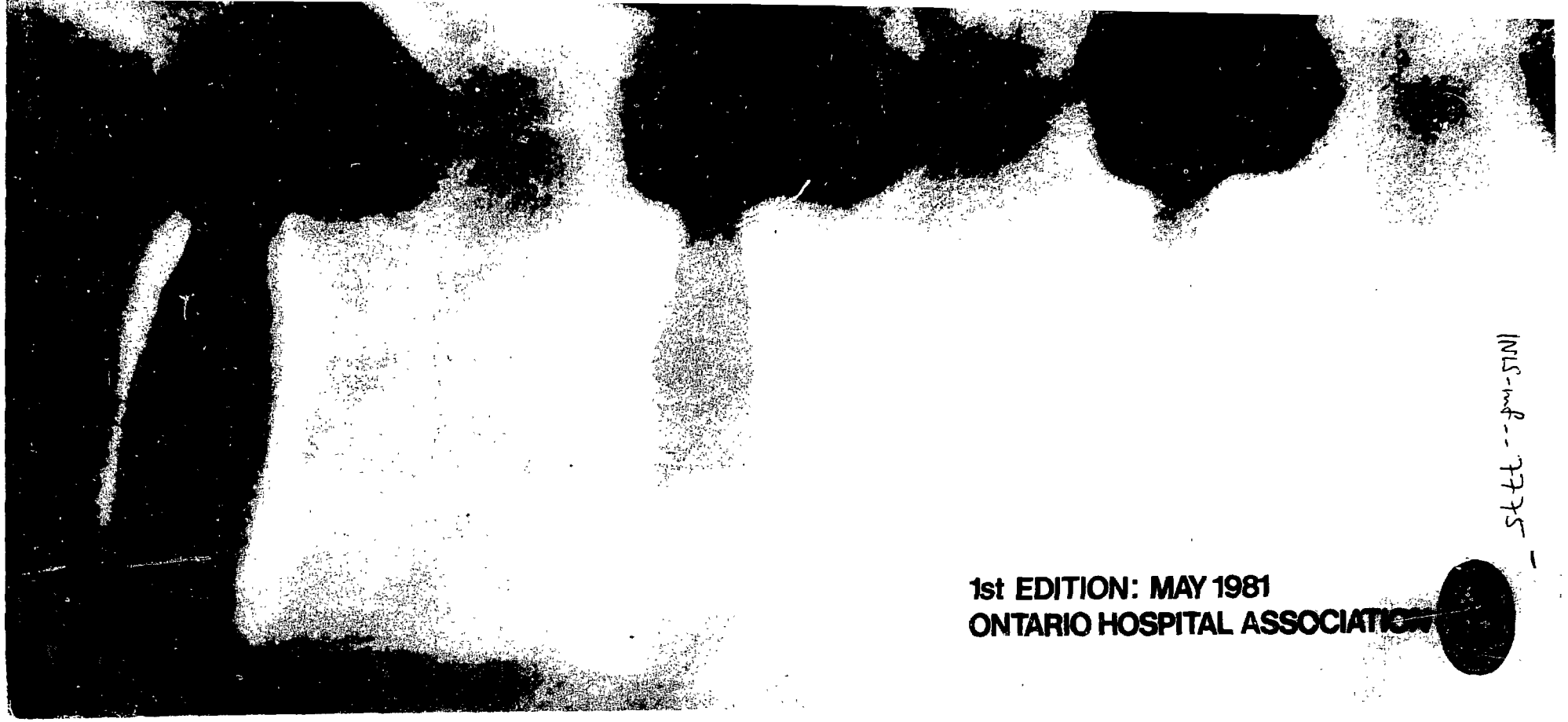

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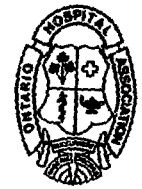

ONTARIO HOSPITAL ASSOCIATION

G U I D E L I N E S

FOR A

RADIOLOGY DEPARTMENT

QUALITY ASSURANCE AND DOSE MEASUREMENT AUDIT PROGRAM

1st EDITION

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I

FOREWORD

Early in 1980, the Ontario Minister of Health's Advisory Committee on Radiology completed its examination of the issues concerning the safe operation of x-ray equipment within the province.* Among the committee's recommendations was one which called for the mandatory establishment of audit programs for all x-ray facilities in the province.

In the belief that adequate quality assurance can be achieved through voluntary effort, the Ontario Hospital Association's Administration Services Committee established a Sub-Committee on Radiation Safety to develop guidelines for hospitals on a radiology quality assurance and dose measurement audit program. In so doing, the Sub-Committee utilized the experience gained by many hospitals with already established procedures for the safe operation of x-ray equipment. This first edition of "Guidelines for a Radiology Department Quality Assurance and Dose Measurement Audit Program" is the result of the Sub-Committee's work, and is recommended to hospitals as a base upon which to establish their own radiology audit programs. It is intended that these guidelines will be revised and updated as the need arises.

