DELAWARE HEALTH AND SOCIAL SERVICES
Division of Public Health
Office of Radiation Control

Authority on Radiation Protection

Radiation Machine Registration Permit Manual

BASED ON THE

"DELAWARE RADIATION CONTROL REGULATIONS"

Adopted July 22, 1969

AMENDED
July 10, 2002

BY THE

AUTHORITY ON RADIATION PROTECTION

In conformance with 16 Del. C. § 7405 (a)

MESSAGE TO DELAWARE RADIATION MACHINE SOURCE FACILITIES

Radiation safety is the business--and the responsibility--of every person taking part in the use of radiation for diagnostic, therapeutic, industrial, or research purposes.

Using ionizing radiation in a way that is safe for patients, staff, and the general public is the personal responsibility of every authorized user of radiation. To exercise that responsibility, each person who uses ionizing radiation sources in Delaware must have a basic understanding of how the equipment works, of necessary safety principles and practices, and of the Delaware regulations for control of ionizing radiation. The owners and operators of registered radiation machine source facilities permitted to operate in Delaware are obligated to ensure that facilities are designed and constructed properly, that radiation service providers used are state-registered, and that radiation machine sources are used in compliance with established safety and health standards and regulations.

To assure that proper safety standards are met, Delaware's Authority on Radiation Protection requires that all Radiation Machine Source Facilities hold a registration permit in good standing, and be subject to periodic safety inspections. This manual contains instructions and other necessary information to assist radiation machine source facilities to obtain registration, and achieve compliance with regulations established by the State of Delaware.

William Holden, Chair, 2009
Authority on Radiation Protection
State of Delaware

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DEFINITIONS

AGENCY	The administrative agent of the Authority on Radiation Protection; i.e., the Office of Radiation Control, Division of Public Health, Delaware Department of Health and Social Services.
AMPERE	Unit of electric current . One ampere is produced by one volt acting through resistance of 1 ohm.
ANODE	The positively-charged side of the x-ray tube. It contains the target.
AUTHORITY	Delaware's Authority on Radiation Protection as specified by 16 Del. Code 7404.
BARRIER	A radiation-absorbing material such as lead, concrete, or plaster, used to protect an individual or an area by reducing exposure.
BITEWING RADIOGRAPHS	Intra-oral films that show the crown portions of opposing teeth in the biting position.
CASSETTES	A holder for x-ray film that protects the film from exposure to visible light but permits penetration of x-rays. Cassettes may be plastic, cardboard or metal.
CATHODE	The negatively-charged side of the x-ray tube. It contains the filament and the focusing device.
CENTRAL RAY	The x-ray that is located in the center of the x-ray beam as it leaves the tube head.
CERTIFICATE	A document issued by the Agency recognizing the successful completion of an Authority-approved Certification Examination. Unless otherwise specified, a “certificate” allows practice of Radiation Technology to the level of examination passed. A “temporary certificate” may be issued under certain circumstances.
COLLIMATION	The process of restricting the diameter of the x-ray beam which restricts the area of exposure to the patient. Collimation can be by an extension tube or blades that limit the size of exposure to the affected area.

DENSITY	The mass of an object through which the x-ray beam passes, which makes it appear either radiopaque or radiolucent.
DENTAL TECHNICIAN	An individual who is certified to perform Dental Radiography.
DENTAL HYGIENIST	An individual with formal training in dental hygiene, including application of dental x-rays, licensed by the Delaware Board of Dental Examiners.
DENTAL RADIOGRAPHER	An individual who is qualified to apply ionizing radiation to humans for diagnostic purposes in dentistry. This category includes Dental Assistants, Dental Hygienists and Dental Technicians.
DEVELOPER	The solution used in the processing of exposed x-ray film that turns it into a visible image.
ELECTRON	A subatomic particle with a small mass carrying a negative charge. The electrons are converted into x-ray photons upon striking the target of the anode.
EXPOSURE TIME	The time interval, usually expressed in fraction of a second during which x-rays are generated.
FILM BADGE or DOSIMETER	A recording device worn to record an individual's cumulative exposure to ionizing radiation.
FILM SPEED/ SENSITIVITY	An expression of how much radiation (milliampere-seconds) will be necessary to produce a diagnostic image on the film. Films are produced by the manufacturer with designated speeds by number (i.e., 100 speed, 400 speed, etc.) or letter (i.e. D, E, etc.).
FIXER	The chemical solution used in the processing of exposed x-ray film that preserves the developed image by removing the unexposed silver halide crystals. The proper “fixing” of a film allows for extended archival quality.
FOCAL-FILM DISTANCE (FFD) or SOURCE IMAGE DISTANCE (SID)	The distance from the focal spot (target) at the anode of the x-ray tube to the film. It is usually expressed in inches, for example 8-inch FFD. More recently called the source image distance or SID.

