Diagnostic X-Ray Systems Guidance Document

Supplement to Chapter 281

Definitions

"Analog signal" means a form information transmission in which the signal varies in a continuous manner and is not limited to discrete steps.

"Applicator" means a structure which determines the extent of the treatment field at a given distance from the virtual source.

"Average Glandular Dose" means, in mammography, the value in millirad for a given breast or phantom thickness which estimates the average absorbed dose to the glandular tissue extrapolated from free air exposure and based on fixed filter thickness and target material.

"Barrier" (See definition of "Protective barrier" in this Section.)

"Beam monitoring system" means a system designed to detect and measure the radiation present in the useful beam.

"Board" means the Oklahoma State Board of Health.

"Cooling curve" means the graphical relationship between heat units stored and cooling time.

"Detector" (See definition of "Radiation detector" in this Section.)

"Diaphragm" means a device or mechanism by which the x-ray beam is restricted in size.

"Direct scattered radiation" means that scattered radiation which has been deviated in direction only by materials irradiated by the useful beam. (See definition of "Scattered radiation" in this Section.)

"Equipment" (See definition of "X-ray system" in this Section.)

"External dose" means that portion of the DE received from any source of radiation outside the body.

"Heat unit" means a unit of energy equal to the product of the peak kilovoltage, milliamperes, and seconds, i.e., kVp x mA x second.

"Inherent filtration" means the filtration of the useful beam provided by the permanently installed components of the tube housing assembly.

"Interruption of radiation" means the stopping of irradiation with the possibility of continuing irradiation without resetting of operating conditions at the control panel.

"Isocenter" means the intersection of the collimator axis of rotation and the gantry axis of rotation.

"Line-voltage regulation" means the difference between the no-load and the load line potentials expressed as a percent of the load line potential. It is calculated using the following equation: Percent line-voltage regulation = 100 $(V_n - V_1)/V_1$ where V_n = No-load line potential and V_1 = Load Line potential.

"Maximum line current" means the root-mean-square current in the supply line of an x-ray system operating at its maximum rating.

"Mobile diagnostic x-ray system" (See definition of "Diagnostic x-ray system" in this Section.)

"Nominal section thickness" means the fill width at half- maximum of the sensitivity profile taken at the center of the cross-sectional volume over which x-ray transmission data are collected.

"Peak tube potential" (See definition of "kilovolt peak (kVp)" in this Section.)

"Picture element" means an elemental area of a tomogram.

"Portable diagnostic x-ray system" (See definition of "Diagnostic x-ray system" in this Section.)

"Practical range of electrons" corresponds to classical electron range where the only contribution to dose is from bremsstrahlung x-rays. Precise definition may be found in ICRU Report 35, "Radiation Dosimetry: Electron Beams with Energies Between 1 and 50 MeV," International Commission on Radiation Units and Measurements, September 15, 1984.

"Primary dose monitoring system" means a system which will monitor the useful beam during irradiation and which will terminate irradiation when a pre-selected number of dose monitor units have been acquired.

"Primary protective barrier" (See definition of "Protective barrier" in this Section.)

"Secondary protective barrier" (See definition of "Protective barrier" in this Section.)

"Shadow tray" means a device attached to the radiation head to support auxiliary beam blocking material.

"Stationary diagnostic x-ray system" (See definition of "Diagnostic x-ray system" in this Section.)

"Target" means that part of a radiation head which by design intercepts a beam of accelerated particles with subsequent emission of other radiation.

"Telemedicine" means the use of electronic communication processes for the transmission of information and data related to the diagnosis and/or treatment of medical conditions.

"Termination of irradiation" means the stopping of irradiation in a fashion which will not permit continuance of irradiation without the resetting of operating conditions at the control panel.

"Tube" means an x-ray tube, unless otherwise specified.

"Variable-aperture beam-limiting device" means a beam- limiting device which has capacity for stepless adjustment of the x-ray field size at a given SID.

"X-ray subsystem" means any combination of two or more components of an x-ray system.

APPENDIX B. CT OPERATOR COMPETENCY CHECKLIST

The checklist with the minimum requirements for CT operator competency follows:

OPERATOR COMPETENCY

CT (model):
Rm #:

The following CT functions have been monitored for the individual listed below. The individual has been evaluated as proficient to operate the equipment independently of supervision as indicated.

