SUMMARY OF
DENTAL MEASUREMENT PROCEDURES
(Abridged Protocol)

INTRAORAL IMAGING PROCEDURE

Entrance Skin Exposure / Air Kerma

Objective

To measure the typical intraoral Entrance Skin Exposure (ESE) and Entrance Skin Air Kerma (ESAK) Free-in-Air for an average patient.

Required Test Equipment

- Phantom cradle
- MDH meter

Set-up

1. Place the NEXT CDRH dental phantom cradle on some form of support (a tripod if available). The phantom cradle should be placed so that it is level and secure to avoid the possibility of damage due to a fall. If a tripod is utilized, it can be attached to the underside of the phantom cradle using the tripod mounting screw.

2. The phantom cradle should be placed at a height that enables easy positioning of the intraoral tube so that the cone lies level and parallel to the phantom cradle. The probe holder should be opposite from the cone.

3. Attach the MDH probe to the probe holder. It should be attached to the probe holder so that the sensitive volume of the chamber is centered in the phantom cradle. The end or tip of the intraoral tube cone should then be placed in the phantom cradle so that the cone just makes contact with the MDH probe.

> ONCE YOU HAVE ALIGNED THE MDH PROBE AND UNIT, DO NOT MOVE THEM UNTIL ALL MEASUREMENTS HAVE BEEN COMPLETED.

Test Steps

1. Initialize the MDH
   A) Turn on and warm up.

   B) Set the selector switch to the “Pulse Exposure” mode.

C) The pulse fraction threshold should be set at 0.2 for all single phase unit measurements. The majority of the units you encounter will be single-phase. If a unit is determined to be a three-phase unit, change the pulse fraction threshold to 0.5. For units that have pre-exposure filaments, set the pulse fraction threshold at 0.8.

D) Make an exposure with the technique factors set at the facility's standard technique and record this exposure as exposure #1. Do not record the time for this exposure.

> THE NEXT THREE EXPOSURES WILL PROVIDE INFORMATION ON REPRODUCIBILITY. AS A REMINDER, DO NOT MANUALLY RE-SET THE MDH METER TO ZERO BETWEEN EXPOSURES.

2. Make an exposure. Record the exposure as exposure #2. Switch the MDH meter to "Pulse Duration" mode and record the measured time. Once completed, switch the MDH back to "Pulse Exposure."

3. Repeat this procedure for exposures #3 and #4.

4. Calculate and record the average (E_{avg}) of the four exposure values.

5. Measure and record the Source to Cone Tip Distance or (SSD).

6. Measure and record the Cone Tip to Cheek Distance (CCD).

7. Calculate and record the ESE using the formula:
   ESE = (E_{avg}) * ((SSD) / (SSD + CCD)) **2;

Beam Quality Assessment

Objective

To determine the half-value layer (HVL) of the x-ray beam. This would determine the total HVL of the x-ray tube assembly. The HVL is also a measure of beam quality, which is necessary to calculate patient dose.

Required Test Equipment

- Phantom cradle
- MDH meter
- 1100 Aluminum Alloy Filters: one 0.5 mm Al, two 1.0 mm Al, and four 2.0 mm Al.

Set-up

1. Use the same technique settings for this section that were used for collecting the intraoral unit exposure data in the last section.

2. Slide the end of the cone away from the probe in the phantom cradle so that it is aligned with the edge of the filter slot.

3. In order to position the dental cone, first insert a thickness of aluminum into the slot and bring the cone tip as close to the aluminum as possible. The cone tip should make contact with the aluminum.

Test Steps

1. Remove the aluminum and make an exposure. Record the output (in mR) in the boxes provided for the output for 0.0 mm of aluminum.

2. Insert a 1.0 mm aluminum filter in the slot of the phantom cradle. Make a second exposure and record the mR for 1.0 mm Al.

3. Insert an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 2.0 mm Al.

4. Insert an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 3.0 mm Al.

5. Insert an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 4.0 mm Al.

6. Using the graph on the back of the worksheet, plot the exposure versus the aluminum thicknesses used. Determine the HVL to the nearest tenth of a millimeter of aluminum by drawing the best straight line fit to all but the first (0.0 mm Al) data points.

   Find the point on the line where the exposure is half that of the 0.0 mm aluminum exposure. The thickness of Al corresponding to this point is the HVL.

Optical Density and Image Quality

Objectives

- To determine the Optical Density (OD) of the phantom film. The phantom film OD, which correlates with clinical film density, is a check on the exposure techniques to assure they are adequate to deliver a clinical image.

