

NEXT 2002
Protocol for the Survey of A/P Abdomen
and Lumbo-Sacral Spine Radiography

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In association with

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***Trends (NEXT)* of the Conference of Radiation Control Program Directors**
(CRCPD), Inc.

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NEXT 2002

Protocol for the Survey of A/P Abdomen and Lumbo-Sacral Spine Radiography

Introduction

The purpose of this survey is to capture data and information which characterize patient exposure and image quality associated with the state of the practice of adult A/P Abdomen and LumboSacral (L/S) Spine Radiography. A NEXT survey of these exams was previously conducted in 1995, and the results have since been published.¹ The 2002 survey protocol details survey procedures for screen-film radiography systems, computed radiography (CR) systems and other digital-based x-ray imaging systems.

The protocol covers the following features of A/P Abdomen and L/S Spine Radiography:

- Facility practice: number of tubes, patient workload, and type of equipment;
- Clinical technique factors: tube potential, tube current, mAs, and exposure mode;
- Image-receptor information: film and screen data, and digital-imaging practice;
- Clinical exposure data using the CDRH adult A/P Abdomen and L/S Spine phantom;
- Beam quality at the selected clinical technique;
- Image quality of the radiographic film, background optical density and test-tool evaluation;
- Darkroom fog integrity; and
- Film processing quality.

If you have any questions, please contact the following CDRH staff:

Albert E. Moyal
301-827-1230
aem@cdrh.fda.gov

David C. Spelic
301-594-0865
dcs@cdrh.fda.gov

¹ Conference of Radiation Control Program Directors (1998) *Nationwide Evaluation of X-ray Trends (NEXT) Tabulation and Graphical Summary of Surveys 1995 Abdomen L/S-Spine Survey*. CRCPD Publication 98-2, Frankfort, Kentucky.

An updated survey protocol

The survey protocol for 2002 has been modified from the protocol used during the 1995 survey. A separate questionnaire is now provided for the facilities conducting L/S Spine exams to complete. This form requests information regarding their quality assurance and quality control programs as well as further details regarding their equipment and procedures. We ask that you mail or fax this separate form to the facility prior to your arrival. Advance transmission will give the facility personnel time to complete the form and also allows you to review and clarify their responses prior to leaving the facility after your survey.

Your state facility sample

The number of facilities you are asked to survey is based on your state's population relative to the rest of the U.S. In addition, you are asked to perform one or more surveys at facilities that have Digital/Computed Radiography capabilities. For each facility you are asked to survey, you will also be provided with back-up facilities in the event the primary facility does not wish to participate. Please do not select the back-up facilities over the primary facility merely because it is convenient or near a desirable location because biased selections may compromise the integrity of the random sample. However, we do understand that the finite resources and time of your state program may preclude you from traveling to some facilities. If you have any questions regarding your facility sample, contact Albert Moyal or David Spelic.

What you should do before starting your surveys

- Review your facility sample: you may be aware of facilities that no longer are in service, or there may be locations you cannot visit. Please advise us as soon as possible regarding these matters.
- Check the calibration of your MDH survey meter and probe. They should be calibrated **BY CDRH** annually. If you need to make arrangements for calibration, contact Albert Moyal or David Spelic.

NOTE: It is acceptable to use an MQSA-calibrated Sensitometer and/or Densitometer.

- Check the calibration of your sensitometer and densitometer. These instruments also should be calibrated **by CDRH** annually. Contact Albert Moyal or Dave Spelic if they are near the end of their current calibration period.
- The Abdomen/L/S-Spine phantom does not require any assembly, other than attaching the probe arm.

What to bring with your to the survey site

You will need the following equipment and supplies for each survey:

1. CDRH Adult A/P Abdomen and L/S Spine phantom.
2. CDRH yellow image-quality test-tool and circular aluminum disk test-tool.
3. Calibrated MDH model 1015 or 1515 survey meter with calibrated 10X5-6 probe.
4. Aluminum filters for HVL determination (2.0 mm and 1.0 mm increments).
5. Calibrated Sensitometer and Densitometer.
6. One box of STEP test control film and appropriate STEP worksheet.
7. Fog folder or other similar darkroom fog test tool.
8. Stop watch or clock for indicating minutes.
9. Protocol and survey form (along with facility questionnaire, if appropriate)
10. NEXT tri-folds for the facility.

What items you are asked to return to CDRH

In addition to the paper survey form, you will be provided an electronic spreadsheet with which to record your data. You will be provided one spreadsheet file for each facility you are asked to survey. The paper forms are actually printed copies of the Excel spreadsheet files; hence you may print paper copies from the provided disk(s).

Please return your survey material/S to the following address:

Attention: Albert Moyal / David Spelic 1350 Piccard Drive, HFZ-240 Rockville, MD 20850

For each survey, you are asked to return the following to CDRH:

- Completed paper survey form (**MAKE A PHOTOCOPY OF YOUR ORIGINAL**) or Spreadsheet Disk if used;
- Facility questionnaire;
- Phantom film(s);
- Fog film(s);
- STEP film and worksheet;
- HVL graph.

We appreciate your participation!

INSTRUCTIONS FOR COMPLETING THE SURVEYOR WORKSHEET

A. Surveyor Information (items 1-3)

1. Surveyor name; (2) State, and (3) Survey date.

Enter your complete name, your state and the date the survey was performed. For your state, use the two letter abbreviation, e.g., TX. For the survey date, use the notation MM/DD/YY e.g., 06/23/01.

B. Facility Information (items 4-11)

4. Facility name

Write the name of the facility on the surveyor worksheet as it appears on your NEXT sample list. If the entry on your sample list is incomplete, then write the full name of the facility on the form.

Facility name

EXAMPLE Montgomery General Hospital

5. Facility ID number

Enter the unique alpha-numeric number your state uses to identify this particular facility. This can be any combination of numbers and/or letters.

Facility

EXAMPLE A15972XX

6. Facility type

Enter the appropriate Facility Type code from the list provided below.

- 6a. If you select '99' ('Other') for the Facility Type code, then briefly describe the type of facility on the surveyor worksheet beside your response to *item* 6.

Facility type codes

- 01 = Private Practice:** An individual practitioner or a group of practitioners engaged in the **same** specialty. This includes a group of general practitioners. An example would be a pediatric practice. If you select '01', then please fill in '**Private practice specialty**' (item 7).

- 02 = Hospital:** A facility that has beds for overnight care of patients. Please note that satellite facilities of a major hospital are coded '11'.
- 03 = Multiple Specialty Practice:** Group of practitioners having **different** specialties. This category includes school infirmaries and school clinics.
- 04 = Mobile Unit:** An establishment that provides x-ray machines transported by motor vehicle.
- 05 = School:** An educational institution such as university medical schools. School infirmaries or clinics are coded 03. Medical school hospitals are coded 02.
- 06 = Private Laboratory:** A commercial facility that takes diagnostic radiographs by prescription but is not involved in film interpretation.
- 07 = Health Agency:** Private (non-profit) and government health agencies that do not fall under any of the above categories.
- 08 = Industry:** A plant dispensary or first-aid station.
- 09 = Nursing Home:** A facility with provisions for long-term care of patients.
- 10 = Breast Clinic:** A facility specializing in mammography and breast disease.
- 11 = Hospital Satellite Facility** A facility affiliated with a hospital or medical center that is located at a distance from the first medical facility.
- 99 = Other:** Enter a brief description on item 6a on the surveyor worksheet.

Facility Type

EXAMPLE

02

7. Facility SPECIALTY Code

Use this code listing if the facility specializes in a certain type of medical practice, such as Pediatrics etc. *If the Facility Type code from item 6 = '01' (Private Practice) then determine the appropriate Facility Specialty code from the following list. If the Facility Type code is not '01' skip items 7 and 7a.

- 7a. If you code the specialty '99' (Other) then write a brief description of the specialty on the surveyor worksheet in item 7a.

Facility Specialty Codes

01 = Dental (EXCEPT ORTHODONTICS)	18 = Geriatrics (diseases related to old age)
02 = Orthodontics	19 = Hematology (diseases of the blood)
03 = Medical GP	20 = Immunology
04 = Radiology	21 = Infectious Diseases
05 = Internal Medicine	22 = Nephrology (diseases of the kidney)
06 = Surgery	23 = Neurology
07 = Urology	24 = Nuclear Medicine
08 = Pediatrics	25 = Oncology (including Radiation Therapy)
09 = Orthodontics	26 = Ophthalmology
10 = Gastroenterology	27 = Otolaryngology
11 = Chiropractic	28 = Physical Medicine
12 = Podiatry	29 = Pulmonary Medicine
13 = Osteopathy	30 = Emergency/Shock/Trauma Medicine
14 = OB/GYN	
15 = Cardiology	
16 = Electrophysiology	
17 = Endocrinology	
	99 = Other

Private Practice Specialty

EXAMPLE **04**

- Although this code type should be primarily used to describe smaller private practice offices, you may provide a code to describe the specialty of large facilities, including hospitals (i.e. a pediatric hospital).

8a. Number of x-ray units at facility

Determine separately the number of stationary and the number of portable x-ray tubes the facility *routinely* uses to **perform abdomen and L/S-spine** x-ray exams. Portable units are units that remain in the building but can be moved from room to room.

Abdomen Exams

8a1. Number of Stationary X-ray Units

8a2. Number of Portable X-ray Units

EXAMPLE

8

3

L/S-Spine Exams

8a3. Number of Stationary X-ray Units

8a4. Number of Portable X-ray Units

EXAMPLE

2

2

8b. Determine the Number of each type of imaging equipment the facility uses on a routine basis:

1. General radiographic stationary (excluding portable) X-ray units: _____
2. Portable X-ray units: _____
3. Fluoroscopic units (excluding special procedure suites): _____
4. Fluoroscopy suites for performing special procedures (Cardiac): ____
5. Mammography units for routine screening and biopsy: _____
6. Magnetic Resonance Imaging (MRI) units: _____
7. Computed Tomography (CT) units: _____
8. Dental (including Panoramic and Cephalometric) X-ray units: _____
9. Ultrasound units: _____
10. Mobile* X-ray (any type) units: _____
11. Nuclear Medicine Imaging Suites: _____
12. Equipment specifically used for performing bone densitometry: _____

* Mobile X-ray units are essentially 'x-ray units on wheels', and are used for performing off-site radiographic exams.

9. **Exams Surveyed at Facility:** Indicate with a Y/N whether the facility routinely conducts these exams that you will be surveying.

9a. Abdomen

9b. L/S Spine

EXAMPLE:

Y

N

10. **Total facility weekly abdomen/L/S-spine examination workload**

Enter the facility's best estimate of the **total** number of x-ray exams they routinely perform each week on all x-ray units for each type of exam, abdomen and lumbar-spine.

NOTE: This item refers to the number of **exams**, *not the total number of films*.

10a. Total facility weekly workload: Abdomen

10b. Total Facility weekly workload: L/S Spine

EXAMPLE

310

105

11. **Number of films for a typical routine abdomen/L/S-spine examination**

For each applicable exam (Abdomen, L/S Spine), enter the number of films taken by the facility for each projection (Anterior-Posterior (AP), Posterior-Anterior (PA), Lateral (LAT), and Oblique (OBL)) during a routine of exam.

11a. Abdomen: Number of Films per patient

EXAMPLE:

PA AP LAT OBL

1 0 1 0

11b. L/S Spine: Number of Films per patient

PA AP LAT OBL

1 2 1 1

C. X-ray equipment information

At this time determine the x-ray unit the facility routinely uses most often for abdomen/L/S-spine exams. This is the x-ray unit you should survey. The Excel spreadsheet you received has two sections, one for each exam. This will account for the possibility that a facility may use two different x-ray machines for the two exams. You do not have to repeat the capture of x-ray equipment information if the facility uses the same unit for both exams; there is space on the data form for you to indicate that they use the same x-ray unit.

12.a. Is the same x-ray unit used for both abdomen and L/S spine exams? (Y/N) (if answer is 'N', please answer questions 12-18 separately for the abdomen and for the L/S spine exams).

12.b. Single x-ray unit weekly patient workload

For the particular tube you will survey, enter the facility's best estimate of the total number of patients they routinely perform abdomen/L/S-spine exams on (patients) respectively, each week.

12a. Single x-ray unit weekly Abdomen Patient workload

EXAMPLE **14**

12b. Single x-ray unit weekly L/S Spine Patient workload:

5

13. X-ray control manufacturer

Determine the manufacturer of the x-ray unit and write the name in the space provided. Also determine the appropriate code for the manufacturer from the list provided in the *NEXT* Supplement, Section B (page 4) '**Standard x-ray control manufacturers**' and enter into the appropriate spaces. If there is no code listed, then leave the Code blank.

13a. Abdomen Exam
X-ray control manufacturer name Code

EXAMPLE **General Electric** **GECO**

13b. L/S Spine Exam
X-ray control manufacturer name Code

EXAMPLE **General Electric** **GECO**

14. X-ray unit: Month and Year of Manufacture

Determine as best possible the month and year of manufacture for the x-ray unit being surveyed. The date of manufacture is often indicated by a label on the control unit.

NOTE: The x-ray tube may have been replaced since initial installation date. The goal is to determine the date when the x-ray system was originally manufactured.

X-ray unit Date of Manufacture

EXAMPLE month **09** year **1996**

15. Type of x-ray unit

From the following list, determine which category best describes the particular x-ray unit you will survey.

