Chapter H 57

RADIATION PROTECTION CODE

H 57.01 Public policy. Since ionizing radiations and their sources can be instrumental in the improvement of the health and welfare of the public if properly utilized, and may be destructive or detrimental to life or health if carelessly or excessively employed or may detrimentally affect the environment of the state if improperly utilized, it is hereby declared to be the public policy of this state to encourage the constructive uses of radiation and to prohibit and prevent exposure to ionizing radiation in amounts which are or may be detrimental to health. The rules adopted in the interest of radiation safety, in general, conform to nationally accepted standards.

History: Cr. Register, January, 1966, No. 121, eff. 2-1-66.

H 57.02 Definitions. (1) ABSORBED DOSE. Energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad.

(2) ACTIVITY. The number of atoms decaying per unit of time.

(3) ALUMINUM EQUIVALENT. The thickness of aluminum affording the same attenuation, under specified conditions, as the material in question.

(4) ADDED FILTER. Filter added to the inherent filtration.

(5) ATTENUATION. Decrease in exposure rate of radiation caused by passage through material.

(6) BARRIER. See *protective barrier.*

(7) BOARD. The state board of health.

(8) BYPRODUCT MATERIAL. Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

(9) COMMISSION. The industrial commission.

(10) CONCRETE EQUIVALENT. The thickness of concrete based on a density of 2.35 grams per cubic centimeter (147 pounds per cubic foot) affording the same attenuation, under specified conditions, as the material in question.

(11) CONSTANT POTENTIAL (cp). In radiological practice, this term is applied to a unidirectional potential (or voltage) which has little, or no, periodic variation. The periodic component is called the rippl potential (or ripple voltage).

(12) CONTROLLED AREA. A defined area in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. (This implies that a controlled area is one that requires control of access, occupancy, and working conditions for radiation protection purposes.)

(13) CURIE (c). A unit of activity defined as the activity of a quantity of any radioactive nuclide in which the number of disintegrations per second is 3.700×10^{10}.

(a) *Millicurie* is 1/1000 of a curie.

(b) *Microcurie* is 1/1,000,000 of a curie.

(14) DEADMAN SWITCH. A switch so constructed that a circuit closing contact can only be maintained by continuous pressure by the operator.

(15) DIAGNOSTIC-TYPE PROTECTIVE TUBE HOUSING. A shockproof x-ray tube housing so constructed that the leakage radiation at a distance of 1 meter from the target cannot exceed 100 milliroentgens in 1 hour when the tube is operated at any of its specified ratings.

(16) DOSE EQUIVALENT (DE). Dose equivalent is the product of absorbed dose D, quality factor (QF), dose distribution factor (DF), and other necessary modifying factors. (DE) = D (QF) (DF).

Note: The term RBE dose has been used in the past, in both radiobiology and radiation protection. This term is now reserved for radiobiology only and is replaced by dose equivalent (DE) for radiation protection.

(a) *Quality factor* (QF). The linear-energy-transfer-dependent factor by which absorbed doses are to be multiplied to obtain for radiation protection purposes, a quantity that expresses on a common scale for all ionizing radiations, the irradiation incurred by exposed persons.

(b) *Dose distribution factor.* (DF). The factor used to express the modification of biological effect due to nonuniform distribution of internally deposited isotopes.

(17) EXPOSURE DOSE. The exposure does of X- or gamma radiation of a certain place is a measure of the radiation that is based upon its ability to produce ionization. The unit of exposure dose is the roentgen. (When the meaning is clear, this term may be shortened to "exposure".)

(18) EXPOSURE DOSE RATE (exposure rate, intensity). Exposure dose per unit time.

(19) FILM BADGE. A pack of appropriate photographic film and filters used to determine radiation exposure.

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(20) FILTER. Material placed in the useful beam to absorb preferentially the less penetrating radiations.

(21) FSD. Distance from focal spot to skin surface of patient.

(22) HALF-VALUE LAYER (hvl). Thickness of an absorber required to reduce a beam of radiation to one-half its incident exposure dose rate.

(23) HIGH RADIATION AREA. Any area, accessible to individuals, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirems.

(24) INHERENT FILTRATION. Filtration in the useful beam due to the window of the x-ray tube and any permanent tube enclosure.

(25) INTERLOCK. A device for precluding access to an area of radiation hazard either by preventing entry or by automatically removing the hazard.

(26) KILOVOLTS CONSTANT POTENTIAL (kvcp). The potential in kilovolts of a constant potential generator.

(27) KILOVOLTS PEAK (kvp). The crest value in kilovolts of the potential of a pulsating potential generator. When only one-half of the wave is used, the value refers to the useful half of the wave.

(28) LEAD EQUIVALENT. The thickness of lead affording the same attenuation, under specified conditions, as the material in question.

(29) LEAKAGE RADIATION. See radiation.

(30) MAXIMUM PERMISSIBLE DOSE (MPD). The maximum dose that the body of a person or specific parts thereof shall be permitted to receive in a stated period of time. See *table 1, appendix A.*

(31) MILLIRAD. One-thousandth of a rad.

(32) MILLIREM. One-thousandth of a rem.

(33) MILLIROENTGEN (mr). One-thousandth of a roentgen.

(34) MONITORING. Periodic or continuous determination of the exposure rate in an area (area monitoring) or the exposure received by a person (personnel monitoring).

(35) NUCLEAR FACILITY. Any reactor plant, any equipment or device used for the separation of the isotopes of uranium or plutonium, the processing or utilizing of radioactive material or handling, processing or packaging waste; any premise, structure, excavation or place of storage or disposition of waste or by-product; or any equipment used for or in connection with the transportation of such material.

