

**INFORMAL SECTION ROUGH DRAFT – APRIL 2005**

**MICHIGAN DEPARTMENT OF COMMUNITY HEALTH  
RADIATION SAFETY SECTION  
IONIZING RADIATION RULES**

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**PART 7. MEDICAL DIAGNOSTIC X-RAY INSTALLATIONS**

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**R325.5311. Purpose and scope.**

**Rule 311. (1)** ~~This part establishes requirements governing the use of x-radiation in medicine, osteopathy, chiropractic and podiatry.~~ This Part establishes requirements, for which a registrant is responsible, for use of diagnostic x-ray equipment by, or under the supervision of, an individual authorized by and licensed in accordance with State statutes to engage in the healing arts. The provisions of this Part are in addition to, and not in substitution for, other applicable provisions of these regulations.

This part is meant to address the specific requirements for the different types of general purpose human, non-dental, healing arts x-ray uses. This would include all General Radiographic, Fluoroscopic, Extremity, and Bone density uses. Computed Tomography and Radiation Therapy are addressed in new parts 12 and 15 respectively.

**(2)** This part applies to ~~all licensees and~~ registrants who use x-radiation in these healing arts disciplines for the intentional exposure of humans, including medicine, osteopathy, chiropractic, and podiatry.

**(3)** In addition to this part all ~~licensees and~~ registrants are subject to parts 1, 4 and ~~5-2, 3, 4, and 6~~ and all applicable provisions of the other parts.

**R325.xxxx. Definitions A to B.**

**Rule XXX. (1)** As used in this part:

**(a)** "Accessible surface" means the external surface of the enclosure or housing of the radiation producing machine as provided by the manufacturer.

**(b)** "Added filtration" means any filtration which is in addition to the inherent filtration.

**(c)** "Aluminum equivalent" means the thickness of type 1100 aluminum alloy affording the same attenuation, under specified conditions, as the material in question.

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69 (d) "Assembler" means any person engaged in the business of assembling, replacing, or installing  
70 one or more components into an x-ray system or subsystem. The term includes the owner of an x-ray  
71 system or his or her employee or agent who assembles components into an x-ray system that is  
72 subsequently used to provide professional or commercial services.

73 (e) "Attenuation block" means a block or stack, having dimensions 20 centimeters by 20 centimeters  
74 by 3.8 centimeters, of type 1100 aluminum alloy or other materials having equivalent attenuation.

75 (f) "Automatic exposure control (AEC)" means a device which automatically controls one or more  
76 technique factors in order to obtain at a preselected location(s) a required quantity of radiation  
77 (Includes devices such as phototimers and ion chambers).

78 (g) "Barrier" (See "Protective barrier").

79 (h) "Beam axis" means a line from the source through the centers of the x-ray fields.

80 (i) "Beam-limiting device" means a device which provides a means to restrict the dimensions of the  
81 x- ray field.

82

83 **R325.xxxx. Definitions C to D.**

84

85 **Rule xxx. (1) As used in this part:**

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87 (a) "C-arm x-ray system" means an x-ray system in which the image receptor and x-ray tube housing  
88 assembly are connected by a common mechanical support system in order to maintain a desired spatial  
89 relationship. This system is designed to allow a change in the projection of the beam through the patient  
90 without a change in the position of the patient.

91 (b) "Certified components" means components of x-ray systems which are subject to regulations  
92 promulgated under Public Law 90-602, the Radiation Control for Health and Safety Act of 1968, the  
93 Food and Drug Administration.

94 (c) "Certified system" means any x-ray system which has one or more certified component(s).

95 (d) "Changeable filters" means any filter, exclusive of inherent filtration, which can be removed from  
96 the useful beam through any electronic, mechanical, or physical process.

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97 (e) "Coefficient of variation (C)" means the ratio of the standard deviation to the mean value of a set  
98 of observations. It is estimated using the following equation:

$$C = \frac{s}{\bar{x}} = \frac{1}{\bar{x}} \left[ \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1} \right]^{1/2}$$

99 \_\_\_\_\_ where:

100 \_\_\_\_\_ s = Standard deviation of the observed values;

101 \_\_\_\_\_  $\bar{x}$  = Mean value of observations in sample;

102 \_\_\_\_\_  $x_i$  =  $i_{th}$  observation in sample;

103 \_\_\_\_\_ n = Number of observations in sample.

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109 (f) "Control panel" means that part of the x-ray control upon which are mounted the switches, knobs,  
110 pushbuttons, and other hardware necessary for manually setting the technique factors.

111 (g) "Cooling curve" means the graphical relationship between heat units stored and cooling time.

112 (h) "Dead-man switch" means a switch so constructed that a circuit closing contact can be maintained  
113 only by continuous pressure on the switch by the operator.

114 (i) "Detector" (See "Radiation detector").

115 (j) "Diagnostic source assembly" means the tube housing assembly with a beam-limiting device  
116 attached.

117 (k) "Diagnostic x-ray system" means an x-ray system designed for irradiation of any part of the human  
118 or animal body for the purpose of diagnosis or visualization.

119 (l) "Diagnostic x-ray imaging system" means an assemblage of components for the generation,

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120 emission and reception of x-rays and the transformation, storage and visual display of the resultant x-ray  
121 image.

122 (m) "Direct scattered radiation" means that scattered radiation which has been deviated in direction  
123 only by materials irradiated by the useful beam (See "Scattered radiation").

### 124 **R325.xxxx. Definitions E to H.**

125 **Rule xxx. (1) As used in this part:**

126  
127  
128  
129 (a) "Entrance exposure rate" means the exposure free in air per unit time at the point where the  
130 center of the useful beam enters the patient.

131 (b) "Equipment" (See "X-ray equipment").

132 (c) "Filter" means material placed in the useful beam to preferentially absorb selected radiations.

133 (d) "Fluoroscopic imaging assembly" means a subsystem in which x-ray photons produce a visible  
134 image. It includes the image receptor(s) such as the image intensifier and spot-film device, electrical  
135 interlocks, if any, and structural material providing linkage between the image receptor and diagnostic  
136 source assembly.

137 (e) "Focal spot (actual)" means the area projected on the anode of the x-ray tube bombarded by the  
138 electrons accelerated from the cathode and from which the useful beam originates.

139 (f) "General purpose radiographic x-ray system" means any radiographic x-ray system which, by  
140 design, is not limited to radiographic examination of specific anatomical regions.

141 (g) "Gonad shield" means a protective barrier for the testes or ovaries.

142 (h) "Half-value layer" means the thickness of specified material which attenuates the beam of  
143 radiation to an extent such that the exposure rate is reduced by one-half. In this definition, the  
144 contribution of all scattered radiation, other than any which might be present initially in the beam  
145 concerned, is deemed to be excluded.

146 (i) "Healing arts screening" means the testing of human beings using x-ray machines for the  
147 detection or evaluation of health indications when such tests are not specifically and individually ordered

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148 by a licensed practitioner of the healing arts legally authorized to prescribe such x-ray tests for the  
149 purpose of diagnosis or treatment.

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

152 (k) "HVL" (See "Half-value layer").

153  
154 **R325.xxxx. Definitions I to L.**

155  
156 **Rule xxx. (1) As used in this part:**

157  
158 (a) "Image intensifier" means a device, installed in its housing, which instantaneously converts an x-  
159 ray pattern into a corresponding light image of higher intensity.

160 (b) "Image receptor" means any device, such as a fluorescent screen or radiographic film, which  
161 transforms incident x-ray photons either into a visible image or into another form which can be made into  
162 a visible image by further transformations.

163 (c) "Image receptor support" means, for mammographic systems, that part of the system designed to  
164 support the image receptor during mammography.

165 (d) "Inherent filtration" means the filtration of the useful beam provided by the permanently installed  
166 components of the tube housing assembly.

167 (e) "Irradiation" means the exposure of matter to ionizing radiation.

168 (f) "Kilovolts peak" (See "Peak tube potential").

169 (g) "kV" means kilovolts.

170 (h) "kVp" (See "Peak tube potential").

171 (i) "kWs" means kilowatt second.

172 (j) "Lead equivalent" means the thickness of lead affording the same attenuation, under specified  
173 conditions, as the material in question.

174 (k) "Leakage radiation" means radiation emanating from the diagnostic source assembly except for:  
175 the useful beam; and radiation produced when the exposure switch or timer is not activated.

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176 (l) "Leakage technique factors" means the technique factors associated with the diagnostic source  
177 assembly which are used in measuring leakage radiation. They are defined as follows:

178  
179 (i) For diagnostic source assemblies intended for capacitor energy storage equipment, the  
180 maximum-rated peak tube potential and the maximum-rated number of exposures in an hour for  
181 operation at the maximum-rated peak tube potential with the quantity of charge per exposure being 10  
182 millicoulombs, i.e., 10 milliamperere seconds, or the minimum obtainable from the unit, whichever is  
183 larger;

184 (ii) For diagnostic source assemblies intended for field emission equipment rated for pulsed  
185 operation, the maximum-rated peak tube potential and the maximum-rated number of x-ray pulses in  
186 an hour for operation at the maximum-rated peak tube potential;

187 (iii) For all other diagnostic source assemblies, the maximum-rated peak tube potential and  
188 the maximum-rated continuous tube current for the maximum-rated peak tube potential.

189 (m) "Light field" means that area of the intersection of the light beam from the beam-limiting device  
190 and one of the set of planes parallel to and including the plane of the image receptor, whose perimeter is  
191 the locus of points at which the illumination is one-fourth of the maximum in the intersection.

192 (n) "Line-voltage regulation" means the difference between the no-load and the load line potentials  
193 expressed as a percent of the load line potential. It is calculated using the following equation:

194 Percent line-voltage regulation =  $100 (V_0 - V_l) / V_l$

195  
196 where:

197  
198  $V_0$  = No-load line potential; and

199  $V_l$  = Load line potential.

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201 **R325.xxxx. Definitions M to P.**

202  
203 **Rule xxx. (1). As used in this part:**

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**(a)** "mA" means milliampere.

**(b)** "mAs" means milliampere second.

**(c)** "Maximum line current" means the root-mean-square current in the supply line of an x-ray machine operating at its maximum rating.

**(d)** "Mobile x-ray equipment" (See "X-ray equipment").

**(e)** "Patient" means an individual or animal subjected to healing arts examination, diagnosis, or treatment.

**(f)** "PBL" See "Positive beam limitation."

**(e)** "Peak tube potential" means the maximum value of the potential difference across the x-ray tube during an exposure.

**(f)** "Phantom" means a volume of material behaving in a manner similar to tissue with respect to the attenuation and scattering of radiation. This requires that both the atomic number (Z) and the density of the material be similar to that of tissue.

**(g)** "Portable x-ray equipment" (See "X-ray equipment").

**(h)** "Positive beam limitation" means the automatic or semi-automatic adjustment of an x-ray beam to the size of the selected image receptor, whereby exposures cannot be made without such adjustment.

**(i)** "Primary protective barrier" (See "Protective barrier").

**(j)** "Protective apron" means an apron made of radiation absorbing materials used to reduce radiation exposure.

**(k)** "Protective barrier" means a barrier of radiation absorbing material(s) used to reduce radiation exposure. The types of protective barriers are as follows:

**(l)** "Primary protective barrier" means the material, excluding filters, placed in the useful beam;

**(m)** "Secondary protective barrier" means the material which attenuates stray radiation.

**(n)** "Protective glove" means a glove made of radiation absorbing materials used to reduce radiation exposure.

**R325.xxxx. Definitions Q to S.**

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**Rule xxx. (1) As used in this part:**

**(a)** "Qualified expert" means an individual who has demonstrated to the satisfaction of the department that such individual possesses the knowledge, training and experience to measure ionizing radiation, to evaluate safety techniques, and to advise regarding radiation protection needs.

**(b)** "Radiation detector" means a device which in the presence of radiation provides a signal or other indication suitable for use in measuring one or more quantities of incident radiation.

**(c)** "Radiograph" means an image receptor on which the image is created directly or indirectly by an x-ray pattern and results in a permanent record.

**(d)** "Radiographic imaging system" means any system whereby a permanent or semi-permanent image is recorded on an image receptor by the action of ionizing radiation.

**(e)** "Rating" means the operating limits as specified by the component manufacturer.

**(f)** "Recording" means producing a permanent form of an image resulting from x-ray photons.

**(g)** "Scattered radiation" means radiation that, during passage through matter, has been deviated in direction (See "Direct scattered radiation").

**(h)** "Secondary protective barrier" (See "Protective barrier").

**(i)** "Shutter" means a device attached to the tube housing assembly which can intercept the entire cross sectional area of the useful beam and which has a lead equivalency not less than that of the tube housing assembly.

**(j)** "SID" (See "Source-image receptor distance").

**(k)** "Source" means the focal spot of the x-ray tube.

**(l)** "Source-image receptor distance" means the distance from the source to the center of the input surface of the image receptor.

**(m)** "Spot film" means a radiograph which is made during a fluoroscopic examination to permanently record conditions which exist during that fluoroscopic procedure.

**(n)** "Spot-film device" means a device intended to transport and/or position a radiographic image receptor between the x-ray source and fluoroscopic image receptor. It includes a device intended to

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260 hold a cassette over the input end of an image intensifier for the purpose of making a radiograph.

261 (o) "SSD" means the distance between the source and the skin entrance plane of the patient.

262 (p) "Stationary x-ray equipment" (See "X-ray equipment").

263 (q) "Stray radiation" means the sum of leakage and scattered radiation.

264  
265 **R325.xxxx. Definitions T to V.**

266  
267 **Rule xxx. (1) As used in this part:**

268  
269 (a) "Technique factors" means the following conditions of operation:

270 (i) For capacitor energy storage equipment, peak tube potential in kV and quantity of charge  
271 in mAs;

272 (ii) For field emission equipment rated for pulsed operation, peak tube potential in kV, and  
273 number of x-ray pulses;

274 (iii) For CT x-ray systems designed for pulsed operation, peak tube potential in kV, scan time  
275 in seconds, and either tube current in mA, x-ray pulse width in seconds, and the number of x-ray  
276 pulses per scan, or the product of tube current, x-ray pulse width, and the number of x-ray pulses in  
277 mAs;

278 (iv) For CT x-ray systems not designed for pulsed operation, peak tube potential in kV, and  
279 either tube current in mA and scan time in seconds, or the product of tube current and exposure time  
280 in mAs and the scan time when the scan time and exposure time are equivalent; and

281 (v) For all other equipment, peak tube potential in kV, and either tube current in mA and  
282 exposure time in seconds, or the product of tube current and exposure time in mAs.

283  
284 (b) "Termination of irradiation" means the stopping of irradiation in a fashion which will not permit  
285 continuance of irradiation without the resetting of operating conditions at the control panel.

286 (c) "Tomogram" means the depiction of the x-ray attenuation properties of a section through the body.