IMPORTANT: Computed radiography (CR) and digital x-ray systems predominantly use conventional x-ray tube systems! A CR or digital x-ray suite will often resemble a conventional x-ray suite using screens and film. *First consult with the technologist if you are unsure what form of imaging the facility is using.*

S = Standard radiographic x-ray system using screen-film technology.

C = Computed Radiography (CR) system.
This system uses cassettes called Image Plates (IP) which look similar to traditional x-ray screens but contain no film. Be certain that the facility is using CR before coding the type of equipment 'C'.

D = Completely digital format x-ray imaging system such as flat panel technology. Other terminology used is DR (for 'direct radiography'). This technology uses no screens nor cassettes.

Type of x-ray equipment

EXAMPLE **C**

16. X-ray Generator Phase

Determine the phase of the x-ray generator you are surveying and enter the appropriate code from the list below. The following tips may help you to obtain this information.

- a. Consult facility staff or any available user documentation.
- b. Many times the manufacturer will list the phase along with other electrical information on an identification plate attached to the high-voltage generator.
- c. Observe the time settings on the control panel. Single phase units will most frequently have time stages in increments of 1/120th of a second, s (i.e. 0.008 s, 0.016 s, 0.032 s, etc.) Three-phase and higher (or constant potential) will usually have exposure time stages in decimal increments (e.g. 5 ms, 10 ms, 20 ms, 30 ms, etc.)

Generator Codes

S	=	Single-phase
T	=	Three-phase (not falling load)
F	=	Three-phase falling load
D	=	DC filtered or capacitor discharge
C	=	Constant potential
H	=	High frequency
U	=	Unknown

Generator phase

EXAMPLE

I

17. Scatter suppressor

Determine the method of scatter suppression used with the particular x-ray unit you are surveying and enter the corresponding code on the survey form using the list of codes provided below.

If you cannot determine what form of scatter suppression is used, enter '**U**' for **unknown**. Enter a value of '**N**' only if the facility explicitly states that they do not use any form of scatter suppression for abdomen / L/S-spine x-rays. Do not leave this space blank.

NOTE: The facility may incorporate specific grids into the patient set-up depending on the type of exam (Abdomen or L/S Spine), so request a response to this item that is specific to the x-ray exam.

Scatter suppressor codes

G = **Grid**
A = **Air gap**
N = **None**
U = **Unknown**

Scatter suppressor

EXAMPLE **G**

18. Grid Ratio

If the facility uses a grid for scatter suppression during adult abdomen/L/S-spine x-ray exams, then determine the grid ratio. The grid ratio may be marked on the grid. Code the grid ratio '**UU**' if you can not determine this value.

Grid ratio

EXAMPLE **12 : 1**

D. Screen-film and digital image-receptor information

NOTE: For computed radiography systems skip to item 26.
For digital x-ray systems, skip to item 31.

D.1 Screen and Film Information

19-20. Film brand and type

Determine from the facility technologist the brand and type of film typically used for abdomen/L/S-spine exams. Write the name of the brand and type on the surveyor worksheet. Refer to the *NEXT* Supplement section C, (page 8) '**Film codes**' and determine the film brand and type codes, respectively. Enter these in the appropriate spaces on the surveyor worksheet. If the film brand or type code is not on the list, write the complete names of each product, and the name, address and telephone number of the supplier in the comment section, if such information is available. Additionally, the facility may use different films and screens for the exams. Please be aware of this.

	19. <u>Film brand code</u>	<u>Film brand name</u>
<u>EXAMPLE</u>	EKCO	Kodak

	20. <u>Film type code</u>	<u>Film type name</u>
<u>EXAMPLE</u>	TML	T-Mat L

21-23. Film size

Enter the film size that the facility typically uses for Abdomen/L/S-spine exams in inches or centimeters. The **width** (item 19) is the dimension across the body (the shorter dimension.) The **length** (item 20) is the dimension along the length of the body (head to toe). Specify the units as inches (IN) or centimeters (CM) in *item 23*.

Film size:

	21. <u>Width</u>	22. <u>Length</u>	23. <u>Units</u>
<u>EXAMPLE</u>	14	17	IN

24-25. Screen brand and type

Determine from the facility technologist the brand and type of screens typically used for abdomen/L/S-spine exams. Write the name of the brand and type on the surveyor worksheet. Refer to the *NEXT* Supplement Section D (page 22), '**Screen codes**' and determine the screen brand and type codes, respectively.

Enter these in the appropriate spaces on the surveyor worksheet. If the screen brand or type code is not on the list, write the complete names of each product, and the name, address and telephone number of the supplier in the comment section, if such information is available. **Skip items 26 through 32.**

	24. <u>Screen brand code</u>	<u>Screen brand name</u>
<u>EXAMPLE</u>	EKCO	Kodak

	25. <u>Screen type code</u>	<u>Screen type name</u>
<u>EXAMPLE</u>	LNM	Lanex Medium

30. CR system speed

CR systems are typically configured to respond in a manner that may be characterized in terms of the traditional concept of screen-film combination speed. Determine from the technologist or other staff members the speed at which the CR system is configured to perform for abdomen/L/S-spine radiographs. If you can not determine this enter **UNK**.

CR system speed

EXAMPLE **200**

31. CR Dual-energy subtraction

Determine whether the facility does energy subtraction imaging using CR. In this method, two cassettes are used for a single x-ray projection, separated by a filter material (typically copper).

Enter a **Y** (Yes) or **N** (No) on the surveyor worksheet. Skip to section E, *Technique Data* (next page).

32. Digital Radiography (DR) and other digital systems- vendor name and model

Determine the **vendor** (such as Siemens, GE, etc.) and **model** name/number of the DR system and write the names in the space provided on the surveyor worksheet.

Digital Radiography:

EXAMPLE vendor: **GECO**

EXAMPLE model: **GE-D5000R**_____

33. Digital Radiography and other digital systems– Image Receptor Manufacturer

Determine the actual manufacturer (not necessarily the same as the vendor) of the digital image receptor and write the name on the surveyor worksheet.

Digital Radiography - Image Receptor Manufacturer

EXAMPLE **Direct Radiography**

E. Technique Information

All of these items will need to be captured separately for the abdomen and L/S Spine exams. The *NEXT* Abdomen/L/S-Spine phantom is equivalent to a human patient standing 5'8" tall, weighing 164 pounds and having a 23.0 cm A/P abdomen. Provide this information to the facility technologist so that he or she can configure the x-ray equipment as they would for clinical exams.

At this time do the following :

- a. Ask the facility technologist to configure the x-ray gantry for a typical adult abdomen/L/S-spine exam. This includes positioning the x-ray tube, selecting the appropriate grid (if appropriate), and collimating the beam.
- b. Request a loaded film cassette of the same film size and type you recorded *in item 21 - 23* for abdomen/L/S-spine radiographs. *Use this same cassette for all measurements.*

34. Source-to-film distance (also referred to as 'Source-to-Image Distance' or SID)

Measure and record **in centimeters** the source-to-film distance. The '**Source**' is the x-ray tube focal spot location, and is usually indicated on the tube by a small dot. You should insert a film cassette partially into the bucky/film holder, in order to accurately determine the location of the film.

NOTE: Centimeters = inches x 2.54

Source-to-film distance

Abdomen:

L/S-Spine:

EXAMPLE

112.0 cm

112.0 cm

35. Source-to-patient support distance

Measure and record **in centimeters** the distance from the '**Source**' (tube focal spot) to the surface that the patient rests against during the exam. This is essentially the front plate of the wall bucky or the table top.

Source-to-patient support distance

EXAMPLE

111.5 cm

36. Projection code

Enter the appropriate code that indicates whether the facility does routine abdomen/L/S-spine exams anterior-posterior (AP) where the patient faces the x-ray tube position, or posterior-anterior (PA) positioning.

AP = Anterior-posterior exam
PA = Posterior-anterior exam

Projection code

EXAMPLE

AP

NOTE: The NEXT Abdomen and L/S Spine phantom is designed to survey AP Exams only.

37. Exposure technique (manual or automatic exposure (AEC))

Determine whether the facility uses a manual technique or uses automatic exposure control (AEC) and record the appropriate code:

A = automatic exposure controlled technique
M = manual technique

If the facility uses a manual technique then skip items 38 and 39.

Exposure technique

EXAMPLE

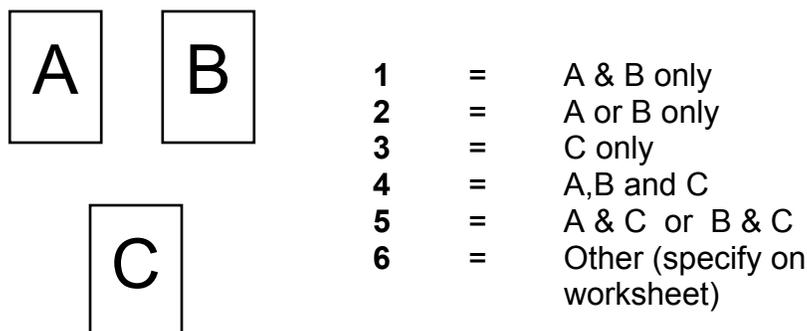
A

38. AEC detector configuration (AEC technique only)

Refer to the diagram below and enter the code that represents the detector configuration the facility uses for automatic exposure controlled exams.

NOTE: If the unit has a detector configuration that does not appear like the one shown below, then enter '6' for the code and sketch on the surveyor worksheet a diagram of the configuration and indicate which cells are used.

Detector configuration codes



AEC detector configuration

EXAMPLE **1**

39. **Density setting (AEC technique only)**

Ask the technologist what density control setting they typically use for an adult abdomen/L/S-spine exam. Remember that our NEXT patient is 5'8" tall, weighs 164 pounds, and has a 23.0-cm abdomen dimension in the AP direction.

Density setting (AEC only)

EXAMPLE **+1**

40. **Technique Charts (manual and AEC modes)**

Determine from the technologist if the facility maintains technique charts for the specific unit you are surveying and for the particular exam you are surveying. If the technologist claims that technique charts exist, but can not locate them, enter 'Y'. Enter 'N' only after verifying that they do not maintain technique charts for the x-ray unit you are surveying.

41. **Technique factors for routine adult Abdomen/L/S-spine exam: kVp, mAs, tube current, and exposure time.**

Ask the facility technologist to select at the console the technique factors for both the adult abdomen AND lumbar-spine X-ray exams. Enter the **selected** factors on the worksheet in the appropriate spaces.

Ask the technologist to provide technique factors for any other possible projections (Lateral and Oblique) their facility uses during the routine adult abdomen/L/S-spine exams. If they do not perform a particular projection, then enter 'NA' for the respective cells.

NOTE: Only those technique factors *selected at the console prior to exposure* should be entered into *items 41a through 41d*. Do not attempt to estimate the exposure time in *41d* using the output from the MDH meter, for example.

41.a. kVp;

41.b. mAs (manual mode only);

41.c. Tube current (mA);

41.d. Exposure time (in milliseconds (ms) - manual mode).

EXAMPLE

Pre-Selected Technique factors for routine Adult Abdomen Exam

	41.a		41.b	41.c		41.d	
	kVp		mAs	Tube current (mA)		Exposure time (ms)	
AP	80		12		400		30
PA	NA		NA		NA		NA
Oblique	NA		NA		NA		NA
Lateral	100		20		400		50
Other							

Pre-Selected Technique factors for routine Adult L/S Spine Exam

	41.a		41.b	41.c		41.d	
	kVp		mAs	Tube current (mA)		Exposure time (ms)	
AP	80		12		400		30
PA	NA		NA		NA		NA
Oblique	NA		NA		NA		NA
Lateral	80		20		400		50
Other							

F. Exposure measurements – Standard Exposure Information

At this time, the phantom will be set up and you will perform the x-ray exposure and time measurements according to the facility's clinical technique. Four MDH exposure measurements (**Items 42, 43, 45, and 47**) and three exposure time measurements (**Items 44, 46, and 48**) will be made. You will also acquire one or more films for image quality evaluation and for assessing darkroom fog, if applicable.

Watch your units! Record exposure values in **milliroentgens (mR)**, and record time measurements in **milliseconds (ms)**. NOTE: 1 Roentgen = 1000 milliroentgens, and 1 second = 1000 milliseconds.

Example of a clinically reasonable MDH exposure entry:

	41.	MDH Exposure #1 (mR)	
<u>EXAMPLE</u>		318.5	Number is reasonable for the exam being surveyed.

Example of a Questionable MDH exposure entry:

		<u>MDH Exposure #1 (mR)</u>	
<u>EXAMPLE</u>		11.24	Number is either very low or high for this exam. If MDH reading is 11.24 <i>Roentgens</i> , then the value should be entered as 11240 mR.

Good example of an MDH time entry:

	42.	MDH Exposure #2 time (ms)	
<u>EXAMPLE</u>		417.2	Number is reasonable for the exam being surveyed.

Example of a Questionable MDH time entry:

		<u>MDH Exposure #2 time (ms)</u>	
<u>EXAMPLE</u>		2.03	Again, number is either very low or high for this exam. If the MDH time reading is 2.03 seconds, then the value should be entered as 2030 msec.