(36) OCCUPANCY FACTOR (T). The factor by which the workload should be multiplied to correct for the degree or type of occupancy of the area in question. See *table 7, appendix A.*

(37) OCCUPIED AREA. An area that may be occupied by persons or radiation-sensitive materials.

(38) OPERATOR. A person who operates x-ray equipment or equipment containing radioisotopes and/or handles sources of radioisotopes.

(39) PERSON IN CONTROL. Person directly responsible for radiation protection competent to carry out the duties set forth in Wis. Adm. Code section H 57.03 (1).

(40) PERSONNEL MONITORING EQUIPMENT. Devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.).

(41) POCKET CHAMBER. A small condenser ionization chamber used for determining radiation exposure.

(42) POCKET DOSIMETER. A small ionization instrument which indicates radiation exposure directly.

(43) PRIMARY PROTECTIVE BARRIER. See *protective barrier.*

(44) PROTECTIVE BARRIER. Barrier of attenuating materials used to reduce radiation exposure. (a) *Primary protective barrier.* Barrier sufficient to attenuate the useful beam to the required degree.

(b) *Secondary protective barrier.* Barrier sufficient to attenuate stray radiation to the required degree.

(45) RAD. Unit of absorbed dose. 1 rad is 100 ergs per gram.

(46) RADIATION. Radiation or ionizing radiation as used in this code refers to electromagnetic radiations such as X-rays and gamma rays, or particulate radiations such as electrons or beta particles, protons, neutrons, alpha particles, usually of high energy, but in any case it includes all radiations capable of producing ions directly or indirectly in their passage through matter. (a) *Leakage radiation.* The radiation which escapes through the protective shielding of an x-ray tube housing or radioisotope storage container.

(b) *Scattered radiation.* Radiation that, during passage through matter, has been deviated in direction.

(c) *Secondary radiation.* A form of scattered radiation emitted by any irradiated material.

(d) *Stray radiation.* Radiation not serving any useful purpose.

(e) *Useful beam.* That part of the radiation which passes through the window, aperture, cone, or other collimating device of the tube housing.

(47) RADIATION AREA. Any area, accessible to individuals, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any 5 consecutive days a dose in excess of 100 millirems. (Also see *high radiation area.*)

(48) RADIATION HAZARD. A condition under which persons might receive radiation in excess of the maximum permissible dose, or radiation damage might be caused to materials.

(49) RADIATION INSTALLATION. Any location or facility where radiation machines are used or where radioactive material is produced, transported, stored, disposed of or used for any purpose.

(50) RADIATION MACHINE. Any device that produces radiation when in use.

(51) RADIOACTIVE MATERIAL. Includes any solid, liquid or gaseous substance which emits radiation spontaneously.

(52) RADIATION SOURCE. A radiation machine or radioactive material as defined herein.

(53) REM. The unit of dose equivalent (for diagnostic x-rays one rem is equivalent to one rad).

(54) ROENTGEN (R). Unit of exposure of x- or gamma-radiation. One roentgen is an exposure of x-radiation or gamma-radiation such that the associated corpuscular emission per 0.001293 g of air produces, in air, ions carrying 1 esu of quantity of electricity of either sign.

(55) SCATTERED RADIATION. See *radiation.*

(56) SECONDARY PROTECTIVE BARRIER. See *protective barrier.*

(57) SECONDARY RADIATION. See *radiation.*

(58) SHALL. Shall denotes that the ensuing recommendation is necessary or essential to meet the currently accepted standards of protection.

(59) SHOULD. Should, is recommended, indicates advisory recommendations that are to be applied when practicable.

(60) SHUTTER. A movable and controllable device, generally of lead, fixed to a radiation source, employed to intercept and collimate the useful beam.

(61) SOURCE. Discrete amount of radioactive material or radiation producing equipment.

(62) STRAY RADIATION. See *radiation.*

(63) SURVEY. An evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

(64) THERAPEUTIC-TYPE PROTECTIVE TUBE HOUSING. A shockproof x-ray tube housing so constructed that the leakage radiation at a distance of 1 meter from the target cannot exceed 1 roentgen in 1 hour and at a distance of 5 centimeters from any point on the surface of the housing accessible to the patient cannot exceed 30 roentgens in 1 hour when the tube is operated at any of its specified ratings.

(65) TOTAL FILTRATION. The sum of the inherent and added filtration.

(66) USE FACTOR. (U). The fraction of the workload during which the useful beam is pointed in the direction under consideration. See *table 8, appendix A.*

(67) USEFUL BEAM. See *radiation.*

(68) USER. A person, organization, or institution having administrative control over one or more installations or mobile surces of radiation.

(69) WORKLOAD (w). A measure in suitable units of the amount of use of radiation equipment. For the purpose of this standard the workload is expressed in milliampere-minutes per week for x-ray sources and roentgens per week at 100 centimeters from the source for gamma-ray sources.

(70) X-RAY APPARATUS. Any device for the production of x-rays.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.03 Working conditions. (1) PERSON IN CONTROL. (a) There shall be a person in control of each radiation installation responsible to the User for advising on the establishment of safe working conditions according to current standards and for compliance with all pertinent sections of the state radiation protection code.

(b) The specific duties of the person in control shall include:

1. Establishing and maintaining operational procedures so that the radiation exposure of each worker is kept as far below the maximum permissible exposure as is practicable.

2. Instructing personnel in safe working practices and in the nature of injuries resulting from overexposure to radiation.