287 (d) "Tube" means an x-ray tube, unless otherwise specified.

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288 (e) "Tube housing assembly" means the tube housing with tube installed. It includes high-voltage  
289 and/or filament transformers and other appropriate elements when such are contained within the tube  
290 housing.

291 (f) "Tube rating chart" means the set of curves which specify the rated limits of operation of the tube  
292 in terms of the technique factors.

293 (g) "Type 1100 aluminum alloy" means aluminum that has a nominal chemical composition of 99.00  
294 percent minimum aluminum and 0.12 percent copper.

295 (h) "Useful beam" means the radiation emanating from the tube housing port or the radiation head  
296 and passing through the aperture of the beam limiting device when the exposure controls are in a mode  
297 to cause the system to produce radiation.

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

300 (j) "Visible area" means that portion of the input surface of the image receptor over which incident x-  
301 ray photons are producing a visible image.

302

### 303 **R325.xxxx. Definitions X to Z.**

304

#### 305 **Rule xxx. (1) As used in this part:**

306

307 (a) "X-ray exposure control" means a device, switch, button or other similar means by which an  
308 operator initiates and/or terminates the radiation exposure. The x-ray exposure control may include such  
309 associated equipment as timers and back-up timers.

310 (b) "X-ray equipment" means an x-ray system, subsystem, or component thereof. Types of x-ray  
311 equipment are as follows:

312 (c) "Mobile x-ray equipment" means x-ray equipment mounted on a permanent base with wheels  
313 and/or casters for moving while completely assembled.

314 (d) "Portable x-ray equipment" means x-ray equipment designed to be hand-carried.

315 (e) "Stationary x-ray equipment" means x-ray equipment which is installed in a fixed location.

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316 (f) "X-ray field" means that area of the intersection of the useful beam and any one of the set of  
317 planes parallel to and including the plane of the image receptor, whose perimeter is the locus of points  
318 at which the exposure rate is one-fourth of the maximum in the intersection.

319 (g) "X-ray high-voltage generator" means a device which transforms electrical energy from the  
320 potential supplied by the x-ray control to the tube operating potential. The device may also include  
321 means for transforming alternating current to direct current, filament transformers for the x-ray tube(s),  
322 high-voltage switches, electrical protective devices, and other appropriate elements.

323 (h) "X-ray system" means an assemblage of components for the controlled production of x-rays. It  
324 includes minimally an x-ray high-voltage generator, an x-ray control, a tube housing assembly, a beam-  
325 limiting device, and the necessary supporting structures. Additional components which function with the  
326 system are considered integral parts of the system.

327 (i) "X-ray table" means a patient support device with its patient support structure (tabletop)  
328 interposed between the patient and the image receptor during radiography and/or fluoroscopy. This  
329 includes, but is not limited to, any stretcher equipped with a radiolucent panel and any table equipped  
330 with a cassette tray (or bucky), cassette tunnel, image intensifier, or spot-film device beneath the  
331 tabletop.

332 (j) "X-ray tube" means any electron tube which is designed for the conversion of electrical energy  
333 into X-ray energy.

**THERAPEUTIC MACHINES OPERATED  
-ABOVE 85 KVP**

**R325.5312. ~~\_\_\_\_\_~~ X-ray equipment.**

338 **Rule 312. (1) ~~\_\_\_\_\_~~** The tube housing shall be of the therapeutic type.

341 **(2) ~~\_\_\_\_\_~~** Permanent diaphragms or cones used for collimating the useful beam shall afford the same  
342 degree of attenuation as is required of the housing.

343 **(3) ~~\_\_\_\_\_~~** Adjustable or removable beam-limiting devices shall transmit not more than 5% of the useful  
344 beam as determined at the maximum tube potential and with maximum treatment filter.

345 **(4) ~~\_\_\_\_\_~~** Filters shall be so mounted as to prevent their movement during the treatment.

346 **(5) ~~\_\_\_\_\_~~** The filter slot shall be so constructed that the radiation escaping through it does not produce  
347 an exposure rate exceeding 1 R/h at 1 meter, or if the patient is likely to be exposed to radiation escaping from  
348 the slot, 30 R/h at 5 centimeters (2 inches) from the external opening.

349 **(6) ~~\_\_\_\_\_~~** A removable filter shall be permanently marked with its thickness and material.

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355 ~~(7) ————— A filter indication system shall be used on therapy machines which use changeable filters and~~  
356 ~~are manufactured after the effective date of these rules. It shall indicate, from the control panel, the presence~~  
357 ~~or absence of any filter and it shall be designed to permit easy recognition of the filter in place.~~

358  
359 ~~(8) ————— The x-ray tube shall be so mounted that it cannot turn or slide with respect to the housing~~  
360 ~~aperture. A reproducible means of measuring the focal spot to patient distance shall be provided.~~

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363  
364 ~~(9) ————— Means to immobilize the tube housing during stationary portal treatment shall be provided.~~

365  
366 ~~(10) — An easily discernible indicator which shows whether or not x-rays are being produced shall be on the~~  
367 ~~control panel.~~

368  
369 ~~(11) — On therapeutic machines manufactured after the effective date of these rules beam monitoring~~  
370 ~~devices shall be fixed in the useful beam to indicate any error due to incorrect filter, tube current, or tube~~  
371 ~~potential, unless the device introduces more filtration than is clinically acceptable.~~

372  
373 ~~(12) — A suitable exposure control device (e.g. an automatic timer, exposure meter or dose meter) shall be~~  
374 ~~provided to terminate the exposure after a preset time interval or preset exposure or dose limit. If a timer is~~  
375 ~~used, it shall permit accurate presetting and determination of exposure times as short as 1 second. Means for~~  
376 ~~the operator to terminate the exposure at any time shall be provided.~~

377  
378 ~~(13) — Mechanical or electrical stops or both shall be provided to insure that the useful beam is oriented only~~  
379 ~~toward primary barriers.~~

380  
381 ~~(14) — Interlocks shall be provided so that, when any door to the treatment room is opened, the machine will~~  
382 ~~shut off automatically or the radiation level within the room will be reduced to an average of not more than 2~~  
383 ~~mR/h and a maximum of 10 mR/h at a distance of 1 meter in any direction from the source. After the shut-off~~  
384 ~~or reduction in exposure rate, it shall be possible to restore the machine to full operation only from the control~~  
385 ~~panel.~~

386  
387 ~~(15) — The x-ray control circuit shall be so designed that it is not possible to energize the x-ray tube to~~  
388 ~~produce x-rays without resetting the x-ray "ON-OFF" switch at the control panel.~~

389  
390 ~~(16) — When the relationship between the beam interceptor (when present) and the useful beam is not~~  
391 ~~permanently fixed, mechanical or electrical stops shall be provided to insure that the beam is oriented only~~  
392 ~~toward primary barriers.~~

393  
394 ~~(17) — X-ray equipment installed after the effective date of these rules shall be installed and used in accord~~  
395 ~~with the appropriate portions of the 1975 national electrical code (NFPA No. 70-1975) reproduced or~~  
396 ~~referenced in rule 359. X-ray equipment installed before the effective date of these rules shall conform with~~  
397 ~~the appropriate national electrical code in effect at the time of installation.~~

398  
399 ~~(18) — X-ray machines with electron beam extraction capability shall be provided with such additional safety~~  
400 ~~devices as determined necessary and specified in writing by the department to prevent accidental electron~~  
401 ~~beam exposure.~~

402  
403 ~~(19) — To reduce the electron contamination of high energy treatment beams, shadow trays or other~~  
404 ~~accessories placed in the primary beam shall be placed at a sufficient distance from the patient that the~~  
405 ~~electron contamination contribution to the skin dose is minimal.~~

406  
407 ~~(20) — X-ray machines capable of producing radioactive material in excess of exempt quantities~~  
408 ~~listed in schedule B of rule 147 unless excluded from the particle accelerator definition in part 1 by design and~~  
409 ~~use shall comply with the applicable requirements of part 11.~~

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### ~~R325.5315. Enclosures.~~

~~Rule 315. (1) An enclosure shall be a permanent part of the building or equipment. Portable protective barriers shall not be used for permanent installations.~~

~~(2) The degree of protection required for an enclosure shall be determined by the workload, use and occupancy factors and the kilovoltage, milliamperage, mechanical movement, and distance factor, and shall be subject to design approval by the department.~~

~~(3) All wall, ceiling and floor areas that can be irradiated by the useful beam plus an additional area extending at least 30 centimeters (1 foot) beyond shall be provided with a primary protective barrier.~~

~~(4) For equipment capable of operating above 150 kVp the control station shall be outside of the therapy room.~~

~~(5) The enclosure shall be so constructed that persons may at all times be able to escape from within.~~

~~(6) If the radiation exposure rate within the therapy room is so high that a person who is accidentally in the treatment room when the machine is turned "ON" may receive as much as 1250 mR exposure during the time required to reach an access door, special cut-off or panic buttons shall be required. When pressed, these buttons, operable by open hand at appropriate positions about the treatment room, shall cause the irradiation to be terminated.~~

~~(7) Effective means shall be provided to prevent access to the treatment room during exposure. For equipment capable of operating above 150 kVp, each access door to the treatment room shall be provided with a fail-safe interlock. The interlock system shall be so designed that the failure of any 1 component will not jeopardize the safety of the system, (e.g., the use of series connected double switch assemblies at access doors, and dual interlock relays). If an access door is opened when the machine is "ON", the interlock shall cause termination or reduction of exposure as specified in rule 312 (14).~~

~~(8) Red warning signal lights, energized only when the useful beam in "ON", shall be located on the control panel and near each entrance to the therapy room. Under conditions as specified in subrule (6) a visible signal shall also be located within the therapy room. Depending upon control panel and door locations, a single warning signal light may be sufficient to comply with this subrule.~~

### ~~R325.5317. Conditions of operation.~~

~~Rule 317. (1) An installation shall be operated in compliance with any limitations determined necessary and specified in writing by the department.~~

~~(2) The output of the x-ray generator shall be calibrated before use for the treatment of patients for each technique or condition of use. The department shall be informed by telephone or in writing of completion of initial calibration before patient treatment is initiated. A written report of this initial calibration only shall be submitted within 30 days to the department. Recalibration shall be required after each tube replacement and after any changes or replacement in the generating apparatus which could effect a change in the x-ray output. Check calibrations shall be made on an annual basis and records of all calibration maintained for not less than 7 years.~~

~~(3) X-ray therapy equipment capable of operating above 150 kVp shall not be operated routinely until the radiation safety of the installation has been established by a protection survey conducted in accordance with rule 221. The department shall be informed by telephone or in writing of completion of the initial survey before patient treatment is initiated. A written report of this initial survey shall be submitted within 30 days to the department. All x-ray therapy equipment shall be operated in conformance with recommendations of the protection survey.~~

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466  
467 ~~(4) ————— Both the control panel and the patient shall be observable during exposure.~~

468  
469 ~~(5) ————— When a patient must be held in position for radiation therapy, mechanical supporting or~~  
470 ~~restraining devices should be used. If the patient must be held by an individual, upon approval by the~~  
471 ~~radiologist in charge followed by written notice to the department, that individual shall be provided protection~~  
472 ~~equivalent to 7 half value layers and he shall be positioned so that no part of his body will be struck by the~~  
473 ~~useful beam and so that his body is as far as possible from the edge of the useful beam. The exposure of any~~  
474 ~~individual used for this purpose shall be monitored and a permanent record maintained. The individual~~  
475 ~~selected for this purpose shall not otherwise be occupationally exposed to ionizing radiation.~~

476  
477 ~~(6) ————— With the exception of subrule (5), a person other than the patient shall not be permitted in the~~  
478 ~~treatment room when the tube is operated at potentials exceeding 85 kVp. At potentials of 85 kVp or below,~~  
479 ~~other persons may be permitted in the treatment room by the radiologist in charge if essential to conduct the~~  
480 ~~treatment, but only if they are protected as specified in subrule (5) and their radiation exposure is monitored~~  
481 ~~and permanently recorded.~~

482  
483 ~~(7) ————— Personnel monitoring shall be performed in controlled areas for each individual occupationally~~  
484 ~~exposed to ionizing radiation from therapeutic x-ray equipment. Personnel monitoring devices such as film~~  
485 ~~badge dosimeters or thermoluminescent dosimeters shall be permanently assigned to each occupationally~~  
486 ~~exposed individual. This monitoring shall be continuous during employment as a radiation worker.~~

487  
488 ~~(8) ————— Personnel exposure records shall be kept on permanent available file at the facility where the~~  
489 ~~exposure occurs.~~

490  
491 ~~(9) ————— Monitoring devices used to estimate whole body exposure shall normally be worn on the chest~~  
492 ~~or abdomen. Monitoring of any other body part shall comply with rule 222.~~

493  
494 ~~(10) Monitoring devices worn to estimate personnel occupational exposure shall not be worn by the~~  
495 ~~individual when he is exposed as a patient for any medical or dental reason.~~

496  
497 ~~(11) Lead, lead rubber, lead foil and similar materials used for limiting the field shall not transmit more than~~  
498 ~~5% of the useful beam under the conditions at which the machine is operated for therapy. This subrule does~~  
499 ~~not pertain to treatment blocks used to adjust or modify the intended radiation dose to the area of treatment.~~

500  
501 ~~(12) A therapeutic x-ray system shall not be left unattended without locking the apparatus, room or building~~  
502 ~~in some manner which will prevent use of the apparatus by unauthorized persons.~~

503  
504 ~~————— THERAPEUTIC MACHINES OPERATED~~

505 ~~————— AT OR BELOW 85 KVP~~

506  
507 ~~R325.5321. ————— X-ray equipment.~~

508  
509  
510 ~~Rule 321. (1) ————— The x-ray equipment shall comply with the general requirements of rule 312~~  
511 ~~excluding subrules (11), (14) and (16).~~

512  
513 ~~(2) ————— Maximum potential shall be mechanically or electronically limited to 85 kVp.~~

514  
515 ~~(3) ————— A contact therapy machine shall meet the additional requirement that the leakage radiation at~~  
516 ~~5 centimeters (2 inches) from the surface of the tube housing shall not exceed 0.1 R/h. As used in this subrule~~  
517 ~~"contact therapy machine" means an x-ray therapy machine designed for source to skin treatment distances of~~  
518 ~~5 centimeters or less at tube potentials in the range of 20 to 50 kVp.~~

519  
520 ~~R325.5322. ————— Enclosures.~~

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522 ~~Rule 322.~~— An enclosure shall comply with the general requirements of rules 315 (1) and (2).

523

524 ~~R325.5323.~~ ~~Conditions of operation.~~

525

526 ~~Rule 323. (1)~~— Operation shall comply with the general requirements of rule 317.