G. Phantom Set-up Procedures: Abdomen

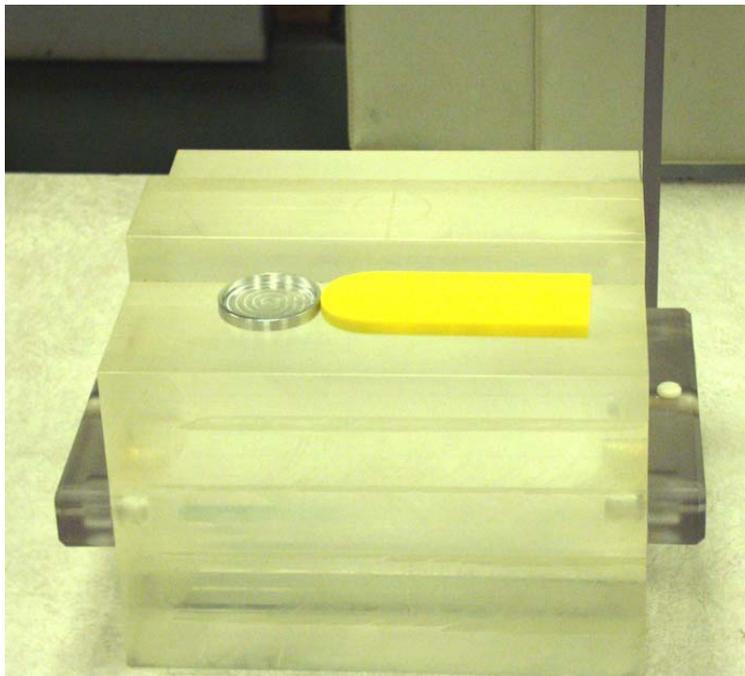
Abdomen Phantom Set-up

The abdomen phantom does not require any assembly. Simply attach the probe holder to the phantom.

Attach the test tools to the Abdomen phantom as follows:

- This year you will be using two test tools. One test tool is the standard Yellow Test tool, and the second is a new aluminum disk containing holes with specified depths.
- Both test tools are to be used for this procedure.
- Place the test tools as shown along the raised spine part of the phantom, and parallel to the spine axis of the phantom.
- For consistency, position the test tools in the same location for each survey you do.

Figure 4. Abdomen Test Tool Placement



H. Abdomen Exam: MDH Exposure and Time Measurements Procedure

Refer to the section corresponding to the type of imaging the facility does.

- **Screen-film systems:** Complete section H.1.
- **Computed radiography:** Complete section H.2.
- **Other digital systems:** Complete section H.3.

H.1 **Screen-Film X-ray Systems (items 42-48)**

X-ray Exposure and time measurements

This section describes the procedures for performing the following tasks:

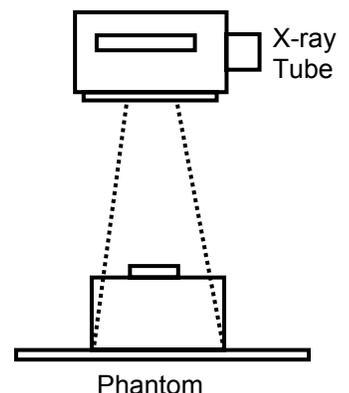
- Exposure and exposure time measurements which will be used for entrance skin exposure analysis;
- Phantom film with radiographic test tools (standard Yellow Test tool and aluminum disk) for image quality evaluation; and
- Unprocessed phantom film for darkroom fog test and analysis.

The first set of measurements that you will be taking relates to the techniques being used by the facility for obtaining images. In the second set of measurements, you will obtain an image of the phantom and both of the test tools together. This film will be used to determine background optical density and to score only the Yellow test tool image (number of visible holes and meshes). If the facility maintains a darkroom, you will perform a darkroom fog test even though the facility may not typically handle clinical abdomen films there.

NOTE: If the x-ray tube has not been used for a period of time so that it is “cold,” make a couple of short exposures (with assistance from the technologist if needed) to warm the tube, if possible.

Procedure

1. Collimate the beam down to a 10 x 10 inch **area at the top of the table**. Refer to diagram at the right.
2. Position the phantom so that it rests directly against the front plate of the wall bucky or the table top. **Remember** - the phantom simulates the radiation absorption and scatter properties presented by a real patient, so the phantom should rest against the same surface the patient would.



TIP: In facilities that do upright exams with a wall bucky, you may be able to move the tabletop close to the bucky to support the phantom.

3. Center the phantom transversely (across the patient, left to right) using the collimated 10 x 10 inch area light field. The technologist should already have positioned the tube for the exam. Position the phantom (without the Test Tool) vertically (head to foot), depending on the exposure mode:
 - a. *Manual mode:* such that the phantom is approximately centered with the position indicators/light field.
 - b. *AEC mode:* such that the phantom completely covers relevant AEC cells. The phantom may thus not be centered with the table top or bucky surface, but shifted up slightly in order to cover the detectors. Adjust the x-ray tube position as needed to re-center the phantom in the beam according to the light field (do not adjust image receptors/bucky).

NOTE: The following MDH exposure and time measurements are made with NO TEST TOOLS on the phantom!

4. Place the *Radcal* MDH probe into the probe holder-Set the mode selector to **'PUL/SE EXPOSURE'**
5. Set the threshold thumb-wheel to **0.2** for single phase units. For three phase and constant potential units, set the threshold to **0.5**.
6. Set the function selector to **'MEASURE'**.
7. Obtain a loaded cassette of the appropriate film type and size (see *items 19-25*) and insert into the bucky / cassette holder. Verify that your cassette and film are consistent with your responses to these items, the typical screen-film system used for routine adult abdomen radiography.
8. VERIFY that the technique factors set at the console are those that you recorded in *items 41a –41d* for an abdomen exam.
9. Make an exposure and record ONLY the MDH exposure (*item 42*). DO NOT record the time measurement from the MDH meter at this time. (This first exposure serves to initialize the MDH for subsequent exposures.) Record the value of the exposure in **milliroentgens (mR)**. Leave the cassette in its place.

10. Make a second, third, and fourth exposure. No useful image is needed from this film, but it is important that there be film in the cassette. After each exposure :
 - Record the exposure in mR (*items 43, 45, and 47*)
 - Switch the MDH selector to **PUL/SE DURATION** and record the exposure time in milliseconds (ms) (*items 44, 46, and 48*). Switch the MDH selector back to **PUL/SE EXPOSURE**.
11. Add both of the test tools to the phantom (please see picture on page 23) and remove the MDH probe.
12. Remove the cassette and either process or discard the film. Reload the cassette and install into the bucky / cassette holder.
13. Make an exposure.
14. Remove the film cassette and process the film. Reload the cassette and install for the remaining exposures.
15. Measure the optical density of the film anywhere in the main body portion of the abdomen section of the phantom image. Do not record this number on the surveyor worksheet, but keep in mind whether the number is ≥ 1.0 .

CHECK THE FILM! Be certain the film was produced without problems. If the film is unusually light (background < 0.60) or dark (background > 2.5) or has other features that suggest a problem with the film processor or other source, then check:

- Other clinical abdomen/L/S-spine films, if available, for similar appearance/features;
- Your clinical technique factors
- Verify with the technologist that their processor is operating in an acceptable manner.

Document your actions in the comments section on the Surveyor Worksheet

16. When you are satisfied the film is acceptable, label the processed film '*Abdomen Phantom Film Evaluation*', and include the facility name and date on the film. Section K describes the methods for measuring background optical density and scoring the image of both test tools.

17. ***IF the background density of your phantom film is between 1.0 and 2.5 (from procedure step 14),***

- Make an exposure. Put it aside for the darkroom fog test (section L).
- Proceed to Section J below and perform the HVL measurements.

IF the background density of your phantom film is less than 1.0 or greater than 2.5,

- You will need to adjust the x-ray technique factors to produce a film dark enough to use for the darkroom fog test.
- Using a **manual technique**, increase (or *decrease*, if your film was too dark) the exposure mAs (mainly the exposure time) by a factor of approximately **2** and make another exposure. This should be adequate to produce a phantom film having an acceptable background optical density. **Do NOT process this film yet!** Put the cassette aside for the darkroom fog test (section I).
- Perform the entrance skin exposure calculation and then proceed to Section J and perform the HVL measurements.

Entrance skin exposure calculation

Use the procedure below to compute the entrance skin exposure. This is the entrance exposure that a standard patient with an AP abdomen dimension of 23.0 cm would receive, using the same clinical factors and conditions that you conducted your exposure measurements.

- a. Compute the average exposure resulting from your four exposure measurements.
- b. Refer back to the Source-to-patient support distance. Using this distance measurement and your mean exposure value from step a. above, compute the entrance skin exposure to the standard NEXT patient (having a 23.0 cm AP dimension.).

ESE equation for both the Abdomen and L/S spine exams.

$$ESE(mR) = \left(\frac{\text{Source to patient support distance} - 40.9\text{cm}}{\text{Source to patient support distance} - 23\text{cm}} \right)^2 \times \text{Average Exposure}(mR)$$

NOTE: For an example of an Entrance Skin Exposure (ESE) calculation, please see the APPENDIX (page 69)

H.2 Computed Radiography X-ray Systems

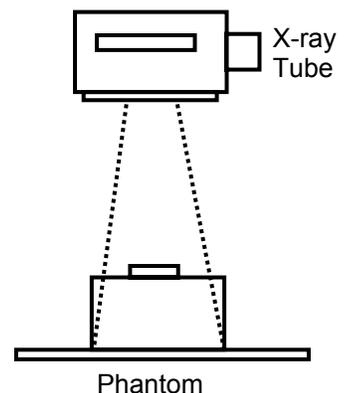
X-ray Exposure and time measurements

You will acquire ONE LASER film containing an image of the phantom and both of the test tools (Yellow Test tool and Aluminum disk) together. This film will be used to determine background optical density and to score the test tool image. If the facility maintains a darkroom, you will perform a darkroom fog test even though the facility may not typically handle clinical abdomen films there. You are asked to obtain a loaded standard film cassette for the darkroom fog test.

Procedure

1. Collimate the beam down to a 10 x 10 inch **area at the top of the table**. Refer to the diagram at the right.

TIP: In facilities that do upright exams with a wall bucky, you may be able to move the tabletop close to the bucky to support the phantom.



2. Center the phantom transversely (across the patient, left to right) using the collimated 10 x 10 inch area light field. The technologist should already have positioned the tube and collimated the beam. Position the phantom (without the Test Tool) vertically (head to foot), depending on the exposure mode:
 - a. *Manual mode*: such that the phantom is approximately centered with the position indicators/light field.
 - b. *AEC mode*: such that the phantom completely covers relevant AEC cells. The phantom may thus not be centered with the table top or bucky surface, but shifted up slightly in order to cover the detectors. Adjust the x-ray tube position as needed to re-center the phantom in the beam according to the light field (do not adjust image receptors/bucky).
3. Position the phantom so that it rests directly against the front plate of the wall bucky or the table top. **Remember** - the phantom simulates the radiation absorption and scatter properties presented by a real patient, so the phantom should rest against the same surface the patient would.
4. Place the *Radcal* MDH probe into the probe holder-Set the mode selector to **'PUL/SE EXPOSURE'** .

5. Set the threshold thumb-wheel to **0.2** for single phase units. For three phase and constant potential units, set the threshold to **0.5**.
6. Set the function selector to '**MEASURE**'.
7. Insert an unexposed CR imaging plate (IP) appropriate for adult abdomen exams into the bucky / cassette holder.
8. Verify that the technique factors set at the console are those you recorded in *items 41a-41d*.
9. Make an exposure and record ONLY the MDH exposure - do NOT record the time measurement from the MDH meter at this time. This first exposure serves to initialize the MDH for subsequent exposures.
10. Record your answer in **milliroentgens (mR)** (*item 42*).
11. Make a second, third and fourth exposure without removing the cassette. **No useful image is needed** from these exposures, and the CR cassette can safely be exposed several times without being damaged. After each exposure:
 - Record the exposure in mR (*items 43, 45, and 47*).
 - Switch the MDH selector to **PUL/SE DURATION** and record the exposure time in milliseconds (ms) (*items 44, 46, and 48*). Switch the MDH selector back to **PUL/SE EXPOSURE**.
12. Remove the CR cassette and ask the technologist to conduct a PRIMARY ERASURE on it. Reinstall the image plate into the bucky/cassette holder.
13. Add both of the test tools to the phantom (as described in the picture on page 23) and remove the MDH probe.
14. Make an exposure.
15. Remove the CR cassette and process it as follows:
 - Ask the technologist to process the CR cassette using the menu option(s) the facility normally would use for an adult abdomen radiograph. **RECORD in the comments section a brief description of the specific imaging processing that was performed**. Retain the same CR plate for the remaining exposures after it has been processed.

- Ask for a hardcopy film of the phantom image using a size they normally would use for adult abdomen films. If the facility previews and manipulates the image on a computer monitor prior to printing, ask the appropriate person to follow normal procedures prior to printing the phantom film.

CHECK THE FILM! Be certain the film was produced without problems. If the film is unusually light (background < 0.60) or dark (background > 2.5) or has other features that suggest a problem with the laser film processor or other source, then check:

- Other abdomen films (if available) for similar appearance or features;
- Your clinical technique factors;
- The algorithm used: the facility usually has particular image processing routines for different exams that are applied to the image prior to producing a film.

Document your actions in the comments section on the Surveyor Worksheet.

Label the processed film “*Abdomen Phantom Film Evaluation*” and include the facility name and date on the film. Section K describes the method for measuring background optical density and for scoring the image of both test tools.

16. Return the CR cassette to the department’s storage area.

This completes the exposure measurement procedure. You will now acquire a film for performing the darkroom fog test.

