenberger of the Mackenzie Regional Health Service, and Mr. S. Bara and the 1997-98 Medical X-ray Technology students who participated from the Northern Alberta Institute of Technology, for their collaboration and assistance during the various development and production stages of the test tool. Discussions with and comments by the authors' colleagues are also gratefully appreciated.

Michel A. Périard
Paul Chaloner
X-ray Section
March, 1998

The X-Ray Quality Control Test Tool

The X-Ray Quality Control Test Tool is a simple device used to check the constancy of the x-ray machine output and film processing system performance. It is designed for routine quality control (QC) testing of conventional radiographic equipment with manual or low workload automatic film processing systems. The X-Ray QC Test Tool is recommended for use in small hospitals, Health Centres, Nursing Stations and facilities operating under federal jurisdiction.

The X-Ray QC Test Tool consists of the following parts:

- the test tool body, including step by step instructions for use,
- a copper square,
- a sliding reference film strip, with a density step range labeled from -5 to +5,
- a film slot, to insert the test film image of the copper square,
- a viewing window, to compare the test film image density to the reference film strip, and
- a test tool jacket, including a Trouble Shooting Guide

How to Use The X-Ray QC Test Tool

1. Establishing Loading Factors Procedure

Note: It is essential at this point that your x-ray equipment and film processing system function correctly before this procedure is performed. This may involve replacement, repair, upgrading or calibration of the equipment. The film processing chemicals should also be replaced with fresh chemistry.

The purpose of this initial procedure is to determine the correct loading factors (mA and irradiation time, or mAs) at 80 kVp required, using the x-ray machine and film/screen system used at your radiographic facility, to produce an image of the copper square with a film density equal to the reference film density step 0. These factors may range between 5 and 20 mAs depending on the type of x-ray machine and film/screen combination used at your facility. The procedure is outlined on the test tool and in the *Quick Start* section on page 4.

After having determined the correct loading factors, these factors and the film cassette number should be recorded on the test tool. These loading factors, the same film cassette, and the test tool must now be used in the *Periodic Monitoring Procedure*. It will not be necessary again to determine any new loading factors unless the x-ray machine, or the film/screen system, is changed.

2. Periodic Monitoring Procedure

The purpose of *periodic QC monitoring* is to routinely evaluate the performance of the x-ray machine and film processing system to control the quality of the diagnostic images being produced. This can be done with the test tool at regular intervals. The goal is to confirm that a new image of the copper square, with a density matching reference film step 0, can be reproduced using the same loading factors and film processing method used previously. Corrective action is indicated when the density of the new image differs by ±2 steps from the reference density step 0. The *Periodic Monitoring Procedure* is outlined on the test tool

Periodic QC monitoring should be done regularly, *at least monthly*. QC testing should also be performed if the following conditions apply:

- after a suspected malfunction of the x-ray equipment,
- after x-ray equipment repair (or following corrective action)
- after processing chemistry changes or replenishment, and
- to verify the current activity or condition of the processing chemistry.

3. Record Keeping

The density step number of the monitor film should be recorded on the *Periodic QC Monitoring Chart* on page 8, along with the date and other important information related to the QC test. Charting the test results will provide a continuous picture of the x-ray and film processing system performance. Extra *pull-out* charts are supplied with this manual. (Note from the ACAC: one copy is provided for you to reproduce as desired, and can be found as Form 9 in the Forms section of the *Radiation Health and Safety Manual*).

Periodic QC monitoring should not be eliminated if the results indicate relatively stable equipment performance. The purpose of a QC programme is to *control the quality* of diagnostic images, something which cannot be done without periodic measurements of the equipment performance. Small but progressive changes in the clinical radiographs, which may not be readily detectable to the eye, will be more easily noticed using the *X-Ray QC Test Tool.*

4. Trouble Shooting Guide

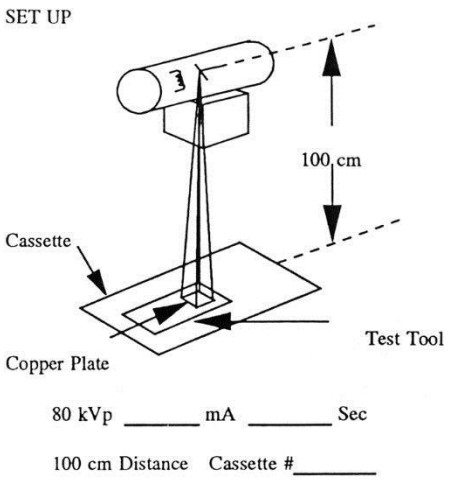
A *Trouble Shooting Guide*, page 36, is printed on the test tool jacket. This guide should assist you in correcting minor problems that might occur during quality control monitoring.

X-ray QC Test Tool

Purpose

To check the consistency of the x-ray machine output and film processing. Recommended for small Hospitals, Health Centres and Nursing Stations.

Establishing Loading Factors Procedure



Load the smallest cassette with regular film. Place the cassette on the x-ray table or floor and the test tool of the cassette

Position the x-ray tube focal spot 100 cm above the copper plate.

Collimate the x-ray field to the size of the copper plate

Expose the test film using loading factors of 80 kVp, 5 mAs. For example 20 mA and 15/60 second for a 400 speed system,

Develop the film in **new** solutions according to the manufacturer's time-temperature chart for the film and chemistry in use.

After drying the test film, cut out the image to size and insert it into the test tool film slot. Place the test tool on a view box.

Slide the reference film strip in the test tool until one of the density steps matches the test film density.