3. Assuring that personnel monitoring devices are used where indicated and that records are kept of the results of such monitoring.

4. Conducting periodic radiation surveys where indicated and keeping records of such surveys, including descriptions of corrective measures.

5. Investigating each case of excessive or abnormal exposure to determine the cause and taking steps to prevent its recurrence.

6. Notification of excessive or abnormal exposure. a. Immediate notification. The person in control or his substitute shall immediately notify the Wisconsin state board of health by telephone or telegraph of any incident involving registered sources of ionizing radiation possessed by him and which may have caused or threatens to cause exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual to 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation.

b. Twenty-four hour notification. The person in control or his substitute shall within 24 hours notify the Wisconsin state board of health by telephone or telegraph of any incident involving registered sources of ionizing radiation possessed by him and which may have caused or threatens to cause exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rems or more of radiation.

c. The person in control or his substitute shall, within 30 days, notify the Wisconsin state board of health in writing of the accumulative exposure of any employee when the exposure exceeds 1.25 rems per quarter.

(2) GENERAL SAFETY PROVISIONS. (a) It is the responsibility of the User to assure that all radiation sources under his jurisdiction are operated only by competent personnel.

(b) The User shall be responsible for the instruction of personnel in safe operating procedures and in the nature of injuries resulting from overexposure to radiation. He shall promulgate rules for work-

ing safety, including any restrictions of the operating technique known to be necessary.

(c) Every operator shall be familiar with the safety rules and with the sections of this code applicable to his work.

(d) All persons entering a controlled area shall comply with all radiation safety instructions which concern or affect their conduct and shall use such safety devices as are furnished for their protection.

(e) Under no circumstances shall a person be occupationally exposed to radiation in excess of the limits specified in table 1, appendix A.

(3) PERSONNEL MONITORING. (a) Each licensee or registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by: 1. Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25% of the applicable value specified in table 1, appendix A.

2. Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5% of the applicable value specified in table 1, appendix A.

3. Each individual who enters a high radiation area.

(b) Each licensee or registrant shall maintain records showing the radiation exposure of all individuals for whom personnel monitoring is required under this section. Such records shall be kept on form RAD-A of the Wisconsin state board of health in accordance with the instructions contained in that form, or on an approved form containing all the information required by form RAD-A. See *appendix C.* The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

(c) Records of individual radiation exposure which must be maintained pursuant to the provisions of this section shall be preserved permanently as provided for in section 102.17(4), Wis. Stats. Records which must be maintained pursuant to this section may be maintained in the form of microfilms.

(d) Photographic reproductions of all records required under this section shall be transferred to the Wisconsin state board of health immediately in the event of the termination of the licensee's or registrant's business operations and at such other times as the Wisconsin state board of health may direct.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.04 Fluoroscopic installations. (1) EQUIPMENT. (a) The tube housing shall be shockproof and of diagnostic type.

(b) The target-to-panel or target-to-table top distance of equipment installed before August 1, 1966 shall not be less than 12 inches, and shall not be less than 18 inches in equipment installed (or reinstalled) thereafter. (See *table 16, appendix A*)

(c) The total filtration permanently in the useful beam shall not be less than 2.5 millimeters aluminum equivalent. This requirement may be assumed to have been met if the half-value layer is not less than 2.5 millimeters aluminum at normal operating voltages. (See *table 16, appendix A*)

(d) The equipment shall be so constructed that the entire cross section of the useful beam is attenuated by a primary barrier. This

barrier is usually the viewing device, either a conventional fluoroscopic screen or an image intensification mechanism. 1. a. For equipment installed before August 1, 1966, the required lead equivalent of the barrier shall not be less than 1.5 millimeters for 100 kvp, shall not be less than 1.8 millimeters for 125 kvp, or shall not be less than 2.0 millimeters for 150 kvp.

b. For equipment installed (or re-installed) after August 1, 1966, the required lead equivalent of the barrier shall not be less than 2.0 millimeters for 100 kvp, shall not be less than 2.4 millimeters for 125 kvp, or shall not be less than 2.7 millimeters for 150 kvp.

c. Insofar as related to the provisions of paragraphs 1. a and 1. b of this subsection, for conventional fluoroscopes these requirements may be assumed to have been met if the exposure dose rate measured at the viewing surface of the fluorescent screen does not exceed 50 milliroentgens per hour with the screen in the primary beam of the fluoroscope without a patient, under normal operating conditions.

d. Special attention must be paid to the shielding of image intensifiers so that neither the useful beam nor scattered radiation from the intensifier itself can produce a radiation hazard to the operator or other personnel.

2. Collimators shall be provided to restrict the size of the useful beam to less than the area of the barrier. For conventional fluoroscopes this requirement is met if, when the adjustable diaphragm is opened to its fullest extent, an unilluminated margin is left on the fluorescent screen regardless of the position of the screen during use. Where image intensifiers are used, a protective shield shall be provided so that the useful beam does not produce a radiation hazard.

3. The tube mounting and the barrier shall be so linked together that, under conditions of normal use, the barrier always intercepts the useful beam. This excludes the use of hand-held fluoroscopic screens.

4. Collimators and adjustable diaphragms or shutters to restrict the size of the useful beam shall provide a minimum of 2.0 millimeters lead-equivalent protection for 100 kvp, 2.4 millimeters for 125 kvp or 2.7 millimeters for 150 kvp.

(e) The exposure switch shall be of the deadman type.