In order to update this manual in a second edition, OHA would appreciate hearing about any problems hospitals may experience in implementing the audit program. Blank pages are included at the back of the manual so that any problems can be noted when they arise.

The Administration Services Sub-Committee on Radiation Safety wishes to acknowledge the assistance given to it in the development of this manual by Mrs. Joyce A. Park, Senior Writer/ Editor, Communications Department, OHA, and Miss Dawn Canning, Secretary, Research and Planning, OHA.

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* X-Ray Safety in Ontario: Report of the Advisory Committee on Radiology, March 1980

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III

INTRODUCTION

A quality assurance program in a hospital radiology department is a system of planned actions that monitor and record the performance and effectiveness of the component parts of the radiological service. Properly carried out, the program can inspire confidence that the diagnostic x-ray facility will produce consistently high-quality diagnostic information with minimum radiation dose to patients and healing arts personnel.

The quality assurance program outlined in this manual is, however, only part of a total approach to radiation safety. Two other elements are crucial:

i) Wherever possible, only formally qualified individuals should be allowed to operate radiological equipment; and, in the case of complex radiological examinations, only qualified radiological specialists should be involved;

ii) There should be a mechanism for ensuring an adequate program of peer review at both medical and technical levels.

With all three factors in place and operative, hospitals will be able to achieve the best possible level in radiation safety for both patients and staff.

PRINCIPLES OF QUALITY ASSURANCE *

Quality assurance can be defined as professional accountability for the provision of services of the highest calibre. A quality assurance program is a formal monitoring tool in which specific criteria are assessed according to established standards. The primary objective of such a program is to maintain quality of care by means of frequent review. It is essential to appreciate that a quality assurance program is a regular, on-going commitment to the maintenance of the highest practical standards of patient care.

The following benefits result from a quality assurance program:

1. Improvements in the quality of services with resultant effects on the quality of patient care.
2. An increased awareness of
   (a) the significance of adherence to established policies and procedures.
   (b) professional accountability.
3. An objective evaluation at periodic intervals of the adequacy and appropriateness of policies and procedures.
4. A clear definition of departmental objectives.
5. An up-grading of professional goals.

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*Modified slightly from the definition given in "Hospital Pharmacy Audit - Quality Assurance Manual (Group A and B Hospitals)". Published by the Ontario Hospital Association, 1979.

ESTABLISHING AN AUDIT PROGRAM

1. A meeting of the department staff who will be responsible for the administration of the program should be called to clarify and delegate the responsibility for specific tasks.

2. A group of staff should meet to review this audit manual in its entirety and determine the extent to which it applies to their hospital department. (Note: This manual is intended as a guide to those areas that require review - a periodic check-list to ensure that a monitoring and recording system is established and operating for critical components of the imaging system. Individual hospitals may wish to add further components of their own choosing.)

3. A copy of the minutes of the Guidelines review meeting should be forwarded to the hospital administration, noting any limitations to achieving the goals of the audit and making appropriate recommendations, e.g. on the purchase of necessary equipment, possible collaboration with neighbouring hospitals or involvement of outside agencies such as the Ministry of Health X-Ray Inspection Service or the radiological services of local universities or institutions.

4. When the audit is approved; the person responsible for performing it must be instructed to record the date each task is reviewed and confirm this by initialling the record in the space provided (see Task Review on page 1 to 12).

5. Any unusual observation that is made during the audit, should be recorded in the space provided for "comment" (see page 1 to 12).

6. Plans should be made to conduct the departmental audit on a regular basis, at least once a year.

ADMINISTERING AN AUDIT PROGRAM

Like most high-technology specialities, the component parts of the radiological service are the equipment, the personnel and the practice (techniques), joined together by an organizational structure.

The organizational structure of a radiological service provides the framework for a quality assurance program. As in any hospital department, the principles of good organization can assist in maximizing the use of human and physical resources and in achieving an efficient and professional operation that has, as one of its results, the control of radiation dosage. It is recommended that the following organizational requirements be established and maintained within the radiology department:

1. Well-defined departmental objectives. These should be defined and communicated to all staff, and revised and/or updated at pre-established time intervals. (See appendix A.)
2. A departmental organizational chart which clearly delineates authority and lines of communication.