If the test film density matches the reference film density step 0 you have the correct standard loading factors

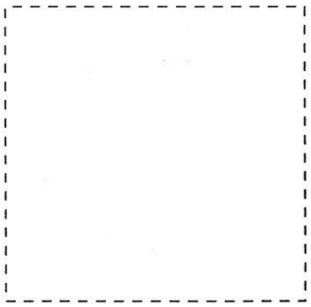
If the test film does not match the reference film density step 0, adjust the timing device to increase or decrease radiation time. Repeat procedures 1-8

Record the final loading factors and other information here:

80 kVp_____mA_____Sec

Distance 100 cm Cassette #_____

Periodic Monitoring Procedure



Periodic monitoring should be done monthly

Load cassette #_____with regular film. Place the cassette on the x-ray table or floor and the test tool on the cassette.

Position the x-ray tube focal spot 100 cm above the copper place.

Collimate the x-ray field to the size of the copper plate.

Set the loading factors recorded on the test tool and make an irradiation.

Develop the monitor film according to the manufacturer's time-temperature chart for the film and chemistry in use.

After drying the monitor film, cut out the image to size and insert it into the test tool film slot. Place the test tool on a view box.

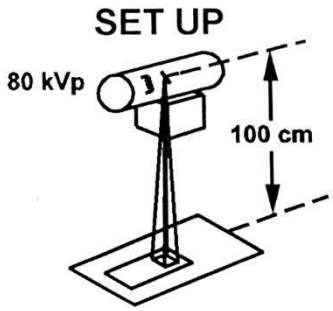
Slide the reference film strip in the test tool until one of the density steps matches the monitor film density.

The monitor film density must match the reference film density step 0 ±1 step

If the monitor film density differs by ±2 steps from the reference density step 0, refer to the Trouble Shooting Guide on page 36.

Health Canada
Radiation Protection Bureau
X-ray Section

Quick Start to establish correct QC loading factors



1. Prepare new developer and fixer solutions according to the manufacturer's recommendations

2. Load an x-ray cassette *[e.g., 24 X 30 cm]* with the film currently in use. Divide the surface of the cassette into four equal areas *[e.g., A, B, C, D]* to allow for four exposures of the test tool on one film.

3. Position the x-ray tube and cassette at **100 cm** source-to-film distance and set the x-ray machine kilovoltage to **80 kVp.** *For Capacitor discharge units, use 90 to 95 kVp*.

4. Centre the test tool in one area *[e.g., area A]* of the cassette and collimate to the size of the copper square. Use lead blockers to protect the three other film areas not in use from the x-ray beam. Expose the test tool once in the centre of each area of the cassette and note the loading factors assigned to each area. Depending on the type of x-ray machine, start with the following timer settings:

For 20 mA units:	[A] 15/60	[B]30/60	[C]8/10	[D] 10/10 second
For mAs units:	[A] 5	[B] 10	[C] 15	[20]20 mAs

5. Process the film according to manufacturer's time and temperature recommendations. Use the *Time/Temperature Chart*, pages 5 or 6 if applicable.

6. When the film is dry, cut out each of the four images to size and insert one into the test tool film slot. Place the test tool on a view box.

7. Slide the reference film strip until one of the density steps matches the test film. Similarly, compare each test film to match reference film density step 0.

8. If one of the test films matches the reference film density step 0, you have established the correct QC loading factors (mA and irradiation time, or mAs) at 80 kVp. Record these factors, along with the film cassette number, on the test tool. Use these loading factors, and the same cassette, for the *Periodic Monitoring Procedure*.

9. If none of the test films match the reference film density step 0, select the exposure closest to step 0 and adjust the timing device to increase or decrease the irradiation time accordingly. Make another exposure and repeat procedures 5 to 8.

Time/Temperature Chart (°F)

As a guide to manually process the following X-ray films, using Kodak CBX chemistry, the manufacturer recommends the following processing guidelines to ensure complete development and yield optimum radiographic quality. An accurate **thermometer** and **timer** must be used to check the developer temperature and ensure appropriate development time at that temperature.

- Stir thoroughly developer & fixer with appropriate paddle.
- Do not process films at temperatures of less than 65°F
- Do not agitate film during development

1. For Kodak: X-Omat RP, L, S; Single Coated Medical:

Dev. Temp. (°F):	65	66	68	70	72	74	76	78	80
Time (min.):	8	7½	7	6½	6	5	4	3¼	2½

2. For Kodak: Dental D, E; Ektamat G; x-Omat AR, Ortho G, L, M; NMB; NMC.
   Dupont: Cronex Medical. 3M: Veterinary:

Dev. Temp. (°F):	65	66	68	70	72	74	76	78	80
Time (min.):	6	5½	5	4½	4	3½	3	2½	2

3. For Kodak: X-Omat K; Min-R; SB. Fuji: RX:

Dev. Temp. (°F):	65	66	68	70	72	74	76	78	80
Time (min.):	4¼	4	3½	3¼	3	2½	2	1¾	1½

4. For Kodak: T-Mat G, L, S, H, M2:

Dev. Temp (°F):				70	72	74	76	78	80
Time (min.):				8	7	6¼	5½	4¾	4

- Rinse: 30 seconds with intermittent agitation in clear or running water
- Fix: 2-4 minutes at (60 – 85)°F with intermittent agitation
- Wash: 20 minutes at (60 – 85)°F in clear or running water

This chart must be posted near the film processing area.