(f) A manual-reset, cumulative timing device shall be used which will either indicate elapsed time by an audible signal or turn off the apparatus when the total exposure reaches a pre-determined limit in one or a series of exposures. The timing device should have a maximum range of 5 minutes.

(g) For routine fluoroscopy, the exposure rate measured at the panel or table top should be as low as practicable and shall not exceed 10 roentgens per minute.

(h) A shield of 0.25 mm lead equivalent between the patient and the fluoroscopist is recommended but shall not substitute for the wearing of a protective leaded apron.

(i) A device for covering the Bucky slot during fluoroscopy should be provided. The thickness of material used should provide protection equivalent to at least 0.25 mm lead.

(2) STRUCTURAL SHIELDING. Ordinarily, only secondary barriers are necessary. Table 1, appendix B shows the barrier requirements for busy fluoroscopic installations. Combined fluoroscopic-radiographic in-

stallations are governed by the requirements for radiographic units. *(See section H 57.05)*

(3) OPERATING PROCEDURES. (a) Fluoroscopic equipment shall be operated only by properly trained persons authorized by the person in control of the installation.

(b) Attention should be given to reducing the light intensity in the room and the eyes of the fluoroscopist should be adequately dark-adapted before he uses the fluoroscope. The use of an image intensifier may reduce the degree of adaptation necessary but should not be considered to eliminate the need for it.

(c) The radiation dose to the patient should be kept to the minimum consistent with clinical requirement. 1. To this end, the fluoroscopist should take advantage of the dose reducing possibilities presented by high kilovoltage, low milliamperage, field reducing shutters, and rapid observation. (See *tables 15 and 16, appendix A*)

2. When properly used, image intensifiers may significantly reduce both observation time and exposure rate, but they do not inherently accomplish this. Special precautions are necessary when cineradiographic techniques are used, since tube currents and voltages are usually higher than those normally used for fluoroscopy, and exposures to both patients and personnel can become quite large.

3. When fluoroscoping persons who have not passed the reproductive age, special attention should be paid to avoiding exposure of the gonads to the useful beam. It is recommended that, whenever possible, fluoroscopy of the abdominal region of fertile women should be carried out only during the first 10 days of the regular menstrual cycle.

(d) Unless measurements indicate otherwise, protective aprons of at least 0.25 millimeter lead equivalent shall be worn by all persons in the fluoroscopic room, except the patient. The apron of the fluoroscopist shall be at least 0.5 millimeter lead equivalent.

(e) Unless measurements indicate otherwise, protective gloves of at least 0.25 millimeter lead equivalent and preferably 0.5 millimeter lead equivalent shall be worn by the fluoroscopist during every examination.

(f) The hand of the fluoroscopist shall not be placed in the useful beam unless the beam is attenuated by the patient and a protective glove.

(g) Only persons needed in the fluoroscopic room shall be there during fluoroscopy.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.05 Radiographic installations other than dental intra-oral and veterinary medicine. (1) EQUIPMENT. (a) The tube housing shall be shockproof and of diagnostic type.

(b) Diaphragms or cones capable of restricting the beam to the area of clinical interest shall be provided within 6 months of the effective date of this code for collimating the useful beam and shall provide the same degree of protection as is required of the housing.

(c) Except when contraindicated for a particular medical purpose, for equipment capable of operating above 70 kvp, the total filtration permanently in the useful beam shall be equivalent to at least 2.5 mm of aluminum. This requirement may be assumed to have been met if

the half-value-layer is not less than 2.5 mm aluminum at normal operating voltages.

(d) An automatic device shall be provided to terminate the exposure after a preset time or exposure.

(e) A deadman type of exposure switch should be so arranged that it cannot be conveniently operated outside a shielded area. Exposure switches for "spot film" devices used in conjunction with fluoroscopic tables are excepted from this shielding requirement.

(2) STRUCTURAL SHIELDING. Table 2 in appendix B gives the barrier thickness requirements for busy radiographic installations. (a) All wall, floor, and ceiling areas exposed to the useful beam shall have primary barriers. Primary barriers in walls shall extend to a minimum height of 7 feet above the floor.

(b) Secondary barriers shall be provided in all wall, floor, and ceiling areas not having primary barriers or where the primary barrier requirements are lower than the secondary barrier requirements.

(c) Unless measurements indicate otherwise, the operator's station at the control shall be behind a protective barrier, either in a separate room, in a protected booth, or behind a shield which will intercept the useful beam and any radiation which has been scattered only once.

(d) If a barrier is required, a window of lead-equivalent glass equal to that required by the adjacent barrier or a mirror or other viewing system shall be provided large enough and so placed that the operator can see the patient without having to leave the protected area during exposure.

(3) OPERATING PROCEDURES. (a) No individual occupationally exposed to radiation shall be permitted to hold patients during exposures except during emergencies, nor shall any individual be regularly used for this service.

(b) Only individuals required for the radiographic procedure shall be in the radiographic room during exposure; and, except for the patient, no unprotected parts of their bodies shall be in the useful beam. All such persons, except the patient, shall be provided with protective aprons and gloves unless measurements indicate that these are not required.

(c) The radiation exposure of the patient should be kept to the minimum consistent with clinical requirements. The useful beam shall be restricted to the area of clinical interest. (See *tables 2 and 15, appendix A*)

(d) The gonads of children and persons who have not passed the reproductive age should be protected from the useful beam by the use of careful field collimation or special gonad shields when this will not impair the value of the examination.

History: Cr. Register, January, 1966, No. 121, eff. 2-1-66.

