Appendix Z

Glossary

Acceptance Test: Those tests and measurements that are performed by biomedical equipment maintenance personnel to insure that the diagnostic x-ray system complies with the manufacturer's stated specifications. This also includes a verification that all provisions of the contract have been fulfilled.

Accessible Surface: The external surface of the enclosure or housing provided by the manufacturer**.**

Activity: Number of nuclear transformations per unit time measured in bequerels or curies.

Actual vs. Indicated Field Size: A measurement to assure manual settings of the beam limiting device corresponds to the actual field size. Proper operation of the beam limiting device limits the beam size to the intended area of clinical interest.

Actual Focal Spot: The location at which the anode of an x-ray tube intercepts the electron beam and x-rays are produced.

Air Gap: The gap between a patient and imaging receptor used in magnification examinations that reduces scattered radiation that reaches the film.

Aluminum Equivalent: The thickness of aluminum (type 1000 alloy) affording the same attenuation, under specified conditions, as the material in question.

Analog-to-Digital Converter (ADC): Converts analog signals to digital values for subsequent use in a computer.

Ancillary Equipment: Any equipment that is not a major component of the x-ray system; used in support of radiologic procedures.

Anode: Positive side of an electric circuit such as the x-ray tube anode that includes the target.

Atom: The constituent of matter consisting of a positively charged nucleus surrounded by a cloud of electrons.

Attenuation: The reduction of exposure rate upon passage of radiation through matter.

Attenuation Coefficient (m): Measure of the x-ray attenuating property of a material measured in **cm -1.**

Auger Electron: Electron (rather than characteristic x-ray) emitted by an excited (energetic) atom.

Automatic Brightness Control (ABC): The device which regulates x-ray tube output to maintain a constant brightness at image intensifier output.

Automatic Exposure Control (AEC): A device that automatically controls one or more technique factors in order to obtain at a preselected location(s) a required quantity of radiation.

Autotransformer: Allows the number of windings included in the circuit to be increased or decreased to produce the output voltage needed.

Beam Hardening: The increase in mean energy of a polychromatic x-ray beam as lower energy photons are preferentially absorbed.

Beam Limiting Device: A device that provides a means to restrict the dimensions of the x-ray or gamma-ray field, also called a collimator or beam defining device.

Beam Quality: A measurement to determine the half-value layer (HVL). HVL relates to the thickness of a specified material, usually aluminum, required to decrease the dosage rate of a beam of x-rays to one-half its initial value. The purpose of the filtration is to absorb the lower energy portion of the x-ray spectrum which would otherwise be absorbed by the patient without contributing to the diagnosis. HVL performance standards are expressed in millimeters of Aluminum.

Becquerel: The SI unit of radioactivity (1 Bq = 1 disintegration per second).

BEIR: The United States National Academy of Sciences Committee on the **B**iological **E**ffects of **I**onizing **R**adiation.

Beta Minus Decay: Nuclear process in which a neutron is converted to a proton with emission of an electron and antineutrino.

Beta Particle: Electron or positron emitted from a nucleus during beta decay.

Beta Plus Decay: Nuclear process in which a proton is converted to a neutron with emission of a positron and neutrino.

Blur: The "smeared out" image of an object produced by an imaging system.

Bremsstrahlung Radiation: General or "braking radiation" x-rays produced when electrons lose energy.

Brightness gain: Ratio of image brightness on an image intensifier output to brightness produced on the input phosphor.

Bucky: Moving grid.

Bucky Factor: Ratio of incident to transmitted radiation for a given grid.

Cassette Holder: A device, other than a spot film device, that supports and/or fixes the position of an x-ray film cassette during a radiographic exposure.

Cathode: Negative side of a x-ray tube containing the filament.

Cephalometric Device: A device intended for the radiographic visualization and measurement of the dimensions of the human head.

Characteristic Curve: Plot of film density against the logarithm of relative exposure, also known as a Hurter and Driffield (H and D) curve.

Characteristic Radiation: X-ray photon of characteristic energy emitted from an atom when an inner shell vacancy is filled by an outer shell electron.

Coefficient of Variation: The ratio of the standard deviation to the mean value of a population of observations.

Coherent Scatter: Photon scattered by an atom without suffering any energy loss, also known as Raleigh scatter.

Collimation: The restriction of the useful (primary) beam to an appropriate size.

Collimator: A device to restrict the size of the X-ray beam. Also called a beam-limiting or beam-defining device.

Compliance Test: Those tests and measurements that are performed by health physicists in order to insure that the diagnostic x-ray system complies with the performance standard contained in this manual and 21 CFR Part 1000, subchapter J.

Compton Interaction: Photon interaction with an outer shell electron resulting in a scattered electron and photon of lower energy.

Cone: A device used to indicate beam direction and establish a minimum source-surface or source-skin distance (SSD). It may or may not incorporate a collimator, also known as a position-indicating device (PID).

