CALCULATION TECHNIQUE

ABOVETABLE X-RAY SOURCE RADIOGRAPHIC SYSTEMS

(Test Procedure ARA - Form FDA 2784)

A. REPRODUCIBILITY

1. Refer to data items 23, 25, 27, and 29 of the Field Test Record. (Use also data items 31, 33, 35, 37, 39, and 41, if ten exposures were made for reproducibility.

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

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

   Record the value of $\overline{E_1}$ at Result 1.

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

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

   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 11, 12, and 13 on the Field Test Record and compute the mAs. This may be given as a selected technique factor, or must be calculated as a product of the exposure time and the tube current.

3. Calculate the average exposure per mAs_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 44-47, calculating the average exposure, $\overline{E_2}$, as follows:

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

   Record the value of $\overline{E_2}$ at Result 4.

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

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

   Record the value of C_2 at Result 5.

6. If the control is manufactured before May 1994 refer to data items 12 and 43 on the Field Test Record and compute the mAs by multiplying the exposure time in 12 by the tube current in 43. For controls manufactured after May 1994 data item 43 should be the mAs product. Calculate the average exposure per mAs_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. 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 18-21 and convert to normalized exposures by dividing each item by E_1 (Result 1). Record the normalized exposures at the indicated locations; 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-valve-layer (HVL) as that thickness of added aluminum which would yield a normalized exposure of 0.50. Record the observed HVL and selected kVp (data item 10) 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 underestimates 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 selected kVp (data item 10) at Result 13.

D. TIMER ACCURACY

1. Refer to the time setting of data item 12, and if left blank, omit the timer accuracy calculation. Otherwise, record it at Result 14 as the indicated time setting.

2. Refer to data items 24, 26, 28, and 30, and if ten exposures were made, to data

items 32, 34, 36, 38, 40, and 42, also. Choose the one value which has the maximum deviation from the indicated time setting. Calculate the maximum deviation as the absolute value of the measured time from the indicated time. Record the deviation at Result 15.

3. Calculate the timer inaccuracy as follows:

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

    Record the percent timer inaccuracy at Result 16.

E. SID Determination

1. Refer to data item 9, the indicated SID (ISID), and if necessary, convert to centimeters before recording it at Result 17.

2. The measured SID is given by:

    Measured SID = data item 48 + data item 49

    Record the measured SID at Result 18.

3. Calculate the percent SID difference as follows:

    % SID difference = ((ISID - measured SID) x 100) / ISID

    Record at Result 19.

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

1. Refer to data items 85 and 86 and record at Results 20 and 21.

2. Determine the distance from the source to the center of the light field as follows:

    SID' = (data item 48 - 4.6) cm

    Record SID' at Result 22.

3. Calculate the misalignment as a percent of the SID'

    Percent along table misalignment = Result 20 x 100 / SID'

    Percent across table misalignment = Result 21 x 100 / SID'

    Record the percent misalignments along and across table at Results 23 and 24, respectively.

4. Refer to data items 81 through 84 and calculate the along table correction factor (ALFC) and the across table correction factor (ACCF) as follows:

ALCF = data item 81/data item 83
ACCF= data item 82/data item 84

Record the ALCF at Result 25 and the ACCF at Result 26.

G. X-RAY FIELD/UTIR CENTERS COMPARISON

1. Refer to data item 87 and record at Result 27.

2. Calculate the centers misalignment as a percent of the measured SID (Result 18):

% Centers Misalignment = (Result 27 x 100) / Result 18

Record the percent centers misalignment at Result 28.

H. PBL X-RAY FIELD/UTIR SIZE COMPARISON

1. Refer to data items 50, 51, and 52 and record at Results 29-31. Convert any item given in inches to centimeters prior to recording on the results record.

2. Refer to data items 55 and 56 and calculate the x-ray field dimensions along and across table:

CAL = data item 55 x ALCF x ISID / (ISID - data item 49)
CAC = data item 56 x ACCF x ISID / (ISID - data item 49)

Record these values at Results 32 and 33.

3. Calculate the along and across table differences, the percent differences, and the sum of percent difference along and across table:

along table differences = CAL - Result 29
across table difference = CAC - Result 30
% difference along table = (along table difference x 100) / ISID
% difference across table = (across table difference x 100) / ISID
% differences along and across table = abs (% difference along table)
+ abs (% difference across table)

where the ISID is Results 31. Record at Results 34 - 38.

4. Refer to data item 57 and, if necessary, convert into centimeters before recording at Result 39.

5. Refer to data items 58 and 59 and repeat the calculations of steps 2 and 3 using the ISID of Result 39. Record at Results 40 - 46.

6. Refer to data items 60, 61, and 62 and record at Results 47 - 49. Convert any item in inches to centimeters before recording on the Results Record.

7. Refer to data items 63 and 64 and repeat the calculations of steps 2 and 3 using the ISID of Result 49 and the film dimensions along and across table of Results 47 and 48. Record at Results 50 - 56.