1. Basic machine setup for making an exposure
A. Positioning of patient _____
B. Reference plane and tomographic plane _____
C. Tomographic plane light source _____
D. Indications of CT scan conditions _____
E. X-ray production, shutter indicators _____
F. Emergency buttons, switches _____
G. Aural communication with patient _____
H. Viewing of patient _____
I. Dose measurements of the beam _____
J. Phantom images quarterly _____

2. The proper operation and orientation of gantry _____
3. The proper operation and orientation of couch _____
4. The proper initiation of scans _____
5. Knowledge of emergency buttons, switches _____
6. Knowledge of film loading, exposing and unloading _____
7. Knowledge of occupancy requirement during exposure _____
8. Knowledge of basic radiation safety rules _____
9. Aware of special concerns for infant and pediatric _____
10. Aware of special concerns for pregnant patient _____

Employee (name) _____
Employee signature _____ Date _____
Supervisor signature _____ Date _____

APPENDIX E. EQUATIONS FOR 310:281-1-2 DEFINITIONS

"Coefficient of variation" (C) is estimated using the following equation:

$$\epsilon = \frac{s}{\overline{X}} = \frac{1}{\overline{X}} \sqrt{\left[\frac{\sum_{i=1}^{n} \left(X_i - \overline{X} \right)^2}{n-1} \right]}$$

where:
s = Estimated standard deviation of the population.
$\overline{X}$ = Mean value of observations in sample.
X_i = i^{th} observation in sample.
n = Number of observations in sample.

"Computed tomography dose index" (CTDI):

$$\overline{CTDI} = \frac{1}{nT} \int_{+7T}^{-7T} D(z)\,dz$$

where:

z = Position along a line perpendicular to the tomographic plane.
D(z) = Dose at position z.
T = Nominal tomographic section thickness.
n = Number of tomograms produced in a single scan.

"Contrast scale" (CS):

$$\overline{CS} = \frac{\mu_x - \mu_w}{\overline{CTN}_x - \overline{CTN}_w}$$

where:

μ_x = linear attenuation coefficient of the material of interest.
μ_w = linear attenuation coefficient of water.
$\overline{CTN}_x$ = CTN of the material of interest.
$\overline{CTN}_w$ = CTN of water.

"CT number" (CTN):

$$\overline{CTN} = \frac{k\left(\mu_x - \mu_w\right)}{\mu_w}$$

where:

k = constant (a normal value of 1000 when the Hounsfield scale of $\overline{CTN}$ is used.)
μ_x = linear attenuation coefficient of the material of interest.
μ_w = linear attenuation coefficient of water.

"kWs":

$$(A\ kWs) = (X\ kV) \times (Y\ mA) \times (Z\ s) \times \frac{kWs}{10^3\ kV \times mA \times s} = \frac{XYZkWs}{10^3}$$

"Mean" ($\overline{X}$):

$$\overline{X} = \frac{\sum (x_1 + x_2 + \ldots\ldots x_n)}{n - 1}$$

n = Number of observations in sample.
x = A number in the sample of observations.

"Multiple scan average dose (MSAD)":

1.

$$MSAD = \frac{(E \times f \times K \times L)}{T}$$

where:
E=average exposure reading in coulombs per kilogram or in milliroentgens.
f=factor to convert exposure in air to absorbed dose in tissue or other attenuating matter, in grays per coulomb per kilogram or in rad per milliroentgen for acrylic, at an effective energy of 70 KeV; f is equal to 30.2 Gy per C/Kg(0.78×10^{-3} rad/mR).
K=calibration factor to account for the radiation measuring device's response and volume.
L=effective length of the radiation measuring device in millimeters.
T=thickness in millimeters of the tomographic section selected.
NOTE: this calculation assumes tomographic sections are contiguous, without overlap of sections or gaps between sections.
2. If the tomographic sections overlap, the MSAD must be multiplied by a fraction, which is the thickness of the tomographic section divided by the scan increment.
Corrected MSAD= MSAD X (T/scan increment.)

"Noise":

$$S_n = \frac{100\,\overline{CS}\,s}{\mu_w}$$

where:

$\overline{CS}$ = Linear attenuation coefficient of the material of interest.

μ_w = Linear attenuation of water.

s = Standard deviation of the CTN of picture element in a specified area of the CT image.

"Standard deviation" (s):

$$s = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n-1}}$$

s = Estimated standard deviation of the population.

$\overline{X}$ = Mean value of observations in sample. X_i = i^{th} observation in sample.

n = Number of observations in sample.