Contrast: The difference in signal intensity between an object and the surrounding background.

Contrast Improvement Factor: Ratio of image contrast levels obtained with, and without, the use of scatter reduction systems such as grids or air gaps.

Conversion Efficiency: The percentage of energy deposited into a screen that is converted into light photon energy.

Coulomb: Unit of electric charge.

Curie (Ci): The non-SI unit of activity (1 Ci = 3.7×10^{10} disintegrations per second).

Current: The flow of electric charge measured in amperes.

Dead-man Switch: A switch so constructed that a circuit closing contact can be maintained only by continuous pressure on the switch.

Defect: Any unsafe condition or any failure associated with the use of an x-ray system or component thereof which relates to the health and safety of use by reason of the emission of ionizing radiation for other than its intended purpose.

Densitometer: Device used to measure optical density on film.

Diaphragm: A plate, usually of lead, with a central aperture so placed as to reduce the useful (primary) beam to an appropriate area. (See Collimation.)

Effective Focal Spot: The projection of the actual focal spot on a plane that is perpendicular to the central perpendicular line of the window of the x-ray tube housing or to an agreed specified direction. It is also known as the projected focal spot.

Electron: Fundamental constituent of matter with 1/1836 of the mass of a proton and a negative charge.

Emulsion: Layer of film that contains silver halide grains.

Entrance Skin Exposure: The amount of radiation delivered at the skin surface. It is generally the sum of the air dose at that point and backscatter.

Exposure: Measure of the ability of a source of x-rays to ionize air measured in coulombs per kilogram (C/kg) or roentgens (R).

Filament: Wire on the cathode of a x-ray tube that emits electrons.

Filter: Thin plate, usually made of aluminum, placed in a x-ray beam to absorb unwanted low-energy X-rays.

Film Latitude: The range of exposure levels over which the film may be used without being under- or overexposed.

Film Mottle: Random fluctuations in film density due to the granular nature of the emulsion.

Fluoroscopic Imaging Assembly: A subsystem in which x-ray photons produce a fluoroscopic image. It includes the image receptor(s) such as the image intensifier and spot-film device, electrical interlocks, if any, and structural material providing linkage between the image receptor and diagnostic source assembly.

Flux Gain: The number of light photons at the output phosphor of an image intensifier per light photon produced at the input phosphor.

Focal Spot: Area of anode where x-ray beam is produced.

Focusing Cup: Directs electrons leaving the x-ray tube filament.

Fog Level: Film blackening in the absence of radiation exposure.

Full Width Half Maximum (FWHM): A measure of spatial resolution equal to the width of an image of a line source, defined at points where the intensity is reduced to one-half the maximum intensity.

Geiger Counter: Ionization chamber with a high voltage resulting in amplified output following the detection of an ionizing particle (x-ray photon).

General Purpose Radiographic X-ray System: Any radiographic x-ray system that, by design, is not limited to radiographic examination by specific anatomical regions (e.g., extremities, head or head and neck, thoracic, and abdominal).

Gradient: The average slope of a film characteristic curve, normally obtained between the film densities of 0.5 and 2.0.

Gray: The SI unit of absorbed dose (1 Gy = 1 J/kg).

Grid: Strips of lead in a radiolucent matrix used to reduce scattered radiation.

Grid Line Density: The number of grid lines per centimeter.

Grid Ratio: Ratio of height to separation gap of lead strips in a grid.

Half-value Layer (HVL): Thickness of specified material (e.g., aluminum) needed to reduce the x-ray beam intensity by 50%.

Heat Unit (HU): For single-phase x-ray units, the product of exposure time, peak voltage, and amperage (1J = 1.35 HU).

Heel Effect: The x-ray intensity is greater at the cathode side and is lower at the anode side because of anode absorption.

High-voltage Generator: A device that transforms electrical energy from the electrical potential supplied by the x-ray control to the x-ray tube operating electrical potential. The device may also include means for transforming alternating current to direct current, filament transformers for the x-ray tube(s), high-voltage switches, electrical protective devices and other appropriate components/subsystems, also known as a x-ray high-voltage generator.

ICRP (International Commission on Radiological Protection): International radiation protection agency founded in 1928 that issues recommendations regarding radiation safety.

Image Intensifier (II): Converts incident x-ray pattern to a light image of higher energy density that can be viewed, recorded, or photographed.

Image Receptor: Any device, such as a fluorescent screen or radiographic film, which transfers incident x-ray photons either into a visible image or onto another form which can be made into a visible image by further transformations.

Intensification Factor: Ratio of x-ray exposure without, and with, an intensifying screen to produce a given film density.

Intensifying Screen: Converts x-rays to light, producing many light photons for each absorbed x-ray photon.