Time/Temperature Chart (°C)

As a guide to manually process the following X-ray films, using Kodak CBX chemistry, the manufacturer recommends the following processing guidelines to ensure complete development and yield optimum radiographic quality. An accurate **thermometer** and **timer** must be used to check the developer temperature and ensure appropriate development time at that temperature.

- Stir thoroughly developer & fixer with appropriate paddle.
- Do not process films at temperatures of less than 65°F
- Do not agitate film during development

1. For Kodak: X-Omat RP, L, S; Single Coated Medical:

Dev. Temp. (°C):	18.5	19	20	21	22	23	24	25	26	27
Time (min.):	8	7½	7	6½	6	5¼	4½	3¾	3	2½

2. For Kodak: Dental D, E; Ektamat G; x-Omat AR, Ortho G, L, M; NMB; NMC.
   Dupont: Cronex Medical. 3M: Veterinary:

Dev. Temp. (°C):	65	66	68	70	72	74	76	78	80
Time (min.):	6	5½	5	4½	4	3½	3	2½	2

3. For Kodak: X-Omat K; Min-R; SB. Fuji: RX:

Dev. Temp. (°C):	65	66	68	70	72	74	76	78	80
Time (min.):	4¼	4	3½	3¼	3	2½	2	1¾	1½

4. For Kodak: T-Mat G, L, S, H, M2:

Dev. Temp (°C):	70	72	74	76	78	80
Time (min.):	8	7	6¼	5½	4¾	4

- Rinse: 30 seconds with intermittent agitation in clear or running water
- Fix: 2-4 minutes at (60 – 85)°F with intermittent agitation
- Wash: 20 minutes at (60 – 85)°F in clear or running water

This chart must be posted near the film processing area.

Trouble Shooting Guide

Light Film (Density -2 or more)

Cause	Correction
Exposure time too short:	Check control timer setting
kVp or mA too low:	Check kVp and mA settings
Film distance too long:	Check film distance. Set to 100 cm
Film/Screen mismatch	Check film and screen type
Developing time too short:	Check timer. Use time-temperature chart
Developer too cold:	Check thermometer. Use time-temperature chart
Fixing time too long:	Fix for 10 minutes only
Wash time too long:	Wash for 20 minutes only
Developer too weak:	Mix new solutions following manufacturer's recommendations

Repeat the test film after a corrective action is completed.

Dark Film (Density +2 or more)

Cause	Correction
Exposure time too long:	Check control timer settings
kVp or mA too high:	Check kVp and mA settings
Film distance too short:	Check film distance. Set to 100 cm.
Film/Screen mismatch:	Check film and screen type
Developing time too long:	Check timer. Use time-temperature chart
Developer too warm:	Check thermometer. Use time-temperature chart.
Dryer temperature too high:	Check dryer temperature
Developer too strong:	Mix new solutions following manufacturer's recommendations

Repeat the test film after a corrective action is completed.

Investigations of Complaints Concerning Authorized Radiation Protection Agencies

- Owners of designated radiation equipment will continue to report complaints to the ACAC. This mechanism is logical in that there is currently an exchange of information concerning radiation equipment between the owner and the ACAC.

- In accordance with Section 2.4 of their Quality Management Plans (QMP), ACAC will initiate an investigation of the complaint or incident by contacting Alberta Labour and providing details concerning the dispute.

- Alberta Labour will contact the Authorized Radiation Protection Agency involved, to inform them of the complaint and/or disagreement.

- In accordance with Section 4.4 of their Authorization Agreement, the Radiation Protection Agency will provide interpretations relative to the Radiation Protection Act and Regulation associated with the services that they provided the owner.

- The Authorized Radiation Protection Agency will formally respond to the complaint and/or disagreement in writing to the ACAC, citing, as required, relevant Safety Codes or Standards referenced in the Radiation Protection Regulation.

- The ACAC will then convey the response to the owner. If the response concerns any condition that contravenes the Radiation Protection Act and Regulation, the ACAC may issue a directive for remedial action under Section 16(1) of the Radiation Protection Act.

- If the owner is still not satisfied, he/she will inform the ACAC in writing. A meeting will then be held between the four concerned parties (owner, agency, organization and government) to attempt to resolve the dispute.

- If the owner is still not satisfied, and the issue involves:

    a) a refusal by the Director to issue a registration certificate under Section 10, or

    b) the suspension or cancellation of a registration certificate under Section 10, or

    c) a directive under Section 16

- The owner may enter into an appeal process in accordance with Section 17 of the Radiation Protection Act.

Investigation of Overexposure

Section 2(6) of the Radiation Health Administration Regulation delegates all the powers duties and functions of the Minister under Sections 13(2) Notice of Incidents and Overexposures and 16(2) Remedial Action of the Radiation Protection Act to the ACAC:

- if a radiation worker receives a reading from their commercial dosimetry service in excess of allowable limits, then the National Dose Registry (NDR) send a High Exposure Notification to both the owner and Alberta Labour

- if the incidence of overexposure occurred from x-ray equipment, Alberta Labour will contact the ACAC which oversees that owner group, requesting the Organization to co-ordinate an investigation into the overexposure

- the ACAC will contact the owner, instructing the owner to:

    a) notify the organization as to the time, place and nature of the overexposure or incident,
    b) carry out an investigation into the circumstances surrounding the overexposure or incident, and
    c) prepare a report outlining the circumstances of the overexposure or incident and the corrective action, if any, undertaken to prevent a recurrence of the overexposure or incident

- the owner has responsibility to organize the overexposure investigation. The investigator can be

    a) the ACAC with its delegated authority to investigate or
    b) an Agency that has been contracted
        i) by the owner
        ii) by an Organization

- if the ACAC is satisfied with the results of the investigation, they will forward the report to Alberta Labour

- Alberta Labour will give the report final approval prior to forwarding a recommendation to the National Dose Registry

- if the report concerns any conditions that contravenes the Radiation Protection Act and Regulation, the ACAC may issue a directive to

    a) prohibit the use of the facility or equipment or
    b) require action to remedy a danger

Standards of Practice and Administrative Policies Related to Radiography

The following Standards of Practice and Administrative Policies are in place for the ACAC's Radiation Health and Safety Program. Follow the links below to review these documents on the ACAC website.