H 57.06 Mobile Diagnostic Equipment. (1) EQUIPMENT. (a) For mobile radiographic equipment, all provisions of section H 57.05(1) apply except for H 57.05(1)(e).

(b) Mobile fluoroscopic equipment shall meet the requirements of section H 57.04(1) where applicable, except that 1. In the absence of a panel or table top, a cone or spacer frame shall limit the target-to-skin distance to not less than 12 inches.

2. Image intensification shall always be provided. Conventional fluoroscopic screens shall not be used.

3. The machine shall not be operated when the collimating cone or diaphragm is not in place.

4. A maximum permissible dose rate of 10 roentgens per minute shall be measured at the minimum target-to-skin distance.

(c) The exposure control switch shall be of the deadman type and shall be so arranged that the operator can stand at least 6 feet from the patient and well away from the useful beam.

(2) STRUCTURAL SHIELDING. When a mobile unit is used routinely in one location, it shall be considered a fixed installation subject to the shielding requirements specified in section H 57.05(2).

(3) OPERATING PROCEDURES. (a) For mobile radiographic equipment, all provisions of section H 57.05(3) apply except for H 57.05 (3)(b).

(b) For mobile fluoroscopic equipment, all provisions of section H 57.04(3) apply.

(c) For mobile diagnostic radiographic units, the target-to-skin distance shall be not less than 12 inches.

(d) The operator should stand as far as possible from the tube and patient and well away from the useful beam during all exposures and should wear a protective leaded apron.

(e) Personnel monitoring shall be required for all individuals operating mobile x-ray equipment.

History: Cr. Register, January, 1966, No. 121, eff. 2-1-66.

H 57.07 Chest photofluorographic installations. (1) EQUIPMENT. (a) All provisions of section H 57.05(1) apply.

(b) A collimator shall restrict the useful beam to the area of the photofluorographic screen.

(2) STRUCTURAL SHIELDING. All provisions of section H 57.05(2) apply.

(3) OPERATING PROCEDURES. (a) All provisions of section H 57.05 (3) apply.

(b) All individuals except the patient being examined shall be in shielded positions during exposures.

(c) Personnel monitoring shall be required for all individuals operating the equipment.

History: Cr. Register, January, 1966, No. 121, eff. 2-1-66.

H 57.08 Dental intra-oral radiographic installations. (1) EQUIPMENT. (a) The tube housing shall be shockproof and of diagnostic type.

(b) A cone or spacer frame shall provide a target-to-skin distance of not less than 7 inches with apparatus operating above 50 kvp or 4 inches with apparatus operating at 50 kvp or below.

(c) Diaphragms or cones shall be used for collimating the useful beam and shall provide the same degree of protection as the housing. The diameter of the useful beam at the end of the cone or spacer frame shall not be more than 3 inches.

(d) 1. For equipment operating up to 70 kvp, the total filtration permanently in the useful beam shall be equivalent to at least 1.5 mm of aluminum. This requirement may be assumed to have been met if

the half-value layer is not less than 1.5 mm aluminum at normal operating voltages.

2. For equipment operating above 70 kvp, the total filtration permanently in the useful beam shall be equivalent to at least 2.5 mm of aluminum. This requirement may be assumed to have been met if the half-value layer is not less than 2.5 mm aluminum at the normal operating voltages.

(e) An automatic device shall be provided to terminate the exposure after a preset time or exposure.

(f) The exposure control switch shall be of the deadman type.

(g) Each installation shall be provided with a protective barrier for the operator and/or assistant or shall be so arranged that the operator and/or assistant stands at least 6 feet from the patient's head and well away from the useful beam.

(2) STRUCTURAL SHIELDING. (a) Rooms or areas containing dental x-ray machines shall be provided with primary barriers at all areas struck by the useful beam.

Note: In many cases structural materials of walls suffice as a protective barrier without addition of special shielding material. (See *Tables 3 and 4, Appendix B and Table 12, Appendix A*)

(b) In multiple installations, consideration shall be given to the possible exposure from all sources.

(3) OPERATING PROCEDURES. (a) Neither the operator nor assistant shall be permitted to hold patients or films during exposure, nor shall any individual be regularly used for this service.

(b) During each exposure, the operator and assistant shall stand behind a protective barrier or at least 6 feet from the patient's head. Unless measurements indicate otherwise, a protective leaded apron shall be worn.

(c) Only the patient shall be in the useful beam and should be provided with a protective leaded apron.

(d) Neither the tube housing nor the pointer cone shall be handheld during exposure.

(e) Fluoroscopy shall not be used with dental examinations.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.09 Therapeutic x-ray installations operated at potentials above 60 KVP. (1) EQUIPMENT. (a) The tube housing shall be shockproof and of therapeutic type.

(b) Permanent diaphragms or cones used for collimating the useful beam shall afford the same degree of protection as the tube housing. Adjustable or removable beam-defining diaphragms or cones shall transmit not more than 5% of the useful beam obtained at the maximum kilovoltage and with maximum treatment filter. (See *table 17, appendix A*)

(c) Filters shall be secured in place to prevent them from dropping out during treatment. The filter slot shall be so constructed that the radiation escaping through it does not exceed 1 roentgen per hour at 1 meter, or, if the radiation from the slot is accessible to the patient, 30 roentgens per hour at 5 centimeters from the external opening.

(d) The x-ray tube shall be so mounted that it cannot turn or slide with respect to the aperture. A mark on the housing should show the location of the focal spot.

(e) Means shall be provided to immobilize the tube housing during stationary portal treatment.

(f) A timer shall be provided to terminate the exposure after a preset time regardless of what other exposure limiting devices are present.