527

528 If the x-ray tube of a contact therapy machine as defined in rule 321 (3) is hand held during irradiation, the  
 529 operator shall wear protective gloves and a protective apron. When practical, a cap of at least 0.5 millimeter  
 530 lead equivalence should cover the aperture window of the tube housing of such apparatus when the apparatus  
 531 is not being used. Because the exposure rate at the surface of the window of contact therapy and beryllium  
 532 window machines may be more than 10,000 R per minute, extreme precautions are necessary to prevent  
 533 accidental exposure to the useful beam.

All therapy requirements have been moved to new Part 15.

534

535

536

**FIXED RADIOGRAPHIC INSTALLATIONS**

These rules are being replaced with the updated SSRCR equivalent. General requirements have been moved to Part 6.

537

538

539

~~R325.5325.~~ ~~X-ray equipment.~~

540

541

~~Rule 325. (1)~~— All x-ray tube housings in fixed radiographic installations shall be of the diagnostic type.

542

543

544

~~(2)~~— The aluminum equivalent of the total filtration in the useful beam shall not be less than the values shown in Table 1.

545

546

**TABLE 1**

Operating kVp	Minimum Total Filter
(Inherent plus added)	
Below 50 kVp	0.5 mm aluminum
50-70 kVp	1.5 mm aluminum
Above 70 kVp	2.5 mm aluminum

547

548

549

550

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553

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555

~~(3)~~— If the filter in the machine is not accessible for examination and the total filtration is not known subrule (2) may be assumed to have been met if the half-value layer is not less than

— 0.6 mm aluminum at 49 kVp

— 1.6 mm aluminum at 70 kVp

— 2.6 mm aluminum at 90 kVp

556

557

558

559

560

561

~~(4)~~— Under conditions of subrule (3) for tube potentials above 90 kVp subrule (2) may be assumed to have been met if the half-value layer is not less than that specified in table 2.

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**TABLE 2**

Design operating range	Measured potential	Half-value layer

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<del>(Kilovolts peak)</del> _____	<del>(Kilovolts peak)</del>	<del>(millimeters)</del>
<del>Below 50</del> _____	<del>30</del>	<del>0.3</del>
_____	<del>40</del>	<del>0.4</del>
_____	<del>49</del>	<del>0.5</del>
<del>50 to 70</del> _____	<del>50</del>	<del>1.2</del>
_____	<del>60</del>	<del>1.3</del>
_____	<del>70</del>	<del>1.5</del>
<del>Above 70</del> _____	<del>80</del>	<del>2.3</del>
	<del>90</del>	<del>2.5</del>
	<del>100</del>	<del>2.7</del>
	<del>110</del>	<del>3.0</del>
	<del>120</del>	<del>3.2</del>
	<del>130</del>	<del>3.5</del>
	<del>140</del>	<del>3.8</del>
	<del>150</del>	<del>4.1</del>

570 ~~(6)~~ \_\_\_\_\_ If it is necessary to determine the half value layer at an x ray tube potential which is not listed  
 571 in table 2, linear interpolation or extrapolation may be made. Positive means shall be provided to insure that at  
 572 least the minimum filtration needed to achieve these beam quality requirements is in the useful beam during  
 573 each exposure.

574  
 575 ~~(7)~~ \_\_\_\_\_ Machines equipped with beryllium window x-ray tubes with removable filters shall contain  
 576 keyed filter interlock switches in the tube housing and suitable indication on the control panel of the added filter  
 577 in the useful beam. The total filtration permanently in the useful beam shall not be less than 0.5 millimeter  
 578 aluminum equivalent and shall be clearly indicated on the tube housing.

579  
 580 ~~(8)~~ \_\_\_\_\_ Beryllium window x-ray tubes shall not be used routinely for general purpose diagnostic  
 581 examinations. Such a tube may comprise an x-ray subsystem if needed for special soft tissue technique in  
 582 accord with subrule (7).

583  
 584 ~~(9)~~ \_\_\_\_\_ Beam-limiting devices (diaphragms, cones, adjustable collimators), capable of restricting the  
 585 useful beam to the area radiographically recorded shall be provided to define the beam and shall provide the  
 586 same degree of attenuation as that required of the tube housing.

587  
 588 ~~(10)~~ Beam-limiting devices shall be calibrated in terms of the size of the projected useful beam at specified  
 589 source image distances (SID). This calibration shall be clearly and permanently recorded on the  
 590 beam-limiting device. Calibration of adjustable beam-limiting devices shall permit reproducible  
 591 settings.

592  
 593 ~~(11)~~ X-ray systems designed for only 1 image receptor size at a fixed SID shall be provided with means to  
 594 limit the field at the plane of the image receptor to dimensions no greater than those of the image  
 595 receptor, and to align the center of the x-ray field with the center of the image receptor to within 2%  
 596 of the SID. However, for mammography the x-ray field need not be aligned with the center of the  
 597 image receptor if the x-ray field does not extend beyond the edge of the image receptor.

598  
 599 ~~(12)~~ General purpose radiographic x-ray systems shall be equipped with adjustable beam-limiting devices  
 600 containing light localizers that define the entire field. Rectangular beam-limiting devices are usually preferable.

601  
 602 ~~(13)~~ The size of the x-ray beam projected by fixed aperture beam-limiting devices, except those used for  
 603 stereoradiography, shall not exceed the dimensions of the image receptor by more than 2% of the SID when  
 604 the axis of the x-ray beam is perpendicular to the plane of the image receptor.

605

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606 ~~(14) The calibrated field size indicator on adjustable beam-limiting devices shall be accurate to within 2% of~~  
607 ~~the SID. The light field shall be aligned with the x-ray field with the same degree of accuracy. The field size~~  
608 ~~projected by automatic adjustable beam-limiting devices shall provide the same precision.~~  
609

610 ~~(15) For radiographic procedures resulting in multiple views on a single x-ray film the beam-limiting device~~  
611 ~~shall limit the x-ray field size to the recorded radiographic image size within 2% of the SID. Covering a portion~~  
612 ~~of the radiographic film with radio-opaque material is not a substitute for proper x-ray field limitation. This~~  
613 ~~subrule does not apply to spotfilm devices manufactured before the effective date of these rules.~~  
614

615 ~~(16) After the effective date of these rules radiographic x-ray machines used for purposes other than~~  
616 ~~mammography or extremity radiography only shall be capable of operation at not less than an~~  
617 ~~average current of 100 milliamperes (mA) during any radiographic technique used. A machine not~~  
618 ~~capable of sustained operation at not less than an average of 100 mA for the duration of a given~~  
619 ~~technique shall not be used for that technique. As used in this subrule "extremity radiography"~~  
620 ~~means radiography of the hand or arm excluding the shaft of the humerus or the foot or leg~~  
621 ~~excluding the shaft of the femur.~~  
622

623 ~~(17) A device shall be provided which terminates the exposure at a preset time interval or exposure limit.~~  
624 ~~The operator shall be able to terminate the exposure at any time by discontinuing pressure upon the~~  
625 ~~exposure switch except that during serial radiography means may be provided to permit completion~~  
626 ~~of any single exposure in progress.~~  
627

628 ~~(18) The exposure switch, except for those used in conjunction with spot film devices in fluoroscopy, shall~~  
629 ~~be securely fixed so that the operator is required to be behind a fixed shield which will intercept the~~  
630 ~~useful beam and any radiation which has been scattered only once.~~  
631

632 ~~(19) When 2 or more x-ray tube heads are operated from a single exposure switch (multiple tube units),~~  
633 ~~there shall be indication at the control panel showing which tube is connected and ready to be energized, and~~  
634 ~~means to prevent energizing more than 1 tube head at the same time unintentionally. Machines designed for~~  
635 ~~simultaneous multiple tube operation shall have positive means for selecting single tube or multiple tube~~  
636 ~~operation.~~  
637

638 ~~(20) The control panel shall provide positive visual identification of the production of x-rays whenever the x-~~  
639 ~~ray tube is energized. A milliammeter may comply with this subrule.~~  
640

641 ~~(21) On radiographic machines manufactured after the effective date of these rules, a signal audible to the~~  
642 ~~operator shall indicate that the exposure has ended.~~  
643

644 ~~(22) The technique factors to be used during an exposure shall be indicated before the exposure begins,~~  
645 ~~except when automatic exposure controls are used, in which case the technique factors which are set before~~  
646 ~~the exposure shall be indicated. On equipment having fixed technique factors, this requirement may be met~~  
647 ~~by permanent markings. Indication of technique factors shall be visible from the operator's position.~~  
648

649 ~~(23) X-ray equipment installed after the effective date of these rules shall be installed and used in accord~~  
650 ~~with the appropriate portions of the 1975 national electrical code (NFPA No. 70-1975) reproduced or~~  
651 ~~referenced in rule 359. X-ray equipment installed before the effective date of these rules shall conform with~~  
652 ~~the appropriate national electrical code in effect at the time of installation.~~  
653

### RADIOGRAPHIC SYSTEMS

#### R325.5325. Radiographic x-ray equipment.

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659 **Rule 325.** The x-ray equipment shall meet the requirements of rule xx15 (equipment requirements)  
660 in Part 6.

661

662 **R325.5326. Radiation exposure control.**

663

664 **Rule 326. (1) Exposure Control Location.** The x-ray exposure control shall be so placed that the  
665 operator can view the patient while making any exposure.

666

667 **(2) Operator Protection - Stationary Systems.** Stationary x-ray systems shall be required to have the  
668 x-ray control permanently mounted in a protected area so that the operator is required to remain in that  
669 protected area during the entire exposure.

670

671 **(3) Operator Protection - Mobile and Portable Systems.** Mobile and portable x-ray systems which are:

672

673 **(a)** Used continuously for greater than one week in the same location, i.e., a room or suite, shall meet  
674 the requirements of rule 326(8):

675

676 **(b)** Used for less than one week at the same location shall be provided with either a protective barrier  
677 at least 2 meters (6.5 feet) high for operator protection during exposures, or means shall be provided to  
678 allow the operator to be at least 2.7 meters (9 feet) from the tube housing assembly during the  
679 exposure.

680

681 **R325.5328. Machine output .**

682

683 **Rule 328. (1) Minimum output.** Radiographic x-ray machines used for purposes other than extremity  
684 radiography shall be capable of operation at not less than an average current of 100 milliamperes (mA)  
685 during any radiographic technique used. Mobile or portable units shall be capable of an output of at least

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686 75 mR per second at 80 kVp and 40 inches from the x-ray tube target to be used for purposes other than  
687 extremity radiography.

688  
689 (2) Radiation from Capacitor Energy Storage Equipment in Standby Status. Radiation emitted from the  
690 x-ray tube when the system is fully charged and the exposure switch or timer is not activated shall not  
691 exceed a rate of 0.5  $\mu$ C/kg (2 milliroentgens) per hour at 5 centimeters from any accessible surface of the  
692 diagnostic source assembly, with the beam-limiting device fully open.

693  
694 **R325.5329. Additional requirements applicable to certified systems only.**

695  
696 **Rule 329. Diagnostic x-ray systems incorporating one or more certified component(s) shall be**  
697 **required to comply with the following additional requirement(s) which relate to that certified component(s).**

698  
699 **(a) Beam Limitation for Stationary and Mobile General Purpose X-Ray Systems.**

700 **(i) There shall be provided a means of stepless adjustment of the size of the x-ray field. The**  
701 **minimum field size at an SID of 100 centimeters shall be equal to or less than 5 centimeters by 5**  
702 **centimeters.**

703 **(ii) When a light localizer is used to define the x-ray field, it shall provide an average illumination of**  
704 **not less than 160 lux or 15 footcandles at 100 centimeters or at the maximum SID, whichever is less.**  
705 **The average illumination shall be based upon measurements made in the approximate center of each**  
706 **quadrant of the light field. Radiation therapy simulation systems manufactured on and after May 27,**  
707 **1980, are exempt from this requirement.**

708 **(iii) The edge of the light field at 100 centimeters or at the maximum SID, whichever is less, shall have**  
709 **a contrast ratio, corrected for ambient lighting, of not less than 4 in the case of beam-limiting devices**  
710 **designed for use on stationary equipment, and a contrast ratio of not less than 3 in the case of beam-**  
711 **limiting devices designed for use on mobile equipment. The contrast ratio is defined as  $I_1/I_2$  where  $I_1$  is**  
712 **the illumination 3 millimeters from the edge of the light field toward the center of the field; and  $I_2$  is the**

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713 illumination 3 millimeters from the edge of the light field away from the center of the field. Compliance  
714 shall be determined with a measuring instrument aperture of 1 millimeter in diameter.

715 **(b)** Beam Limitation and Alignment on Stationary General Purpose X-Ray Systems Equipped with

716 PBL. If PBL is being used, the following requirements shall be met:

717 **(i)** PBL shall prevent the production of x-rays when:

718 **(A)** Either the length or width of the x-ray field in the plane of the image receptor differs,  
719 except as permitted by rule 329(b)(iii), from the corresponding image receptor dimensions by more  
720 than 3 percent of the SID; or

721 **(B)** The sum of the length and width differences as stated in (a) above without regard to sign  
722 exceeds 4 percent of the SID;

723 **(ii)** Compliance with rule 329(b)(i) shall be determined when the equipment indicates that the beam  
724 axis is perpendicular to the plane of the image receptor. Compliance shall be determined no sooner  
725 than 5 seconds after insertion of the image receptor;

726 **(iii)** The PBL system shall be capable of operation, at the discretion of the operator, such that the size  
727 of the field may be made smaller than the size of the image receptor through stepless adjustment of the  
728 field size. The minimum field size at an SID of 100 centimeters shall be equal to or less than 5  
729 centimeters by 5 centimeters;

730 **(iv)** The PBL system shall be designed such that if a change in image receptor does not cause an  
731 automatic return to PBL function as described in rule 329(b)(i), then any change of image receptor size  
732 or SID must cause the automatic return.

733 **(c)** Beam Limitation for Portable X-Ray Systems. Beam limitation for portable x-ray systems shall  
734 meet the beam limitation requirements of rule 325(1)(a) or Rule 329(b).

735  
736 **R325.5331. Enclosures.**

737  
738 **Rule 331. ~~(1)~~** An enclosure shall be a permanent part of the building or equipment. Portable shields shall  
739 not be used for permanent installations.

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741 ~~(2)~~—The degree of protection required for an enclosure shall be determined by the workload, use and  
742 occupancy factors and the kilovoltage, milliamperage, mechanical movement and distance factor, and shall be  
743 subject to design approval by the department. Recommended shielding appears in rule 357.

744  
745 ~~(3)~~—Radiographic room wall and floor areas exposed to the useful beam plus an additional area extending  
746 at least 30 centimeters (1 foot) beyond shall be provided with a primary protective barrier where necessary as  
747 determined by workload, use, occupancy and distance factors. All vertical primary protective barriers specified  
748 in this rule shall extend continuously from the floor to a minimum height of 2.1 meters (7 feet).