3. Job descriptions that specify areas of responsibility for radiation safety for the following personnel:
   a) Director of Radiology
   b) Radiation Protection Officer
   c) Chief Technologist
   d) X-Ray Technologist
   e) Other departmental personnel.
4. Specific procedures for formulating radiographic policies and dissemination of such policies to all medical and technical staff.
5. A departmental policy and procedures manual covering the following topics:
   a) Radiation monitoring for both equipment and personnel
   b) Acceptance of patients for radiological examination
   c) Preparation and pre-examination instruction of patients
   d) Recording, filing and retrieval of previous radiological examinations
   e) Methods of obtaining x-ray films from other hospitals
   f) Emergency procedures
   g) Use of drugs and solutions
   h) Disposal of out-dated drugs and solutions
   i) Staffing
   j) Departmental meetings of professional, technical and other staff

k) Orientation and continuing education of technical and other staff

l) Disaster plan instructions

6. Sufficient records to monitor the department's workload and utilization, and to monitor the examinations of individual patients (e.g. number and frequency of repeat examinations.)

7. Film discard and retake analysis procedures.

8. Installation records. The following facts about equipment installation should be available for review by authorized persons:

a) copy of order and specifications

b) date of installation

c) state of equipment (new or used)

d) if used, date of original manufacture

e) record of initial room plan, and approval of radiation protection arrangements

9. Manufacturers' information. The following data should be supplied by the manufacturer and available for review by authorized persons:

a) dated official statement that equipment meets purchase specifications

b) circuit diagrams including all modifications

c) operational data, e.g. tube and transformer ratings

d) cautionary data, if any, to include instructions for safe operating procedures

e) record of official handover and commissioning of equipment including documentation and demonstration of conformity to specifications.

The complexity of the organization required to meet the above suggestions will depend on the size and wishes of the individual hospital.

DEVELOPMENT OF THE OHA GUIDELINES

In developing this manual the OHA Radiation Safety Sub-Committee considered the following questions:

1. What specific tasks in the hospital radiology department must be performed in order to ensure that there is minimum exposure to radiation?
2. When should such tasks be done?
3. How should such tasks be conducted?
4. Who should hold responsibility within the hospital radiology department organization for ensuring that such periodic reviews are conducted?

The Sub-Committee identified a list of some 56 tasks that need to be reviewed periodically. They are listed in the Task Review Charts on pages 1 to 12 of this manual, together with suggestions about the frequency of review. It must be emphasized that these frequencies are recommended minimums only. These Task Review Charts have spaces where audit dates, initials of auditor, and comments can be inserted.

The extent of any audit program will vary with the size and type of department being considered. A brief explanation of how the tasks can be conducted is included on pages 13 to 32.

Each hospital will make its own decision about who is to be responsible for the establishment and maintenance of a quality assurance program, taking into consideration its own needs and the requirements of Provincial and Federal legislation. It is recommended that deliniation of responsibility be documented either in job descriptions or a policy and procedures manual, or both.

Radiology Department Quality Assurance and Dose Measurement Program: Task Review

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
AUTOMATIC FILM PROCESSORS ***											
	1. Check developer temperature	daily									
	2. Check fixer temperature	daily									
	3. Check wash temperature	daily									
	4. Check replenisher rates of developer and fixer	weekly									
	5. Wash all crossover racks and drive rollers exposed to air	daily									
	6. Check for noises	daily									
	7. Measure processing time, dry to dry	weekly									
	8. Process sensitometric strip	weekly									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.
*** *It is expected that the daily records will be kept in the department and* not in this document

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
AUTOMATIC FILM PROCESSORS (cont.)											
	9. Check rollers, bearings, gears, chains and microswitches in drive and transport system	once a month									
	10. Check tubing, oil and grease pump; check main tanks, valves, and replace filters, strainers. Adjust the chain tension and rack rollers in recirculation and replenishment system.	once a month									
	11. Check blower, heater element, motors, rollers, heat exchangers, thermostats on dryer section	once a month									

Comments: _____

* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
GENERAL RADIOGRAPHIC EQUIPMENT											
	1. Check patient radiation exposure for standard radiographic exam	6 months									
	2. Calibrate kVp	6 months									
	3. Check half value layer of beam	once a year									
	4. Calibrate timer	6 months									
	5. Check milliamperage linearity	6 months									
	6. Check *exposure reproducibility*	3 months									
	7. Check light and x-ray field congruence of collimator	***									
	8. Check Bucky	once a year									
	9. Check and correct mechanical operation of all switches, controls, inter-locks, meters and lights.	once a year									