- To determine the imaging capabilities of the facility.

Required Test Equipment

- Dental Phantom
- Film Packet
- Densitometer
- View Box

Test Steps

1. Insert the Dental phantom loaded with a film packet between the cone and the MDH probe.

2. Make an exposure using the same technique as an exposure measurement (See above).

3. Develop the film that utilized the facility's standard technique settings. Measure and record the optical density at the area adjacent to the lone contrast object of the phantom image.

4. Measure and record the densities of the three low contrast objects.

5. Count and record the number of different gauge wire meshes that are visible. A wire mesh pattern is not counted if the "tiny" spaces that result from the mesh running vertically and horizontally are not seen.

Darkroom Fog Evaluation

Objective

To determine the optical density of darkroom fog for Intraoral film processing.

The following procedure is to be used to sensitize film for determining darkroom fog levels. A darkroom fog test tool has been provided for this measurement.

Required Test Equipment

- Image Test Tool
- Film Packets
- Densitometer
- View Box

Set-up

An optical density of 1.0 on one of the fog test tool steps is needed in order to evaluate fog. Because of this, two films will need to be taken.

1. Take the fog test tool and invert it. A visible depression lies underneath the steps of the test tool.

2. Place a packet of the facility's film in this depression making sure that the tube side or flat side of the film packet is in contact with the test tool. Take the test tool and turn it back over. The steps of the test tool should be facing upright toward the x-ray tube.

3. Bring the cone from the Intraoral unit down so that it makes contact with the test tool. The cone should cover the steps of the test tool.

Test Step

1. For the first film, make an exposure using the facility's standard technique. Remove the film from the fog test tool, mark the film and place it in a shielded area.

2. For the second film, insert a new packet of the facility's film into the depression area of the fog test tool and setup as you did previously. The kVp should remain unchanged. Divide the mAs setting by 10 and make this exposure.

3. In the darkroom, unwrap these exposed films from their packaging and insert the films into the test tool. The long side of the films should be inserted into the slots located on the left and right hand sides of the test tool. The slots are located in the flat part of the test tool and not the step portion. Be sure that you are approximately bisecting the latent image.

4. Position the films and test tool in an area of the darkroom closest to a safelight. This should represent an area where film is routinely handled and has the highest probability of safelight exposure. Expose the uncovered half of the films to normal safelight conditions for two minutes. Make sure that you do not accidentally shield the films from other potential fog sources such as light leaks or digital light sources.

5. After two minutes have elapsed, quickly remove the films from the step-wedge and feed them into the processor.

6. If a visible line appears down the center of the film, then fog is present. Using the densitometer, measure the densities of both the left and right hand sides of the film at various steps. Record the greatest density difference.

CEPHALOMETRIC IMAGING PROCEDURE

Entrance Skin Exposure / Air Kerma

Objective

To measure the typical cephalometric entrance skin exposure (ESE) and entrance skin air kerma (ESAK) free-in-air for an average patient.

Required Test Equipment

- Phantom
- MDH meter

Set-up

1. Place the MDH so that it is mounted securely in the primary beam roughly midway between the image receptor and the tube, but preferably nearer the image receptor. *Positioning the probe near the tube may make it difficult to ensure that the probe is fully within the useful beam.*

> *You may need to be creative here -*
>
> - Try lowering the gantry to permit use of a cart or chair, etc.
> - On some units (on a Pan/Ceph combo for example) you can hang the MDH probe down into the beam.

2. If the unit has a collimator light, utilize it to insure that the entire sensitive volume of the probe lies in the beam.

> ONCE YOU HAVE ALIGNED THE MDH PROBE AND UNIT, DO NOT MOVE THEM UNTIL ALL MEASUREMENTS HAVE BEEN COMPLETED.

Test Steps

1. Initialize the MDH
   A) Turn on and warm up.

   B) Set the selector switch to the “Pulse Exposure” mode.

C) The pulse fraction threshold should be set at 0.2 for all single phase unit measurements. The majority of the units that you encounter will be single-phase. If a unit is determined to be three-phase, change the pulse fraction threshold to 0.5. For units that have pre-exposure filaments, set the pulse fraction threshold at 0.8.

D) Make an exposure with the technique factors set at the facility's standard technique and record this exposure as exposure #1. Do not record the time for this exposure.

THE NEXT THREE EXPOSURES WILL PROVIDE INFORMATION ON REPRODUCIBILITY. AS A REMINDER, DO NOT MANUALLY RE-SET THE MDH METER TO ZERO BETWEEN EXPOSURES.