749  
750 ~~(4)~~—Secondary protective barriers shall be provided in the radiographic room ceiling, FLOOR, and in those  
751 walls not requiring primary barriers.

Subrules 1-4 Moved to the general requirements (Part 6).
--

752  
753 ~~(5)(1)~~ General purpose radiography Control apparatus for the radiographic equipment shall be shielded by  
754 a primary protective barrier which cannot be removed from a protective position between the operator and the  
755 radiation source during machine operation.

756  
757 ~~(6)(2)~~ Movable barriers with electrical interlocks shall not be approved in lieu of compliance with subrule  
758 ~~(5)(1)~~.

759  
760 ~~(7)(3)~~ General purpose radiography Exposure switch location and control shield shall be oriented so that, at  
761 arm's length from the exposure switch, the operator shall not be exposed to the useful beam, leakage radiation  
762 or any radiation scattered only once.

763  
764 ~~(8)(4)~~ The operator of general purpose radiographic equipment shall be able to see and communicate with  
765 the patient from a shielded position at the control panel. When an observation window is provided, it shall be a  
766 lead equivalence at least equal to that required of the control barrier and shall be installed so that the  
767 attenuation effectiveness of the barrier is not impaired.

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**(9)** At times it may be necessary for personnel to remain within operating room or special procedure installations during radiographic exposures. A primary protective barrier shall be provided for personnel protection under these circumstances unless necessary technique prevents use of such protection. This barrier may be movable if necessary. Movable barriers shall not be permitted in lieu of the provisions of subrules ~~(3) and (5)~~ (1).

**(10) Design requirements for an operator's booth**

**(a) Space Requirements:**

**(i)** The operator shall be allotted not less than 0.70 m<sup>2</sup> (7.5 square feet) of unobstructed floor space in the booth;

**(ii)** The operator's booth may be any geometric configuration with no dimension of less than 0.6 m (2 feet);

**(iii)** The space shall be allotted excluding any encumbrance by the x-ray control panel, such as overhang, cables, or other similar encroachments;

**(iv)** The booth shall be located or constructed such that unattenuated direct scatter radiation originating on the examination table or at the wall-mounted image receptor will not reach the operator's position in the booth.

**(b) Structural Requirements:**

**(i)** The booth walls shall be permanently fixed barriers of at least 2.1 meters (7 feet) high;

**(ii)** Shielding shall be provided to meet the requirements of Part 4 of these regulations.

**(c) Radiation Exposure Control Placement:**

The radiation exposure control for the system shall be fixed within the booth and:

**(i)** SHALL BE AT LEAST 1.0 M (40 INCHES) FROM ANY POINT SUBJECT TO DIRECT SCATTER, LEAKAGE OR PRIMARY BEAM RADIATION;

**(ii)** Shall allow the operator to use the majority of the available viewing windows.

**(d) Viewing System Requirements:**

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816 (i) Each booth shall have at least one viewing device which will:

817 (A) Be so placed that the operator can view the patient during any exposure; and

818 (B) Be so placed that the operator can have full, undistorted view of any occupant of the room  
819 and should be so placed that the operator can view any entry into the room. If any door which allows  
820 access to the room cannot be seen from the booth, then outside that door there shall be an "x-ray  
821 on" warning sign that will be lighted anytime the rotor of the x-ray tube is activated. Alternatively, an  
822 interlock shall be present such that exposures are prevented unless the door is closed.

823 (ii) When the viewing system is a window, the following requirements also apply:

824 (A) The window shall have a viewing area of at least 0.09 m<sup>2</sup> (1 square foot);

825 (B) Regardless of size or shape, at least 0.09 m<sup>2</sup> (1 square foot) of the window area must be  
826 centered no less than 0.6 m (2 feet) from the open edge of the booth and centered 1.5 m (5.0 feet)  
827 from the floor;

828 (C) The window shall have at least the same lead equivalence as that required in the booth's  
829 wall in which it is mounted.

830 (iii) When the viewing system is by mirrors, the mirror(s) shall be so located as to accomplish  
831 the general requirements of subrule (d)(i) above.

832 (iv) When the viewing system is by electronic means The camera shall be so located as to  
833 accomplish the general requirements of Appendix B4.(a), and There shall be an alternate viewing  
834 system as a backup for the primary system.

835 **R325.5333. — Conditions of operation.**

836 ~~**Rule 333. (1)** An operator shall properly utilize the beam-limiting devices provided to restrict the useful~~  
837 ~~beam to the smallest area consistent with clinical requirements. Particular care shall be taken to align~~  
838 ~~accurately the x-ray beam with the patient and film.~~

839 ~~**(2)** The operator shall insure the presence of adequate filtration before any radiographic procedure.~~

840 ~~**(3)** Staff personnel routinely working with or around radiation sources shall not be required by the licensee~~  
841 ~~or registrant to hold film or restrain patients during radiography. If such procedure is permitted personnel~~  
842 ~~exposure shall not exceed rule 205 or the procedure shall be prohibited.~~

843 ~~**(4)** When a patient must be held in position for radiography, mechanical supporting or restraining devices~~  
844 ~~shall be available and shall be used unless contraindicated. If the patient must be held by an individual, this~~  
845 ~~individual shall wear protective gloves and a protective apron of 0.5 millimeter minimum lead equivalence and~~

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831 he shall be so positioned that no part of his body will be struck by the useful beam and that his body is as far  
832 as possible from the edge of the useful beam.

833  
834 ~~(5) Only individuals whose presence is necessary shall be permitted in the radiographic room during~~  
835 ~~exposure. Each individual, except the patient, shall be protected by 0.5 millimeter minimum lead equivalent~~  
836 ~~aprons unless protected by an approved primary barrier.~~

837  
838 ~~(6) Personnel monitoring shall be performed in controlled areas for each individual occupationally~~  
839 ~~exposed to ionizing radiation from diagnostic x-ray equipment. Personnel monitoring devices such as film~~  
840 ~~badge dosimeters or thermoluminescent dosimeters shall be permanently assigned to each occupationally~~  
841 ~~exposed individual. This monitoring shall be continuous during employment as a radiation worker.~~

842  
843 ~~(7) Personnel exposure records shall be kept on permanent available file at the facility where the~~  
844 ~~exposure occurs.~~

845  
846 ~~(8) Monitoring devices used to estimate whole body exposure shall normally be worn on the chest or~~  
847 ~~abdomen. Monitoring of any other body part shall comply with rule 222.~~

848  
849 ~~(9) Monitoring devices worn to estimate personnel occupational exposure shall not be worn by the~~  
850 ~~individual when he is exposed as a patient for any medical or dental reason.~~

851  
852 ~~(10) The gonads of children and persons who have not passed the reproductive age shall be protected~~  
853 ~~from the useful beam either by the use of shielding (0.5 mm lead equivalent), collimation, or special gonad~~  
854 ~~shields when this will not interfere with the conditions or objectives of the examination.~~

855  
856 ~~(11) Intensifying screens shall be employed to reduce patient exposure except in cases where a noticeable~~  
857 ~~decrease in image definition may reduce the clinical value of the examination. Film and screen speed~~  
858 ~~combinations shall be carefully selected to produce the necessary clinical information with the least exposure~~  
859 ~~to the patient consistent with current clinical judgement.~~

860  
861 ~~(12) Film processing materials and techniques shall be those recommended by the x-ray film and~~  
862 ~~processing materials manufacturers unless otherwise tested to insure maximum information content of the~~  
863 ~~developed film. Sight developing is not permitted except under extreme emergency conditions. Correct~~  
864 ~~temperature control and development time are necessary to minimize radiation dose to the patient.~~

865  
866 ~~(13) A radiographic x-ray system shall not be left unattended without locking the apparatus, room or~~  
867 ~~building in some manner which will prevent use of the apparatus by unauthorized persons.~~

Above Rule 333 is now covered in new Part 6.

868  
869 **FIXED-FLUOROSCOPIC INSTALLATIONSSYSTEMS**

870  

The entire fluoroscopic section is being deleted and replaced with the SSRCR equivalent due to the large number of changes since 1975.

871  
872 **R325.5337. Fluoroscopic x-ray equipment.**

873  
874 **Rule 337. (1) All x-ray tube housings of fixed fluoroscopic installations shall be of the diagnostic type.**

875

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876 ~~(2) The aluminum equivalence of the total filtration permanently in the useful beam shall not be less than~~  
877 ~~2.5 millimeters aluminum.~~

878  
879 ~~(3) Beam quality of fluoroscopic machines manufactured after the effective date of these rules shall~~  
880 ~~comply with the provisions of rules 325 (5) and (6).~~

881  
882 ~~(4) The source-patient distance on fluoroscopic machines manufactured before the effective date of these~~  
883 ~~rules should not be less than 45 centimeters (18 inches) and shall not be less than 30 centimeters (12 inches).~~  
884 ~~Specific exemption may be granted in writing by the department for special purpose equipment such as heart~~  
885 ~~catheterization machines.~~

886  
887 ~~(5) On fluoroscopic machines manufactured after the effective date of these rules, means shall be~~  
888 ~~provided to limit the source-skin distance to not less than 38 centimeters. For image intensified fluoroscopes~~  
889 ~~intended for specific surgical application that would be prohibited at this source-skin distance, provisions may~~  
890 ~~be made for operation at shorter source-skin distances but in no case less than 20 centimeters.~~

891  
892 ~~(6) Provision shall be made to intercept the scattered x rays from the undersurface of the table top and~~  
893 ~~other structures under the fluoroscopic table if the tube is mounted under the table. A cone or shield shall~~  
894 ~~provide the same degree of attenuation as is required of the tube housing.~~

895  
896 ~~(7) On fluoroscopic machines manufactured after the effective date of these rules a shielding device of at~~  
897 ~~least 0.25 millimeter lead equivalence for covering the bucky slot during fluoroscopy shall be provided.~~

898  
899 ~~(8) On fluoroscopic machines manufactured after the effective date of these rules a shielding device of at~~  
900 ~~least 0.25 millimeter lead equivalence, such as overlapping protective drapes or hinged or sliding panels, shall~~  
901 ~~be used to intercept scattered radiation which would otherwise reach the fluoroscopist and others near the~~  
902 ~~machine.~~

903  
904 ~~(9) The equipment shall be so constructed that, under conditions of normal use, the entire cross-section~~  
905 ~~of the useful beam is attenuated by a primary protective barrier, permanently incorporated into the equipment.~~  
906 ~~The exposure shall automatically terminate when the barrier is removed from the useful beam.~~

907  
908 ~~(10) On fluoroscopic machines manufactured after the effective date of these rules:~~

909 ~~(a) The entire cross section of the useful beam shall be intercepted by the primary protective barrier of the~~  
910 ~~fluoroscopic image assembly at any SID. The fluoroscopic tube shall not produce x rays unless the barrier~~  
911 ~~is in position to intercept the entire useful beam. The exposure rate due to transmission through the barrier~~  
912 ~~with the attenuation block in the useful beam combined with radiation from the image intensifier, if provided,~~  
913 ~~shall not exceed 2 milliroentgens per hour at 10 centimeters from any accessible surface of the fluoroscopic~~  
914 ~~imaging assembly beyond the plane of the image receptor for each roentgen per minute of entrance~~  
915 ~~exposure rate.~~

916 ~~(b) The entrance exposure rate shall be measured in accordance with subrule (20). The exposure rate~~  
917 ~~due to transmission through the primary barrier combined with radiation from the image intensifier shall be~~  
918 ~~determined by measurements averaged over an area of 100 square centimeters with no linear dimension~~  
919 ~~greater than 20 centimeters. If the source is below the tabletop, the measurement shall be made with the~~  
920 ~~input surface of the fluoroscopic imaging assembly positioned 30 centimeters above the tabletop. If the~~  
921 ~~source is above the tabletop and the SID is variable, the measurement shall be made with the end of the~~  
922 ~~beam-limiting device or spacer as close to the tabletop as it can be placed, if it is not closer than 30~~  
923 ~~centimeters. Movable grids and compression devices shall be removed from the useful beam during the~~  
924 ~~measurement. For all measurements, the attenuation block shall be positioned in the useful beam 10~~  
925 ~~centimeters from the point of measurement of the entrance exposure rate and between this point and the~~  
926 ~~input surface of the fluoroscopic imaging assembly.~~

927  
928 ~~(11) The lead equivalence of the barrier of conventional fluoroscopes shall be not less than 1.5 millimeters~~  
929 ~~at 100 kVp, 1.8 millimeters at 125 kVp, and 2.0 millimeters at potentials greater than 125 kVp.~~

930

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931 ~~(12) A beam-limiting device shall be provided to restrict the size of the useful beam to less than the area of~~  
932 ~~the barrier. The x-ray tube and beam-limiting system shall be linked with the fluorescent screen assembly so~~  
933 ~~that the useful beam at the fluorescent screen is confined within the barrier irrespective of the panel-screen~~  
934 ~~distance. For image intensifiers, the useful beam shall be centered on the input phosphor. It should not~~  
935 ~~exceed the diameter of the input phosphor during fluoroscopy or cine recording. Ideally, for spot film~~  
936 ~~radiography with image intensifier equipment, the shutters should automatically open to the required field size~~  
937 ~~before such exposure.~~

938  
939 ~~(13) Beam-limiting devices (collimators, adjustable diaphragms or shutters) shall provide the same degree~~  
940 ~~of attenuation as is required of the tube housing.~~

941  
942 ~~(14) When the beam-limiting device is opened to its fullest extent, a minimum 3 inch unilluminated margin~~  
943 ~~shall exist at all edges of the fluorescent screen when the screen is 35 centimeters (14 inches) from the panel~~  
944 ~~surface or table top, or at the fixed screen position in equipment such as an orthodiascope. In equipment used~~  
945 ~~solely for image intensified fluoroscopy, the x-ray beam shall not have dimensions greater than the diameter of~~  
946 ~~the input phosphor.~~

947  
948 ~~(15) On fluoroscopic machines manufactured after the effective date of these rules:~~

949 ~~(a) The x-ray field produced by nonimage intensified fluoroscopic equipment shall not extend~~  
950 ~~beyond the entire visible area of the image receptor. Means shall be provided to permit further limitation of~~  
951 ~~the field. The minimum field size at the greatest SID shall be equal to or less than 5 by 5 centimeters.~~

952 ~~(b) For image intensified fluoroscopic equipment the total misalignment of the edges of the x-ray field with~~  
953 ~~the respective edges of the visible area of the image receptor along any dimension of the visually defined~~  
954 ~~field in the plane of the image receptor shall not exceed 3% of the SID. The sum, without regard to sign, of~~  
955 ~~the misalignment along any 2 orthogonal dimensions intersecting at the center of the visible area of the~~  
956 ~~image receptor shall not exceed 4% of the SID. For rectangular x-ray fields used with circular image~~  
957 ~~receptors, the error in alignment shall be determined along the length and width dimensions of the x-ray field~~  
958 ~~which pass through the center of the visible area of the image receptor. Means shall be provided to permit~~  
959 ~~further limitation of the field. The minimum field size, at the greatest SID, shall be equal to or less than 5 by~~  
960 ~~5 centimeters.~~