NOTE: If the facility’s department is ‘all digital’ and does not routinely handle ANY standard radiographic film in their darkroom, then do not perform the darkroom fog test, and proceed directly to Section I, L/S-Spine Procedure.

17. *Darkroom fog film:* Obtain a loaded standard **film** cassette from the technologist. Request a size that will adequately cover most if not the entire phantom (the suggested size is 10 in x 12 in or 24 cm x 30 cm). The film type should be one the facility uses routinely for general purpose exams.
18. Configure the x-ray technique for a manual mode exposure. If the kVp is below 80, adjust the kVp to at least 80 kV. Select a combination of tube current and exposure time to obtain an exposure of 50-70 mAs. This

technique should give a film with sufficient background density for performing the darkroom fog test. The phantom should still be positioned as it was for the exposure measurements.

19. Install the cassette into the bucky and make an exposure. Put this cassette aside until you are ready to perform the darkroom fog test.
20. Perform the entrance skin exposure calculation and then proceed to perform the HVL measurements.

Entrance skin exposure calculation

Use the procedure below to compute the entrance skin exposure. This is the entrance exposure that a standard patient with an adult abdomen dimension of 23.0 cm would receive using the same clinical factors and conditions you made your exposure measurements with.

- a. Compute the average exposure resulting from your four exposure measurements from section G.
- b. Refer back to the Source-to-patient support distance. Using this distance measurement and your mean exposure value from step a. above, compute the entrance skin exposure to the standard NEXT patient (having a 23.0 cm adult abdomen dimension.).

IMPORTANT: Your value for *Source-to-patient support distance* should be expressed in centimeters, otherwise the below calculation will be incorrect.

ESE equation for both the Abdomen and L/S spine exams.

$$ESE(mR) = \left(\frac{\text{Source to patient support distance} - 40.9\text{cm}}{\text{Source to patient support distance} - 23\text{cm}} \right)^2 \times \text{Average Exposure}(mR)$$

NOTE: For an example of an Entrance Skin Exposure (ESE) calculation, please see the APPENDIX A (page 69)

H.3 Digital X-ray Systems

X-ray exposure and time measurements

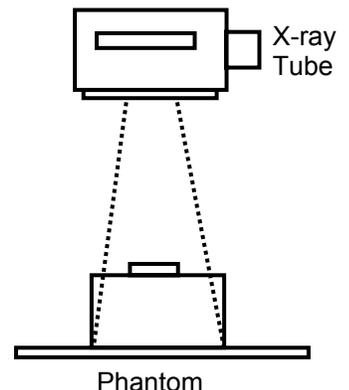
This section describes procedures for measuring x-ray exposure and time on digital x-ray systems that have no removable form of image cassette. These systems may provide for laser film output (hard-copy) as well as for viewing of the image on a computer monitor (soft-copy).

You will acquire **one laser film** containing an image of the phantom and both of the test tools (Yellow test tool and Aluminum disk) together. Inform the technologist of this intent prior to making exposures so that they can make appropriate arrangements if needed. This film will be used to determine background optical density and score both the Yellow test tool image (number of visible holes and meshes) and the Aluminum disk (no. of visible holes). If the facility maintains a darkroom, you will perform a darkroom fog test even though the facility may not typically handle clinical abdomen films there. You are asked to obtain a loaded standard film cassette for performing the darkroom fog test if possible.

Procedure

1. Collimate the beam down to a 10 x 10 inch area **at the table top**. Refer to the diagram at the right.

NOTE: If the x-ray tube has not been used for a period of time such that it is cold, make a couple of exposures (with assistance from the technologist if needed) to warm the tube, if possible.



2. Center the phantom transversely (across the patient, left to right) using the collimated 10 x 10 inch area light field. You should already have positioned the tube and collimated the beam. Position the phantom (without the Test Tool) vertically (head to foot), depending on the exposure mode:
 - a. *Manual mode*: such that the phantom is approximately centered with the position indicators/light field.
 - b. *AEC mode*: such that the phantom completely covers relevant AEC cells or area on the digital receptor. The phantom may thus not be centered with the table top area on the digital panel, but shifted up slightly in order to cover the detectors. Adjust the x-ray tube position as needed to re-center the phantom in the beam according to the light field (do not adjust image receptors/bucky).

TIP: In facilities that do upright exams with a wall bucky, you may be able to move the tabletop close to the bucky to support the phantom.

3. Place the *Radcal* MDH probe into the probe holder. Make certain the MDH probe is fully in the x-ray beam!
4. Set the mode selector to '**PUL/SE EXPOSURE**'
5. Set the threshold thumb-wheel to **0.2** for single phase units. For three phase and constant potential units, set the threshold to **0.5**.
6. Set the function selector to '**MEASURE**'.
7. Ask the technologist to configure the control panel with the settings typically used to acquire an image of an adult abdomen. Verify that these are the same technique factors you recorded for *items 41.a-41.d*.
8. Make an exposure (you may need assistance with the control panel) and record **ONLY** the MDH exposure. **DO NOT** record the time measurement from the MDH meter at this time. This first exposure serves to initialize the MDH for subsequent exposures. Record your answer in milliroentgens (mR).
9. Make a second, third, and fourth exposure. No useful image is needed from these exposure. After each exposure:
 - Record the exposure in mR (*items 43, 45, and 47*).
 - Switch the MDH selector to **PUL/SE DURATION** and record the exposure time in milliseconds (ms) (*items 44, 46, and 48*). Switch the MDH selector back to **PUL/SE EXPOSURE**.
10. Add both of the test tools to the phantom and remove the MDH probe.
11. Make an exposure according to set technique factors.
12. Ask the technologist to produce a hardcopy (film) using the menu option(s) the facility normally would use for an adult abdomen radiograph. If the facility previews and manipulates the image on a computer monitor prior to printing, ask the appropriate person to follow normal procedures prior to printing the phantom film.

CHECK THE FILM! Be certain the film was produced without problems. If the film is unusually light (background OD > 0.6) or dark (background OD > 2.5) or has other features that suggest a problem with the laser film processor or other source, then check:

- Other clinical abdomen films, if available, for similar appearance/features
- Your clinical technique factors
- The algorithm used: the facility may have particular image processing routines for different exams that are applied prior to producing a film.

Document your actions in the comments section on the Surveyor Worksheet.

13. Label the processed film '*Abdomen Phantom Film Evaluation*', and include the facility name and date on the film.

This step completes the exposure measurement procedure. You will now acquire a film for performing the darkroom fog test.

NOTE: If the facility's department is 'all digital' and does not routinely handle ANY standard radiographic film in their darkroom, then do not perform the darkroom fog test, and proceed directly to section J. Perform the HVL Measurements.

14. *Darkroom fog film:* Obtain a loaded standard **film** cassette from the technologist- request a size that will adequately cover most if not the entire phantom (a suggested minimum size is 10 in x 12 in or 24 cm x 30 cm). The film type should be one the facility uses routinely for general purpose exams.

NOTE: The digital unit may or may not provide a means of exposing a standard film cassette. You may need to use the table top (if there is one), or ask to use a x-ray suite where a standard cassette can be exposed.

15. Configure the x-ray technique for a manual mode exposure. If the kVp is below 80, adjust the kVp to at least 80 kV. Select a combination of tube current and exposure time to obtain an exposure of 50-70 mAs. This

technique should give a film with sufficient background density for performing the darkroom fog test. The phantom should still be positioned as it was for the exposure measurements.

16. Install the cassette into the bucky and make an exposure. Put this cassette aside until you are ready to perform the darkroom fog test.
17. Perform the entrance skin exposure calculation and then proceed to the HVL Section J. to perform the HVL measurements.

Entrance skin exposure calculation

Use the procedure below to compute the entrance skin exposure. This is the entrance exposure that a standard patient with an adult abdomen dimension of 23.0 cm would receive using the same clinical factors and conditions you made your exposure measurements with.

- a. Compute the average exposure resulting from your four exposure measurements from section H.
- b. Refer back to Source-to-patient support distance. Using this distance measurement and your mean exposure value from step a. above, compute the entrance skin exposure to the standard NEXT patient (having a 23.0 adult abdomen dimension.).

IMPORTANT: Your value for *Source-to-patient support distance* should be expressed in centimeters.

ESE equation for both the Abdomen and L/S spine exams.

$$ESE(mR) = \left(\frac{\text{Source to patient support distance} - 40.9\text{cm}}{\text{Source to patient support distance} - 23\text{cm}} \right)^2 \times \text{Average Exposure}(mR)$$

NOTE: For an example of an Entrance Skin Exposure (ESE) calculation, please see the APPENDIX A (page 69)

I. Phantom Set-up Procedures: Lumbo-Sacral (L/S) Spine Procedure

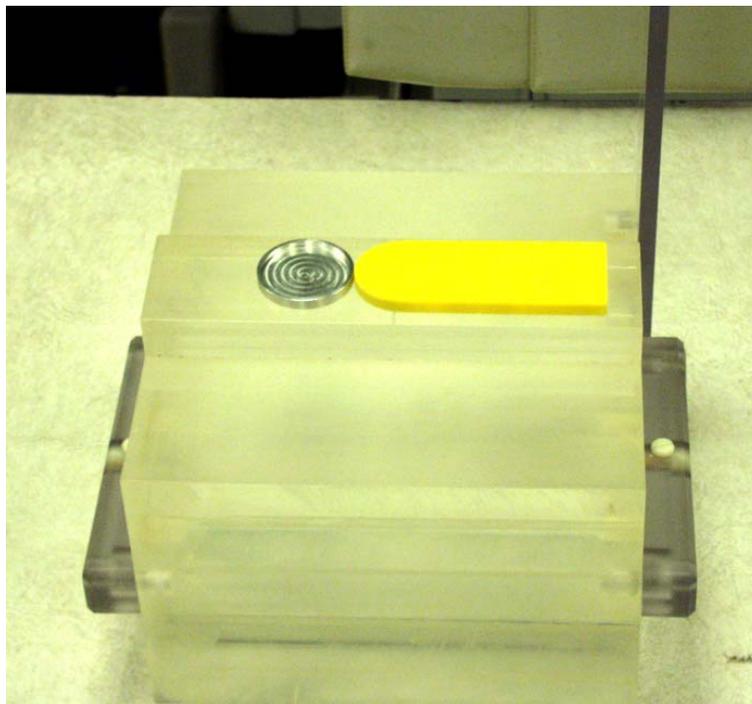
L/S Spine Phantom Set-Up

Prepare the adult abdomen assembly and verify proper placement of the image quality test tool. The lumbosacral phantom does not require any assembly. Simply attach the probe holder to the abdominal phantom.

Attach the test tool to L/S Spine phantom as follows:

- This year you will be using two test tools. One test tool is the standard Yellow Test tool, and the second is a new Aluminum disk containing holes with specified depths.
- Both test tools are to be used for this procedure.
- Place the test tool along the raised spine part of the phantom, and parallel to the spine axis of the phantom.
- For consistency, it is desirable to position the test tool in the same location for all measurements. With a pencil outline the position of the test tools. This will make it easier to return the test tools to their correct position.

Figure 5. Test Tool placement for the L/S spine survey



I. Lumbosacral (L/S) Spine Exam: MDH Exposure and Time Measurements

Refer to the section corresponding to the type of imaging the facility does.

- **Screen-film systems:** Complete section I.1.
- **Computed radiography:** Complete section I.2.
- **Other digital systems:** Complete section I.3.

I.1 Screen-Film X-ray Systems

X-ray Exposure and time measurements

This section describes the procedures for performing the following tasks:

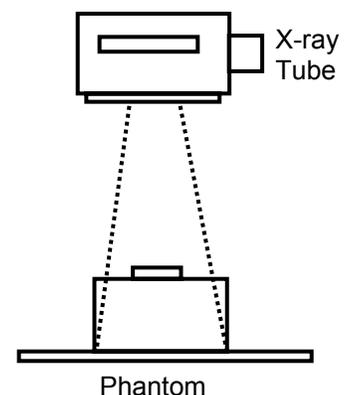
- Exposure and exposure time measurements which will be used for entrance skin exposure analysis;
- Phantom film with radiographic test tool (standard Yellow Test tool and Aluminum disk) for image quality evaluation; and
- Unprocessed phantom film for darkroom fog test and analysis.

The first set of measurements you will take relate to the techniques being used by the facility for obtaining images. In the second set of measurements, you will obtain an image of the phantom and both of the test tools (Yellow Test tool and the Aluminum disk) together. This film will be used to determine background optical density and to score both the Yellow test tool (number of visible holes and meshes) and the Aluminum disk (number of visible holes). If the facility maintains a darkroom, you will perform a darkroom fog test (if not performed previously) even though the facility may not typically handle clinical abdomen films there. For the case of a digital x-ray system, you are asked to obtain a loaded standard film cassette, if the facility can provide one, for performing the darkroom fog test.

Procedure

NOTE: If the x-ray tube has not been used for a period of time so that it is “cold,” make a couple of short exposures (with assistance from the technologist if needed) to warm the tube, if possible.