Standards of Practice

http://albertachiro.com/standard-document/acac-standards-of-practice/

- Standard of Practice 8.1 Diagnostic Imaging Studies for Adults
- Standard of Practice 8.2 Advanced Diagnostic Imaging Studies for Adults
- Standard of Practice 8.3 Diagnostic Imaging for Children
- Standard of Practice 8.4 ACAC Radiation Health and Safety Program
- Standard of Practice 5.4 Health Records Retention (applies to patient x-rays)

Administrative Policies

http://albertachiro.com/standard-document/acac-administrative-policies/

- Administrative Policy 1.8 X-ray Equipment
- Administrative Policy 1.9 Laser Equipment
- Administrative Policy 2.4 X-ray Quality Assurance Program Reviews

Safety Code 35 Compliance Checklists and Annual Preventative Maintenance Form

Safety Code 35 Checklists

Safety Code 35 checklists are used by Authorized Radiation Protection Agencies (ARPAs) to evaluate new facilities and to confirm compliance in existing facilities. A compliance inspection report produced by an ARPA for an x-ray facility will include the following checklists, which are provided for your information only.

- Safety Code 35 - Facility Checklist
- Safety Code 35 - Image Processing Systems Checklist
- Safety Code 35 - Radiation Protection Checklist (disregard 4. Radioscopic Equipment & 5. Angiography Equipment)
- Safety Code 35 - Radiographic Equipment Checklist

Compliance inspections are required for new registrations, generator upgrades, and five-year compliance inspection and registration renewals (for which notification begins in December with all requirements due by March 31st on each fifth anniversary year of the initial registration.)

Access to Safety Code 35 is available via the following URL: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code_35-securite/index-eng.php.

Annual Preventative Maintenance

Annual Preventative Maintenance (APM) is completed by an authorized service professional once every year. Notification begins in March and all requirements are due by June 30th each year.

The form included here is for your information only and will be provided via email as part of a larger package of information each time APM comes due.

- X-ray Annual Preventative Maintenance form

Radiation Protection Agency
Compliance Verification Checklist for Medical X-ray Equipment

In accordance with Safety Code 35:
"Safety Procedures for the Installation Use and Control of X-ray Equipment in Large Medical Radiological Facilities "
published by Health Canada

Item No.	Facility Requirements Compliance Item Description	Safety Code Section B	Yes	No	N/A
1.	**Adequate Shielding:** 1. 20 mSv per year for radiation worker in controlled areas 2. 1 mSv per year for any other person in uncontrolled areas In uncontrolled areas, where radiation sensitive populations are present, such as paediatric wards, a constraint level of 0.30 mSv per year **should** be used.	1.1 1.2.1			
2.	**Facility Floor Plan:** has been prepared, identifying the following: 1. Dimensions, shape and physical orientation of the x-ray room 2. Location of the X-ray equipment and the control booth 3. Location, occupancy level and use factor of adjacent rooms (as well as rooms above and below) and their designation (controlled or uncontrolled) 4. Position of all windows, doors, louvers, etc., that may affect radiation protection requirements 5. Materials used for shielding, as well as their thicknesses	1.2.1			
3.	**Room Design and Layout:** 1. Radiology room doors must be identified with **warning signs** that incorporate the X-ray warning symbol and should incorporate the words "Unauthorized Entry Prohibited" 2. A **control booth** must be provided and, along with the viewing window, must have shielding properties such that no operator is occupationally exposed to more than 0.4 mSv/week 3. Mobile protective screens must not be considered adequate as a control booth for radiological procedures. 4. The X-ray beam must always be directed toward adequately shielded areas. 5. Shielding must be constructed to form an unbroken barrier 6. Whenever possible, the X-ray beam and scattered radiation must be absorbed as close as possible to the patient or scatterer. 7. Mobile X-ray equipment used routinely in one location must be considered as a fixed installation and the shielding needs for the equipment and room must be determined accordingly. 8. Radiology rooms which can be accessed from public areas **should** be equipped with a self-closing door 9. The X-ray equipment **should** be positioned in the room in such a way that, during an irradiation, no one can enter the room without the knowledge of the equipment operator. 10. The control booth **should** be located in an area such that the radiation has	1.2.2			