(g) A beam monitoring device fixed in the useful beam is recommended to indicate any error due to incorrect filter, milliamperage, or kilovoltage, unless it introduces more filtration than is clinically acceptable.

(h) Equipment utilizing shutters to control the useful beam shall have a shutter position indicator on the control.

(i) There shall be on the control panel an easily discernible indicator which will give positive information as to whether or not the x-ray tube is energized.

(j) Lead rubber, lead foil, etc., used for limiting the field, should transmit not more than 5% of the useful beam. *(See table 17, appendix A)*

(2) STRUCTURAL SHIELDING. (a) All wall, floor, and ceiling areas, plus a border of one foot, that will be struck by the useful beam, shall be provided with primary protective barriers.

(b) All wall, floor and ceiling areas that cannot be struck by the useful beam, because of restrictions in the orientation of the useful beam, shall be provided with secondary barriers. (See *tables 5, 6, 7, 8, 9, 10, 11, and 12, appendix B*). See appropriate tables in National Bureau of Standards Handbook 55 issued February 26, 1954, for barrier requirements involved in voltages up to 100,000,000 electron volts. Handbook 55 may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402. Copies are also on file in the office of the State Board of Health, the Secretary of State and the Revisor of Statutes.

(c) With equipment operating above 125 kvp, the required barriers shall be an integral part of the building.

(d) With equipment operating above 150 kvp, the control station shall be within a protective booth or outside the treatment room.

(e) Interlocks shall be provided within 6 months of the effective date of this code so that when any door of the treatment room is opened either the machine will shut off automatically or the radiation level within the room will be reduced to an average of not more than 2 milliroentgens per hour and a maximum of 10 milliroentgens per hour at a distance of 1 meter in any direction from the target. After such shut-off or reduction in output, it shall be possible to restore the machine to full operation only from the control panel.

(f) In the design of barriers for installations operating above 1,000 kv, a maze, with the entrance door where it can be struck only by multiple-scattered radiation, may be used to reduce the barrier requirement for the door.

(g) Provision for oral communication with the patient from the control room is desirable.

(h) Windows, mirror systems, or closed-circuit television viewing screens used for observing the patient shall be so located that the operator may see the patient and the control panel from the same position.

(3) OPERATING PROCEDURES. (a) The person in control of all new installations shall make or cause to be made such surveys as may be necessary for him to determine compliance with these regulations prior to use. Existing installations not surveyed since January 1, 1965 shall have such a survey. Such surveys shall also be done after any change in the installation which might increase the radiation hazard. The person in control shall in all cases within a reasonable time report the findings of the survey in writing to the User and to the Wisconsin state board of health. The Wisconsin state board of health will cooperate and assist in complying with this section.

(b) The installation shall be operated in compliance with any limitations indicated by the protection survey.

(c) No individual, who works with radiation, unless he is the patient, shall be in the treatment room during exposure unless it is clinically necessary. If an individual is required to be in the treatment room with the patient during exposure, he shall be protected as much as possible from scattered radiation, by wearing radiation protection apparel and shall not be in the useful beam.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.10 X-ray therapy equipment operated at potentials of 60 KVP and below. (1) EQUIPMENT. (a) All provisions of section H 57.09 (1) apply for equipment used for "contact therapy", except under H 57.09 (1) (a), the leakage radiation at the surface of the tube housing shall not exceed 0.1 roentgen per hour.

(b) Automatic timers shall be provided which will permit accurate presetting and determination of exposures as short as one second.

(2) OPERATING PROCEDURES. (a) In the therapeutic application of apparatus constructed with beryllium or other low-filtration windows the registrant shall insure that the unfiltered radiation reaches only the part intended and that the useful beam is blocked at all times except when actually being used.

(b) Machines having an output of more than 1,000 roentgens per minute at any accessible place shall not be left unattended without the power being shut off at the primary disconnecting device.

(c) If the tube is hand-held during irradiation, the operator shall wear protective leaded gloves and leaded aprons.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.11 Veterinary medicine radiographic installations. (1) EQUIPMENT. (a) The tube housing shall be shockproof and of diagnostic type.

(b) Diaphragms or cones shall be provided for collimating the useful beam to the area of clinical interest and shall provide the same degree of protection as is required of the housing.

(c) Except when contraindicated for a particular radiographic purpose the total filtration permanently in the useful beam shall not be less than 1.5 millimeters aluminum-equivalent for equipment operating up to 70 kvp and 2.5 millimeters aluminum-equivalent for machines operated in excess of 70 kvp.

(d) A device shall be provided to terminate the exposure after a pre-set time or exposure.

(e) A deadman type of exposure switch shall be provided, together with an electrical cord of sufficient length so that the operator

can stand out of the useful beam and at least 6 feet from the animal during all x-ray exposures.

(2) STRUCTURAL SHIELDING. All wall, ceiling, and floor areas shall be equivalent to or provided with applicable protective barriers as required in section H 57.05 (2).

(3) OPERATING PROCEDURES. (a) The operator shall stand well away from the tube housing and the animal during radiographic exposures. The operator shall not stand in the useful beam. If film must be held, it shall be held by individuals not occupationally exposed to radiation. Hand-held fluoroscopic screens shall not be used. The tube housing shall not be held by the operator. No individuals other than the operator shall be in the x-ray room while exposures are being made unless such person's assistance is required.

(b) Unless measurements indicate otherwise, in any application in which the operator is not located behind a protective barrier, clothing consisting of a protective apron having a lead-equivalent of not less than 0.5 millimeter shall be worn by the operator and any other individuals in the room during exposures.