Comments: _____

* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.
*** Every 6 months or on replacement of light source.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
GENERAL RADIOGRAPHIC EQUIPMENT (cont.)											
	10. Check dead man switch	6 months									
	11. Check bolts, mountings and cable supports	***									
	12. Check accuracy of x-ray field indicator	6 months									
	13. Check exposure wave-form	once a year									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.
*** Visual and physical inspection once a year. Change as recommended by manufacturer.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
CHECKS ON FLUOROSCOPIC EQUIPMENT											
	1. Check primary beam attenuation	once a year									
	2. Check input phosophor limits	6 months									
	3. Check limiting resolution of imaging system	once a year									
	4. Check contrast response	once a year									
	5. Check exposure rate	6 months									
	6. Check exposure wave-form	6 months									
	7. Check high-dose rate indicator	6 months									
	8. Check automatic brightness control	once a year									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
	CHECKS ON FLUOROSCOPIC EQUIPMENT (cont.)										
	9. Inspect protective curtains and shields	6 months									
	10. Check fluoro timer indicator	6 months									
	11. Measure table-top absorption for under-table intensifier	***									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.
*** Installation and/or once a year.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
SPOT FILMS (Additional Tasks)											
	1. Check photo timer	6 months									
	2. Check density control	6 months									
	3. Check various density settings	6 months									
	4. Check patient entrance exposure	6 months									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
TOMOGRAPHIC EQUIPMENT (Additional Tasks)											
	1. Check consistency of mechanical operation	6 months									
	2. Check exposure angle	6 months									

Comments: _____

* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
MAMMOGRAPHIC EQUIPMENT*** (Additional Tasks)											
	1. Check processing sensometric measures	daily									
	2. Check filter	once a year									
	3. Check kVp	6 months									
	4. Check and/or clean screens	daily or more frequent									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.
*** As for conventional equipment but with strict control over processing and beam quality.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
MOBILE EQUIPMENT (Additional Tasks)											
	1. Check length and condition of exposure cord	6 months									
	2. Check condenser discharge without patient exposure	6 months									
	3. Check mechanical safety devices (brakes, locks, etc.)	6 months									
	4. Check beam shutter control on condenser discharge unit	6 months									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
ACCESSORIES											
	1. Check aprons and gloves for cracks	6 months									
	2. Make inventory of patient protective shielding, e.g., gonadal, eye, thyroid	6 months									
	3. Check restraining devices	6 months									
	4. Check grid	6 months									
	5. Check illuminator uniformity and cleanliness	3 months									

Comments: _____

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* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.

Mach or Room #	Task	Rec.* Freq.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Audit Date	** Init.	Comment Below
CASSETTES AND SCREENS											
	1. Check for light leaks	6 months									
	2. Check film screen contact	6 months									
	3. Check screen and cassette identification	6 months									
	4. Check relative speed of screens	once a year									
	5. Check film/screen speed	once a year									
	6. Check and clean screens	6 months									

Comments: _____

* Recommended minimum frequency (suggested)
** Initials of person officially designated to perform audit.

TASK PROCEDURES

The Sub-Committee's guidelines on how to carry out the audit tasks are tabulated on page 14 to 33.

The testing equipment and methods of compliance suggested in these pages are examples of accepted usage, and their listing here should not be taken to exclude the use of other suitable equipment or test methods.

In these procedures, any evidence of inconsistency of exposure due to inconsistent calibration of kVp, mA, or time observed during an inspection, should be investigated and the problem corrected. Incorrect calibration of any parameter should be promptly reported to the person in charge who will decide whether corrective action is required.

To produce consistent results with the minimum radiation dose to the patient, automatic film processors must be correctly maintained, and their results must be carefully monitored. Individual processors should be maintained in accordance with the recommendations of the manufacturer. The equipment and methods suggested below, however, are considered satisfactory as general methods for all processors.

CAUTION: When working around processors, staff should be aware of the following hazards:

a) Electric shock when working with exposed equipment in a wet, well-grounded environment
b) Fingers, long hair, and loose clothing such as neckties can get caught in gears and drive mechanisms.
c) Solution splashes may be harmful to eyes. Eyes should be protected and emergency eye wash facilities should be available.
d) Fumes from hot processor solutions can be harmful (They should be avoided as much as possible.)
e) Processor solutions can cause severe skin reactions to sensitive individuals.

HOW TO CARRY OUT TASKS

TASK	EQUIPMENT	METHOD
AUTOMATIC FILM PROCESSORS		
1. Check developer temperature	ALCOHOL type thermometer Note; Mercury can permanently contaminate equipment.	Immerse thermometer after processor has been allowed to reach working temperature.
2. Check fixer temperature	Same as developer	Same as developer
3. Check wash water temperature	Same as developer	Same as developer
4. Check replenisher rates for developer and fixer	Clamps, graduated glass container for solutions. Note: Both over and under replenishment can lead to incorrect film density and contrast, and waste of expensive replenishment solutions.	In processors which allow visual inspection of ball float levels, this should be inspected daily. Weekly, the system should be clamped off and bypassed to measure actual solution pumped.