	to be scattered at least twice before entering the booth. 11. The X-ray tube **should** never be directed towards the control booth. 12. If lead is used for shielding it **should** be adequately supported to prevent "creeping."				
4.	**Shielding Requirements: Radiographic Films** - Film storage containers must be shielded to reduce the radiation level to stored film to less than 0.1 mGy. - Once films are loaded into cassettes, radiation exposure levels **should** be less than 0.5 µGy and the resulting increase in the base-plus-fog **should** be less than 0.05 O.D.	1.3.1			
5.	**Protective Equipment:** 1. Protective lead aprons must provide attenuation equivalent to at least: (a) 0.25 mm of lead, for examinations where the peak X-ray tube voltage is 100 kV or less, (b) 0.35 mm of lead, for examinations where the peak X-ray tube voltage is greater than 100 kV and less than 150 kV, and (c) 0.5 mm of lead, for examinations where the peak X-ray tube voltages is 150 kV or greater. 2. Protective gonad shields for patients must have a lead equivalent of at least 0.25 mm Pb and **should** have a lead equivalent thickness of 0.5 mm at 150 kVp. Gonad shields must be of sufficient size and shape to exclude the gonads completely from primary beam irradiation. 3. Protective gloves or gauntlets must possess at least a 0.25 mm Pb equivalency. 4. The lead equivalent thickness of the protective material used must be permanently and clearly marked on all protective equipment and apparel. 5. The attenuation value must be marked on all protective screens and shields. 6. All protective equipment must be tested on a yearly basis for integrity and results must be included in the quality control test records. 7. Defective equipment must be removed from clinical use. 8. Protective equipment must be stored and maintained according to manufacturers' instructions. **9.** For interventional procedures, where no other protective devices are used, full wrap around type protective gowns of 0.50 mm Pb in the front panels and 0.25 mm Pb in the back panels are **recommended.** **10.** For interventional procedures, protective thyroid shields with an equivalent of 0.50 mm Pb are **recommended.** **11.** For interventional procedures, in the situation where scatter radiation to the lenses of eye could approach the annual equivalent dose limit of 150 mSv, the use of leaded glasses is **recommended.** **12.** Ceiling-mounted lead acrylic screens and moveable shields **should** provide protection equivalent to at least 0.50 mm Pb.	4.1			
6..	**Dosimetry:** 1. All operators of x-ray equipment, together with personnel (i.e., nurses) who routinely participate in radiological procedures, and others, likely to receive a radiation dose in excess of 1/20th of the dose limit to radiation workers specified in Appendix I, must be declared radiation workers and	**Section A** 2.1			

	monitor their radiation exposures with the use of a personal dosimeter. 2. Personal dosimeters must be worn and stored according to the recommendations of the dosimetry service provider. When a protective apron is worn, the personal dosimeter must be worn under the apron. If extremities are likely to be exposed to significantly higher doses, additional dosimeters **should** be worn at those locations on the body. 3. All personal dosimetry records must be maintained for at least five years				
7..	**Preventative Maintenance Program**: The facility must have a regular preventative maintenance program for diagnostic x-ray equipmen	Rad. Prot. Act 14(2)			
8..	**Radiation Protection Survey:** must be carried out and **should** include the following: - sketch of the facility - identification of the x-ray equipment - observations of the operational conditions (electrical and mechanical) - radiation measurements - assessment of the condition of protective devices - evaluation of the x-ray performance and the imaging performance	5.0			
9.	**Quality Assurance Program:** All radiological facilities must develop and maintain an effective quality assurance program in accordance with the Diagnostic Imaging Standards and Guidelines – College of Physicians and Surgeons of Alberta Safety policies, procedures and processes **should** be present in a Quality Assurance (QA) manual.	**Section C** 1.0 1.3.1			
10.	**Baseline Performance:** 1. Baseline performance values of X-ray equipment and image processing system must be established after verifying that the equipment functions properly. 2. Baselines values must be determined when new equipment is introduced into the facility, when there are changes in components which effect image quality and patient dose and also when testing equipment is changed.	1.3.2			
11.	**Limits of Acceptability of Data:** 1. Upper and lower limits of acceptability of recorded data must be determined and documented. 2. When these limits are reached, corrective actions must be taken. **Results Evaluation and Action Levels:** 3. These limits **should** be should be established to indicate a level of operation outside of which the system or the function should be closely monitored but where no immediate action is required. Another set of limits **should** also be established where immediate remedial action must be taken.	1.3.3 1.3.2			
12.	**Test Equipment:** 1. Test equipment required to perform daily to monthly quality control tests, must be readily available to the individuals responsible for performing these tests. 2. All test equipment must be calibrated on a regular basis and verified to be operating accurately 3. Test equipment **should** be stored away from heat, direct sunlight, and high humidity.	3.0 **Section B** 4.1			

Radiation Protection Agency
Compliance Verification Checklist for Medical X-ray Equipment

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Item No.	Image Processing Systems Compliance Item Description	Safety Code Section B	Yes	No	N/A
	3.1 Film-Based Systems				
1.	**X-ray Film:** 1. The level of optical density from the base material and film fog from all causes must not be greater than 0.30 O.D. 2. Sealed film packages must be allowed to reach room temperature before opening 3. Radiation exposures to stored film must be limited to 0.1 mGy and, for loaded cassettes, to 0.5 µGy. 4. The location of loaded and unexposed cassettes must be clearly marked. 5. X-ray films **should** be stored on edge in an area away from chemical fumes and at temperatures in the range of 10°C to 21°C with humidity between 30 % and 60 %.	3.1.1			
2.	**Cassettes and Screens:** 1. Cassettes **should** be checked regularly for wear and cleanliness. 2. Damaged cassettes **should** be replaced 3. Manufacturers' recommended screen cleaner **should** be used. 4. The intensifying screens and cassettes **should** be cleaned at least monthly. 5. The intensifying screens **should** be inspected with an ultraviolet light to find dust particles. 6. Cassettes and screens **should** be numbered for identification and matching, both inside the cassette and on the outside of the cassette.	3.1.2			
3.	**Darkroom:** 1. The room must be light-tight. A film strip exposed to an optical density of 1.2 units must not show an increase in optical density greater than 0.05 units in two minutes exposure to the darkroom light environment. 2. Safelights, fitted with bulbs of intensity not greater than 15 watts, must be provided above the work areas inside the darkroom. The safelight must have filters appropriate to the specifications of the film used and must be positioned at distances greater than 1 metre from work areas to minimize film fogging. 3. The darkroom **should** incorporate a lockable door, double doors or a blackened maze entrance to ensure light-tightness 4. A warning light **should** be located outside the darkroom 5. The darkroom **should** be under positive pressure. The processor **should** be	3.1.3			