8. Refer to data item 65 and if necessary, convert it to centimeters before recording it at Result 57.

9. Refer to data items 66 and 67 and repeat the calculations of steps 2 and 3 using the ISID of Result 57 and the film dimensions along and across table of Results 47 and 48. Record at Results 58 - 64.

I. ACTUAL VERSUS INDICATED FIELD SIZE

1. Refer to data item 72 and record at Result 65 as the indicated SID (ISID). If the ISID is given in inches, convert it to centimeters before recording.

2. Refer to data items 73 and 74, the film dimensions along and across table. Convert to centimeters, if necessary, before recording as Results 66 and 67.

3. Refer to data items 75 and 76 and calculate the x-ray field dimensions along and across table as follows:

   CAL = ALCF x data item 75 x (ISID/(ISID-data item 49))

   Similarly,

   CAC = ACCF x data item 76 x (ISID/(ISID-data item 49))

   Record at Results 68 and 69.

4. Calculate the along and across table difference and the percent differences along and across table.

   Along table difference = (CAL Result 66)

   Across table difference = (CAC -Result 67)

   % difference along table = (along table difference x 100) / ISID
   % difference across table = (across table difference x 100) / ISID

   Record at Results 70 - 73.

J. Illuminance of the Light Localizer

Refer to data items 77, 78, 79, and 80. Calculate the average illuminance value by summing the four values and dividing by four. Record at Result 74.

RESULTS RECORD

ABOVETABLE X-RAY SOURCE RADIOGRAPHIC SYSTEMS

(Test Procedure ARA - Form FDA 2784)

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 A1
9. N_3 = _____at 3.5 mm A1
10. N_2 = _____at 2.5 mm A1
11. N_1 = _____at 1.5 mm A1

N_0 = 1.00 at 0.0 mm A1

12. Observed HVL = _____mm A1 at _____kVp
13. Actual HVL = _____mm A1 at _____kVp

TIMER ACCURACY

14. Indicated time setting = _____seconds
15. Maximum deviation from indicated setting = _____seconds

16. Percent timer inaccuracy = _____%

SID DETERMINATION

17. Indicated SID = _____cm

18. Measured SID = _____cm

19. Percent SID difference = _____%

X-RAY FIELD/LIGHT FIELD ALIGNMENT AND SIZE COMPARISON

20. Total misalignment along table = _____cm

21. Total misalignment across table = _____cm

22. SID' = _____cm

23. Percent misalignment along table = _____%

24. Percent misalignment across table = _____%

25. ALCF = _____ 26. ACCF = _____

X-RAY FIELD/UTIR CENTERS COMPARISON

27. Centers misalignment = _____cm

28. Percent centers misalignment = _____%

PBL X-RAY FIELD/UTIR SIZE COMPARISON

29. Film dimension along table = _____cm

30. Film dimension across table = _____cm

31. Indicated SID (ISID) = _____cm

32. CAL = _____cm 33. CAC = _____cm

34. Along table difference = _____cm

35. Across table difference = _____cm

36. % difference along table = _____%

37. % difference across table = _____%

38. Sum % difference along and across table = _____%

39. Indicated SID (ISID) = _____cm

40. CAL = _____cm 41. CAC = _____cm

42. Along table difference = _____cm

43. Across table difference = _____cm

44. % difference along table = _____%

45. % difference across table = _____%

46. Sum % difference along and across table = _____%

47. Film dimension along table = _____cm

48. Film dimension across table = _____cm

49. Indicated SID (ISID) = _____cm

50. CAL = _____cm 51. CAC = _____cm

52. Along table difference = _____cm

53. Across table difference = _____cm

54. % difference along table = _____%

55. % difference across table = _____%

56. Sum % difference along and across table = _____%

57. Indicated SID (ISID) = _____cm

58. CAL = _____cm 59. CAC = _____

60. Across table difference = _____cm

61. Across table difference = _____cm

62. % difference along table = _____%

63. % difference across table = _____%

64. Sum % difference along and across table = _____%

ACTUAL VERSUS INDICATED FIELD SIZE

65. Indicated SID (ISID) = _____cm

66. Indicated field size along table _____cm

67. Indicated field size across table _____cm

68. CAL =_____cm 69. CAC = _____cm

70. Along table difference = _____cm

71. Across table difference = _____cm

72. % Difference along table = _____%

73. % Difference across table = _____%

ILLUMINANCE OF LIGHT LOCALIZER

74. Average illuminance = _____footcandles

PBL X-RAY FIELD/WALL CASSETTE SIZE COMPARISON

75. Film dimension (vertical) = _____cm

76. Film dimension (horizontal) = _____cm

77. Indicated SID (ISID) = _____cm

78. VER = _____cm 79. HOZ = _____cm

80. Vertical difference = _____cm

81. Horizontal difference = _____cm

82. % vertical difference = _____%

83. % horizontal difference = _____%

84. Sum % difference vertical and horizontal = _____%

X-RAY FIELD/WALL CASSETTE CENTERS COMPARISON

85. Centers misalignment = _____cm

86. % centers misalignment = _____%