961  
962 ~~(16) X-ray production in the fluoroscopic mode shall be controlled by a device which requires continuous~~  
963 ~~pressure by the operator for the entire time of any exposure. When recording serial fluoroscopic images, the~~  
964 ~~operator shall be able to terminate the x-ray exposures at any time, but means may be provided to permit~~  
965 ~~completion of any single exposure of the series in progress.~~

966  
967 ~~(17) When the fluoroscope is operated at 80 kVp, the exposure rate at the position where the beam enters~~  
968 ~~the patient shall not exceed 3.2 R/mA-min and should not exceed 2.1 R/mA-min.~~

969  
970 ~~(18) The entrance exposure rate at the position where the center of the useful beam enters the patient~~  
971 ~~should be as low as is consistent with the fluoroscopic requirements and shall not normally exceed 10 R/min.~~  
972 ~~With modern equipment, most fluoroscopy can be carried out with entrance exposure rates of less than 5~~  
973 ~~R/min.~~

974  
975 ~~(19) Entrance exposure rate limits for fluoroscopic equipment manufactured after the effective date of~~  
976 ~~these rules shall be as follows:~~

977 ~~(a) Machines with automatic exposure rate control shall not be operable at any combination of tube~~  
978 ~~potential and current which will result in an a exposure rate in excess of 10 roentgens per minute at the point~~  
979 ~~where the center of the useful beam enters the patient, except during recording of fluoroscopic images or~~  
980 ~~when an optional high level control is provided. When so provided, the equipment shall not be operable at~~  
981 ~~any combination of tube potential and current which will result in an exposure rate in excess of 5 roentgens~~  
982 ~~per minute at the point where the center of the useful beam enters the patient unless the high level control is~~  
983 ~~activated. Special means of activation of high level controls, such as additional pressure applied~~  
984 ~~continuously by the operator, shall be required to avoid accidental use. A continuous signal audible to the~~  
985 ~~fluoroscopist shall indicate that the high level control is being employed.~~

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986 ~~(b) Machines without automatic exposure rate control shall not be operable at any combination of tube~~  
987 ~~potential and current which will result in an exposure rate in excess of 5 roentgens per minute at the point~~  
988 ~~where the center of the useful beam enters the patient, except during recording of fluoroscopic images or~~  
989 ~~when a optional high level control is activated. Special means of activation of high level controls, such as~~  
990 ~~additional pressure applied continuously by the operator, shall be provided to avoid accidental use. A~~  
991 ~~continuous signal audible to the fluoroscopist shall indicate that the high level control is being employed.~~

992  
993 ~~(20) Compliance with subrules (18) and (19) shall be determined as follows:~~

994 ~~(a) If the source is below the table, the exposure rate shall be measured 1 centimeter above the tabletop~~  
995 ~~or cradle.~~

996 ~~(b) If the source is above the table, the exposure rate shall be measured at 30 centimeters above the~~  
997 ~~tabletop with the end of the beam limiting device or spacer positioned as closely as possible to the point of~~  
998 ~~measurement.~~

999 ~~(c) In a C-arm type of fluoroscope, the exposure rate shall be measured 30 centimeters from the input~~  
1000 ~~surface of the fluoroscopic imaging assembly.~~

1001  
1002 ~~(21) A cumulative timing device, activated by the fluoroscope exposure switch, shall be provided. It shall~~  
1003 ~~indicate the passage of a predetermined period if irradiation either by an audible signal or by temporary~~  
1004 ~~interruption of the irradiation when the increment of exposure time exceeds a predetermined limit not~~  
1005 ~~exceeding 5 minutes.~~

1006  
1007 ~~(22) On fluoroscopic machines manufactured after the effective date of these rules means shall be~~  
1008 ~~provided to present the cumulative on time of the fluoroscopic tube. The maximum cumulative time of the~~  
1009 ~~timing device shall not exceed 5 minutes without resetting. A signal audible to the fluoroscopist shall indicate~~  
1010 ~~the completion of any preset cumulative on time. This signal shall continue to sound while x rays are~~  
1011 ~~produced until the timing device is reset.~~

1012  
1013 ~~(23) Devices which indicate the x-ray tube potential and current shall be provided. On image intensified~~  
1014 ~~fluoroscopic equipment, these devices should be located in such a manner that the operator may monitor the~~  
1015 ~~tube potential and current during fluoroscopy.~~

1016  
1017 ~~(24) X-ray equipment shall be installed and used in accord with article 660 of the national electrical code~~  
1018 ~~which is reproduced in rule 359.~~

### 1019 1020 **R325.5347. Enclosures.**

1021  
1022 ~~Rule 347. (1) An enclosure shall be a permanent part of the building or equipment. Portable shields shall~~  
1023 ~~not be used for permanent installations.~~

1024  
1025 ~~(2) The degree of protection required for an enclosure shall be determined by the workload, use and~~  
1026 ~~occupancy factors and the kilovoltage, milliamperage, mechanical movement and distance factor, and shall be~~  
1027 ~~subject to design approval by the department. Recommended shielding appears in rule 357.~~

1028  
1029 ~~(3) For conventional fluoroscopy extraneous light that interferes with the fluoroscopic examination shall be~~  
1030 ~~eliminated. Dark adaptation normally is not necessary when using image intensifiers.~~

1031  
1032 **Rule 337. (1) All fluoroscopic x-ray systems used shall be image intensified.**

1033  
1034 **(2) Primary Barrier.**

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1036 (a) The fluoroscopic imaging assembly shall be provided with a primary protective barrier which intercepts  
1037 the entire cross section of the useful beam at any SID.

1038 (b) The x-ray tube used for fluoroscopy shall not produce x rays unless the barrier is in position to  
1039 intercept the entire useful beam.

1040  
1041 (3) Fluoroscopic Beam Limitation.

1042 (a) For certified fluoroscopic systems with or without a spot film device, neither the length nor the width of  
1043 the x-ray field in the plane of the image receptor shall exceed that of the visible area of the image receptor  
1044 by more than 3 per-cent of the SID. The sum of the excess length and the excess width shall be no greater  
1045 than 4 percent of the SID.

1046 (b) For uncertified fluoroscopic systems with a spot film device, the x-ray beam with the shutters fully  
1047 opened (during fluoroscopy or spot filming) shall be no larger than the largest spot film size for which the  
1048 device is designed. Measurements shall be made at the maximum SID available but at no less than 20  
1049 centimeters table top to the film plane distance.

1050 (c) For uncertified fluoroscopic systems without a spot film device, the requirements of Rule 337(3)(A)  
1051 apply.

1052 (d) Other requirements for fluoroscopic beam limitation:

1053  
1054 (i) Means shall be provided to permit further limitation of the field. Beam-limiting devices manufactured  
1055 after May 22, 1979, and incorporated in equipment with a variable SID and/or a visible area of greater  
1056 than 300 square centimeters shall be provided with means for stepless adjustment of the x-ray field;

1057 (ii) All equipment with a fixed SID and a visible area of 300 square centimeters or less shall be  
1058 provided with either stepless adjustment of the x-ray field or with means to further limit the x-ray field size  
1059 at the plane of the image receptor to 125 square centimeters or less;

1060 (iii) If provided, stepless adjustment shall, at the greatest SID, provide continuous field sizes from  
1061 the maximum attainable to a field size of 5 centimeters by 5 centimeters or less;

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1062        (iv) For equipment manufactured after February 25, 1978, when the angle between the image  
1063 receptor and beam axis is variable, means shall be provided to indicate when the axis of the x-ray beam is  
1064 perpendicular to the plane of the image receptor;

1065        (v) For non-circular x-ray fields used with circular image receptors, the error in alignment shall be  
1066 determined along the length and width dimensions of the x-ray field which pass through the center of the  
1067 visible area of the image receptor.

1068  
1069 (4) Spot-film Beam Limitation. Spot-film devices shall meet the following requirements:

1070        (a) Means shall be provided between the source and the patient for adjustment of the x-ray field size in  
1071 the plane of the film to the size of that portion of the film which has been selected on the spot film selector.  
1072 Such adjustment shall be automatically accomplished except when the x-ray field size in the plane of the film  
1073 is smaller than that of the selected portion of the film. For spot film devices manufactured after June 21,  
1074 1979, if the x-ray field size is less than the size of the selected portion of the film, the means for adjustment  
1075 of the field size shall be only at the operator's option;

1076        (b) Neither the length nor the width of the x-ray field in the plane of the image receptor shall differ from the  
1077 corresponding dimensions of the selected portion of the image receptor by more than 3 percent of the SID  
1078 when adjusted for full coverage of the selected portion of the image receptor. The sum, without regard to  
1079 sign, of the length and width differences shall not exceed 4 percent of the SID;

1080        (c) It shall be possible to adjust the x-ray field size in the plane of the film to a size smaller than the  
1081 selected portion of the film. The minimum field size at the greatest SID shall be equal to, or less than, 5  
1082 centimeters by 5 centimeters;

1083        (d) The center of the x-ray field in the plane of the film shall be aligned with the center of the selected  
1084 portion of the film to within 2 percent of the SID; and

1085        (e) On spot-film devices manufactured after February 25, 1978, if the angle between the plane of the  
1086 image receptor and beam axis is variable, means shall be provided to indicate when the axis of the x-ray  
1087 beam is perpendicular to the plane of the image receptor, and compliance shall be determined with the  
1088 beam axis indicated to be perpendicular to the plane of the image receptor.

1089

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1090 (5) Override. If a means exists to override any of the automatic x-ray field size adjustments required in  
1091 rule 337(3) and (4), that means:

1092 (a) Shall be designed for use only in the event of system failure;

1093 (b) Shall incorporate a signal visible at the fluoroscopist's position which will indicate whenever the  
1094 automatic field size adjustment is overridden; and

1095 (c) Shall be clearly and durably labeled as follows:

1096 FOR X-RAY FIELD

1097 LIMITATION SYSTEM FAILURE

1098

1099 (6) Activation of the Fluoroscopic Tube. X-ray production in the fluoroscopic mode shall be controlled by  
1100 a device which requires continuous pressure by the fluoroscopist for the entire time of any exposure. When  
1101 recording serial fluoroscopic images, the fluoroscopist shall be able to terminate the x-ray exposure(s) at any  
1102 time, but means may be provided to permit completion of any single exposure of the series in process.

1103

1104 (7) Entrance Exposure Rate Allowable Limits.

1105 (a) Fluoroscopic equipment which is provided with automatic exposure rate control shall not be operable  
1106 at any combination of tube potential and current which will result in an exposure rate in excess of 2.6 mC/kg  
1107 (10 roentgens) per minute at the point where the center of the useful beam enters the patient, except:

1108 (i) During recording of fluoroscopic images; or

1109 (ii) When an optional high level control is provided. When so provided, the equipment shall not  
1110 be operable at any combination of tube potential and current which will result in an exposure rate in  
1111 excess of 1.3 mC/kg (5 roentgens) per minute at the point where the center of the useful beam enters the  
1112 patient unless the high level control is activated. Special means of activation of high level controls shall be  
1113 required. The high level control shall only be operable when continuous manual activation is provided by  
1114 the operator. A continuous signal audible to the fluoroscopist shall indicate that the high level control is  
1115 being employed.

1116 (b) Fluoroscopic equipment which is not provided with automatic exposure rate control shall not be  
1117 operable at any combination of tube potential and current which will result in a exposure rate in excess of

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1118 1.3 mC/kg (5 roentgens) per minute at the point where the center of the useful beam enters the patient,

1119 except:

1120 (i) During recording of fluoroscopic images; or

1121 (ii) When an optional high level control is activated. Special means of activation of high level  
1122 controls shall be required. The high level control shall only be operable when continuous manual  
1123 activation is provided by the operator. A continuous signal audible to the fluoroscopist shall indicate that  
1124 the high level control is being employed.

1125 (c) Fluoroscopic equipment which is provided with both automatic exposure rate control mode and a  
1126 manual mode shall not be operable at any combination of tube potential and current which shall result in  
1127 an exposure rate in excess of 2.6 mC/kg (10 roentgens) per minute in either mode at the point where the  
1128 center of the useful beam enters the patient, except:

1129 (i) During recording of fluoroscopic images; or

1130 (ii) When the mode or modes have an optional high level control, in which case that mode or  
1131 modes shall not be operable at any combination of tube potential and current which shall result in an  
1132 exposure rate in excess of 1.3 mC/kg (5 roentgens) per minute at the point where the center of the  
1133 useful beam enters the patient, unless the high level control is activated. Special means of activation  
1134 of high level controls shall be required. The high level control shall only be operable when continuous  
1135 manual activation is provided by the operator. A continuous signal audible to the fluoroscopist shall  
1136 indicate that the high level control is being employed.

1137 (d) Any fluoroscopic equipment manufactured after May 19, 1995 which can exceed 1.3 mC/kg (5  
1138 roentgens) per minute shall be equipped with an automatic exposure rate control. All entrance exposure  
1139 rate limits shall be 2.6 mC/kg (10 roentgens) per minute with an upper limit of 5.2 mC/kg (20 roentgens) per  
1140 minute when high level control is activated

1141 (e) Compliance with the requirements of rule 337(7) shall be determined as follows:

1142 (i) If the source is below the x-ray table, the exposure rate shall be measured 1 centimeter above  
1143 the tabletop or cradle;

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1144 (ii) If the source is above the x-ray table, the exposure rate shall be measured at 30 centimeters  
1145 above the tabletop with the end of the beam-limiting device or spacer positioned as closely as possible to  
1146 the point of measurement;

1147 (iii) For a C-arm type of fluoroscope, the exposure rate shall be measured  
1148 30 centimeters from the input surface of the fluoroscopic imaging assembly, with the source positioned  
1149 at any available SID, provided that the end of the beam-limiting device or spacer is no closer than 30  
1150 centimeters from the input surface of the fluoroscopic imaging assembly;

1151 (iv) For a lateral type fluoroscope, the exposure rate shall be measured at a point 15 centimeters  
1152 from the centerline of the x-ray table and in the direction of the x-ray source with the end of the beam-  
1153 limiting device or spacer positioned as closely as possible to the point of measurement. If the tabletop is  
1154 movable, it shall be positioned as closely as possible to the lateral x-ray source, with the end of the beam-  
1155 limiting device or spacer no closer than 15 centimeters to the centerline of the x-ray table.