	vented to the outside. The number of air changes must be high enough for the processor to operate properly and not create a hazardous situation for personnel. 6. Cleanliness is essential: - An ultraviolet light **should** be used to find dust areas around the darkroom. - No one **should** eat or drink in the darkroom area. - All working surfaces, tops of counters and the floor **should** be cleaned regularly, at least once a day. - Tops of cabinets, vents, light fixtures and any other areas which can collect dust **should** be cleaned on a regular basis. - The ventilation system **should** be checked to make sure that no dust is carried from it to the inside the darkroom; any filter **should** be changed on a regular basis. - Chemicals **should not** be mixed inside the darkroom - Personnel **should** wear personal protection devices (gloves, masks, etc.) when handling chemicals. - Clutter which may collect dust **should** be eliminated. - Corrugated cardboard boxes containing film boxes, chemicals, and other supplies **should** not be stored or opened inside the darkroom. The boxes **should** be opened outside the darkroom, and films and supplies carried inside. - Any articles of clothing made of loose fibres or static generating such as wool, silk, some cottons or cotton blend fabrics **should not** be worn in the darkroom or **should** be covered with a laboratory coat.				
4.	**Film Processing:** 1. Processor monitoring using a sensitometer and densitometer must be done daily when the processor is started and has stabilized, and at additional times after the processor has been cleaned, or after fresh chemicals have been added. 2. Manufacturers' recommendations with respect to strength of solution, temperature and time must be followed. 3. Developing solutions must be replenished as necessary and must be changed or recycled regularly, as required. 4. Processing chemicals must be protected from freezing. 5. Chemicals showing signs of oxidation or sedimentation must not be used. 6. Fixer must be adequately removed from the processed films. 7. Film transport mechanisms of film processors must be cleaned frequently. 8. Film processors must be maintained regularly, according to manufacturers' instructions. 9. Silver containing chemicals must not be disposed of directly into the sewer system. These chemicals must be collected and released to the appropriate waste management agency for disposal and/or recycling. The management of silver containing waste must be carried out in accordance with provincial and municipal requirements. 10. The processor **should** be given sufficient time to stabilize, before	3.1.4			

	processing patient radiographs. 11. Manufacturers' recommendations **should** be followed in storing chemicals to avoid oxidation. 12. Manufacturers' recommendations for film wash **should** be followed. 13. Fixer retention tests **should** be done on a regular basis. 14. Abrasive cloths or cleaners **should** never be used on processors. 15. The accuracy of the processor thermometer **should** be checked regularly against a non-mercury thermometer. The digital processor thermometer **should** be accurate to within 0.5°C. 16. When film processing volume is less than 50 films per day, flood replenishment **should** be used to better control chemical concentrations. 17. When film processing volume is at least 50 films per day, a volume replenishment system is generally used – manufacturers' specifications for replenishment of processor solutions **should** be followed.				
5.	**Viewbox:** The conditions of viewboxes **should** be checked regularly.	3.1.5			
	3.2 Digital Imaging Systems				
6.	**CR Imaging Plates:** 1. The conditions of imaging plates must be evaluated on a regular basis. 2. The imaging plates must be cleaned monthly following manufacturer recommended procedures and using manufacturer recommended cleaners. Cleaner must not be poured directly onto the plates. 3. It is **recommended** that a log book be maintained to track the physical conditions of all imaging plates and cassette assemblies. 4. A weekly visual inspection for dust and dirt is **recommended**.	3.2.1			
7.	**CR Cassette:** 1. It is **recommended** that a log book be maintained to track the physical conditions of all cassettes and screens. 2. A weekly visual inspection for dust and dirt is **recommended** and a monthly cleaning of CR cassettes and screens following manufacturer recommended procedures and using manufacturer recommended cleaners.	3.2.2			
8.	**Electronic Display:** 1. The performance of the video display monitor must be checked routinely. 2. The cleanliness of the display surface must be maintained. 3. Manufacturer recommended cleaners and cleaning procedures must be followed. 4. The performance of the monitor must be verified using test pattern designed for evaluating various characteristics of monitor performance 5. An overall assessment **should** be made daily prior to clinical use. 6. It is **recommended** that geometric distortion, luminance and resolution be evaluated monthly and a detailed evaluation be performed annually by a medical physicist.	3.2.3			