(c) No individuals shall be regularly employed to hold or support animals during radiation exposures. Operating personnel shall not perform this service except in cases in which no other method is available.

(d) Any individual holding or supporting an animal or the film during radiation exposure shall wear protective gloves and apron having a lead-equivalent of not less than 0.5 millimeter.

History: Cr. Register, January, 1966, No. 121, eff. 2-1-66.

H 57.12 Industrial x-ray and industrial radium installations. Industrial x-ray installations shall be classified as either class A, class B, class C or class D. This section includes radium and its decay products and appropriate requirements under each installation class shall be applied. Class A permits unlimited use at maximum capacity as specified by the registrant at the time of registration. Class B permits unlimited use under limited operating conditions as specified by the registrant at the time of registration. Class C permits limited use under conditions specified by the registrant at the time of registration. Class D permits limited use and temporary operation, including portable or mobile industrial x-ray installations.

(1) CLASS A INSTALLATION REQUIREMENTS AND OPERATING AND EMERGENCY PROCEDURES. (a) *Enclosure.* The x-ray source and the objects exposed thereto must be contained within a permanent enclosure. 1. The enclosure shall be constructed: a. So that the primary and secondary x-rays are attenuated to a dose rate as measured in air at any accessible external point not to exceed 2 milliroentgens per hour when the x-ray beam is adjusted to give maximum dose rate with the x-ray generator running at maximum operating conditions and the x-ray tube placed in the shortest "tube to wall" radiographically usable position. Mechanical or electrical limiters may be placed on the x-ray apparatus to restrict the movement of the beam to an area which will result in a dose rate not in excess of 2 milliroentgens per hour measured in air at any accessible point.

b. With reliable interlocks which will either prevent opening of the enclosure while the x-ray generator is in operation or will terminate the generation of x-rays should the enclosure be opened.

c. So that persons may at all times be able to escape from within the enclosure.

d. With visible and/or audible signals within the enclosure which are actuated a minimum of 5 seconds prior to the generation of x-rays.

e. So that if the ceiling barrier does not attenuate the dose rate as set forth in subsection a. above, a posted barrier, such as a fence, shall be used to restrict access to the area having excessive dose rate.

2. No person is permitted to remain within the enclosure while the x-ray generator is in operation.

3. No x-ray apparatus or other radiographic sources shall be left unattended without locking the apparatus itself, or the room or building in some manner which will prevent its use by unauthorized persons.

4. All protective enclosures and equipment shall be kept in good repair.

(b) *Operating and emergency procedures.* Such procedures shall be a part of each unit and shall include the following: 1. Procedures for the handling and use of radium sources and radiographic exposure devices such that no person is likely to be exposed to radiation doses in excess of the limits specified in table 1, appendix A.

2. The procedure for notifying the Wisconsin state board of health and emergency agencies in event of accident or fire.

3. Procedure for minimizing exposure to persons in the event of an accident.

4. Methods and occasions for radiation surveys.

5. Security procedures during each radiographic operation. Either the radiographer or the radiographer's assistant shall maintain direct vigilance of the operation to protect against unauthorized entry into high radiation area.

6. The person in control shall make or cause to be made such surveys as may be necessary for him to determine compliance with these regulations. Records shall be kept of each survey for inspection by the Wisconsin state board of health.

7. Loss of any radium source must be reported to the Wisconsin state board of health within 24 hours of the discovery of the loss.

(2) CLASS B INSTALLATION REQUIREMENTS AND OPERATING AND EMERGENCY PROCEDURES. (a) All provisions of section H 57.12(1) apply when the x-ray source is operated under maximum normal operating conditions as specified by the registrant at the time of registration.

(b) The controls for the kilovoltage and milliamperage shall be limited by mechanical or electrical means so as not to exceed the maximum normal operating conditions as specified by the registrant at the time of registration.

(3) CLASS C INSTALLATION REQUIREMENTS AND OPERATING AND EMERGENCY PROCEDURES. (a) All provisions of section H 57.12(1) apply except that a dose rate of 50 milliroentgens per hour at accessible external points is allowable.

(b) The number of hours per week for permissible operation shall be established for the x-ray generator by the Wisconsin state board of health.

(c) Warning signs shall be posted in those areas outside the protective barriers in which the dose rate in air at any accessible external point exceeds 2 milliroentgens per hour with the generator operating at its maximum rated capacity and the x-ray beam adjusted to give its maximum dose rate and the x-ray tube placed in the shortest "tube to wall" usable and/or limited radiographic position. A visible and/or audible signal shall be provided within the posted area which shall be actuated during the generation of x-rays.

(d) Film badges or other permanent recording instruments shall be provided and required to be worn continuously by persons in the posted area.

(4) CLASS D INSTALLATION REQUIREMENTS AND OPERATING AND EMERGENCY PROCEDURES. (a) An x-ray installation not meeting the conditions and specifications as described as class A, class B, or class C may be operated for a period not to exceed 30 days. When it is impractical or when an undue and unnecessary hardship is involved, such period may be extended by the Wisconsin state board of health. In either case, such installation and operation of such installation, before use, must be approved by the Wisconsin state board of health and shall be classified as a class D installation.

(b) No x-ray apparatus or other radiographic sources shall be left unattended without locking the apparatus itself, or the room or building in some manner which will prevent its use by unauthorized persons.

(c) To exclude all unauthorized persons, all such installations shall have the radiation area in excess of 5 milliroentgens per hour posted and barricaded by a fence, rope, or other suitable personnel barriers erected outside the 5 milliroentgens per hour contour line.