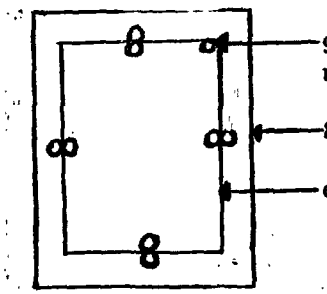
TASK	EQUIPMENT	METHOD
AUTOMATIC FILM PROCESSORS (cont.)		
5. Wash all crossover racks and drive rollers exposed to air	Sponge or cloth. Avoid use of abrasives.	Flush with clean water in a suitable sink, and wipe clean.
6. Check for noises	Technologists should make themselves familiar with the normal operating sounds of the equipment. Thumping noises usually indicate film hold up, or roller problems, and will lead to failure of the system to transport film. Squeaks or grinding noises from motors or pumps, indicate need for service and should be investigated before failure occurs, resulting in ruined film and repeated examinations.	
7. Measure processing time, dry to dry	Stop watch, or watch with second hand.	Measure time from first insertion, till film drops in receiving bin. Significant changes indicate drive problems which affect immersion times.
8. Process sensitometric strip, graph results, and estimate contrast, density, and base fog produced by system	Sensitometer, to produce test strips with graduated densities. (Pre-exposed strips provided by the manufacturer may be used.) Densitometer, to measure densities on processed strip. Appropriate graph paper to produce D Log E curve.	In the sensitometer, expose a large number of test strips cut from the film batch most used in the department. Strips must be stored for at least one hour before use to minimize errors due to latent image fade. Storage should be in a light-tight box, away from radiation, and preferably under refrigerated conditions. Test strips must be prepared for a significant monitoring period, bearing in mind that they fog with age. The test should be made at about the same time each day, preferably at least one hour after the processor has come into full use for the day. Strips should be passed through the processor with the least exposed portion of the film first, to avoid bromide flow variations. The recommendations

TASK	EQUIPMENT	METHOD
AUTOMATIC FILM PROCESSORS (cont.)		
Process sensitometric strip (cont.)		of the densitometer's manufacturer should be followed in its calibration and use. It is important to allow appropriate warm up time, tc isolate the densitometer from line voltage variations with a constant voltage transformer, and to zero the instrument correctly before making density measurements. Densities should be measured in areas free of artifact and close to the centre of each density step to avoid edge and adjacency effects. Results should be graphed on appropriate paper, and day to day variations of the important parameters graphed. It should be borne in mind that even under the closest control there will be day-to-day variations, and that these only become significant when they depart from acceptable limits. Film strips from new film batches should be overlapped with existing batches.
9. Check bearings, gears, chains, and microswitches in drive and transport system		Observe correct operation, and listen for noises indicating malfunction. Drive chains must not be so loose as to allow rollers to slip, or so tight as to cause excessive wear. Microswitches may require periodic adjustment, and may malfunction due to dirt on actuating rollers. Dry-to-dry time will indicate drive malfunction.

TASK	EQUIPMENT	METHOD
AUTOMATIC FILM PROCESSORS (cont.)		
10. Check tubing, oil and grease pump: check main tanks, valves, and replace filters, strainers. Adjust chain tension etc.		See manufacturer's recommendations. Failure to clean or replace filters or strainers will affect recirculation and replenishment rates.
11. Check blower, heater element, motors, rollers, heat exchangers, thermostats on dryer section		See manufacturer's recommendations. Drying section must be kept free of dust and rubber O rings replaced, as they deteriorate with heat and can lead to transportation failures.

TASK	EQUIPMENT	METHOD
GENERAL RADIOGRAPHIC EQUIPMENT		
1. Check patient radiation for standard radiographic exam	Dosimeter	Measure the exposure for a given procedure for the average technique at the focal-patient distances without phantom Suggested procedures: a) lateral skull b) P.A. chest c) A.P. abdomen d) Lateral lumbar spine
2. Calibrate kVp	Any of the following: a) Wisconsin cassette b) Dynalyzer c) Appropriate x-ray monitor	(i) At nominal 80 kVp, measure actual kvp for all mA stations routinely used. (ii) For one of the above mA stations, check actual kVp for 3 other kVp setting covering the range of kVp's routinely used.
3. Check half value layer of beam	Dosimeter, Type 1100 Aluminum	Use approximately 100 cm target to table distance and field size approximately 15cm x 15cm at table top. Place dosimeter on table top in centre of field. a) At 80kVp, 25 mA, measure exposure on table top with dosimeter. Repeat for total of three readings and determine average. b) Add approximately 2mm aluminum to face of collimator ensuring that the aluminum completely covers radiation field. Repeat the exposures in (a) three times and determine average exposure. c) Repeat (b) for a total of approximately 3mm and 4mm of aluminum added to the face of the collimator and determine average exposures. d) Repeat (a) to establish consistency. e) Plot average exposure vs. aluminum thickness. From the graph determine the H.V.L.

