290-5-22-.06 Radiation Safety Requirements for the Use of Non-Medical X-Ray.

(1) Purpose. This section establishes the requirements for the non-healing arts use of x-rays.
(2) Scope. This section applies to all non-healing arts radiographic, fluoroscopic, and analytical x-ray installations and any apparatus capable of emitting x-rays as either a useful product or an unwanted by-product. The provisions of this section are in addition to and not in substitution for other applicable provisions of these regulations.
(3) General Provisions.
   (a) Each registrant shall provide personnel monitoring devices which are calibrated for the appropriate radiations and energies of radiation produced, and these devices shall be used by:
      1. Each individual who receives, or is likely to receive, a whole body dose in excess of 25 millirems per week; and
      2. Each individual who enters a high radiation area.
   (b) Each installation shall be provided with such primary protective barriers and/or secondary protective barriers as are necessary to assure compliance with section .01(8) and .03(2).
   (c) All areas in which radiation hazards may arise shall be identified by an appropriate and easily recognizable warning sign as described in .03(4).
   (d) Audible or visible signals shall be provided in the vicinity of installations to provide warning during irradiation and shall be activated prior to any exposure.
   (e) X-ray tubes shall be provided with protective housing(s) appropriate to the nature of the work to afford adequate protection to personnel. The housing(s) shall be at least equivalent to a therapeutic tube housing.
   (f) The operator or radiographer shall be provided with and shall have available for inspection a copy of normal operating and emergency procedures.
   (g) A key-operated primary control switch shall be provided such that x-ray production shall not be possible with the key removed.
   (h) Manufacturers of radiation machines shall provide for purchasers, and to the Department upon request, manuals and instructions which shall include at least the following technical and safety information:
      1. potential, current, and duty cycle ratings of the x-ray generation equipment; and
      2. adequate instructions concerning any radiological safety procedures and precautions which may be necessary because of unique features of the machine; and
      3. a schedule of maintenance necessary to keep the machine in compliance with these regulations.
   (i) A suitable and functioning survey instrument, calibrated for the energy used, shall be at each installation.
   (j) Each entrance or access point to a high radiation area shall be:
      1. equipped with a control device which shall cause the radiation generator to turn off automatically upon entry into the area; or
      2. maintained locked except during periods when access to the area is controlled.
   (k) Each high radiation area shall be arranged in such a way that an individual can quickly leave that area.
Tests of all devices such as interlocks, shutters, and warning lights shall be conducted at intervals not to exceed 3 months for all operable analytical x-ray equipment. Records of such tests shall be maintained for inspection by the Department.