1. Collimate the beam down to a 10 x 10 inch **area at the top of the table**. Refer to the diagram at the right.



2. Center the phantom transversely (across the patient, left to right) using the collimated 10 x 10 inch area light field. The technologist should already have positioned the tube and collimated the beam. Position the phantom (without the Test Tool) vertically (head to foot), depending on the exposure mode:
 - a. *Manual mode*: such that the phantom is approximately centered with the position indicators/light field.
 - b. *AEC mode*: such that the phantom completely covers relevant AEC cells. The phantom may thus not be centered with the table top or bucky surface, but shifted up slightly in order to cover the detectors. Adjust the x-ray tube position as needed to re-center the phantom in the beam according to the light field (do not adjust image receptors/bucky).
3. Position the phantom so that it rests directly against the front plate of the wall bucky or the table top. **Remember** - the phantom simulates the radiation absorption and scatter properties presented by a real patient, so the phantom should rest against the same surface the patient would.
4. After you have completed the positioning of the phantom, and without moving the phantom, collimate the horizontal field to the width normally used for the L/S spine examination. Have the facility technologist assist you with this. If there is some doubt as to the proper vertical width, use five inches (5”).
5. Place the *Radcal* MDH probe into the probe holder-Set the mode selector to **‘PUL/SE EXPOSURE’**
6. Set the threshold thumb-wheel to **0.2** for single phase units. For three phase and constant potential units, set the threshold to **0.5**.
7. Set the function selector to **‘MEASURE’**.
8. Obtain a loaded cassette of the appropriate film type and size (see *items 19-25*) and insert into the bucky / cassette holder. Verify that your cassette and film are consistent with your responses to these items, the typical screen-film system used for routine adult L/S-Spine radiography.
9. VERIFY that the technique factors set at the console are those that you recorded in *items 41a –41d*.

<p>NOTE: The following MDH exposure and time measurements are made with NO TEST TOOLS on the phantom!</p>
--

10. Make an exposure and record **ONLY** the MDH exposure (*item 42*). **DO NOT** record the time measurement from the MDH meter at this time. (This first exposure serves to initialize the MDH for subsequent exposures.) Record the value of the exposure in **milliroentgens (mR)**.
11. Make a second, third, and fourth exposure. No useful image is needed from this film, but it is important that there be film in the cassette. After each exposure:
 - Record the exposures in mR (*item 43, 45, and 47*)
 - Switch the MDH selector to **PUL/SE DURATION** and record the exposure time in milliseconds (ms) (*items 44, 46, and 48*). Switch the MDH selector back to **PUL/SE EXPOSURE**.
12. Remove the cassette and either process or discard the film. Reload the cassette and install into the bucky / cassette holder.
13. Add both of the test tools to the phantom (refer to the illustration on page 37) and remove the MDH probe.

PLACEMENT OF THE TEST TOOLS FOR L/S SPINE: place both of the test tools along the raised spine part of the phantom and parallel to the spine axis of the phantom (page 37). For consistency position the test tools in the same location for all measurements.

14. Make an exposure.
15. Remove the film cassette and process the film. Reload the cassette and install for the remaining exposures.
16. Measure the optical density of the film anywhere in the spinal insert portion of the L/S-spine phantom image. Do not record this number on the surveyor worksheet, but keep in mind whether the number is ≥ 1.0 .

CHECK THE FILM! Be certain the film was produced without problems. If the film is unusually light (background < 0.60) or dark (background > 2.5) or has other features that suggest a problem with the laser film processor or other source, then check:

- Other clinical L/S-spine films, if available, for similar appearance/features;
- Your clinical technique factors
- Verify with the technologist that their processor is operating in an acceptable manner.

Document your actions in the comments section on the Surveyor Worksheet

17. When you are satisfied the film is acceptable, label the processed film '*L/S-Spine Phantom Film Evaluation*', and include the facility name and date on the film. There is a section below that describes the methods for measuring background optical density and scoring both of the test tools.

18. ***IF the background density of your phantom film is between 1.0 and 2.5 (from procedure step 11),***

- Insert a new cassette (following instructions listed above).
- Make an exposure. **Do NOT process this film yet!** Put it aside for the darkroom fog test (section L).
- Proceed to section J and perform the HVL measurements.

IF the background density of your phantom film is less than 1.0 or greater than 2.5,

- You will now need to adjust the x-ray technique factors to produce a film dark enough to use for the darkroom fog test.
- Using a **manual technique**, increase (or *decrease*, if your film was too dark) the exposure mAs (mainly the exposure time) by a factor of approximately **2** and make another exposure. This should be adequate to produce a phantom film having an acceptable background optical density. **Do NOT process this film yet!** Put the cassette aside for the darkroom fog test (section I).
- Perform the entrance skin exposure calculation and then proceed to the Section J and perform the HVL measurements.

Entrance skin exposure calculation

Use the procedure in the appendix to compute the entrance skin exposure. This is the entrance exposure that a standard patient with an L/S-Spine dimension of 23.0 cm would receive using the same clinical factors and conditions you made your exposure measurements with.

- a. Compute the average exposure resulting from your four exposure measurements.
- b. Refer back to the Source-to-patient support distance. Using this distance measurement and your mean exposure value from step a. above, compute the entrance skin exposure to the standard NEXT patient (having a 23.0 cm L/S-Spine dimension.).

ESE equation for both the Abdomen and L/S spine exams.

$$ESE(mR) = \left(\frac{\text{Source to patient support distance} - 40.9\text{cm}}{\text{Source to patient support distance} - 23\text{cm}} \right)^2 \times \text{Average Exposure}(mR)$$

NOTE: For an example of an Entrance Skin Exposure (ESE) calculation, please see the APPENDIX

1.2 Computed Radiography X-ray Systems

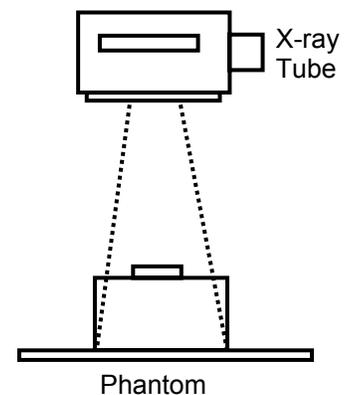
X-ray Exposure and time measurements

You will acquire ONE film containing an image of the phantom and both of the test tools (Yellow Test tool and the Aluminum disk) together. This film will be used to determine background optical density and to only score the Yellow test tool image. If the facility maintains a darkroom, you will perform a darkroom fog test even though the facility may not typically handle clinical L/S-Spine films there. You are asked to obtain a loaded standard film cassette for the darkroom fog test.

Procedure

1. Collimate the beam down to a 10 x 10 inch area at the top of the table. Refer to the diagram at the right.

TIP: In facilities that do upright exams with a wall bucky, you may be able to move the tabletop close to the bucky to support the phantom.



2. Center the phantom transversely (across the patient, left to right) using the collimated 10 x 10 inch area light field. The technologist should already have positioned the tube and collimated the beam. Position the phantom (without the Test Tool) vertically (head to foot), depending on the exposure mode:
 - a. *Manual mode*: such that the phantom is approximately centered with the position indicators/light field.
 - b. *AEC mode*: such that the phantom completely covers relevant AEC cells. The phantom may thus not be centered with the table top or bucky surface, but shifted up slightly in order to cover the detectors. Adjust the x-ray tube position as needed to re-center the phantom in the beam according to the light field (do not adjust image receptors/bucky).
3. Position the phantom so that it rests directly against the front plate of the wall bucky or the table top. **Remember** - the phantom simulates the radiation absorption and scatter properties presented by a real patient, so the phantom should rest against the same surface the patient would.

4. After you have completed the positioning of the phantom, and without moving the phantom, collimate the horizontal field to the width normally used for the L/S spine examination. Have the facility technologist assist you with this. If there is some doubt as to the proper horizontal width, use five inches (5”).
5. Place the *Radcal* MDH probe into the probe holder-Set the mode selector to **‘PUL/SE EXPOSURE’** .
6. Set the threshold thumb-wheel to **0.2** for single phase units. For three phase and constant potential units, set the threshold to **0.5**.
7. Set the function selector to **‘MEASURE’**.
8. Insert an unexposed CR imaging plate (IP) appropriate for adult abdomen exams into the bucky / cassette holder.
9. Verify that the technique factors set at the console are those you recorded in items 41a-41d.
10. Make an exposure and record **ONLY** the MDH exposure - do **NOT** record the time measurement from the MDH meter at this time. This first exposure serves to initialize the MDH for subsequent exposures.
11. Record your answer in **milliroentgens (mR)**.
12. Make a second, third and fourth exposure without removing the imaging plate. **No useful image is needed** from these exposures, and the CR cassette can safely be exposed several times without being damaged. After each exposure:
 - Record the exposure in mR (items 43, 45, and 47).
 - Switch the MDH selector to **PUL/SE DURATION** and record the exposure time in milliseconds (ms) (items 44, 46, and 48). Switch the MDH selector back to **PUL/SE EXPOSURE**.
13. Add both of the test tools to the phantom (see diagram on page 37) and remove the MDH probe.

PLACEMENT OF THE TEST TOOL FOR L/S SPINE: place the test tool along the raised spine part of the phantom and parallel to the spine axis of the phantom. It is desirable to position the test tool in the same location for all measurements.

14. Make an exposure and record all the measurements.

15. Remove the CR cassette and process it as follows:

- Ask the technologist to process the CR cassette using the menu option(s) the facility normally would use for an adult abdomen radiograph. RECORD in the comments section a brief description of the specific imaging processing that was performed. Retain the same CR plate for the remaining exposures after it has been processed.
- Ask for a hardcopy film of the phantom image using a size they normally would use for adult abdomen films. If the facility previews and manipulates the image on a computer monitor prior to printing, ask the appropriate person to follow normal procedures prior to printing the phantom film.

CHECK THE FILM! Be certain the film was produced without problems. If the film is unusually light (background < 0.60) or dark (background > 2.5) or has other features that suggest a problem with the laser film processor or other source, then check:

- Other L/S-Spine films (if available) for similar appearance or features;
 - Your clinical technique factors;
 - The algorithm used: the facility usually has particular image processing routines for different exams that are applied to the image prior to producing a film.
- Document your actions in the comments section on the Surveyor Worksheet.

16. Label the processed film “*L/S-Spine Phantom Film Evaluation*” and include the facility name and date on the film. Section K describes the method for measuring background optical density and for scoring both of the test tools.

17. Return the CR cassette to the department’s storage area.

This completes the exposure measurement procedure. You will now acquire a film for performing the darkroom fog test.

NOTE: If the facility’s department is ‘all digital’ and does not routinely handle ANY standard radiographic film in their darkroom, then do not perform the darkroom fog test, and proceed directly to section HVL calculation Procedure.

18. **Darkroom fog film:** Obtain a loaded standard **film** cassette from the technologist. Request a size that will adequately cover most if not the entire phantom (the suggested size is 10 in x 10 in or 24 cm x 24 cm). The film type should be one the facility uses routinely for general purpose exams.
19. Configure the x-ray technique for a manual mode exposure. If the kVp is below 80, adjust the kVp to at least 80kV. Select a combination of tube current and exposure time to obtain an exposure of 50-70 mAs. This technique should give a film with sufficient background density for performing the darkroom fog test. The phantom should still be positioned as it was for the exposure measurements.
20. Install the cassette into the bucky and make an exposure. Put this cassette aside until you are ready to perform the darkroom fog test.
21. Perform the entrance skin exposure calculation and then proceed to Section J to perform the HVL measurements.

Entrance skin exposure calculation

Use the procedure in the appendix to compute the entrance skin exposure. This is the entrance exposure that a standard patient with an adult L/S-Spine dimension of 23.0 cm would receive using the same clinical factors and conditions you made your exposure measurements with.

- a. Compute the average exposure resulting from your four exposure measurements from section I (CR section).
- b. Refer back to the Source-to-patient support distance. Using this distance measurement and your mean exposure value from step a. above, compute the entrance skin exposure to the standard NEXT patient (having a 23.0 cm adult L/S-Spine dimension.).

IMPORTANT: Your value for *Source-to-patient support distance* should be expressed in centimeters, otherwise the below calculation will be incorrect.

ESE equation for both the Abdomen and L/S spine exams.

$$ESE(mR) = \left(\frac{\text{Source to patient support distance} - 40.9\text{cm}}{\text{Source to patient support distance} - 23\text{cm}} \right)^2 \times \text{Average Exposure}(mR)$$

NOTE: For an example of an Entrance Skin Exposure (ESE) calculation, please see the APPENDIX A (page 69)

I.3 Digital X-ray Systems

X-ray exposure and time measurements

This section describes procedures for measuring x-ray exposure and time on digital x-ray systems that have no removable form of image cassette. These systems may provide for laser film output (hard-copy) as well as for viewing of the image on a computer monitor (soft-copy).

You will acquire **one laser film** containing an image of the phantom and both of the test tools (Yellow test tool and the Aluminum disk) together. Inform the technologist of this intent prior to making exposures so that they can make appropriate arrangements if needed. This film will be used to determine background optical density and to score only the Yellow test tool image. If the facility maintains a darkroom, you will perform a darkroom fog test (if not performed previously) even though the facility may not typically handle clinical L/S-Spine films there. You are asked to obtain a loaded standard film cassette for performing the darkroom fog test if possible.

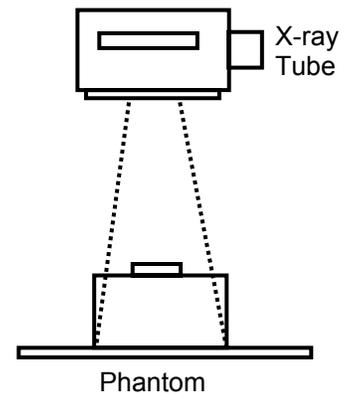
NOTE: If the x-ray tube has not been used for a period of time such that it is cold, make a couple of exposures (with assistance from the technologist if needed) to warm the tube, if possible.