Interlock: A limiting device to preclude activation or exposure of a radiation source unless some specific condition is met.

Ionization: Production of electrons and positive ions following the absorption of radiation energy.

Ionization Chamber: Gas chamber used to accurately determine radiation levels based on measurements of charge liberated in a given mass of gas (air).

Ionizing Radiation: Radiation that can result in the ejection of electrons from atoms.

Kilovolt (kV): 1000 volts.

Kilovolts Peak Potential (kVp): The crest value of the potential wave in kilovolts. This indicates the maximum energy level of the X-ray photon.

kV Accuracy: A comparison of measured kV versus that indicated on the machine selector control.

kV Compensation: A comparison of measured kV values at varying mA stations to assure consistency.

Leakage radiation: The radiation emerging from an x-ray unit when the collimators are fully closed.

Limiting Resolution: The highest spatial frequency resolved by an imaging system measured in line pairs per millimeter.

Line Focus Principle: Result of viewing a sloped surface (x-ray tube anode) at an angle, thus reducing its apparent size.

Linear Attenuation Coefficient: The fraction of photons lost from an x-ray beam in traveling a unit of distance measured in cm^{-1}.

Linearity: The ability of an x-ray system to maintain a near constant ratio of the radiation output to the measured product of the tube current (mA) and exposure time(s), mAs, expressed as mR/mAs at various technique factors while maintaining a constant mAs.
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Milliampere (mA): One thousandth of an ampere. This indicates the rate of x-ray production.

Milliampere-second (mAs): The numerical product of the milliamperage and the time in seconds. With all the other factors held constant, the film density is related to mAs and will not change as the mA and the time are varied; as long as they are varied reciprocally and their product is unchanged.

mA Linearity: A comparison of X-ray exposure at adjacent mA settings to assure consistency. Performance standards for linearity are expressed using a statistical ratio (Coefficient of Linearity).

Multipurpose X-ray System: (See General Purpose Radiographic X-ray System)

New X-ray Equipment/system: X-ray equipment/system that was manufactured and installed after 1 August 1974. Therefore, old equipment/system is that manufactured prior to 1 August 1974.

Nuclear Regulatory Commission (NRC): United States federal agency ultimately responsible for regulating nuclear materials.

Operator: The person actually in control of the equipment when exposures are being made.

Optical Density (OD): Measure of the degree of film blackening using a logarithmic scale.

Penumbra: Geometric unsharpness caused by focal spot size.

Phantom: A device that absorbs and scatters X-rays in approximately the same way as tissues of the body. It is used, instead of a human, while making measurements that include scattered radiation.

Position Indicating Device (PID): A device on a dental radiographic x-ray system used to incorporate the beam position and to establish a definite SSD. The devices may or may not incorporate or serve as a beam-limiting device.

Positive Beam Limiting Device (PBL): A device that automatically adjusts the X-ray field to the size of the film cassette in the cassette holder. The PBL device automatically limits the beam size to the area of clinical interest.

Primary Beam: See Useful Beam

Protective Barrier: A barrier of radiation-absorbing materials used to reduce radiation exposure to the required value for radiation protection purposes.

Primary Protective Barrier: A barrier sufficient to attenuate the useful (primary) beam to the required value for radiation protection purposes.

Secondary Protective Barrier: A barrier sufficient to attenuate the stray radiation to the required value for radiation protection purposes.

Quality Assurance: The portion of the Radiation Protection Survey which monitors or audits film processing and its effects on radiation exposure.

Rad: Stands for "radiation absorbed dose," which is a non-SI unit of absorbed dose (1 rad = 100 erg/g).

Radiation (ionizing): Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, by interaction with matter. (See also leakage radiation, scattered radiation, stray radiation, useful beam)

Radiation Protection Survey: An evaluation of existing or potential radiation hazards associated with the use of x-ray equipment under specified conditions.

Radiographic Mottle: Random density fluctuations (noise) observed in an image after a uniform exposure.

Rare Earth Screen: Radiographic screen containing rare earth elements.

Rated Line Voltage: The range of potentials, in volts, of the supply line specified by the manufacturer at which the x-ray system is designed to operate.

Rated Output Current: The maximum allowable load current of the x-ray high-voltage generator.

Rated Output Voltage: The allowable peak tube potential, in volts, at the output terminals of the x-ray high-voltage generator.

Reassembly: The installation of one or more components or subsystems that were previously assembled and used as an x-ray system.

Reciprocating Grid: A grid that moves during a radiographic exposure and smears out the grid lines in the resultant image; also known as a Bucky.

Rectification: Changing an alternating voltage into one that retains a selected polarity (AC to DC).

Rem: Stands for "radiation equivalent man," a non-SI unit of dose equivalent.

Reproducibility: A measure of X-ray consistency for a given technique setting (kVp, mA and time). Performance standards are expressed using a statistical test (Coefficient of Variation). The ability of an x-ray system to maintain near constant radiation exposure (mR) at specified techniques for repetitive exposures.