(4) Industrial Radiography.
(a) Cabinet X-ray Installations.
1. The x-ray source and all objects exposed thereto must be contained within a permanent enclosure.
2. All protective enclosures and equipment shall be kept in good repair.
3. Radiation exposure shall not exceed 0.5 mR in any one hour at a distance of five centimeters (2 inches) from any point on the external surface of the cabinet or of any component outside the cabinet when operated under any conditions for which the machine is designed.
4. A control shall be provided that will enable the operator to initiate and terminate the production of x-rays by means other than the safety interlock system or main power control.
5. It shall not be possible to extend any part of the human body through a port into the primary beam.
6. Each door of a cabinet x-ray system shall have a minimum of two operative safety interlocks. One but not both of the required interlocks shall be such that a door opening results in physical disconnection of the energy supply circuit to the high voltage generator, and such disconnection shall not be dependent upon any moving part other than the door. The registrant shall:
   (i) maintain records that verify the existence of dual interlocks.
   (ii) maintain records of any repairs made on the dual interlocks; and
   (iii) certify to the Department that modifications have not been made to the dual interlocks that are not consistent with manufacturer’s design specifications. Such certification shall be made to the Department with the application for registration, application for renewal of registration, and as a part of any inspection or investigation conducted by the Department. For purposes of inspection, the Department shall review these records and only that the cabinet x-ray system ceases x-ray production when the door is opened.
7. For cabinet x-ray systems designed for entry by an individual during the normal course of use of the machine, there shall also be provided:
   (i) Audible and visible warning signals within the cabinet which must be activated for at least 10 seconds immediately prior to the first initiation of x-radiation production; and
   (ii) A visible signal within the cabinet which shall remain operative for the duration of x-ray production. It shall be automatically initiated prior to x-ray production and terminated with the exposure; and
   (iii) Suitable means of egress, so that any person may escape the interior of the cabinet without delay, or an effective means within the cabinet for preventing or terminating production of the x-radiation, and which cannot be reset from the outside of the cabinet.
8. Following interruption of x-ray generation by operating any interlock, the resumption of x-ray generation shall be possible only from the control panel.
(b) Shielded Room Radiographic Installations.
1. Facilities utilizing shielded room radiography shall assure that:
(i) Radiation levels at any point on the exterior of the room do not exceed those specified in .03(2)(c); and  
(ii) All the requirements specified in .06(4)(a)7. shall apply.  
(iii) Each door of a shielded room shall have a minimum of two operative safety interlocks. One but not both of the required interlocks shall be such that a door opening results in physical disconnection of the energy supply circuit to the high voltage generator.  
(c) Open X-ray Installations.  
1. Radiation areas in excess of 5 mR/hr shall be identified. A fence, rope or other suitable personnel barrier shall be erected along a 5 mR/hr, or less, contour line.  
2. The area described by the temporary barricade shall be suitably posted with caution signs.  
3. Suitable personnel monitoring devices for the energy used shall be provided and shall be used by persons in the area. One device shall be a cumulative direct reading device, the other a film badge, or equivalent.  
4. During each radiographic operation, either the radiographer or an assistant shall maintain direct vigilance of the operation to insure against unauthorized entry into the radiation area.  
5. All persons shall be removed from the radiation area before irradiation is begun.  
6. The radiation machine itself, or the place in which the machine is stored, shall be locked in order to prevent unauthorized use.  
7. Written records of personnel exposure, safety procedures and scaled drawing of the 5 mR/hr contour line shall be at the work site.  
8. Each facility shall have a suitable and functioning survey instrument.  
(5) Analytical X-Ray.  
(a) Equipment.  
1. The leakage radiation from the tube housing shall not exceed a radiation level of 25 milliroentgens in 1 hours at 5 centimeters (2 inches) from the surface of the tube housing at any specified tube rating.  
2. Radiation originating within the high voltage power supply (i.e., transformer and rectifiers) shall not exceed a radiation level of 0.5 milliroentgen in one hour at every specified rating at a distance of 5 centimeters (2 inches) from the housing of the power supply.  
3. For open beam x-ray equipment:  
   (i) Sufficient warning lights or other equally conspicuous signals that operate only when the primary x-ray beam is released from the beam ports shall be provided in such a manner as to alert individuals to the potential radiation hazard. These signals shall be labeled so that their purpose is easily identified.  
   (ii) The operator shall be in immediate attendance at all times when the equipment is in operation except when the area is locked to protect against unauthorized or accidental entry.  
   (iii) When not in use, equipment shall be secured in such a manner as to be inoperable by unauthorized persons.  
   (iv) Each port on the radiation source housing shall be equipped with a shutter that cannot be opened unless a collimator, or a coupling and recording device with beam absorber, has been connected to the port.
4. The radiation level for analytical x-ray equipment in which the primary x-ray beam is completely enclosed shall be less than 2 milliroentgens in one hour at 25 centimeters (10 inches) from the apparatus at every specified tube rating.

5. Each analytical system shall be so arranged as to restrict the entry of parts of the body into the primary beam. This may be accomplished by using such arrangements as adequate barriers or interlocks.

6. The analytical x-ray device shall be provided with a protective barrier which absorbs the useful beam behind the specimen under examination.

7. In addition to any other signs or labels required, a sign or label shall be placed on or adjacent to each x-ray tube housing and shall be located as to be clearly visible to any individual who may be working in close proximity to the primary beam path. The sign or label shall read: "CAUTION - HIGH INTENSITY X-RAY BEAM."

8. A warning light with the notation "X-RAY ON," shall be located on the control panel and:
   (i) shall light only when the x-ray tube is activated; and
   (ii) shall be wired in series with the primary electrical circuit so that if the warning light is inactivated x-ray generation is not possible.

9. The coupling between the x-ray tube and the collimator of the diffractometer, camera, or other accessory shall prevent radiation from escaping the coupling.

10. All tube head ports which are not in use shall be secured in the closed position in a manner which will prevent casual opening. Port covers shall offer the same degree of protection as is required of the tube housing.

(b) Operation of Equipment.

1. The registrant shall not permit the routine operation of any equipment that would require an individual to expose any part of his body to the primary beam.

2. Written operating and emergency procedures pertaining to radiation safety shall be established for each facility and shall be posted in a conspicuous location near each unit of analytical x-ray equipment.

3. Only qualified personnel shall be permitted to install, repair or make modifications to the x-ray generating apparatus and the tube housing-apparatus complex.

4. Any temporary alteration to safety devices, such as bypassing interlocks or removing shielding shall be:
   (i) prohibited during normal operation of the equipment;
   (ii) specified in writing and posted near the x-ray tube housing so that other individuals will know the existing status of the x-ray apparatus; and
   (iii) terminated as soon as possible; and
   (iv) recorded and the record maintained for inspection by the Department. This record should contain such information as date alteration was made, type of alteration, length of time unit remained in the altered condition, and signed by the individual who restored the unit to original condition.