(d) Film badges or other permanent recording instruments shall be provided and required to be properly used on a continual basis for personnel in the posted area and such other personnel who might be specified by the Wisconsin state board of health.

(e) A calibrated and operable survey instrument shall be assigned for each installation. Such instrument shall have a range such that 2 milliroentgens per hour through 1 roentgen per hour can be measured.

(f) Registration. 1. The initial registration shall be in the possession of the Wisconsin state board of health prior to the approval of a radiographic source.

2. If the unit has been previously registered, notification of a change in work address must be in the possession of the Wisconsin state board of health prior to the approval of the source at any address other than that indicated on the registration form.

(g) All provisions of section H 57.12(1)(b) apply.

(5) INDUSTRIAL RADIUM INSTALLATION REQUIREMENTS AND OPERATING AND EMERGENCY PROCEDURES. Installations utilizing sealed radium sources, other than those covered under section H 57.13, shall meet all appropriate requirements for radiological safety specified for x-ray installations of class A, class B, class C, or class D, whichever may be applicable. (a) 1. Except as otherwise specifically authorized by the Wisconsin state board of health, each registrant shall

provide accountability of sealed sources and shall keep a permanent record of the issue and return of all sealed sources.

2. When not in use, sealed sources shall be kept in a protective enclosure of such material and wall thickness as may be necessary to assure compliance with the provisions of table 1, appendix A.

(b) If the source is permanently mounted in a housing with a beam control device or extended from and retracted into a housing, this device shall be of positive design capable of acting in any position of the housing. It shall also be possible to move the source to a shielded position manually with a minimum risk of exposure in the event of the failure of the automatic mechanism. There shall be on the housing and on the control panel a warning device which plainly indicates whether the apparatus is "on" or "off".

(c) If the apparatus is of a type in which the source is removed from the shield when in use, transfer shall be accomplished by a remote control mechanism. Transfer mechanisms shall be designed to minimize the possibility of damage to the source in transit.

(d) Each radiographic exposure device shall be provided with a lock within an enclosure provided with a lock designed to prevent unauthorized or accidental removal or exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of authorized personnel.

(e) Testing sealed sources for leakage and contamination. 1. The registrant shall provide for testing for leakage and contamination prior to initial use. All sealed sources shall be tested for leakage at least every 12 months, unless otherwise specified by the Wisconsin state board of health. If there is reason to suspect that a sealed source might have been damaged, it shall be tested for leakage before further use.

2. Leak tests shall be capable of detecting the presence of 0.005 microcuries of contamination of radium and its decay products. Any test conducted pursuant to this section which reveals the presence of 0.005 microcuries or more of removable contamination shall be considered evidence that the sealed source is leaking. The registrant shall immediately withdraw the source from use and shall cause it to be decontaminated and repaired or to be disposed of.

(f) A radiation survey shall be made after each use to determine that the radium source has been returned to its shielded position. Records shall be kept of each survey for inspection by the Wisconsin state board of health.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.13 Sealed radium sources used in the healing arts. (1) ACCOUNTABILITY, STORAGE AND TRANSIT. (a) Except as otherwise specifically authorized by the Wisconsin state board of health, each registrant shall provide accountability of sealed sources and shall keep a permanent record of the issue and return of all sealed sources.

(b) When not in use, sealed sources and applicators containing sealed sources shall be kept in a protective enclosure of such material and wall thickness as may be necessary to assure compliance with the provisions of table 1, appendix A. The registrant will demonstrate that the proposed methods of use are not likely to cause any individual to receive a dose in any calendar quarter in excess of limits specified in table 1, appendix A.

(2) TESTING SEALED SOURCES FOR LEAKAGE AND CONTAMINATION. (a) The registrant shall provide for testing for leakage and contamination prior to initial use. All sealed sources shall be tested for leakage at least every 12 months unless otherwise specified by the Wisconsin state board of health. If there is reason to suspect that a sealed source might have been damaged, it shall be tested for leakage before further use.

(b) Leak tests shall be capable of detecting the presence of 0.005 microcuries of contamination of radium and its decay products. Any test conducted pursuant to this section which reveals the presence of 0.005 microcuries or more of removable contamination shall be considered evidence that the sealed source is leaking. The registrant shall immediately withdraw the source from use and shall cause it to be decontaminated and repaired or to be disposed of.

(3) OPERATING AND EMERGENCY PROCEDURES. Such procedures shall include the following:

(a) Procedures for the handling and use of radium sources and radiographic exposure devices such that no person is likely to be exposed to radiation doses in excess of the limits specified in table 1, appendix A.

(b) Procedure for notifying the Wisconsin state board of health and emergency agencies in the event of accident or fire.

(c) Procedure for minimizing exposure to persons in the event of an accident.

(d) Methods and occasions for radiation surveys.

(e) Security procedures during each radiotherapeutic operation. Either the physician or his assistant shall maintain vigilance over the operation to protect against unauthorized entry into a radiation area. The patient's room shall be identified as a radiation area and all individuals entering the room should wear personnel monitoring devices.

(f) Records shall be kept of each survey for inspection by the Wisconsin state board of health.

(g) Loss of any radium source must be reported to the Wisconsin state board of health within 24 hours of the discovery of the loss.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.

H 57.14 Nonindustrial research and teaching installations. (1) Such installations shall be subject to applicable provisions of sections H 57.04, H 57.05, H 57.06, H 57.09 and H 57.10.

History: Cr. Register, January, 1966, No. 121, eff. 2–1–66.