TASK	EQUIPMENT	METHOD
GENERAL RADIOGRAPHIC EQUIPMENT (cont.)		
4. Calibrate timer	One of the following: a) *Spin top* (single phase only) b) Wisconsin test tool c) Pulse counter (single phase equip) d) Optech/RRL monitor with oscilloscope e) *x-ray generator timer* (3 phase equipment)	At 80 kVp and commonly used mA check calibration of routinely used timer stations.
5. Check milliamperage linearity	Dosimeter	Measure exposure for all mA settings used in 2(a) above at 80 kVp (nominal) and about 0.05 sec, for a fixed distance and field size.
6. Check exposure reproducibility	Dosimeter	For nominal settings of 80kvp, 15 mA, measure each of 10 successive exposures at a given focal distance. (Acceptable values: Extreme values should be within ± 10% of mean.
7. Check light and x-ray field congruence of collimator	Loaded 8" x 10" cassette and 9 one cent pieces	Place cent pieces on cassette as indicated in diagram and expose film at 100cm FFD, using about 60 kVp, 5mA, so as to give a reasonable density on the film.



TASK	EQUIPMENT	METHOD
GENERAL RADIOGRAPHIC EQUIPMENT (cont.)		
8. Check Bucky		Examine and record type, condition and orientation of grid in Bucky. Confirm that grid moves satisfactorily.
9. Check and correct operation of all switches, controls, interlocks, meters and lights.		Inspect visually and confirm that all switches, controls and interlocks are operating satisfactorily.
10. Check dead man switch		Inspect visually and confirm that all dead man switches are operating satisfactorily.
11. Check bolts, mountings, and cable supports		Visually inspect
12. Check accuracy of x-ray field indicator		a) Equipment without automatic collimation. Place a 14x17 inch film in a cassette in the cassette tray. Centre the x-ray tube over the centre of the cassette at the standard 40" F.F.D. Select a 10"x12" field at this F.F.D. on the collimator. Expose the film to 60 kVp x-rays at approximately 3-5 mA. Develop the film and measure the size of the exposed portion of the film. b) Equipment with positive beam limitation systems. Place an unloaded 8"x10" cassette in the cassette tray. Centre the x-ray tube 40" above the centre of

TASK	EQUIPMENT	METHOD
GENERAL RADIOGRAPHIC EQUIPMENT (cont.)		
12. Accuracy of x-ray field indicator (cont.)		this cassette. Place a loaded cassette on the table top so that the centre of the light field coincides with the centre of the cassette. Place markers one on each edge of the field defined by the light localizer. Expose to 60kVp x-rays at approximately 1 to 2 mA. Override the positive beam limitation system and adjust to provide a 14" x 17" field. Repeat the above exposure at 60 kVp and 1 mA. Develop film and determine field size when PBL system was activated. (N.B. if exposure too light or too dark, repeat procedure and adjust exposures accordingly)
13. Check exposure wave-form	Appropriate x-ray monitor and oscilloscope	On installation the exposure wave form should be recorded for exposures at high mA, moderate kVp and duration 20ms (2ms/div) and 200ms (20ms/div). Once per year exposure wave forms made under the same condition should be compared with these records.

TASK	EQUIPMENT	METHOD
FLUOROSCOPIC EQUIPMENT		
1. Check primary beam attenuation	Radiographic film in light-tight packet. Use standard radiographic screen film without screens.	Place film in a light-tight packet above protective spot-film carriage and fluoroscope the phantom for 2 minutes. There should be no visual darkening of the films.
2. Check source input phosphor limits		For fluoroscopic equipment where the field is automatically coned to the input phosphor. The diaphragm should limit the irradiated area to the edge of the input phosphor for all table-top image intensifier distances.
3. Check limiting resolution of imaging system	a) Wisconsin wire mesh pattern or b) lead bar pattern For 9" I.I., resolution obtained should be 2 lp/mm; or if viewed through monitor, 0.9 lp/mm	Place wire mesh pattern or lead bar pattern as close to image intensifier input phosphor as possible and observe limiting resolution on image intensifier output or, if that is not possible, on the T.V. monitor Use 60-70 kVp and place and aluminum plate (1.9 cm) in the path of the x-ray beam.
4. Check contrast response	Wisconsin penetrameter and aluminum plates.	Consult manufacturer's instructions