2. Insert an unloaded cassette and make an exposure. Record the exposure as exposure #2. Switch the MDH meter to "Pulse Duration" mode and record the measured time. Switch the MDH meter back to "Pulse Exposure".

3. Repeat this procedure for exposures #3 and #4.

4. Calculate and record the average (E_{avg}) of the four exposure values.

5. Measure the source-to-image distance (SID) and record this value on the survey form along with the units of measure (cm).

6. Measure the source-to probe-distance (SPD) and use the same units (in/cm) as you did for SID.

7. Calculate and record the ESE using the formula:
   ESE = (E_{avg}) *((SPD)/ (SID - 17.5)) **2;

   (The Source-to-Skin-Distance (SSD) is approximated to be 17.5 cm)

Beam Quality Assessment

Objective

To determine the cephalometric half-value layer (HVL) of the x-ray beam. This would determine the total HVL of the x-ray tube assembly. The HVL is also a measure of beam quality, which is necessary to calculate patient dose.

Required Test Equipment

- MDH meter
- 1100 Aluminum Alloy Filters: one 0.5 mm Al, two 1.0 mm Al, and four 2.0 mm Al.

Set-up

Use the same set-up for this section that you used for collecting the cephalometric unit exposure data in this section.

Test Steps

1. Make an exposure without aluminum. Record the output (in mR) in the boxes provided for the output for 0.0 mm of aluminum.

2. Tape a 1.0 mm aluminum filter to the end of the cone. Make a second exposure and record the mR for 1.0 mm Al.

3. Add an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 2.0 mm Al.

4. Add an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 3.0 mm Al.

5. Add an additional 1.0 mm aluminum filter. Make an exposure and record the mR for 4.0 mm Al.

6. Using the graph on the back of the worksheet, plot the exposure versus the aluminum thicknesses used. Determine the HVL to the nearest tenth of a millimeter of aluminum by drawing the best straight line fit to all but the first (0.0 mm Al) data points.

   Find the point on the line where the exposure is half that of the 0.0 mm aluminum exposure. The thickness of Al corresponding to this point is the HVL.

Darkroom Fog Evaluation

Objective

To determine the optical density of darkroom fog for cephalometric film processing. This is performed in addition to the intraoral darkroom fog evaluation since intraoral film has a sensitometric response that is different from cephalometric film.

Required Test Equipment

- Fog folder
- Loaded film cassette
- Image Test Tool
- Densitometer
- View Box

Set-up
An optical density of 1.2 on one of the fog test tool steps is needed in order to evaluate cephalometric fog.

1. Load a film cassette.

2. Position the tube so that it has a source-to-image distance of 40 inches. Orient the tube so that it is facing downwards.

3. Place the image test tool on the center of the cassette with the long side of the wedge parallel with the long side of the cassette.

4. Adjust the light field, or collimator, to the approximate size of the image test tool.

Test Step
1. Take can exposure using 70 kVp and 5 mAs. This should be adequate to give a density of 1.2 from one of the steps when the film is developed.

2. In the darkroom unwrap the exposed film from its packaging and insert the film halfway into the fog folder.

3. Position the film and fog folder in an area of the darkroom closest to a safelight. This should represent an area where film is routinely handled and has the highest probability of safelight exposure. Expose the uncovered half of the film to normal safelight conditions for two minutes. Make sure that you do not accidentally shield the film from other potential fog sources such as light leaks or digital light sources.

4. After two minutes have elapsed, quickly remove the film from the fog folder and feed it into the processor.

5. If a visible line appears down the center of the film, then fog is present. Using the densitometer, measure the densities of both the left and right hand sides of the film at various steps. Record the greatest density difference.

FILM PROCESSING EVALUATION (Cephalometric and Intraoral)

Objective
To determine the efficiency of processing at the facility surveyed

Required Test Equipment
- Sensitometer
- Control Film
- Processor
- Densitometer

Set-up

1. With a calibrated sensitometer, flash each of the four sides of the calibration film.

2. Process the film.

Test Steps

1. Determine the speed density by adding 1.00 to the optical density of the base (background) plus fog of the film. Record this optical density on the STEP worksheet.

2. Select the two steps of the calibration film (i.e. Steps 9 and 10) that have optical densities above and below the speed density. Record these two steps on the worksheet.
3. Measure the optical densities of the two selected steps for all four sides of the film.

4. Average the four measured densities for each step. Record these two average densities on the worksheet.

5. Using these two average densities, refer to the STEP worksheet and determine the resulting speed of the film processor.