FULL MOUTH SURVEY	A series of intra-oral radiographs that gives diagnostic information for all teeth and desired bony areas. It is usually composed of peri-apical and bite-wing films.
IMAGE	Any likeness of an object reproduced on photographic film or other viewing device. The image is the entire radiograph.
ION	An electrically charged (+ or -) particle.
IN-UTERO EXPOSURE	Radiation exposure to the unborn fetus, resulting from irradiation of the pregnant mother.
IONIZATION	Process whereby electrically neutral atoms or molecules are converted to positively or negatively charged fragments on exposure to x-rays.
IONIZING RADIATION	The kind of radiation that produces ions when interacting with matter. Dental equipment and medical equipment produce this type of radiation.
KILOVOLT (kVp)	One thousand (1000) volts. Used in radiology to describe the kilovoltage setting used to expose a particular body part. The thicker (denser) the part, the higher the kVp setting required to penetrate the part to produce a diagnostic image. kVp determines the quality of the x-ray beam.
LICENSED PRACTITIONER	An individual licensed to practice medicine, dentistry, podiatry, chiropractic, or osteopathy in Delaware. In other words, any individual licensed to prescribe therapeutic or diagnostic radiation for human patients. In addition, this category includes dental hygienists who cannot prescribe radiation.
MEDICAL MODALITIES	Radiography, fluoroscopy, computed tomography, angiography, stereotactic breast biopsy systems, and radiation therapy, utilized in humans.
MILLIAMPERE (mA)	10E-3 ampere. In radiography, the current flow from the cathode to the anode that, in turn, regulates the intensity of radiation emitted by the x-ray tube.
NON-MEDICAL MODALITIES	Radiography, fluoroscopy, analytical equipment (including electron microscopes, fluorescence analysis and x-ray diffraction equipment), computed tomography, and particle accelerators, not utilized on humans.

OBJECT	The structure being radiographed, i.e., mandible, tooth, leg.
OBJECT FILM DISTANCE	The distance between the object (area of patient exposed to x-rays) and the x-ray film. Increased OFD, increases magnification of the part and reduces detail.
PANORAMIC RADIOGRAPH	A dental radiograph that shows both the mandible and the maxilla.
PENETRATION	The ability of x-rays to pass through an object and reach the film. Penetration of the beam is determined by the kVp.
PERIAPICAL RADIOGRAPH	An intra-oral film that shows the tooth location and surrounding bony structures.
PRIMARY RADIATION (PRIMARY BEAM)	The original radiation that comes directly from the target of the x-ray tube.
RADIATION	Used for medical and dental imaging. Ionizing radiation can cause cells to mutate and must be used carefully.
RADIATION ABSORBED DOSE	A measurement of the unit of absorbed radiation also known as “Gray”. The older unit is the rad (100 rads = 1 Gray).
RADIATION EXPOSURE	The process of being struck by radiation, either primary or secondary.
RADIATION SERVICE PROVIDER	A company or individual who provides the following services for compensation: a. installation and/or servicing of radiation machines and associated machine components; b. calibration of radiation machines or radiation measurement instruments or devices; c. radiation protection or health physics consultations or surveys; d. personnel dosimeter services; e. radiation shielding per NCRP Report # 49 and # 147; f. radiation therapy physicist (operator of therapeutic radiation machine).
RADIATION TECHNICIAN	Section IV of the Radiation Technologist/Technician Certification Regulation – means any individual who has not graduated from a JRCERT-approved or CODA program in radiation technology, but has passed a State of Delaware-approved examination.