TASK	EQUIPMENT	METHOD
FLUOROSCOPIC EQUIPMENT (cont.)		
5. Check exposure rate	Dosimeter, variable thickness phantom	a) No automatic brightness control (ABC): use 20 cm water phantom. Measure entrance exposure rate over a range of mA and kVp settings. b) With ABC: measure entrance exposure rates for water phantoms of various thicknesses from 10cm up to maximum thickness available. Measure maximum entrance exposure rate obtained by inserting a lead rubber apron (0.5m equivalent) between the water and the image intensifier. Repeat for all I.I. modes.
6. Check exposure wave-form	Appropriate x-ray monitor and oscilloscope; phantom	The exposure rate obtained while fluoroscoping a 20cm water phantom should be displayed on the oscilloscope (set at 0.5 sec/div) and recorded. Exposure wave forms obtained annually under the same conditions should be compared with this.
7. Check high dose-rate indicator		Check for operation
8. Check automatic brightness control		Note which parameter (kVp, mA, or both) are controlled automatically as patient thickness is varied.

TASK	EQUIPMENT	METHOD
FLUOROSCOPIC EQUIPMENT (cont.)		
9. Inspect protective curtains and shields		Visual inspection
10. Check fluoro timer indicator		Check operation of timer and indicator with independent timer or stop watch.
11. Measure table-top absorption and under-table intensifier		

TASK	EQUIPMENT	METHOD
SPOT FILMS		
1. Check photo timer Check automatic exposure control: a) minimum time	Use equipment in timer calibration *radiography* (4)	With no film in cassette and with timer not in the path of radiation to the sensor, measure the timer for an exposure without phantom in the beam.
b) back-up timer	As in (a)	Place a lead apron between the timing device and cassette tray and set a back-up time on the control panel (say 0.5 sec) and measure the time of the exposure and confirm that this is consistent with back-up time set.
2. Check density control	Water phantom, loaded cassette	With density setting normally used and the phantom containing 10 cm, 15 cm, 20 cm and 25 cm water respectively in the beam, expose a film in the cassette for each thickness. Develop and note density.
3. Check various density settings	As for (2)	Repeat 2 at density settings lower than and greater than normally used and 2 thicknesses of water. Develop films and note density.
4. Check patient entrance exposure	20 cm water phantom dosimeter, loaded cassette	With density control as normally set, measure entrance exposure and density of resultant film. Record density setting, entrance exposure and film density.

TASK	EQUIPMENT	METHOD
TOMOGRAPHIC EQUIPMENT (in addition to General Radiographic Equipment tasks)		
1. Check consistency of mechanical operation	Lead aperture plate loaded 8" x 10" cassette	Place lead plate 5 cm above table with the hole on the central ray of the x-ray field when the x-ray tube is perpendicular to the table. Place the loaded cassette in the cassette tray and restrict the x-ray beam to provide a 3x3 inch field on the image receptor. Select tomographic motion to be tested, exposure angle, and sweep speed. Select cut level 12 cm or so above table. Select 60 kVp and mA to yield approximately 100 mA. Expose in tomographic mode selected and process film. Note pattern should be closed and non-overlapping for complexed movements. It should be a straight line for linear motions. Pattern should be free of irregularities or non-uniformities. To ensure that the cut level indicator is correct, repeat above, placing aperture plate at the height of the cut level. An image of the aperture should result.
2. Check exposure angle	Tomographic test wedge (45^{o}) provided with 25 cm scale and 2 3/4" thick plexiglass attenuator blocks	See instructions provided with 45^{o} tomographic test wedge or reference (6)

TASK	EQUIPMENT	METHOD
MAMMOGRAPHIC EQUIPMENT (in addition to General Radiographic Equipment tasks)		
1. Check processing sensitometric measures	As for auto film processor #8	
2. Check filter		Visually inspect and confirm filtration check calibration
3. Check kVp	Voltage divider dynalyzer, other equipment calibrated over a suitable range for mammography and for target material used.	Check calibration of selector
4. Check and clean screens		Visually inspect and follow manufacturer's instructions.

TASK	EQUIPMENT	METHOD
MOBILE EQUIPMENT (in addition to General Radiographic Equipment tasks)		
1. Check length of exposure cord		This should be inspected to confirm that it is of required (3m) length. At same time it should be checked for damage such as pinching or fraying.
2. Check condenser discharge without patient exposure	Appropriate x-ray monitor or oscilloscope	Monitor exposure wave form to ensure termination at end of desired exposure time.
3. Check mechanical safety devices (brakes, locks, etc.)		Visually inspect carriage, to ensure no visible signs of damage to drive system. Test brakes to ensure their smooth uniform action.
4. Check beam shutter control on condenser discharge		Check operation of shutters at termination of exposure.