Procedure

1. Collimate the beam down to a 10 x 10 inch area of the table top. Refer to the diagram at the right.

TIP: In facilities that do upright exams with a wall bucky, you may be able to move the tabletop close to the bucky to support the phantom.

2. Center the phantom transversely (across the patient, left to right) using the collimated 10 x 10 inch area light field. The technologist should already have positioned the tube and collimated the beam. Position the phantom (without the Test Tool) vertically (head to foot), depending on the exposure mode:
 - a. *Manual mode:* such that the phantom is approximately centered with the position indicators/light field.



- b. *AEC mode*: such that the phantom completely covers relevant AEC cells or area on digital receptor. The phantom may thus not be centered with the table top or bucky surface, but shifted up slightly in order to cover the detectors. Adjust the x-ray tube position as needed to re-center the phantom in the beam according to the light field (do not adjust image receptors/bucky).
3. Position the phantom so that it rests directly against the front plate of the wall bucky or the table top. **Remember** - the phantom simulates the radiation absorption and scatter properties presented by a real patient, so the phantom should rest against the same surface the patient would.
4. After you have completed the positioning of the phantom, and without moving the phantom, collimate the vertical field to the width normally used for the L/S spine examination. Have the facility technologist assist you with this. If there is some doubt as to the proper horizontal width, use five inches (5”).
5. Place the *Radcal* MDH probe into the probe holder.
6. Set the mode selector to **‘PUL/SE EXPOSURE’**
7. Set the threshold thumb-wheel to **0.2** for single phase units. For three phase and constant potential units, set the threshold to **0.5**.
8. Set the function selector to **‘MEASURE’**.
9. Ask the technologist to configure the control panel with the settings typically used to acquire an image of an adult L/S-Spine. Verify that these are the same technique factors you recorded for *items 41.a-41.d*.
10. Make an exposure (you may need assistance with the control panel and record **ONLY** the MDH exposure. **DO NOT** record the time measurement from the MDH meter at this time. This first exposure serves to initialize the MDH for subsequent exposures. Record your answer in milliroentgens (mR).
11. Make a second, third and fourth exposure. No useful image is needed from these exposures. After each exposure:
 - Record the exposure in mR (*items 43, 45, and 47*).
 - Switch the MDH selector to **PUL/SE DURATION** and record the exposure time in milliseconds (ms) (*items 44, 46, and 48*). Switch the MDH selector back to **PUL/SE EXPOSURE**.
12. Add both of the test tools to the phantom (see diagram on page 37 for

- placement) and remove the MDH probe.
13. Make an exposure according to set technique factors.

CHECK THE FILM! Be certain the film was produced without problems. If the film is unusually light (background OD > 0.6) or dark (background OD > 2.5) or has other features that suggest a problem with the laser film processor or other source, then check:

- Other clinical L/S-Spine films, if available, for similar appearance / features
- Your clinical technique factors
- The algorithm used: the facility may have particular image processing routines for different exams that are applied prior to producing a film.

Document your actions in the comments section on the Surveyor Worksheet.

14. Label the processed film '*L/S-Spine Phantom Film Evaluation*', and include the facility name and date on the film.

This step completes the exposure measurement procedure. You will now acquire a film for performing the darkroom fog test.

NOTE: If the facility's department is 'all digital' and does not routinely handle ANY standard radiographic film in their darkroom, then do not perform the darkroom fog test, and proceed directly to section J.

15. *Darkroom fog film:* Obtain a loaded standard **film** cassette from the technologist- request a size that will adequately cover most if not the entire phantom (a suggested minimum size is 10 in x 10 in or 24 cm x 24 cm). The film type should be one the facility uses routinely for general purpose exams.

NOTE: The digital unit may or may not provide a means of exposing a standard film cassette. You may need to use the table top (if there is one), or ask to use a x-ray suite where a standard cassette can be exposed.

16. Configure the x-ray technique for a manual mode exposure. If the kVp is below 80, adjust the kVp to at least 80 kV. Select a combination of tube current and exposure time to obtain an exposure of 50-70 mAs. This technique should give a film with sufficient background density for

performing the darkroom fog test. The phantom should still be positioned as it was for the exposure measurements.

17. Install the cassette into the bucky and make an exposure. Put this cassette aside until you are ready to perform the darkroom fog test.
18. Perform the entrance skin exposure calculation as described below and then proceed to the HVL Section to perform the HVL measurements.

Entrance skin exposure calculation

Use the procedure in the appendix to compute the entrance skin exposure. This is the entrance exposure that a standard patient with an adult abdomen dimension of 23.0 cm would receive using the same clinical factors and conditions you made your exposure measurements with.

- a. Compute the average exposure resulting from your four exposure measurements from section I.
- b. Refer back to Source-to-patient support distance. Using this distance measurement and your mean exposure value from step a. above, compute the entrance skin exposure to the standard NEXT patient (having a 23.0 adult L/S-Spine dimension.).

IMPORTANT: Your value for *Source-to-patient support distance* should be expressed in centimeters.

ESE equation for both the Abdomen and L/S spine exams.

$$ESE(mR) = \left(\frac{\text{Source to patient support distance} - 40.9\text{cm}}{\text{Source to patient support distance} - 23\text{cm}} \right)^2 \times \text{Average Exposure}(mR)$$

NOTE: For an example of an Entrance Skin Exposure (ESE) calculation, please see the APPENDIX A (page 69)

J. Beam Quality Determination at Clinical kVp

49. Half-value layer (HVL) exposure measurements

Perform the half-value layer (HVL) exposures with the x-ray unit in the **MANUAL** mode. You should adjust the exposure (exposure time or mAs) such that an MDH exposure reading of at least 200 mR results. You can also move the phantom slightly closer to the x-ray tube to increase the exposure to the MDH probe with minimal increase in the technique.

NOTE: You do not need to perform the HVL exposure measurements for both exams if:

- The same x-ray unit is used;
- The clinical kVp is the same for both exams.

- a. Verify that the x-ray console is in the **MANUAL** mode and that the kVp selected is the same as the kVp setting used for the exposure measurements of section F.
- b. *It is very important that the kVp be the same as the kVp used for the exposure measurements of section H.*

Adjust the phantom position such that the MDH probe is more centered in the x-ray beam. Collimate the beam down to the MDH probe – verify that the chamber is still fully in the x-ray beam using the light field.

- c. Review your exposure values from section F (items 40-48). If the facility uses a technique that results in exposures greater than 400 mR, then reduce the tube current or exposure time to bring exposures to the 200 – 400 mR range:

$$\text{new exposure time (or mAs)} = \text{old exposure time (or mAs)} \times \frac{200 \text{ mR}}{\text{MDH Exp from section F}}$$

For example, if

- Your MDH exposure numbers are about 75 mR from section F.
- The facility selected a mAs (manual mode) of 10 mAs.
- To determine HVL the mAs should be adjusted to about

$$10 \text{ mAs} \times \frac{200 \text{ mR}}{75 \text{ mR}} = 26.6 \text{ mAs}, \text{ or about } 27 \text{ mAs}.$$

- d. Make an exposure with no aluminum filter in the beam, and verify that an exposure of at least 200 mR results. Enter this first exposure on the surveyor worksheet.

49. MDH Exposure (NO Al) (mR)

EXAMPLE **213**

- e. Securely attach 2.0 mm of aluminum to the collimator housing and verify using the light-field that the entire chamber volume of the MDH probe is covered.
- f. Make an exposure and record the MDH reading on the surveyor worksheet (item 50).
- g. Make further exposures for additional **TOTAL** thickness' of 3.0, 4.0, and 5.0 mm of aluminum (items 51, 52, and 53). For each exposure record your MDH exposure on the survey form. Your exposures should decrease with increasing aluminum in the beam-see the data table below for an example. If your exposures remain constant or increase, then the system may be in automatic exposure mode.
- h. Verify that your final MDH exposure value with 5.0 mm of aluminum is beyond the half-value point (i.e. this last exposure should be less than $\frac{1}{2}$ of the first exposure with no aluminum, item 49.)
- i. If you need to add additional aluminum and make further exposures, add 1.0 mm increments and record both the exposure and the TOTAL aluminum thickness (*items 54 and 55*) in the appropriate space provided on the worksheet.
- j. **CHECK YOUR DATA.** Prior to proceeding, inspect your numbers and verify that there is a general decreasing trend of your exposure values with increasing thickness' of aluminum. If the values look suspect, verify that the x-ray unit was configured for a manual technique.

49. Procedure for plotting data and determining HVL (Optional – this is calculated by a program within the laptop.)

Review your exposure data to be certain it is valid for HVL determination (see example data on the following page) Do not proceed to graph your HVL data while you are at the facility- this task can be completed back at your office.

- a. Using the provided semi-log graph paper, plot your exposure values on the vertical axis, and your aluminum TOTAL thickness' on the horizontal axis. DO NOT PLOT THE FIRST (zero-aluminum) EXPOSURE (*item 49*).
- b. Draw a straight line that best fits your plotted data points.
- c. Divide your zero-aluminum exposure value (*item 49*) by 2, and then locate this number on the vertical axis of your graph. At this point on the vertical axis now draw a horizontal line over to the line you made in step 2 above.
- d. Read off the x-axis value of this intersection point. This is your HVL- enter this number on the surveyor worksheet (*item 56*). NOTE: Your units should be in mm of aluminum- refer to the example below.

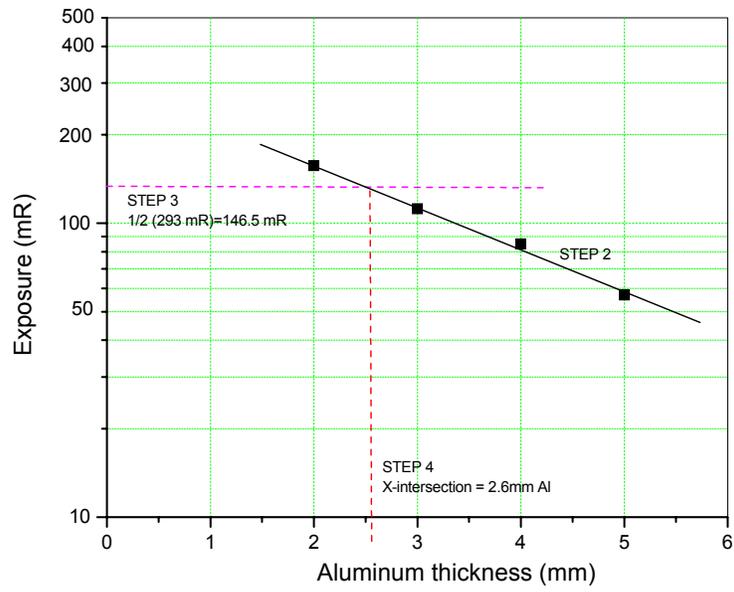
Example: The table of HVL data shown on the following page results in a HVL of 2.6 mm Al.

HVL(mm Al) from data plot

EXAMPLE

2.6

Aluminum (mm)	Exposure (mR)
0	293
2	157
3	112
4	85
5	57



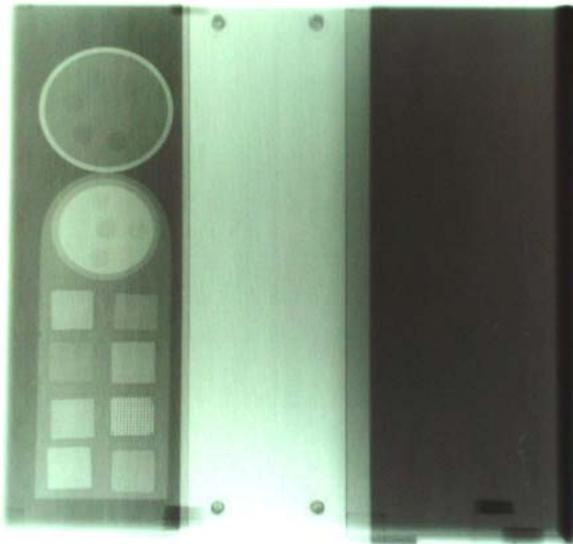
K. Phantom-Film Background Optical Density and Image- Quality Scores

This section describes measurement of optical densities of the phantom film and the scoring of the both the Yellow test-tool and Aluminum Disk images.

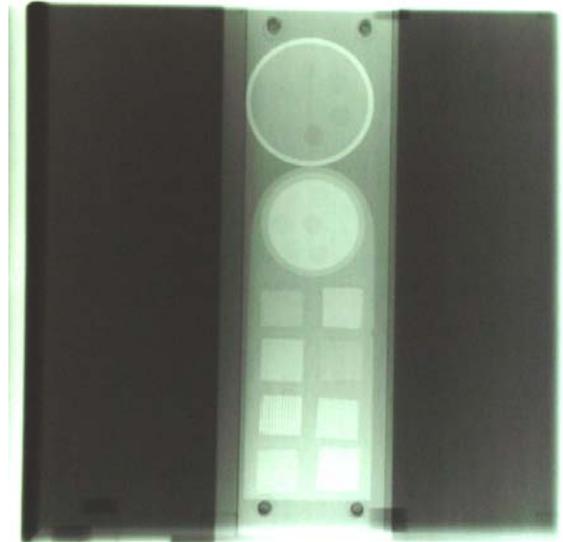
Before proceeding, please check that your Densitometer is in good agreement with an available calibration strip. If CDRH calibrated your Densitometer recently, a calibration strip should have been provided when the unit was returned to you.