Resolution: A manifestation of sharpness and the minimum separation at which two adjacent objects can be distinguished as individual objects. The resolution capability of a focal spot is generally identified as the equivalent focal spot.

Roentgen (R) **:** Unit of exposure that measures charge liberated in air.

Scatter: Radiation deflected from its initial direction.

Scattered Radiation: Radiation that, during passage through matter, has been deviated in direction. It will also have been modified by a decrease in energy.

Scintillator: Material that emits light after absorption of radiation.

Screen Mottle: Random fluctuations in image density produced because of imperfections and variations in screen thickness.

Screen Unsharpness: Blur caused by light diffusion within the intensifying screens.

Secondary Radiation: Radiation such as characteristic x-rays produced as a result of the absorption of primary radiation.

Self-rectification: A reference to the fact that electrons cannot flow from the anode to the cathode in an x-ray tube.

Shutter: In diagnostic equipment, an adjustable device used to collimate the useful (primary) beam.

Signal-to-noise ratio (SNR): Used in imaging to measure the ratio of signal intensity to the image noise level.

Source: The focal spot of the x-ray tube, also known as the tube target.

Source-to-Image Distance (SID): The difference from the X-ray tube target (anode) to the X-ray film or other image receptor. The performance standards are expressed as a percentage of actual distance to the tube head distance setting.

Source-to-Skin Distance (SSD): The distance from the X-ray tube target (anode) to the skin of the patient where the X-ray beam enters the body. The performance standard requires a minimum distance be maintained depending upon machine parameters.

Space Charge: Result of an electron cloud around the filament in an x-ray tube.

Spatial Resolution: Ability to discriminate between two adjacent high-contrast objects.

Spot Film Device: A device intended to transport and/or position a radiographic image receptor between the x-ray source (tube) and the fluoroscopic image receptor. It includes a device intended to hold a cassette over the input end of an image intensifier for the purpose of making a radiograph.

Stationary (Fixed) Equipment: Equipment that is installed in a fixed location.

Stray Radiation: The sum of leakage and scattered radiation.

Streak Artifacts: Artifacts seen in computed tomography that may be caused by patient motion or metallic implants.

Subject Contrast: Difference in x-ray beam intensities emerging from an object.

Technique Factors: The conditions of operation. Specified as follows:

- **a.** For a capacitor energy storage x-ray system, the peak tube potential in kVp and the quantity of charge in mAs.
- **b.** For a field emission x-ray system rated for pulsed operation, the peak tube potential in kVp, and the number of x-ray pulses.
- **c.** For all other x-ray systems, the peak tube potential in kVp and either the tube current in mA and exposure time in seconds, or the product of tube current (mA) and exposure time(s) in mAs.

Tenth-value Layer (TVL): Thickness of material needed to reduce an x-ray beam intensity to 10% of its initial value.

Tube Housing Assembly: A device that includes the insert, high-voltage and/or filament transformers and other components/subsystems when they are contained within the tube housing.

Timer Linearity: A comparison of the X-ray exposure at different machine timer settings to ensure consistency. Performance standards are expressed as a Coefficient of Linearity.

Useful Beam: Radiation that passes through the window, aperture, cone or other beam-limiting device of the source housing when the exposure switch or timer is activated. Sometimes called the "primary beam."

Visible Area: That portion of the input surface to the image receptor over which incident x-ray photons are producing a visible image.

Voltage: Electrical potential difference.

Wavelength: The distance between two consecutive crests of a wave.

X-rays: High-frequency (energetic) electromagnetic radiation produced using electrons.

X-ray Beam/Light Field Alignment: A comparison of the dimensions of the X-ray beam to the corresponding light field dimensions. This is an indication of whether the X-ray beam is limited to the area of clinical interest.

X-ray Control: A device that controls input electrical power to the x-ray high-voltage generator/x-ray tube. It includes components/subsystems such as timers, phototimers, automatic brightness stabilizers, and similar devices which control and display technique factors of an x-ray exposure. Normally there are components/subsystems which permit line voltage compensation.

X-ray Equipment: An x-ray system, subsystem, or component thereof.

X-ray Field/UTIR Centers Comparison: A measurement of the center of the X-ray beam as it corresponds to the film cassette holding device (Bucky). Centers misalignment adversely affects the diagnostic quality of the image.

X-ray system: An assemblage of components or subsystems for the controlled production of x-rays. This system includes as a minimum an x-ray high-voltage generator, an x-ray control, a tube housing assembly, a beam-limiting device, and the necessary supporting structures. Additional components which function with the system are considered integral parts of the system, also called x-ray equipment.

X-ray Tube: Any electron tube that is designed for the conversion of electrical energy into x-ray energy. Also called a tube.