TASK	EQUIPMENT	METHOD
ACCESSORIES		
1. Check aprons and gloves for cracks		Examine each accessory in the fluoroscopic beam to ensure there are no cracks or holes.
2. Make inventory of patient protective shielding: e.g., gonadal, eye, thyroid and general purpose shielding materials		Count the devices in each room, record their number and check with previous inventories.
3. Check restraining devices		Examine any supports or restraining devices for wear or fraying. Ensure they are in satisfactory operating condition
4. Check grid		Examine visually to ensure orientation, alignment and movement is satisfactory. Note grid ratio and lines per inch.
5. Check illuminator uniformity and cleanliness		Visually inspect

TASK	EQUIPMENT	METHOD
CASSETTES AND SCREENS		
1. Check for light leaks	Loaded cassette	Expose the closed loaded cassette to strong light. Then process film and ensure that the film is clean.
2. Check film screen contact	Film screen contact test pattern, loaded cassette	Position the cassette to be tested on the x-ray table surface. Place the long axis of the cassette perpendicular to the anode-cathode axis of the x-ray tube. Place the x-ray tube centred over the cassette and at least 40" above it. Adjust field size so as to just cover the cassette. Place film screen contact test pattern on top of the cassette. Expose to about 5mA, 60kVp to give an optical density of 2.5-3.0 in the centre of the cassette. Areas of poor contact will show reduced sharpness in the image.
3. Check screen and cassette identification		Ensure that each cassette indicates correctly the type of screen mounted within and is identified by a number on the radiograph.

TASK	EQUIPMENT	METHOD
CASSETTES AND SCREENS (cont.)		
4. Check relative speed of screens	A standard, identified "master" cassette/screen confirmation for each speed range, and class of screen to be tested. Densitometer	Select a radiographic room to carry out test, preferably a room capable of 50 inch target-to-table-top distance. Centre x-ray tube with respect to table top. Adjust field size to 10 inch x 10 inch at table top. Select four loaded cassettes including the master cassette of a given type and speed range. Place cassettes together on table top so that one corner of each cassette is as centre of beam and the beam indicates a square 5 inches on a side of each cassette. Expose to 60 kVp and approximately 2 to 5 mA to yield a density on the films of 1.3 to 1.8. Identify each screen by a separate lead marker using a letter R in centre of irradiated portion of master cassette. Measure density of each film developed. Repeat always including the master cassette/screen until all screens have been tested. Find average density of films exposed with master cassette/screen. Compare densities of other films to the average density of master and for each cassette/screen record the ratio of density of film in particular cassette/screen to average master film density.

TASK	EQUIPMENT	METHOD
CASSETTES AND SCREENS (cont.)		
5. Check film/screen speed	20 cm water phantom loaded master cassette Dosimeter Densitometer	Place x-ray tube at 40 inch F.F.D. directly above centre of cassette tray. Select 8x8 " field at table top. Place 20 cm water phantom on table top centred to x-ray field axis. Measure entrance surface exposure and Bucky tray exposure for an x-ray exposure of 80kVp, 50mA. Repeat three times, determine ratio of average entrance/Bucky exposure. Place loaded cassette in Bucky and expose to 80kVp, 50mA or such exposure as to yield a density above base plus fog close to 1.0. Measure entrance exposure at same time film is exposed and calculate Bucky dose to yield this optical density. Repeat with timer increased to next timer station. Plot optical density vs logarithm exposure (or exposure on logarithmic paper). Join the two points with a straight line and determine where this line (extrapolated slightly if necessary) cuts the optical density above base and fog value of 1.0. From this determine the exposure to produce a density of 1 above base plus fog. (N.B. In order to compare results at different times, the quality assurance program on the processor must be carried out.)

TASK	EQUIPMENT	METHOD
CASSETTES AND SCREENS (cont.)		
6. Check and clean screen		Follow screen manufacturer's instructions taking particular care not to scratch or damage screen surface either mechanically or chemically. This process is necessary on a regular basis or whenever dirt is detected on the screens.

Appendix A

Prototype objectives for a hospital radiology department:

1. To provide radiological services.*
2. To obtain high quality diagnostic results using the least amount of ionizing radiation consistent with current practice.
3. To ensure that sufficient, capable, technical staff are available to provide the services.
4. To ensure that consultation services on radiological matters are available to physicians and house staff and other hospital services.
5. To provide a safe, accident-free environment for both staff and patients.
6. To ensure that all staff are kept current in their knowledge about (a) fire prevention (b) accident prevention (c) infection control and other aspects of safety as are applicable.

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* The hospital Board of Directors is expected to specify the type of services that will be provided and when such services will be available.

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NOTES

Comments arising from the use of this document, or suggestions for use, should be directed to Mr. T. Lynch, Secretary, Sub-Committee on Radiation Safety, Ontario Hospital Association, 150 Ferrand Drive, Don Mills, Ontario. M3C 1H6.