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Item No.	Radiation Protection Compliance Item Description	Safety Code Section A	Yes	No	N/A
1.	**General Requirements:** 1. Deliberate irradiation of an individual for training purposes or equipment evaluation must never occur. 2. All personnel must use available protective devices 3. X-ray machines which are energized and ready to produce radiation must not be left unattended.	2.1			
2.	**Mobile Equipment:** 1. The operator must not stand in the direction of the direct beam and must be least 3 metres from the x-ray tube unless wearing personal protective equipment or standing behind a leaded shield. 2. The residual charge in a capacitor discharge unit must be fully discharged before the unit is left unattended.	2.2			
3.	**Radiographic Equipment:** 1. The operator must have a clear view of the patient during every x-ray examination and must be able to communicate with the patient and/or attendants without leaving the control booth. 2. Radiographic cassettes must never be held by hand during an irradiation. 3. Operators **should** control the irradiation from the control panel located inside the control booth or behind a shielded wall. In the case of special techniques where the operator is required to control the irradiation while at the side of the patient, appropriate protective clothing must be worn.	2.3			
4.	**Radioscopic Equipment:** 1. All persons, with the possible exception of the patient, required to be in the room during radioscopy must wear protective aprons. 2. When performing radioscopy, the operator must at all times, have a clear line of sight to the output display of the patient image. 3. Protective gauntlets **should** be worn by the radiologist during palpation in every radioscopic examination. During radioscopy, palpation with the hand **should** be kept to a minimum. 4. For each type of radioscopic procedure, an assessment **should** be made of the physical positions of all personnel to ensure ease of operation of the equipment, visibility of the display, and protection from the radiation field. 5. Higher tube voltage and filtration and lower tube current **should** be used where possible	2.4 3.3.3 2.4 2.4 3.4.4			

5.	**Angiography Equipment:** 1. Full use must be made of the protective devices provided with x-ray equipment such as shielded panels, drapes, bucky slot covers, ceiling-suspended lead acrylic screens, etc. 2. To avoid patient scatter scatter operate the equipment with the tube under the patient and, if the tube is horizontal, stand on the side of the image intensifier. 3. All personnel must wear protective clothing and personnel dosimeters. Protective glasses **should** also be worn 4. All personnel who are not required to be immediately adjacent to the patient during the procedure **must** stand back as far as possible from the patient and, if at all possible, **should** stand behind a protective shield. 5. Appropriate shielding for the patient's eyes and thyroid **should** be used where it does not interfere with the diagnostic information sought	2.4.1 3.3.4			

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Item No.	Radiographic Equipment Compliance Item Description	Safety Code Section B	Yes	No	N/A
1.	**Warning Signs** – The x-ray control panel must bear a permanent, visible and legible sign warning that hazardous X-rays are emitted when the equipment is in operation and prohibit unauthorized use.	2.5.1.1			
2.	**Markings** - All controls, meters, lights and other indicators relevant to the operation of the equipment must be readily discernible and clearly labelled or marked as to function.	2.5.1.2			
3.	**Mechanical Stability** - The X-ray tube must be securely fixed and correctly aligned within the X-ray tube housing. The X-ray source assembly and patient support must maintain their required positions without excessive drift or vibration during operation.	2.5.1.3			
4.	**Indicator Lights** - There must be readily discernible, separate indicators on the control panel that indicate: i) when the control panel is energized and the machine is ready to produce x-rays; ii) when x-rays are being produced; iii) if an automatic exposure control is provided, when that mode of operation is selected; iv) if an automatic exposure control mode is not selected or does not exist, the selected loading factors to the operator before an irradiation; and v) if the equipment is battery powered, whether the battery is adequately charged for proper operation of the equipment	2.5.1.4			
5.	**Indication of Loading Factors** - Medical X-ray equipment having adjustable loading factors must incorporate electrical meters or other indicators on the control panel that enable determination of the X-ray tube voltage, X-ray tube current and time, or combinations of these. For equipment having non-adjustable loading factors, permanent marks or labels may be used to indicate these parameters. The loading factors must be displayed before, during and after the irradiation is complete.	2.5.1.5			
6.	**Irradiation Control** - There must be an irradiation switch, controlling timer or other mechanism to initiate and terminate X-ray production.	2.5.1.6			
7.	**Controlling Timer** - When the equipment is equipped with a controlling timer it must be constructed so that: i) it can automatically terminate an irradiation on completion of a preset irradiation time, on attainment of a preset current time product value, or on completion of a preset number of X-ray pulses; ii) it permits the operator to terminate an irradiation at any time;	2.5.1.7			

	iii) it automatically resets itself to its original setting or to zero on termination of an irradiation; and iv) when it is at zero, at the off position or at an unmarked setting, an irradiation cannot occur.				
8.	**X-ray Tube Shielding** - The X-ray tube must be enclosed in a shielded housing. The shielding of the housing must be such that the leakage radiation from the X-ray source assembly shall not exceed an air kerma rate of 1.0 mGy/h at a distance of 1 m away from the focal spot, when operated at the nominal X-ray tube conditions of loading corresponding to the maximum specified energy input in one hour and, when the equipment is not in the loading state, 20 µGy/h at a distance of 5 cm from any accessible surface.	2.5.1.8			
9.	**X-ray Beam Filtration** - There must be radiation-absorbing filters that provide a degree of attenuation such that the first Half-Value Layer (HVL) of aluminum is not less than the values shown below for a selected X-ray tube voltage. For other X-ray tube voltages, the HVL of the radiation beam must be calculated by linear interpolation from that Table. **X-ray Tube Voltage (kV)** — **Half-Value Layer of Aluminum (mm)** 70 — 2.5 80 — 2.9 90 — 3.2 100 — 3.6 110 — 3.9 120 — 4.3 130 — 4.7 140 — 5.0 150 — 5.4	2.5.1.9			
10.	**Radiation Output Reproducibility** - For any combination of operating loading factors, the coefficient of variation of any ten consecutive radiation irradiation measurements, taken at the same source to detector distanc**e** within a time period of one hour, is no greater than 0.05, and each of the ten irradiation measurements must be within 15 % of the mean value of the ten measurements. The coefficient of variation is the ratio of the standard deviation to the mean value of a series of measurements calculated by using the following equation: $$C = \frac{S}{\overline{X}} = \frac{1}{\overline{X}} \left[\frac{\sum_{i=1}^{n} \left(X_i - \overline{X} \right)^2}{n-1} \right]^{1/2}$$ where C is the coefficient of variation S is the es imated standard deviation Xi is the value of the i^{th} measurement X is the mean value of the measurements n is the number of measurements	2.5.2.1			