1156

1157 (8) Periodic measurement of entrance exposure rate shall be performed by a qualified expert for both  
1158 typical and maximum values as follows:

1159 (a) Such measurements shall be made annually or after any maintenance of the system which might  
1160 affect the exposure rate;

1161 (b) Results of these measurements shall be posted where any fluoroscopist may have ready access to  
1162 such results while using the fluoroscope and in the record required in rule xxx(1)(c)[see part 6 – x-ray  
1163 system information records] The measurement results shall be stated in coulombs per kilogram (roentgens)  
1164 per minute and include the technique factors used in determining such results. The name of the individual  
1165 performing the measurements and the date the measurements were performed shall be included in the  
1166 results;

1167 (c) Conditions of periodic measurement of typical entrance exposure rate are as follows:

1168 (i) The measurement shall be made under the conditions that satisfy the requirements of rule  
1169 337(8)(e);

1170 (ii) The kVp, mA, and/or other selectable parameters shall be adjusted to those settings typical of  
1171 clinical use on a 23 cm thick abdominal patient;

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1172        (iii) The x-ray system that incorporates automatic exposure rate control shall have sufficient  
1173 attenuative material placed in the useful beam to produce a milliamperage and/or kilovoltage to satisfy the  
1174 conditions of rule 337(9)(C)(ii);

1175 **(d)** Conditions of periodic measurement of maximum entrance exposure rate are as follows:

1176        (i) The measurement shall be made under the conditions that satisfy the requirements of rule  
1177 337(8)(e);

1178        (ii) The kVp, mA and/or other selectable parameters shall be adjusted to those settings which  
1179 give the maximum entrance exposure rate;

1180        (iii) The x-ray system(s) that incorporates automatic exposure rate control shall have sufficient  
1181 attenuative material placed in the useful beam to produce the maximum entrance exposure rate of the  
1182 system.

1183  
1184 **(9)** Barrier Transmitted Radiation Rate Limits.

1185        (a) The exposure rate due to transmission through the primary protective barrier with the attenuation  
1186 block in the useful beam, combined with radiation from the image intensifier, if provided, shall not exceed 0.5  
1187 µC/kg (2 milliroentgens) per hour at 10 centimeters from any accessible surface of the fluoroscopic imaging  
1188 assembly beyond the plane of the image receptor for each mC/kg (roentgen) per minute of entrance  
1189 exposure rate.

1190 **(b)** Measuring Compliance of Barrier Transmission.

1191        (i) The exposure rate due to transmission through the primary protective barrier combined with  
1192 radiation from the image intensifier shall be determined by measurements averaged over an area of 100  
1193 square centimeters with no linear dimension greater than 20 centimeters.

1194        (ii) If the source is below the tabletop, the measurement shall be made with the input surface of  
1195 the fluoroscopic imaging assembly positioned 30 centimeters above the tabletop.

1196        (iii) If the source is above the tabletop and the SID is variable, the measurement shall be made  
1197 with the end of the beam-limiting device or spacer as close to the tabletop as it can be placed, provided  
1198 that it shall not be closer than 30 centimeters.

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1199        (iv) Movable grids and compression devices shall be removed from the useful beam during the  
1200        measurement.

1201  
1202        (10) Indication of Potential and Current. During fluoroscopy and cinefluorography the kV and the mA shall  
1203        be continuously indicated.

1204  
1205        (11) Source-to-Skin Distance. The SSD shall not be less than:

1206        (a) 38 centimeters on stationary fluoroscopic systems manufactured on or after August 1, 1974;

1207        (b) 35.5 centimeters on stationary fluoroscopic systems manufactured prior to August 1, 1974;

1208        (c) 30 centimeters on all mobile fluoroscopes; or

1209        (d) 20 centimeters for all mobile fluoroscopes when used for specific surgical applications.

1210  
1211        (12) Fluoroscopic Timer.

1212        (a) Means shall be provided to preset the cumulative on-time of the fluoroscopic x-ray tube. The  
1213        maximum cumulative time of the timing device shall not exceed 5 minutes without resetting.

1214        (b) A signal audible to the fluoroscopist shall indicate the completion of any preset cumulative on-time.  
1215        Such signal shall continue to sound while x rays are produced until the timing device is reset.

1216  
1217        (13) Control of Scattered Radiation.

1218        (a) Fluoroscopic table designs when combined with procedures utilized shall be such that no unprotected  
1219        part of any staff or ancillary individual's body shall be exposed to unattenuated scattered radiation which  
1220        originates from under the table. The attenuation required shall be not less than 0.25 millimeter lead  
1221        equivalent.

1222        (b) Equipment configuration when combined with procedures shall be such that no portion of any staff or  
1223        ancillary individual's body, except the extremities, shall be exposed to the unattenuated scattered radiation  
1224        emanating from above the tabletop unless that individual:

1225        (i) Is at least 120 centimeters from the center of the useful beam; or

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1226        (ii) The radiation has passed through not less than 0.25 millimeter lead equivalent material  
1227        including, but not limited to, drapes, Bucky-slot cover panel, or self-supporting curtains, in addition to any  
1228        lead equivalency provided by the protective apron referred to in rule xxx(5)[see part 6 – radiation safety  
1229        requirements].

1230        (c) The department may grant exemptions to Rule 337(14)(B) where a sterile field will not permit the use  
1231        of the normal protective barriers. Where the use of prefitted sterilized covers for the barriers is practical, the  
1232        Department shall not permit such exemption.

1233  
1234        (14) Spot Film Exposure Reproducibility. Fluoroscopic systems equipped with spot film (radiographic)  
1235        mode shall meet the exposure reproducibility requirements of rule xxx(15)[see part 6 – x-ray equipment] when  
1236        operating in the spot film mode.

1237  
1238        (15) Radiation Therapy Simulation Systems. Radiation therapy simulation systems shall be exempt from  
1239        all the requirements of rule 377(8). In addition, these systems shall be exempt from:

1240        (a) The requirements of rules 337(3-6, and 10). provided such systems are designed and used in such a  
1241        manner that no individual other than the patient is in the x-ray room during periods of time when the system  
1242        is producing x-rays; and

1243        (b) The requirements of rule 337(13) if such systems are provided with a means of indicating the  
1244        cumulative time that an individual patient has been exposed to x-rays. Procedures shall require in such  
1245        cases that the timer be reset between examinations.

1246  
1247        **R325.5347. Enclosures.**

1248  
1249        **Rule 347. Fluoroscopic enclosures shall meet the general shielding requirements listed in Part 6.**

1250  
1251        **R325.5348. Conditions of operation.**

1252  
1253        **Rule 348. (1) Each individual present in a fluoroscopic room, except the patient, shall wear a**  
1254        **protective apron of at least 0.5 millimeter lead equivalence.**

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1255  
1256 ~~(2) Only individuals whose presence is needed to conduct the examination, to conduct radiation~~  
1257 ~~protection surveys or undergoing specific training shall be permitted in the fluoroscopy room during x-ray~~  
1258 ~~exposures.~~

1259  
1260 ~~(3) Personnel monitoring shall be performed in controlled areas for each individual occupationally~~  
1261 ~~exposed to ionizing radiation from diagnostic x-ray equipment. Personnel monitoring devices, such as film~~  
1262 ~~badge dosimeters or thermoluminescent dosimeters, shall be permanently assigned to each occupationally~~  
1263 ~~exposed individual. This monitoring shall be continuous during employment as a radiation worker.~~

1264  
1265 ~~(4) Personnel exposure records shall be kept on permanent available file at the facility where the~~  
1266 ~~exposure occurs.~~

1267  
1268 ~~(5) Monitoring devices used to estimate whole body exposure shall normally be worn on the chest or~~  
1269 ~~abdomen. Monitoring on any other body part shall comply with rule 222. Since employees involved in~~  
1270 ~~fluoroscopic procedures are required to wear protective aprons and may be subjected to non-uniform radiation~~  
1271 ~~fields, a dosimeter assigned to monitor whole body exposure will not necessarily record the dose most~~  
1272 ~~representative of exposure to the lens of the eye. To monitor this critical area for which the exposure limit is~~  
1273 ~~the same as for whole body, active blood-forming organs, or gonads, an auxiliary dosimeter shall be provided~~  
1274 ~~in accordance with rule 222.~~

1275  
1276 ~~(6) Monitoring devices worn to estimate personnel occupational exposure shall not be worn by the~~  
1277 ~~individual when he is exposed as a patient for any medical or dental reason.~~

1278  
1279 ~~(7) The fluoroscopist's eyes should be sufficiently dark-adapted for the visual task required before~~  
1280 ~~commencing conventional fluoroscopy. Under no circumstances shall he attempt to compensate for~~  
1281 ~~inadequate adaptation by increasing exposure factors employed or by prolonging the fluoroscopic~~  
1282 ~~examination.~~

1283  
1284 ~~(8) Special precautions, consistent with clinical needs, shall be taken to minimize exposure of the gonads~~  
1285 ~~of potentially procreative patients and exposure of the embryo or fetus in patients known to be or suspected of~~  
1286 ~~being pregnant. Gonadal shielding is advised whenever it will not interfere with the conditions or objectives of~~  
1287 ~~the examination.~~

1288  
1289 ~~(9) In cineradiography, special care shall be taken to limit patient exposure when, as is often the case,~~  
1290 ~~tube currents and potentials employed are higher than those normally used in fluoroscopy. The exposure~~  
1291 ~~rates to which patients are normally subjected shall be determined quarterly and records of the surveys~~  
1292 ~~maintained.~~

1293  
1294 ~~(10) A fluoroscopic x-ray system shall not be left unattended without locking the apparatus, room or~~  
1295 ~~building in some manner which will prevent use of the apparatus by unauthorized persons.~~

1296  
1297 **Rule 348. (1) Operator Qualifications.**

1298  
1299 (a) The facility shall ensure that only a licensed practitioner of the healing arts or a qualified radiologic  
1300 technologist [or equivalent according to Part 135a] who is trained in the safe use of fluoroscopic x-ray  
1301 systems shall be allowed to operate these systems. All persons using fluoroscopic x-ray systems shall  
1302 have, at a minimum, additional training as specified in (b) below.

refer or insert Part 135a of the public health code if it passes and applies (currently SB 231).
--

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1303 (b) Training to meet the requirements of (a) above shall include, but is not limited to the following:

1304 (i) Principles and operation of the fluoroscopic x-ray system;

1305 (ii) Biological effects of x-ray;

1306 (iii) Principles of radiation protection;

1307 (iv) Fluoroscopic outputs;

1308 (v) High level control options;

1309 (vi) Dose reduction techniques for fluoroscopic x-ray systems; and

1310 (vii) Applicable requirements of these regulations.

1311

1312 (2) Equipment Operation

1313 (a) All imaging formed by the use of fluoroscopic x-ray systems shall be viewed, directly or indirectly, and  
1314 interpreted by a licensed practitioner of the healing arts.

1315 (b) The use of fluoroscopic x-ray systems by radiologic technologists shall be performed under the  
1316 supervision of a licensed practitioner of the healing arts for the purpose of localization to obtain images for  
1317 diagnostic purposes.

1318 (c) Radiologic technology students shall not be allowed to operate fluoroscopic x-ray systems unless  
1319 directly supervised by a licensed practitioner of the healing arts or radiologic technologist as specified in rule  
1320 348(1)(a).

1321 (d) Overhead fluoroscopy shall not be used as a positioning tool for general purpose radiographic  
1322 examinations.

1323 (e) Facilities that use fluoroscopic x-ray systems shall maintain a record of the cumulative fluoroscopic  
1324 exposure time used and the number of spot films for each examination. This record shall indicate patient  
1325 identification, type of examination, date of examination, and operator's name.

1326

1327

**MOBILE OR PORTABLE DIAGNOSTIC X-RAY EQUIPMENT**

1328

1329 **R325.5351. Mobile or portable X-ray equipment.**

1330

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1331 **Rule 351. (1)** ~~Mobile or portable R~~radiographic x-ray equipment shall comply with the general requirements  
1332 of rule ~~325~~ excluding subrules (11) and (18) ~~xxx~~ in Part 6.

1333  
1334 ~~(2)~~ Fluoroscopic x-ray equipment shall comply with the general requirements of rule 337 excluding  
1335 subrules (5), (6), (7), (8), and (11).

1336  
1337 ~~(3)~~**(2)** The radiographic exposure control switch shall be located on the machine where adequate personnel  
1338 protection is provided to attenuate the direct and scatter radiation, or the length of switch cord shall be such  
1339 that the operator shall be able to stand at least 1.8 meters (6 feet) from the patient, the x-ray tube, and out of  
1340 useful beam. A coil type extension switch cord capable of providing more than 1.8 meters (6 feet) of distance  
1341 protection ~~is recommended~~ shall be provided.

1342  
1343 ~~(4)~~**(3)** Hand-held fluoroscopic screens and others not attached to a diagnostic source assembly with stable  
1344 mounting shall not be used.

1345  
1346 ~~(5)~~ Image intensification shall always be provided on mobile fluoroscopic equipment. It shall be  
1347 impossible to operate mobile fluoroscopic equipment unless the useful beam is intercepted by the image  
1348 intensifier. Means shall be provided to limit the source-skin distance to not less than 30 centimeters (12  
1349 inches). For fluoroscopes intended for specific surgical application that would be prohibited at the source-skin  
1350 distances specified in this subrule, provisions may be made for operation at shorter source-skin distances but  
1351 in no case less than 20 centimeters.

Incorporated into the new general fluoroscopy rules.
--

1352  
1353 **R325.5352. Shielding.**

1354  
1355 **Rule 352. (1)** Portable shielding shall be used by the operator and others in the room when possible, 1.6  
1356 millimeter (1/16 inch) lead equivalent.

1357

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1358 ~~(2) Mobile or portable diagnostic x-ray equipment used routinely in 1 location (**3 ROOMS OR LESS? – eg**~~  
1359 ~~**PAIN CLINICS**) shall be considered a fixed installation and shall comply with the general requirements of rules~~  
1360 ~~325 and 331 or rules 337 and 347 or both.~~

Addressed in Part 6.

1361  
1362 **R325.5353. Conditions of operation.**

1363  
1364 **Rule 353.** ~~(1)~~ Operation of mobile or portable x-ray equipment shall comply with the general requirements  
1365 of rules 333 and 348.

1366  
1367 ~~(2) Individuals operating mobile or portable diagnostic x-ray equipment shall wear a protective apron of~~  
1368 ~~minimum 0.5 millimeter lead equivalence unless portable shielding is provided as specified in rule 352 (1).~~

1369  
1370 ~~(3) Mobile or portable diagnostic x-ray equipment shall not be used for routine radiography or fluoroscopy~~  
1371 ~~in hospitals or private offices of practitioners of the healing arts. This equipment shall only be used when it is~~  
1372 ~~medically inadvisable to move a patient to a fixed radiographic or fixed fluoroscopic installation. (**WHAT**~~  
1373 ~~**ABOUT PAIN CLINICS?**)~~

Addressed in Part 6.