57. Number of meshes visible on the phantom film

- a. Place the phantom film on a viewbox that the facility typically uses to view x-ray films. **IMPORTANT: Make sure the film is oriented on the viewbox as shown in the figure below.** Mask the film to cut down on ambient light from the film and viewbox. Turn off neighboring viewbox panels if possible.



Abdomen phantom film



L/S Spine phantom film

- b. Count the number of copper mesh patterns you can visualize on the test tool image.
- Count a mesh square only if you can clearly see the checkerboard-like pattern
 - Do not count a mesh pattern if you can see interference with a stationary grid pattern. (This typically has the appearance of a series of either vertical or horizontal lines that are spaced widely compared with the spacing of the mesh pattern.)
- c. Record your answer on the surveyor worksheet (*item 61*). Indicate with an 'X' exactly which meshes you could see using the diagram on the surveyor worksheet (see example below.)

57-59. Number of holes visible on the phantom film image of the Yellow test tool and Aluminum Disk.

Score at the viewbox the number of holes visible on the film:

- a. Count a hole only if you can visualize the entire circular edge.
- b. Include the center hole in your count.

Record your answer on the surveyor worksheet (*item 62*). Using the diagram on the surveyor worksheet, indicate with an 'X' exactly which holes you could see.

57. Number of holes- aluminum disk

EXAMPLE **4**

58. Number of holes- Yellow test tool

EXAMPLE: **5**

59. Number of meshes- yellow test tool

4

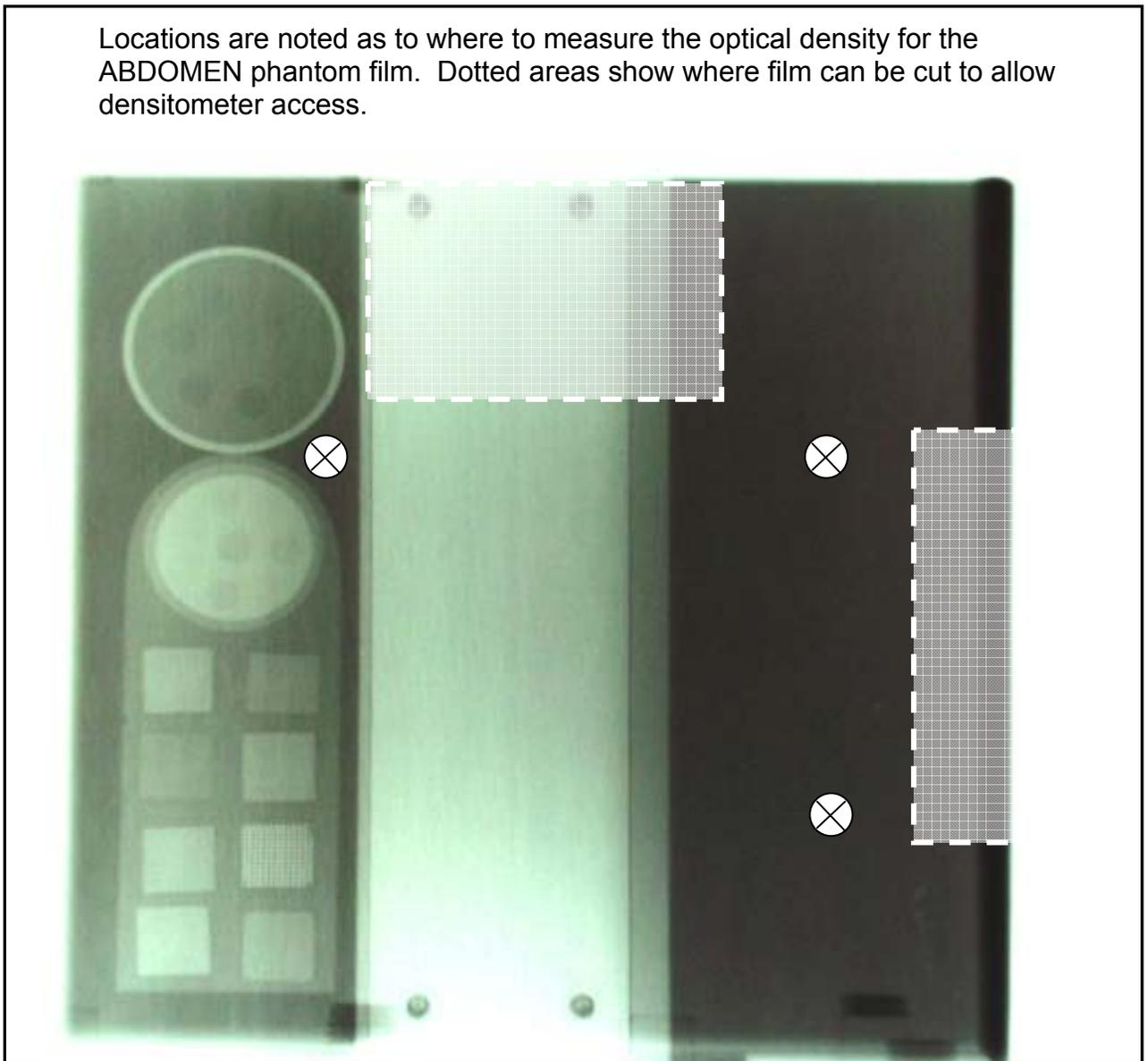
DO NOT MARK YOUR SCORES ON THE PHANTOM FILM !!

- Make sure you orient your phantom film so that the test tool has the same orientation as shown above. (Test tool at top, circular edge of test tool toward the left.)
- Only mark your scores on the drawing on the surveyor worksheet.

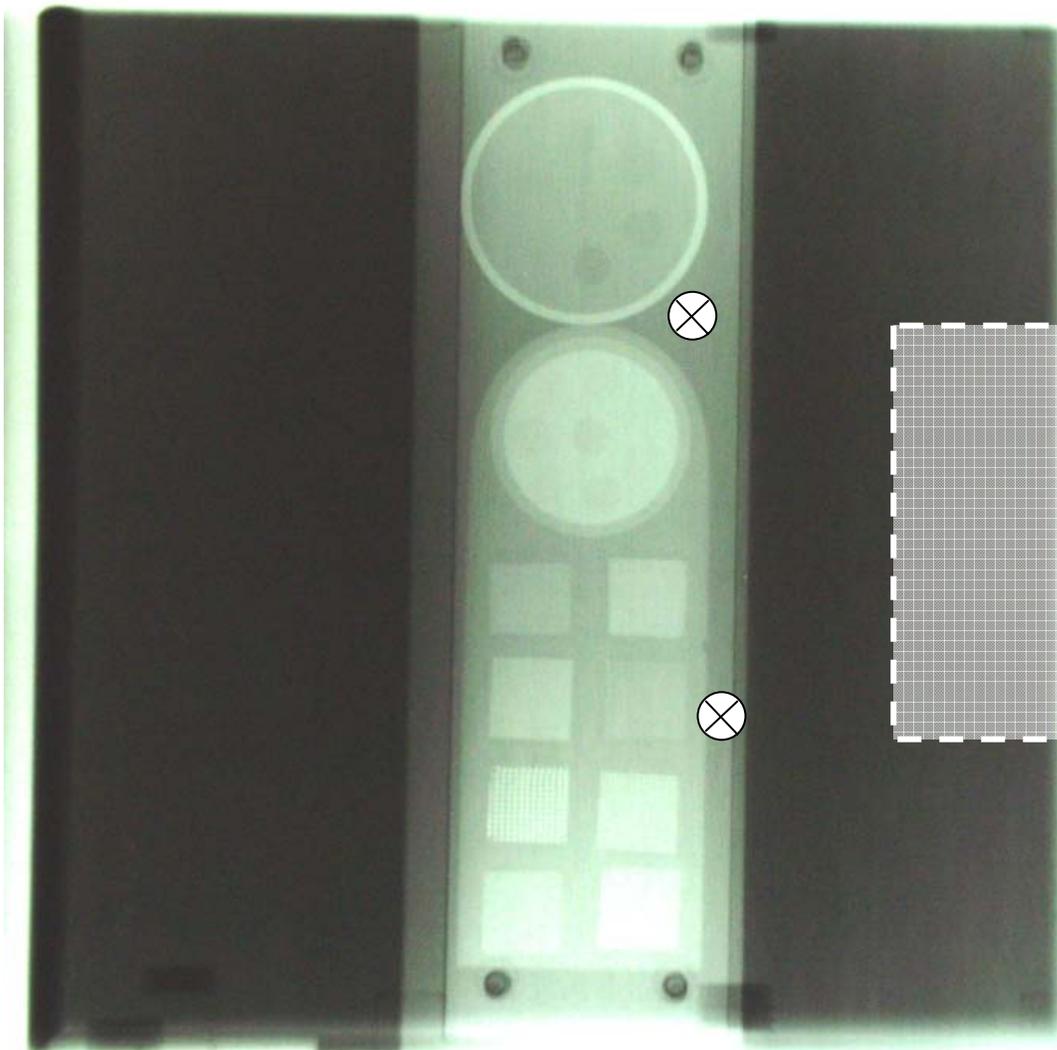
60-62. Phantom film background optical density (Abdomen and L/S spine)

Using your calibrated densitometer measure the background optical density of the phantom films at the locations marked with an ⊗ as shown in the illustration below. These locations are the spine, and the regions to the right and left of the spine. Be certain to zero your Densitometer before making measurements.

NOTE: You may need to cut into the phantom film in order to reach the central region of the film-cutting is acceptable as long as you do NOT cut into the test-tool image.



Locations are marked as to where to measure the optical density for the L/S SPINE phantom film. Dotted areas show where film can be cut to allow densitometer access. The second (lower) position may be difficult to obtain and may be skipped.



L. Darkroom fog evaluation

To the extent possible, the darkroom fog test should be performed in any facility that has a darkroom, regardless of their imaging technology (film-screen, CR, and Digital). YOU ONLY NEED TO DO THIS TEST **ONCE** EVEN IF THE FACILITY PERFORMS BOTH EXAMS.

63. Darkroom / Daylight system

Indicate on the surveyor worksheet whether the facility has a conventional darkroom or uses a daylight loader system for routine handling of abdomen-L/S Spine x-ray films.

C = Conventional darkroom
D = Daylight system

Darkroom /Daylight system

EXAMPLE: **C**

NOTE: Even if the facility uses a daylight loader system **and** has a darkroom, proceed with the fog test.

Take with you into the darkroom:

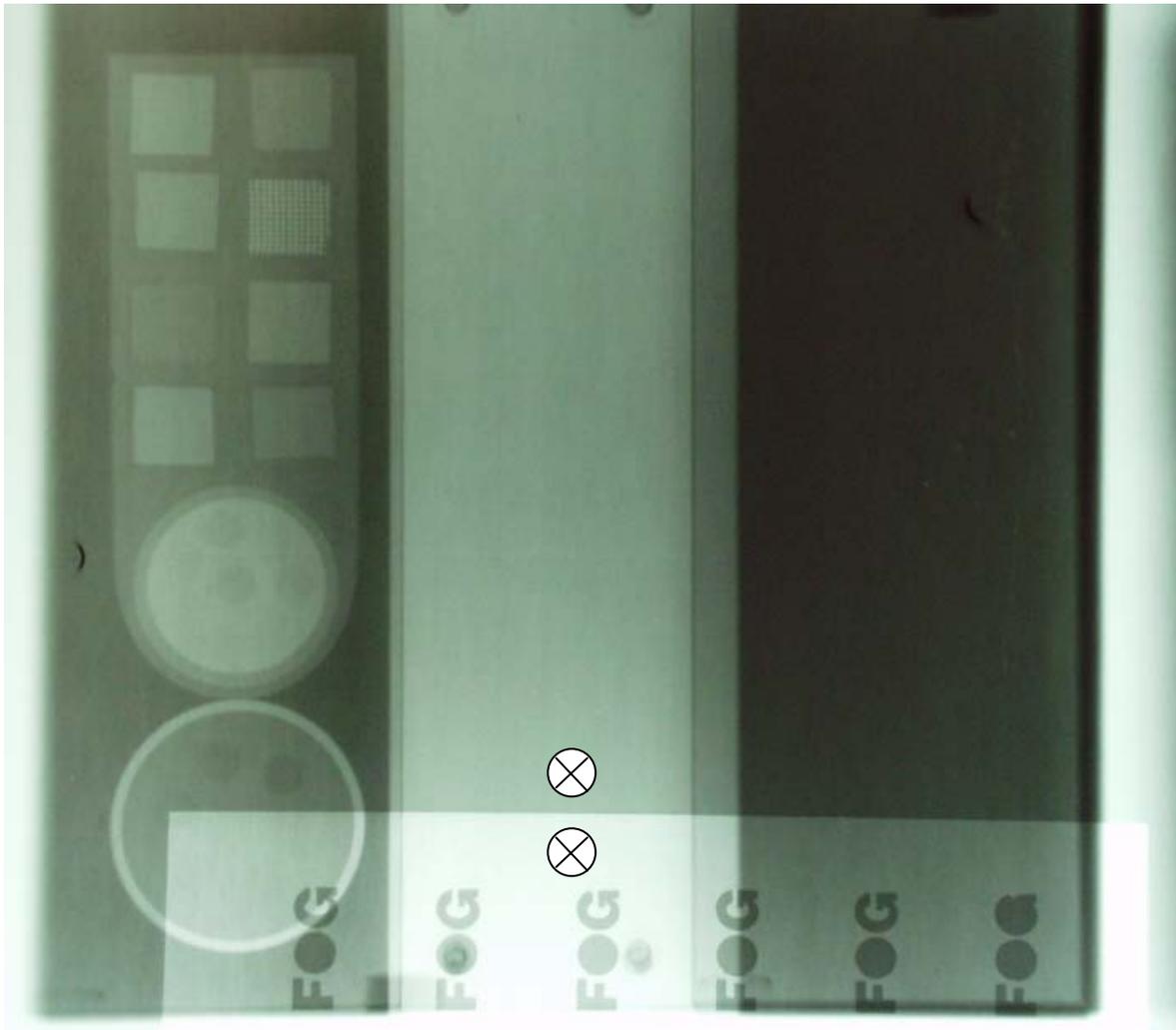
- a. The cassettes with pre-exposed film from section H/I.
- b. A timer or stopwatch for clocking two minutes of time.
- c. The fog folder.

