CALCULATION TECHNIQUE

MOBILE RADIOGRAPHIC SYSTEMS

(Test Procedure MRA - Form FDA 2783)

A. REPRODUCIBILITY

1. Refer to data items 14, 16, 18, and 20 of the Field Test Record. (Use data items 22, 24, 26, 28, 30, and 32, if ten exposures were made for reproducibility.)

   a. Using the following equation, substituting n = 4 or n = 10, as appropriate, calculate the average exposure, $\overline{E_1}$

$$\overline{E_1} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

   where the X_i are the data items referred to above. Record the value of $\overline{E_1}$ at Result 1.

   b. Calculate the coefficient of variation, C_1, as follows:

$$C_1 = \frac{1}{\overline{E_1}} \left(\sum_{i-1}^{n} (X_i - \overline{E_1})^2 / (n-1) \right)^{1/2}$$

   where n = 4 or n = 10, depending on the number of exposures. Record the value of C_1 at Result 2.

2. Refer to data items 5, 6, and 7 on the Field Test Record and compute the mAs, if item 7 is blank, by multiplying item 5 by item 6. If item 6 is given in pulses, convert to time in seconds by dividing by 60 or 120, depending on whether the generator type at data item 3 is "H" or "F," respectively.

3. Calculate the average exposure per mAs, X_1, as follows:

$$\overline{X_1} = \overline{E_1} / mAs_1$$

   Record the value of $\overline{X_1}$ at Result 3.

4. Refer to data items 35-38, calculating the average exposure, $\overline{E_2}$, as follows:

$$\overline{E_2} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

   where the X_1 are the data items referred to above. Record the value of $\overline{E_2}$ at Result 4.

5. Calculate the coefficient of variation, C_2, as before:

$$C_2 = \frac{1}{\overline{E_2}} \left(\sum_{i-1}^{n} (X_i - \overline{E_2})^2 / (n-1) \right)^{1/2}$$

Record the value of C_2 at Result 5.

6. For controls manufactured before May 1994 refer to data items 6 and 34 and compute the mAs by multiplying item 6 by item 34. If item 6 is given in pulses, convert to time in seconds by dividing by 60 if item 3 is "H," or divide by 120, if item 3 is "F." For controls manufactured on or after May 1994 item 34 should always be recorded in mAs units.

7. Calculate the average exposure per mAs_2, $\overline{X_2}$ as follows:

$$\overline{X_2} = \overline{E_2} / mAs_2$$

Record the value of $\overline{X_2}$ at Result 6.

B. LINEARITY

Refer to Results 3 and 6 and calculate the coefficient of linearity, L, as follows:

$$L = \frac{\left| \overline{X_1} - \overline{X_2} \right|}{(\overline{X_1} + \overline{X_2})}$$

where $\overline{X_1}$ and $\overline{X_2}$ are average exposures per mAs. Record the value of L at Result 7.

C. BEAM QUALITY

1. Refer to data items 8 through 11 and convert to normalized exposures by dividing each item by E_1 (Result 1). Record the normalized exposures at the indicated locations; i.e., Results 8 through 11.

2. On semi-log paper, plot the five normalized exposures along the logarithmic scale with the corresponding thickness of aluminum attenuators along the linear axis. Draw a smooth curve fit to the points and determine the observed half-value layer (HVL) as that thickness of added aluminum that would yield a normalized exposure of 0.50. Record the observed HVL and the selected kVp (data item 4) at Result 12.

3. To determine the actual HVL, corrections for geometry effects and energy dependence must be made. For testing with the MDH x-ray Monitor:

Actual HVL = (0.923 x Observed HVL) + 0.165

This equation does not represent a universal correction to the observed HVL. The equation is only applicable to observed HVL's in the vicinity of the limits specified in the X-ray Performance Standard. For extremely large observed HVL's, the equation

underestimated the actual HVL. The intent of the equation is to enable accurate compliance determinations for x-ray beams with marginal observed HVL's. Record the value of the actual HVL and the selected kVp at Result 13.