11.	**Radiation Output Linearity** - For any preselected value of X-ray tube voltage, within an applicable range, the quotient of the average air kerma measurement divided by the indicated current time product obtained at two applicable settings must not differ by more than 0.10 times their sum, that is, $\|X1 - X2\| \leq 0.10(X1 + X2)$ where X1 and X2 are quotients of the average air kermas measurement divided by the current time product at two applicable settings of X-ray tube current or X-ray tube current-time product.	2.5.2.2			
12.	**Irradiation Switch** - When the equipment is equipped with an irradiation switch it must require continuous pressure by the operator to emit X-rays.	2.5.2.3			
13.	**Automatic Exposure Control** - For film-based systems, the automatic exposure control device shall perform in such a way that the variation of optical density in the resultant radiograms shall not exceed the value of i) 0.15 when the X-ray tube voltage is variable and the thickness of the irradiated object is constant, ii) 0.20 when the thickness of the irradiated object is variable and the X-ray tube voltage is constant, iii) 0.20 when the thickness of the irradiated object and the X-ray tube voltage are both variable, and iv) 0.10 when the thickness of the irradiated object and the X-ray tube voltage are both constant. For digital systems, the performance of the automatic exposure control must be assessed according to the manufacturer's procedures and must be within the manufacturer's specifications. It is recommended that the automatic exposure control should perform in such a way that the variation in the mean linearized data on a constant region of interest does not exceed 20% for constant X-ray tube voltage and constant thickness of the irradiated object, when the X-ray system is operated in conditions representative of the typical clinical use. Compliance is checked by ensuring that the ratio of the highest and the lowest measured values is less than or equal to 1.2 or within the manufacturer's specifications.	2.5.2.4			
14.	**Current-Time Product Limit** - There must be a means to ensure that where the X-ray tube voltage is 50 kV or more, the current time product does not exceed 600 mAs per irradiation.	2.5.2.5			
15.	**Accuracy of Loading Factors** - The loading factors must not deviate from the selected value, for any combination of loading factors, by more than i) 10 % for X-ray tube voltage, ii) 20 % for X-ray tube current, iii) 10 % + 1 ms for loading time, and iv) 10 % + 0.2mAs for current-time product.	2.5.2.6			
16.	**Minimum Irradiation Time Capability** - The controlling timer or automatic exposure control device must have a minimum irradiation time capability of 1/60 s or the time required to deliver a current-time product of 5mAs, whichever is greater.	2.5.2.7			
17.	**Beam Limiting Devices** - The X-ray tube housing must be equipped with a beam	2.5.2.8			

	limiting device that enables stepless adjustment of the size of the X-ray field. The minimum X-ray field size permitted by the beam limiting device shall not exceed 5 cm by 5cm at a focal spot to image receptor distance of 100 cm.				
18.	**Radiation Field and Light Field Alignment** - The beam limiting device must incorporate an X-ray field indicator which uses light to visually define the X-ray field so that the limits of the X-ray field are visible under the ambient lighting condition in an X-ray room. When the X-ray beam axis is perpendicular to the image receptor plane, the separation between the perimeter of the visually defined field and that of the X-ray field does not exceed 2 % of the focal spot to image receptor distance.	2.5.2.9			
19.	**Focal Spot Marking** - The location of the focal spot must be clearly and accurately marked on the X-ray tube housing. In the case of dual focal spot X-ray tubes, the location of the mark should be midway between the centres of the two focal spots.	2.5.2. 10			

Annual Preventative Maintenance

ALBERTA COLLEGE AND ASSOCIATION OF CHIROPRACTORS

X-ray Annual Preventative Maintenance Form

Registered Owner(s)	**Date**
Location of Equipment (Full address incl. postal code)	
Equipment Manufacturer	
Generator Model #	**Console Model #**
***Generator Serial #** (*The ACAC tracks generator serials for registration purposes)	**Console Serial #**
Equipment Manufacture Date (Provide **generator** date -- month & year)	**Tube Serial #**

Preventative Maintenance	**Item Checked**	**Complies to Standard**
Check mechanical operation of all moving parts		
Check integrity of all electrical cables		
Clean and lubricate high tension cable terminals		
Clean and lubricate bearings and ropes		
Check operation interlocks		
Other procedures recommended by Manufacturer		
Calibration		
kVp accuracy (+ or – 5%)		
Radiation output reproducibility (+ or – 5%)		
Radiation output linearity (+ or - 10%)		
Timer accuracy (+ or – 7%)		
Focal spot size (+ or – 2%)		
SID indicator (+ or – 2%)		
Radiation field size indicator (+ or – 2%)		
Light/radiation field alignment (+ or –2%)		
Automatic Exposure Control reproducibility (+ or – 5%)		
Automatic Exposure Control – density control (+ or – 5%)		
HVL (filtration, beam quality) (2.5 mm Al at 90 kVp)		

View	**Thickness**	**FFD**	**kVp**	**mAS**	**Time**	**PEE(mR)**	**Rec. Limit**
A-P lower cervical	13 cm						90 mR
A-P thoracic	23 cm						300 mR
A-P lumbar	23 cm						375 mR
Lateral lumbar	32 cm						1500 mR

Service Company Representative: _____ _____

Signature Print Name

Service Company: _____

Copy of detailed performance evaluation to be left on-site.