5. Interlocks shall not be used to deactivate the x-ray tube except in an emergency or during testing of the interlock system; it shall be possible to restore the machine to full operation only from the control panel.

6. Safety glasses shall be provided and required for use by operators, assistants, and maintenance personnel. Personnel monitoring in the form of ring badges or the equivalent should be utilized.
Surveys. Radiation surveys of all analytical radiation machines shall be performed:
1. following any change in the initial arrangement, number, or type of components in the machine; or
2. following any maintenance requiring the disassembly or removal of a component in the machine; or
3. during the performance of maintenance and alignment procedures, if the procedures require the presence of a primary x-ray beam when any component in the machine is disassembled or removed; or
4. any time a visual inspection of the local components in the machine reveals an abnormal condition; and
5. It shall be the responsibility of the registrant to ensure that such radiation surveys are performed by an individual competent to perform such surveys.

Medical Examination. Operators and personnel routinely assisting in analytical x-ray operation or maintenance shall be instructed regarding the potential physical hazards of such an x-ray beam. They shall be required to report any evidence of accidental physical injury or accidental exposure to radiation to the individual in charge of radiation protection. That person shall require immediate medical examination of the suspected injury and, if such injury has occurred, shall notify the Department by telephone and in writing within 24 hours.

Non-Medical Fluoroscopy.
(a) Industrial Use:
1. In addition to the applicable provisions of this section .06, provisions shall be made to maintain adequate protection when manipulating or marking objects under examination.
2. "Hand-held" fluoroscopes shall not be used.
3. The exposure rate due to transmission through the image receptor shall not exceed 2 mR/hr at a distance of 10 centimeters (4 inches) from any point on the receptor.
4. The maximum x-ray dose shall not exceed 0.5 mR in any one hour measured at 5 centimeters (2 inches) from any readily accessible machine surface.
5. A method of dosimetry for these systems shall be employed which shall quantitatively define, with an accuracy of + 20 percent, the x-ray dose within the energy range of 30-150 kVp. Any method of film dosimetry, thermoluminescent dosimetry, or electronic instrumentation which shall be capable of this measurement will be acceptable.
6. Any installation for baggage surveillance shall be enclosed and so designed as to prohibit ready access to x-ray generating equipment.
7. It shall not be possible to insert any part of the body into the primary beam.
8. The control panel shall be equipped with a key lock. It shall not be possible to remove the key in the "on" position.
9. A positive pressure switch shall be provided to control the exposure and shall be located such that the operator has a clear view of the radiation machine.
(b) Non-Controlled Areas. Personnel dose limits shall not exceed 10 mR in any one week or 500 mR in any one year.

X-Rays As Unwanted By-Product.
(a) All equipment in which electrons are accelerated to an energy in excess of 5 keV shall be regarded as a potential source of ionizing radiation, such as: electron microscopes, cathode-ray tubes, television and imaging tubes.
(b) All such equipment shall be constructed, installed and operated in such a manner as to provide adequate protection according to these regulations.
(c) Such items of equipment shall be shielded and provided with interlocks so as to insure that the places where they are used can be regarded as being outside "controlled areas."
(d) The dose rate at any readily accessible point 5 centimeters (2 inches) from the surface of such equipment shall not exceed 0.5 mR/hr.

(8) Instruction of Personnel.
(a) The registrant shall assure that all radiation machines and associated equipment under his control is operated only by individuals instructed in safe operating procedures and competent in the safe use of the equipment. The registrant shall also assure that persons operating his radiation machine and associated equipment have received, at a minimum, two hours of instruction in the following six (6) subject categories:
1. Fundamentals of Radiation Safety:
   (i) Characteristics of radiation
   (ii) Units of radiation measurement
   (iii) Significance of radiation dose and exposure
   (I) Radiation protection standards
   (II) Biological effects of radiation
   (iv) Sources and levels of radiation
   (v) Methods of controlling radiation dose
   (I) Working time
   (II) Working distances
   (III) Shielding
2. Radiation Detection Instrumentation to be Used:
   (i) Use of radiation survey instruments
   (I) Operation
   (II) Calibration
   (III) Limitations
   (ii) Survey techniques
   (iii) Use of personnel monitoring equipment
   (I) Film badges
   (II) Thermoluminescent dosimeters
   (III) Pocket dosimeters
3. Radiographic Equipment to be Used:
   (i) Remote handling equipment
   (ii) Radiographic exposure devices and sealed sources
   (iii) Operation and control of x-ray equipment 4. The Requirements of Pertinent Federal and State Regulations.
5. The Registrant's Written Operating and Emergency Procedures.

(b) Training shall begin within 30 days after employment and shall be completed no later than 90 days after date of employment. The registrant shall maintain a record of all training for each operator. Such record shall be made available for Departmental inspection.