1374  
1375 **MISCELLANEOUS AND SPECIAL INSTALLATIONS**

1376  
1377 **R325.5355. General provisions.**

1378  
1379 **Rule 355. (1)** Types of x-ray sources and uses not specifically covered by this part and not  
1380 exempted in rule 182, shall comply with parts 1, ~~4 and 5~~ through 4.

1381

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1382 | **(2)** For the purpose of registering and approving medical x-ray producing equipment and devices not  
1383 | specifically covered by this part (e.g. therapy simulators) the protective design, the workload, the use factor  
1384 | and the occupancy factor shall be considered.

1385 |  
1386 | ~~**(3)** Therapy simulators are considered special installations not specifically covered by this part and shall  
1387 | be subject to specific requirements designated by the department in the form of registration conditions for the  
1388 | protection of public health and safety until these rules are amended to specifically cover such sources and  
1389 | uses.~~

Therapy Sims are addressed in the fluoro rules above.
---

1390 |

**BONE DENSITOMETRY**

1391 |  
1392 |

1393 | **R325.5356. Bone Densitometry Installations.**

1394 |

1395 | **Rule 356. (1) Bone Desitometry systems shall be:**

1396 | **(a)** Certified by the manufacturer pursuant to the Medical Device Act and Subchapter C-Electronic  
1397 | Product Radiation Control (ERPC) of Chapter V of the federal Food, Drug, and Cosmetic Act.

1398 | **(b)** Registered in accordance with Part 2 of these regulations.

1399 | **(c)** Maintained and operated in accordance with the manufacturer's specifications.

1400 |

1401 | **(2)** Systems with stepless collimators shall be provided with means to both size and align the x-ray  
1402 | field such that the x-ray field at the plane of the image receptor does not extend beyond 2 percent of the  
1403 | SID.

1404 |

1405 | **(3)** Operators of bone density systems, who are not licensed members of the healing arts, shall  
1406 | complete a training course on bone densitometry which is approved by the department. The training shall  
1407 | include:

1408 |

1409 | **(a) Basic Radiation Protection**

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1410 (b) Operating Procedures for bone densitometry systems, to include the use of various system functions,  
 1411 safety, and maintenance.

1412 (c) Patient positioning for the types of exams performed.

1413

1414 (4) During the operation of any bone densitometry system:

1415

1416 (a) The operator, ancillary personnel, and members of the general public shall be positioned at least one  
 1417 meter from the patient and bone densitometry system during the examination.

1418 (b) The operator shall advise the patient that the bone densitometry examination is a type of x-ray  
 1419 procedure.

1420

1421 (5) Bone densitometry on human patients shall be conducted only under a prescription or written standing  
 1422 order of a licensed practitioner of the healing arts.

1423

**APPENDIX A**

1424 **R325.5357. Appendix A. Table 1.**

1425

1426 **Rule 357.** Recommended shielding for medical diagnostic x-ray installations.\*

HIGH WORKLOAD	MODERATE WORKLOAD	LOW WORKLOAD
HOSPITALS RADIOLOGY	CLINICS	OFFICES
OFFICES		

Anticipated Workload	250-1000 mA-min/wk		15-250 mA-min/wk		-min/wk 0-15 mA	
Thickness of shielding material or equivalent protection	Lead <sup>H</sup> (inches)	Concrete <sup>HH</sup> (inches)	Lead <sup>H</sup> (inches)	Concrete <sup>HH</sup> (inches)	Lead <sup>H</sup> (inches)	Concrete <sup>HH</sup> (inches)
OPERATOR SHIELDS	1/16-1/8	5-9	1/16	5	1/16	5
PRIMARY BEAMS						

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Walls—	1/16-1/8	5-9	1/16	5	1/16	5
Doors—	1/16-1/8		1/16		1/16	
Floors—	3/32-1/8	62-9	1/16-3/32	5-62	1/16	5
<b>SECONDARY RADIATION</b>						
Walls—	1/16	5	1/32-1/16	22-5	0-1/32	0-22
Doors—	1/16		1/32-1/16		0-1/32	
Floors—	1/16	5	1/32-1/16	22-5	0-1/32	0-22
Ceilings—	1/16	2-5	1/32	22	0-1/32	0-22

1427

1428

**Rule 357. RECOMMENDED SHIELDING FOR MEDICAL DIAGNOSTIC X-RAY INSTALLATIONS.\***

<u>HIGH WORKLOAD</u>	<u>MODERATE WORKLOAD</u>	<u>LOW WORKLOAD</u>
(HOSPITALS RADIOLOGY AND ORTHOPEDIC OFFICES)	(MEDICAL AND CHIROPRACTIC OFFICES)	(PODIATRY AND VETERINARY OFFICES)

<u>ANTICIPATED WORKLOAD</u>	<u>UP TO 1000 MA-MIN/WK</u>		<u>UP TO 250 MA-MIN/WK</u>		<u>UP TO 15 MA-MIN/WK</u>	
	<u>LEAD<sup>A</sup></u> <u>(INCHES)</u>	<u>CONCRETE<sup>B</sup></u> <u>(INCHES)</u>	<u>LEAD<sup>A</sup></u> <u>(INCHES)</u>	<u>CONCRETE<sup>B</sup></u> <u>(INCHES)</u>	<u>LEAD<sup>A</sup></u> <u>(INCHES)</u>	<u>CONCRETE<sup>B/H</sup></u> <u>(INCHES)</u>
<u>OPERATOR SHIELDS</u>	1/16	5	1/16	5	1/16	5
<u>PRIMARY BEAMS</u>						
<u>WALLS</u>	3/32-1/8	6-7	1/16-1/8	3-6	1/16	3
<u>FLOORS</u>	3/32-1/8	6-8	1/16-3/32	4-6	1/16	4

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<u>SECONDARY RADIATION</u>						
<u>WALLS</u>	<u>1/16</u>	<u>3 - 4</u>	<u>1/32-1/16</u>	<u>3</u>	<u>0-1/32</u>	<u>1</u>
<u>DOORS</u>	<u>1/16</u>		<u>1/32-1/16</u>		<u>0-1/32</u>	
<u>FLOORS</u>	<u>1/32 - 1/16</u>	<u>2.5 – 3.5</u>	<u>1/32</u>	<u>2.5</u>	<u>0-1/32</u>	<u>1</u>
<u>CEILINGS</u>	<u>1/32 - 1/16</u>	<u>2.5 – 3.5</u>	<u>1/32</u>	<u>2.5</u>	<u>0-1/32</u>	<u>1</u>

NEW TABLE BASED ON RECENT SHIELDING DESIGN CRITERIA OF NCRP 147.

1429

1430 \* This table is provided only as a guideline for optimum shielding protection for a few typical  
 1431 radiographic workloads and conditions encountered in hospital, clinic and office situations. More or less  
 1432 shielding may be required in any specific case depending upon many variable factors. Shielding listed is  
 1433 that generally approved by the division of radiological health.

1434 <sup>A</sup> Thickness ranging from 1/32-1/8 inch based on commercial lead sheets ranging from 2-8 pounds per  
 1435 square foot nominal weight.

1436 <sup>B</sup> Thickness based on concrete density of 2.35 grams per cubic centimeter (147 pounds per cubic foot).

1437

1438 ~~Note: As a result of Executive Orders 1996-1 and 1996-2, the authority, powers, duties, functions, and~~  
 1439 ~~responsibilities of the radiation machine registration, licensing, and compliance program were transferred to~~  
 1440 ~~the Michigan Department of Consumer & Industry Services. The reference in these rules to the Division of~~  
 1441 ~~Radiological Health should now reference the Radiation Safety Section.~~

1442

1443 R325.5358. Appendix A. Table 2.

1444

1445 Rule 358. Distances at which shielding may not be required for medical radiographic installations.\*

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HIGH WORKLOAD

HOSPITALS

MODERATE

LOW WORKLOAD

RADIOLOGY OFFICES

WORKLOAD CLINICS

OFFICES

Anticipated Workload	250-1000 mA-min/wk	15-250 mA-min/wk	0-15 mA-min/wk
	DISTANCE IN FEET FROM X-RAY TUBE TO NEAREST OCCUPIED AREA		
<b>PRIMARY BEAMS</b>			
Area controlled	25-200	10-50	6-25
Area non-controlled	80-300	25-150	15-50
<b>SECONDARY RADIATION</b>			
Area controlled	10-25	3-15	0-10
Area non-controlled	30-80	10-40	5-15

1446

1447

\* This table is provided only as a guideline to emphasize the need for protective shielding under most circumstances in typical installations. Distances may vary considerably depending upon many uncontrollable factors. Shielding is the preferred method of radiation protection because it can be precisely calculated and controlled.

1448

1449

1450

1451

1452

R325.5359. Appendix B. National Electrical Code

1454

Rule 359. Excerpts from Articles 100, 500, 517 and 660.

1455

1456

1457

ARTICLE 100 - DEFINITIONS

1458

1459

Approved: Acceptable to the authority having jurisdiction.

1460

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1461  
1462 Approved for the Purpose: ~~————~~ Approved for a specific purpose, environment, or application described in a  
1463 particular Code requirement.

1464  
1465 Ground: A conducting connection, whether intentional or accidental, between an electrical circuit or equipment  
1466 and the earth, or to some conducting body that serves in place of the earth.

1467  
1468 Grounded: ~~————~~ Connected to earth or to some conducting body that serves in place of the earth.

1469  
1470 Grounded Conductor: ~~————~~ A system or circuit conductor that is intentionally grounded.

1471  
1472 Grounding Conductor: ~~—~~ A conductor used to connect equipment or the grounded circuit of a wiring system to a  
1473 grounding electrode or electrodes.

1474  
1475 Grounding Conductor Equipment: ~~————~~ The conductor used to connect noncurrent-carrying metal parts of  
1476 equipment, raceways, and other enclosures to the system grounded conductor at the service and/or the  
1477 grounding electrode conductor.

1478

### 1479 ARTICLE 500

#### 1480 HAZARDOUS (CLASSIFIED) LOCATIONS

1481  
1482 ~~500-4. Class I Locations. ———~~ Class I locations are those in which flammable gases or vapors are or may be  
1483 present in the air in quantities sufficient to produce explosive or ignitable mixtures. ~~Class I locations shall~~  
1484 ~~include those specified in (a) and (b) below.~~

1485 ~~(a) ——— Class I, Division 1. A Class I, Division 1 location is a location: (1) in which hazardous~~  
1486 ~~concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal~~  
1487 ~~operating conditions; or (2) in which hazardous concentrations of such gases or vapors may exist frequently~~  
1488 ~~because of repair or maintenance operations or because of leakage; or (3) in which breakdown or faulty~~  
1489 ~~operation of equipment or processes that might release hazardous concentrations of flammable gases or~~  
1490 ~~vapors, and might also cause simultaneous failure of electric equipment.~~

1491

### 1492 ~~————~~ ARTICLE 517 HEALTH CARE FACILITIES

1493

1494  
1495 ~~517-2. Definitions.~~

1496  
1497 Anesthetizing Location. ~~Any area in which it is intended to administer any flammable or nonflammable~~  
1498 ~~inhalation anesthetic agents in the course of examination or treatment and includes operating rooms, delivery~~  
1499 ~~rooms, emergency rooms, anesthetizing rooms, corridors, utility rooms and other areas when used for~~  
1500 ~~induction of anesthesia with flammable or nonflammable anesthetizing agents.~~

1501  
1502 Critical Patient Care Area. ~~————~~ A section (rooms, wards or portions of wards) designated for the treatment of  
1503 critically ill patients.

1504

1505 Flammable Anesthetics. ~~Gases or vapors such as fluroxene, cyclopropane, divinyl ether, ethyl chloride, ethyl~~  
1506 ~~ether, and ethylene, which may form flammable or explosive mixtures with air, oxygen, or reducing gases such~~  
1507 ~~as nitrous oxide.~~

1508  
1509 Flammable Anesthetizing Location. ~~————~~ Any operating room, delivery room, anesthetizing room,  
1510 corridor, utility room, or any other area if used or intended for the application of flammable anesthetics.

1511  
1512 Patient Grounding Point. ~~————~~ A jack or terminal bus which serves as the collection point for redundant  
1513 grounding of electric appliances serving a patient vicinity, and for grounding conductive furniture or nonelectric  
1514 equipment within reach of a patient or a person who may touch him.

1515

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1516 Patient Vicinity. — The space with surfaces likely to be contacted by the patient or an attendant who can  
1517 touch him. This represents a space 6 feet beyond the reach of the patient.

1518  
1519 Reference Grounding Point. — A terminal bus which is an extension of the equipment grounding bus and is a  
1520 convenient collection point for grounding all electric appliances, equipment and exposed conductive surfaces  
1521 in a patient vicinity.

1522  
1523 Room Bonding Point. — A grounding terminal bus which serves as a collection point for grounding  
1524 exposed metal or conductive building surfaces in a room.

1525  
1526 ~~517-3. Grounding. — In locations intended for occupancy by patients at any time, all noncurrent-carrying~~  
1527 ~~conductive surfaces of electrical equipment that are subject to personal contact shall be grounded by an~~  
1528 ~~insulated copper conductor, sized in accordance with Table 250-95, installed with the circuit conductors~~  
1529 ~~supplying these receptacles and equipment.~~

1530  
1531  
1532 ~~517-50. General:~~

1533  
1534 ~~(b) Patient Care areas shall be classified into one of the three following categories:~~

1535 ~~(1) General Care Area. — Areas where patients ordinarily have only incidental contact with~~  
1536 ~~electrical devices.~~

1537 ~~(2) Critical Care Area, Controlled. — Areas where patients ordinarily are intentionally exposed to~~  
1538 ~~electrical devices, and where the governing body requires protection (insulation) of externalized cardiac~~  
1539 ~~conductors from contact with conductive surfaces other than those designed for connection to such cardiac~~  
1540 ~~conductors.~~

1541 ~~(3) Critical Care Area, Uncontrolled. Areas where patients ordinarily are intentionally exposed to~~  
1542 ~~electrical devices and where the governing body makes no requirements for protection of externalized cardiac~~  
1543 ~~conductors from contact with conductive surfaces other than those designed for the purpose.~~

1544  
1545 ~~517-51. Performance:~~

1546  
1547 ~~(a) Any two exposed conductive surfaces in the patient vicinity shall not exceed the following~~  
1548 ~~potential differences at frequencies of 1000 Hertz or less measured across a 1000 ohm resistance. Exception:~~  
1549 ~~Permanently installed x-ray equipment.~~

1550 ~~(1) General Care Areas. — 500 mv under normal operation.~~

1551 ~~(2) Critical Care Areas, Controlled. — 100 mv under normal operation.~~

1552 ~~(3) Critical Care Areas, Uncontrolled. — 100 mv under normal operation or under conditions~~  
1553 ~~of line-to-ground fault.~~

1554  
1555 ~~(b) Special Requirements. — The following requirements in both categories shall not apply to small~~  
1556 ~~portable nonelectric devices such as bed pans, chairs, and the like.~~

1557 ~~(1) General Care Areas. — Each patient bed location shall be provided with a minimum of four~~  
1558 ~~single or two duplex receptacles, each receptacle shall be grounded by means of an insulated copper~~  
1559 ~~conductor sized in accordance with Table 250-95.~~

1560 ~~(2) Critical Care Areas. — Each patient bed location shall be provided with a minimum of six~~  
1561 ~~single or three duplex receptacles, and grounded to the reference grounding point by means of an insulated~~  
1562 ~~copper equipment grounding conductor.~~

1563 ~~Each patient bed location shall be provided with a patient grounding point, grounded to the reference~~  
1564 ~~grounding point by means of an insulated continuous, stranded copper conductor, not smaller than No. 10.~~  
1565 ~~All exposed conductive surfaces of portable equipment used in the patient vicinity, including those on double-~~  
1566 ~~insulated and nonelectric beds shall be grounded to the reference grounding point.~~

1567 ~~One patient bed location shall not be served by more than one reference grounding point.~~

1568  
1569 ~~(7) The equipment grounding conductor for special purpose receptacles such as the operation of~~  
1570 ~~mobile x-ray equipment shall be extended to the reference grounding points for all locations likely to be served~~  
1571 ~~from such receptacles. When such a circuit is served from an isolated ungrounded system, the grounding~~

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1572 conductor need not be run with power conductors; however, the equipment grounding terminal of the special  
1573 purpose receptacle shall be connected to the reference grounding point.