D. TIME ACCURACY

1. Refer to the time setting of data item 6 on the Field Test Record, and if this item is blank, omit the timer accuracy calculation. Otherwise, record data item 6 in seconds at Result 14 as the indicated time setting.

2. Refer to data items 15, 17, 19, and 21. If ten exposures were made, refer to data items 23, 25, 27, 29, 31, and 33, also. Choose the one value that has the largest deviations from the indicated time setting. Calculate this deviation as the absolute value of the measured time subtracted from the indicted time. Record the deviation at Result 15.

3. Calculate the timer inaccuracy as follows:

   % timer inaccuracy = maximum deviation x 100 / indicated time setting

   Record the % timer inaccuracy at Result 16.

E. MINIMUM SOURCE-TO-SKIN DISTANCE (min SSD)

1. Refer to item 45 on the Field Test Record, the measured outside separation in centimeters of the image of the focal spot strip, I. Calculate the minimum SSD as follows.

   min SSD = ((224.55/(I - 6.35)) - 7.66) cm

   Record min SSD at Result 17.

F. X-RAY FIELD/LIGHT FIELD ALIGNMENT AND SIZE COMPARISON

1. Refer to data items 43 and 44 on the Field Test Record and record at Results 18 and 19. Determine the distance from the source to the center of the light field as follows:

   SID = min SSD + 7.66 + 35.36

   Record SID at Results 20.

2. Calculate the misalignment as a percent of the SID:

   Percent length misalignment = (length misalignment x 100)/SID

   Percent width misalignment = (width misalignment x 100)/SID
   Record the percent length and percent width misalignments at Results 21 and 22, respectively.

G. ILLUMINANCE OF THE LIGHT LOCALIZER

Refer to data items 39, 40, 41, and 42 on the Field Test Record. Calculate the average illuminance value by summing the four values and dividing by four. Record the average value at Result 23.

H. STANDBY RADIATION

Refer to data items 46 and 47 on the Field Test Record. Calculate the standby radiation as follows:

Standby radiation = ((data item 46/data item 47 in seconds) x 3600) mR/hr

Record the value at Result 24.

RESULTS RECORD

MOBILE RADIOGRAPHIC SYSTEMS

(Test Procedure MRA - Form FDA 2783)

FIELD TEST
SERIAL NO._____

REPRODUCIBILITY AND LINEARITY

1. Average Exposure, $\overline{E_1}$ = _____ mR
2. Coefficient of Variation, C_1 = _____
3. Average Exposure / mAs, $\overline{X_1}$ = _____ mR / mAs
4. Average Exposure, $\overline{E_2}$ = _____ mR
5. Coefficient of Variation, C_2 = _____
6. Average Exposure / mAs, $\overline{X_2}$ = _____ mR / mAs
7. Coefficient of linearity, L = _____

BEAM QUALITY

Normalized Exposures:

8. N_4 = _____ at 4.5 mm Al
9. N_3 = _____ at 3.5 mm Al
10. N_2 = _____ at 2.5 mm Al
11. N_1 = _____ at 1.5 mm Al

    N_0 = 1.00 at 0.0 mm Al

12. Observed HVL = _____ mm Al @ _____ kVp
13. Actual HVL = _____ mm Al @ _____ kVp

TIMER ACCURACY

14. Indicated time setting = _____ seconds
15. Maximum deviation from indicated setting = _____ seconds
16. Percent timer inaccuracy = _____%

MINIMUM SSD DETERMINATION

17. Minimum SSD = _____ cm

X-RAY FIELD/LIGHT FIELD ALIGNMENT AND SIZE COMPARISON

18. Length Misalignment = _____ cm

19. Width Misalignment = _____ cm

20. SID = _____ cm

21. Percent Length Misalignment = _____%

22. Percent Width Misalignment = _____%

ILLUMINANCE OF LIGHT LOCALIZER

23. Average Illuminance = _____ Footcandles

STANDBY RADIATION

24. Standby Radiation = _____ mR/hr