64-67. Fog border determination and optical density measurements

- a. Inspect the darkroom for the area where clinical film is routinely handled. Make certain that any safe-lights that are routinely used are 'ON' during the test.
- b. Open the cassette, and quickly insert the film into the fog folder with an orientation as shown below. Make certain that the folder edge lies flat against the film and does not lift up away from it (this would result in a fuzzy fog border.)

NOTE: If the facility uses single-sided emulsion film, be certain that the emulsion side of the film is facing upward.

- c. Let the film sit for two minutes of exposure. Move back away from the film during the two minute exposure so that your body does not accidentally shade the film from sources of fog.
- d. Quickly remove the film from the fog folder and process the film (if the facility uses a daylight processor, you will need to reload the film into the cassette and then insert into the daylight processor).
- e. Using a viewbox, inspect the film for a fog border. Refer to the illustration below.



If you do not see ANY visible border on the film from the fog folder:

1. Enter 'N' on (item 64 of) the surveyor worksheet , 'Fog border visible?'

64. Fog border visible?

EXAMPLE: N

2. Enter '0.00' for the net fog optical density. You are now done with the darkroom fog test.

If you DO see a visible border on the film:

1. Enter 'Y' on (item 64 of) the surveyor worksheet 'Fog border visible?'

64. Fog border visible?

EXAMPLE: Y

2. Locate an area near the center of the film and measure the optical density on either side of the fog border. The illustration on the previous page shows where to measure (indicated by ⊗ .) If the spine region of the phantom film has an optical density less than 1.0, then take your measurements from the abdomen section of the phantom.

NOTE: The darker side is the "Fogged area OD", and the lighter side of the border is the "Non-fogged area OD". Record your measurements on the surveyor form.

3. Subtract the smaller optical density value (*item 66*) from the larger optical density value (*item 65*). This is the net fog density. Record this value (*item 67*) on the worksheet.

EXAMPLES:

<u>Fogged area OD</u>	<u>Unfogged area OD</u>	<u>Net fog OD</u>
1.78	1.71	0.07

M. Film processing information

For **ALL** surveys (conventional screen-film, CR and digital) we ask that you perform a STEP test on the facility's *conventional* film processor if they have one.

CR and digital systems:

Please capture information about their digital (laser) film processor **and also** on their conventional film processor if one is available in the facility/department. Proceed to conduct the STEP processing test on this standard film processor.

Do not evaluate a conventional processor if the facility personnel in the department do not have routine access to it. For example, if there is a conventional film processor on another floor or in another section but it is mostly used for different applications such as mammography or therapy, do not complete , and do not perform the STEP test

Screen-film systems:

Evaluate the film processor that the facility uses to routinely process abdomen/L/S-spine films. This should be the same processor you used to process your phantom and fog films. Do not complete *items relevant if* already completed.

68-69. Conventional film processor manufacturer and model

Determine the manufacturer (*item 68*) and model (*item 69*) for the conventional film processor the facility uses for routine standard film processing. Again, *for surveys of CR and digital systems*, please complete even if the facility uses a laser film printer for CR or digital x-ray abdomen/L/S-spine films.

Write the information on the surveyor worksheet and then identify the corresponding codes from the *NEXT* Supplement, '**Film Processor codes**'. Enter the codes in the appropriate spaces on the worksheet. If you can not locate a code, enter 'X's in the spaces for that particular code.

Please provide as much information as you can about new processors you encounter. There is room on the surveyor worksheet in the comments section.

	68.	<u>Manufacturer code</u>	<u>Manufacturer name</u>
<u>EXAMPLE</u>		<u>EKCO</u>	<u>Kodak</u>
	69.	<u>Model code</u>	<u>Model number / name</u>
<u>EXAMPLE</u>		<u>480</u>	<u>RA 480</u>

70-71. Conventional processing chemistry brand and type

Determine the chemistry brand (*item 70*) and type (*item 71*) that is used with the processor and write this information on the surveyor worksheet.

Find the corresponding codes for chemistry brand/type in the *NEXT* Supplement section F, '**Processor chemistry codes**' and enter on the worksheet. If you can not locate a particular code, enter 'X's for that code.

Please provide as much information as you can about new chemistry brands/types you encounter. There is room on the surveyor worksheet in the comments section.

	70.	<u>Chemistry Brand code</u>	<u>Brand name</u>
<u>EXAMPLE</u>		LOWX	Aqfa

	71.	<u>Chemistry Type code</u>	<u>Type name</u>
<u>EXAMPLE</u>		GEV	Gevmatic

72-73. Digital (Laser) film processor information (CR and digital systems only)

Determine the manufacturer (*item 60*) and model (*item 61*) for the laser film processor the facility routinely uses to generate abdomen/L/S-spine films. Write the information on the surveyor worksheet and then identify the corresponding codes from the *NEXT* Supplement, '**CR and Digital-Film Processors**'. Enter the codes in the appropriate spaces on the worksheet. If you can not locate a code, enter 'X's in the spaces for that particular code.

	72.	<u>Manufacturer code</u>	<u>Manufacturer name</u>
<u>EXAMPLE</u>		EKCO	Kodak

	73.	<u>Model code</u>	<u>Model number / name</u>
<u>EXAMPLE</u>		E21	Ektascan 2180

N. Instructions for performing the STEP test

Perform the STEP test if you completed items 65-68 for a conventional film processor, which the department has routine access to. The STEP test should be performed even if the facility uses a digital x-ray imaging technology and prints laser films of patient exams.

FOR DAYLIGHT SYSTEMS:

You should first verify that the film size provided to you for the STEP test (18 x 24 cm) can be processed in the daylight processor. If this is permitted by the facility, obtain an appropriate size cassette for transporting the exposed STEP film to the processor.

74. Reference STEP number for your control film

Enter on the surveyor worksheet the reference STEP number for your control film (*item 74*). You will find this number on the label attached to your box of film as well as on the STEP worksheet (the reference number is the STEP number corresponding to a speed of 100- check the table on the worksheet).

74. Reference STEP no.(from film box)

EXAMPLE **9.6**

75-81. Processing speed determination (Note that this procedure is also outlined on the STEP worksheet and performed by the laptop.)

- a. Take with you into the darkroom your calibrated sensitometer and your box of control film. Verify that your sensitometer is configured for 'GREEN' mode.
- b. Flash the sensitometer *once with NO film in it*. Next flash one piece of the control film with the sensitometer once on each edge of the film (a total of four exposures).
- c. Process this film normally as film from the x-ray unit surveyed would be processed.
- d. Inspect the film for possible anomalies, and then label the film with the facility name and date of the survey. If the facility has more than one film processor, then test the one that they typically use for Abdomen/L/S Spine films. Indicate on the film which processor you are evaluating.

- e. Zero the calibrated densitometer and measure the optical density (OD) of the **base plus fog** (near the center of the film). Record this value on the STEP worksheet and in the space provided on the surveyor worksheet (*item 75*).

75. Base + fog OD

EXAMPLE: **0.13**

- f. Determine the speed density by adding 1.00 to the optical density of the base-plus-fog optical density. Record this optical density on the STEP worksheet.

EXAMPLE: **If Base plus Fog = 0.13, then the speed density = 1.13.**

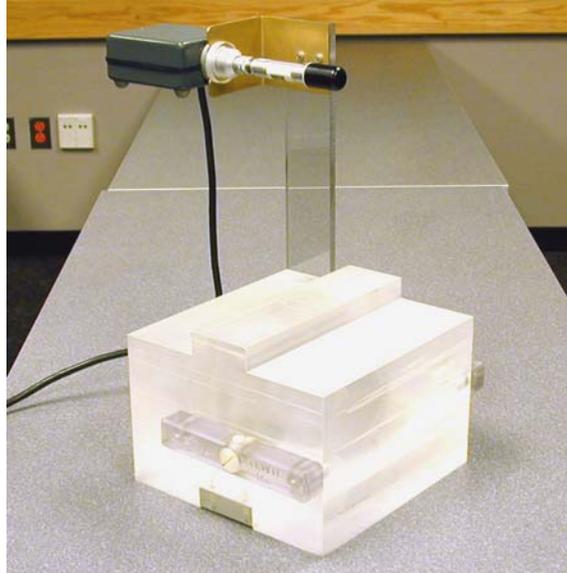
- g. Select the two steps that have optical densities lower and higher than the speed density and enter these values on the surveyor worksheet (*items 76 and 77*).
- h. Read the optical density of each of these two steps (once on each of the four Sensitometric strips on the film) and record the optical densities and their corresponding step numbers on the STEP worksheet (or on the space provided on the Excel spreadsheet if you are doing the survey using a laptop computer – items / item 78). If one strip of densities is dramatically different from the remaining three sets, then discard the optical density values for this one 'bad' strip. The laptop Excel spreadsheet will calculate the speed with as few as two sets of optical density measurements.
- i. Average the four optical densities for both the lower step and upper step. For example, if you measured film densities from steps 9 and 10, then average the four optical densities for step 9 and average the four optical densities for step 10. Record these average values on the STEP worksheet. On the STEP worksheet, plot the step number (x-axis) and the average optical density for the two steps (y-axis) you chose in step g.
- j. Connect these two points with a straight line.
- k. Locate on the Y-axis the speed density (from step f.), and follow this value over horizontally to the straight line you drew in step k. above. At this point of intersection, draw a line straight up to the x-axis and read the resulting step number for this point. **NOTE THAT THIS WILL BE A FRACTIONAL STEP NUMBER, such as 9.7 or 12.3.** Record this resulting STEP number on the surveyor worksheet (*item 79*).

l. Using the look-up table on the STEP worksheet, determine the resulting processing speed value. Record this value on the STEP form and on the worksheet (*item 80*).

m. CHECK YOUR NUMBER!

If you get an unusually high (greater than 130) or low (less than 70) processing speed then check your work!

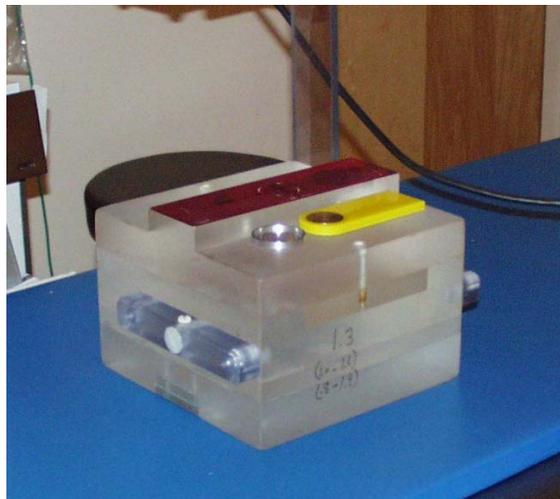
- Review your numbers, where you measured your densities, etc.
- Examine the exposures you obtained from section F- are they low (< 10 mR) or high (> 50 mR) as well for this particular exam? A facility may be compensating for low processing (< 80) by increasing its technique (mA, exposure time or possibly kVp).
- Verify that your sensitometer is the configuration to expose the STEP film in the 'green' mode.
- Repeat the test to be certain your results are correct.

*Appendix A***Phantom assembly and test tool positioning**

Assemble the abdomen/L/S-spine phantom so that it appears as shown above.

Your phantom kit should have the following items:

1. One Abdomen/L/S-Spine phantom
2. One MDH probe holder.
3. One yellow image quality test tool and one aluminum disk test tool.

Placement of Test Tools for Abdomen testing

Placement of Test Tool for L/S Spine testingEntrance Skin Exposure Sample Example

ESE equation for both the Abdomen and L/S spine exams:

$$ESE(mR) = \left(\frac{\text{Source to patient support distance} - 40.9\text{cm}}{\text{Source to patient support distance} - 23\text{cm}} \right)^2 \times \text{Average Exposure}(mR)$$

Let: Source to patient-support distance = 70 cm, and

Exposure 1 = 320 mR Exposure 2 = 315 mR

Exposure 3 = 325 mR Exposure 4 = 321 mR

Average Exposure = (320+315+325+321)/4 = 320.25

$$\begin{aligned} ESE &= [(70\text{cm} - 40.9\text{cm}) / (70\text{cm} - 23\text{cm})]^2 \times 320.25 \text{ mR} \\ &= [29.1 \text{ cm} / 47 \text{ cm}]^2 \times 320.25 \text{ mR} \\ &= (0.62)^2 \times 320.25 \text{ mR} \\ &= (0.38) \times 320.25 \text{ mR} \\ &= 123.1 \text{ mR} \end{aligned}$$