1574

1575 (c) ~~Permanently Installed X-Ray Equipment.~~

1576 (1) ~~In addition to the grounding requirements of Article 660, permanently installed X-ray systems~~  
1577 ~~shall have a patient grounding point as described in (b) above, located as close as possible to the patient~~  
1578 ~~support, and be connected to the metal frame of the patient support by a separate, insulated, continuous,~~  
1579 ~~stranded, copper conductor, not smaller than No. 4.~~

1580 (2) ~~The patient grounding point shall be connected to the ground conductor serving the X-ray~~  
1581 ~~equipment by an insulated, stranded, copper conductor not smaller than No. 10.~~

1582 (3) ~~The permanently installed X-ray system including all equipment powered from the X-ray~~  
1583 ~~generator power supply shall not be required to be powered by an isolated system. The equipment grounding~~  
1584 ~~conductors associated with the equipment shall have a maximum DC resistance of 0.025 ohms, as measured~~  
1585 ~~between the chassis and the patient ground point.~~

1586

1587 517-60. Anesthetizing Locations Classifications.

1588

1589 (a) ~~Hazardous Location.~~

1590 (1) ~~Any room or space in which flammable anesthetics or volatile flammable disinfecting agents~~  
1591 ~~are stored shall be considered to be a Class I, Division 1 location throughout.~~

1592 (2) ~~In a flammable anesthetizing location, the entire area shall be considered to be a Class I,~~  
1593 ~~Division 1 location which shall extend upward to a level 5 feet above the floor.~~

1594

1595 (b) ~~Other Than Hazardous Locations.~~ ~~The term "other than hazardous locations" shall apply to any~~  
1596 ~~operating rooms, delivery rooms, anesthesia rooms, corridors, utility rooms, and other areas permanently used~~  
1597 ~~for or intended for the exclusive use of nonflammable anesthetizing agents.~~

1598 ~~Confirmation of other than hazardous locations shall be accomplished by a written policy by the hospital~~  
1599 ~~administration prohibiting the use of flammable anesthetics and posting of rooms. In such cases, the rooms~~  
1600 ~~are excluded from the requirements of Section 517-61, 517-62, 517-63(f) (2), and 517-63(f) (3) as applied to~~  
1601 ~~X-ray systems only.~~

1602

1603 517-61. Wiring and Equipment Within Hazardous Areas.

1604 (a) ~~In hazardous areas referred to in Section 517-60, all fixed wiring and equipment, and all~~  
1605 ~~portable equipment, including lamps and other utilization equipment, operating at more than 8 volts between~~  
1606 ~~conductors, shall conform to the requirements of Section 501-1 through 501-15 and Sections 501-16(a) and~~  
1607 ~~(b) for Class I, Division 1 locations. All such equipment shall be specifically approved for the hazardous~~  
1608 ~~atmospheres involved.~~

1609

1610 (b) ~~Where a box, fitting or enclosure is partially, but not entirely, within a hazardous area, the hazardous~~  
1611 ~~area shall be considered to be extended to include the entire box, fitting or enclosure.~~

1612 (c) ~~Flexible cords, which are or may be used in hazardous areas for connection to portable~~  
1613 ~~utilization equipment, including lamps operating at more than 8 volts between conductors, shall be of a type~~  
1614 ~~approved for extra-hard usage, shall be of ample length, and shall include an additional conductor for~~  
1615 ~~grounding. A storage device for the flexible cord shall be provided, and shall not subject the cord to bending at~~  
1616 ~~a radius of less than 3 inches.~~

1617

1618 (d) ~~Receptacles and attachment plugs in hazardous areas shall be listed for use in Class I, Group C~~  
1619 ~~hazardous locations, and shall have provision for the connection of a grounding conductor.~~

1620

1621 517-62. Wiring and Equipment in Nonhazardous or Above Hazardous Anesthetizing Areas.

1622

1623 (a) ~~Wiring above a hazardous area as referred to in Section 517-60 or in a nonflammable~~  
1624 ~~anesthetizing area shall be installed in rigid raceways or shall be Type MI cable, Type ALS cable, Type CS~~  
1625 ~~cable, or Type MC cable which employs a continuous, impervious metallic sheath.~~

1626

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1627 ~~(b) — Equipment which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders~~  
1628 ~~for fixed lighting, cutouts, switches, receptacles, generators, motors, or other equipment having make-and-~~  
1629 ~~break or sliding contacts, shall be of the totally enclosed type or so constructed as to prevent escape of sparks~~  
1630 ~~or hot metal particles.~~

1631  
1632 ~~(f) — Plugs and receptacles for connection of 250V, 50-ampere and 60-ampere AC medical~~  
1633 ~~equipment for use in nonhazardous areas of flammable anesthetic Anesthetizing Locations and in~~  
1634 ~~nonflammable Anesthetizing Locations shall be so arranged that the 60-ampere receptacle will accept either~~  
1635 ~~the 50-ampere or the 60-ampere plug. 50-ampere receptacles shall be designed so as not to accept the 60-~~  
1636 ~~ampere attachment plug. The plugs shall be of the two-pole, 3-wire design with a third contact connecting to~~  
1637 ~~the (green or green with yellow stripe) equipment grounding conductor of the electrical system.~~

1638  
1639 ~~517-63. Circuits in Anesthetizing Locations.~~

1640  
1641 ~~(a) — Except as provided in Section 517-63(f) and (g), each circuit within, or partially within, an~~  
1642 ~~anesthetizing location as referred to in Section 517-60 shall be controlled by a switch having a disconnecting~~  
1643 ~~pole in each circuit conductor, and shall be isolated from any distribution system supplying areas other than~~  
1644 ~~anesthetizing locations. Such isolation shall be acceptable by means of one or more transformers having no~~  
1645 ~~electrical connection between primary and secondary windings, by means of motor-generator sets, or by~~  
1646 ~~means of suitable isolated batteries.~~

1647  
1648 ~~(f) — Branch circuits supplying only fixed lighting fixtures in nonhazardous areas of anesthetizing~~  
1649 ~~locations other than surgical lighting fixtures, or supplying only approved permanently installed X-ray~~  
1650 ~~equipment shall be permitted to be supplied by a conventional grounded system, provided: (1) wiring for~~  
1651 ~~grounded and ungrounded circuits does not occupy the same raceways; (2) the lighting fixtures and the X-ray~~  
1652 ~~equipment (except the enclosed X-ray tube and the metal enclosed high-voltage leads to the tube) are located~~  
1653 ~~at least 8 feet above the floor or outside the anesthetizing location; and (3) switches for the grounded circuits~~  
1654 ~~are located outside of the anesthetizing location.~~

1655 ~~(g) — Components of an isolated power center approved for the purpose and its grounded primary~~  
1656 ~~feeder shall be permitted to be located in an anesthetizing location provided it is located in an other than~~  
1657 ~~hazardous area.~~

1658  
1659 ~~Note 1: For a description of approved permanently installed X-ray equipment, see Sections 3384, 3385, 3432,~~  
1660 ~~3433, 4435, and 4437 of the Inhalation Anesthetics Standard, NFPA No. 56A-1973.~~

1661  
1662 ~~Note 2: Remote-control stations for remote-control switches shall be permitted in the anesthetizing location if~~  
1663 ~~the remote-control circuit is energized from the ungrounded distribution system.~~

1664  
1665 ~~517-65. Other Equipment.~~

1666  
1667 ~~(b) — X-ray equipment installed or operated in an anesthetizing location as defined in Section 517-2 shall be~~  
1668 ~~provided with approved means for preventing accumulation of electrostatic charges. All X-ray control devices,~~  
1669 ~~switches, relays, meters, and transformers shall be totally enclosed, and where installed or operated within a~~  
1670 ~~hazardous area, shall be approved for Class I, Group C locations. High-voltage wiring shall be effectively~~  
1671 ~~insulated from ground and adequately guarded against accidental contact. The entire installation shall comply~~  
1672 ~~with Article 660.~~

1673  
1674 ~~517-66. Grounding. — In any anesthetizing area, all metallic raceways, and all noncurrent-carrying~~  
1675 ~~conductive portions of fixed or portable equipment including the conductive floor shall be grounded.~~

1676  
1677 ~~Exception: — Equipment operating at not more than 8 volts between conductors shall not be~~  
1678 ~~required to be grounded.~~

1679  
1680 ~~ARTICLE 660 – X-RAY EQUIPMENT~~

1681  
1682 ~~660-2. Definitions.~~

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1683  
1684 Portable: ~~\_\_\_\_\_ X-ray equipment designed to be hand-carried.~~  
1685  
1686 Mobile: ~~\_\_\_\_\_ X-ray equipment mounted on a permanent base with wheels and/or casters for moving while~~  
1687 ~~completely assembled.~~  
1688  
1689 Transportable: ~~X-ray equipment to be installed in a vehicle or that may be readily disassembled for transport~~  
1690 ~~in a vehicle.~~  
1691  
1692 Long Time Rating: ~~\_\_\_\_\_ A rating based on an operating interval of five minutes or longer.~~  
1693  
1694 Momentary Rating: ~~\_\_\_\_\_ A rating based on an operating interval that does not exceed five seconds.~~  
1695  
1696 660-3. Hazardous Locations. ~~\_\_\_\_\_ Unless approved for the location, X-ray and related equipment shall~~  
1697 ~~not be installed or operated in hazardous locations. See Article 517, Part E.~~  
1698  
1699 660-4. Connection to Supply Circuit.  
1700  
1701 (a) ~~\_\_\_\_\_ Fixed and Stationary Equipment. Fixed and stationary X-ray equipment shall be connected to~~  
1702 ~~the power supply by means of a wiring method meeting the general requirements of this Code.~~  
1703  
1704 Exception: ~~\_\_\_\_\_ Equipment properly supplied by a branch circuit rated at not over 30 amperes shall be~~  
1705 ~~permitted to be supplied through a suitable attachment plug cap and hard-service cable or cord.~~  
1706  
1707 (b) ~~\_\_\_\_\_ Portable, Mobile, and Transportable Equipment. Individual branch circuits shall not be required for~~  
1708 ~~portable, mobile, and transportable medical X-ray equipment requiring a capacity of not over 60 amperes.~~  
1709 ~~Portable and mobile types of X-ray equipment of any capacity shall be supplied through a suitable hard-~~  
1710 ~~service cable or cord. Transportable X-ray equipment of any capacity shall be permitted to be connected to its~~  
1711 ~~power supply by suitable connections and hard-service cable or cord.~~  
1712 (c) ~~\_\_\_\_\_ Over 600-Volt Supply. Circuits and equipment operated on a supply circuit of over 600 volts~~  
1713 ~~shall comply with Article 710.~~  
1714  
1715 660-5. Disconnecting Means. ~~\_\_\_\_\_ A disconnecting means of adequate capacity for at least 50 percent of~~  
1716 ~~the input required for the momentary rating or 100 percent of the input required for the long-time rating of the~~  
1717 ~~X-ray equipment, whichever is greater, shall be provided in the supply circuit. The disconnecting means shall~~  
1718 ~~be operable from a location readily accessible from the X-ray control. For equipment connected to a 120-volt~~  
1719 ~~branch circuit of 30 amperes or less, a grounding-type attachment plug cap and receptacle of proper rating~~  
1720 ~~shall be permitted to serve as a disconnecting means.~~  
1721 660-9. Minimum Size of Conductors. ~~\_\_\_\_\_ Sizes No. 18 or 16 fixture wires as specified in Section 725-~~  
1722 ~~16 and flexible cords shall be permitted for the control and operating circuits of X-ray and auxiliary equipment~~  
1723 ~~where protected by not larger than 20-ampere overcurrent devices.~~  
1724  
1725 D. ~~\_\_\_\_\_ Guarding and Grounding.~~  
1726  
1727 660-47. General.  
1728  
1729 (a) ~~\_\_\_\_\_ High-Voltage Parts. All high-voltage parts, including X-ray tubes, shall be mounted within~~  
1730 ~~grounded enclosures. Air, oil, gas, or other suitable insulating media shall be used to insulate the high voltage~~  
1731 ~~from the grounded enclosure. The connection from the high-voltage components shall be made with high-~~  
1732 ~~voltage shielded cables.~~  
1733  
1734 (b) ~~\_\_\_\_\_ Low-Voltage Cables. Low-voltage cables connecting to oil-filled units that are not completely sealed,~~  
1735 ~~such as transformers, condensers, oil coolers, and high-voltage switches, shall have insulation of the oil-~~  
1736 ~~resistance type.~~  
1737  
1738 660-48. Grounding.

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1739  
1740 ~~Noncurrent-carrying metal parts of X-ray and associated equipment (controls, tables, X-ray tube supports,~~  
1741 ~~transformer tanks, shielded cables, X-ray tube head, etc.) shall be grounded in the manner specified in Article~~  
1742 ~~250. Portable and mobile equipment shall be provided with an approved grounding-type attachment plug cap.~~  
1743 ~~In areas designated as critical care areas, X-ray equipment shall be grounded in the manner prescribed in~~  
1744 ~~Section 517-51.~~  
1745  
1746 Exception: \_\_\_\_\_ Battery operated equipment.  
1747