RADIATION TECHNOLOGIST	Any individual who is a dental hygienist, a medical radiographer, a nuclear medicine technologist, or a Radiation Therapy Technologist who has completed an approved program and is nationally-credentialed.
RADIOGRAPH	The finished visual image of the part produced by exposing an object to radiation and recording that exposure on x-ray film and then chemically processing the film.
ROENTGEN	The special unit of exposure for photons in air in the system of units using centimeters, grams and seconds (cgs system); equal to 2.58 x 10E-4 C/kg (exactly).
SCATTERED RADIATION	Radiation that changes direction during its passage through matter. It may also be changed in its energy, by attenuation, i.e., become "softer." It is one form of secondary radiation. Scattered radiation can present a serious danger to the operator if appropriate protective measures (time, distance, shielding) are not used.
SECONDARY RADIATION	Radiation that comes from any matter being exposed to primary radiation. Secondary x-rays are less penetrating ("softer") than primary x-rays.
SHIELDING	Preventing or hindering the passage of radiation, by use of one or more barriers that attenuate the x-rays. Lead aprons, leaded walls, collimation are all forms of shielding. Patients should have gonadal shielding applied before any radiation that may expose the gonadal region.
SHIELDING PLAN REVIEW	Report containing facility design and construction information relevant to controlling radiation levels within dose limits established for: members of the general public, minors, or in-utero exposure.
TARGET	That part of the anode that the high-speed electrons strike, and that produces x-rays and heat. It is usually made of tungsten.
TECHNIQUE	Term used to define the exposure to the patient based on mA, time, and kVp used to make the radiograph.
TISSUE SENSITIVITY	A measure of the tendency of a given tissue type to mutate when exposed to ionizing radiation. Some tissues (for example, epithelium) are very radiosensitive, while others (for example, bone) are relatively radio-resistant.

TOTAL BODY EXPOSURE	The radiation dosage that describes the effect of an exposure on the entire body of the person.
TUBE	X-ray tube containing the cathode and anode where x-rays are produced.
USEFUL BEAM	The part of the primary radiation that goes where it is aimed and exposes the patient.
WORKLOAD	The degree of use of an x-ray source. The work load of a medical imaging x-ray tube is the time integral of the x-ray tube current and is given in units of milliampere-mnutes (mAmin). The total workload per week (W tot) is the total workload over a specific period expressed in mA min/week._.
X-RAYS	Electromagnetic radiation typically produced by high-energy electrons impinging on a metal target.

I. RADIATION MACHINE SOURCE REGISTRATION

A. *The Radiation Machine Source Permit*

The Delaware Radiation Machine Source Permit is a permit to operate radiation machines in Delaware, as required by Delaware Radiation Control Regulations. It is issued to qualified facility owner/operators who meet the requirements of the Delaware Radiation Control Regulations, as amended, as carried out by the Office of Radiation Control (ORC) in the Division of Public Health, the Administrative Agent of the Authority on Radiation Protection.

- The radiation machine source permit is valid for the period specified on the permit.
- Under a provision of the Delaware Radiation Control Regulations, all facility radiation machine source registration permits, and Radiation Technologist Certificates (medical/dental facilities only) must be posted in a conspicuous location within the registered facility.
- The permit is non-transferable. If a facility changes ownership, the existing permit will be terminated, and a new permit issued to the company acquiring the permitted facility, upon submittal of an application.
- The permit is kept in good standing by payment of an annual permit fee and compliance with the Delaware Radiation Control Regulations, as amended.

B. *Requirements for obtaining a Radiation Machine Source Permit*

1. Application to register an existing radiation machine source facility:

   The Owner/Operator of the radiation machine source facility must submit a completed, signed, official application form (ORC-R1) to:

   Delaware Office of Radiation Control
   417 Federal Street
   Dover, Delaware 19901

   The application must consist of:

   - A request that a registration permit be issued by filing the appropriate, official application form (ORC-R1).

   - Complete information, including: applicant's full company name, owner/operator (with IRS Employer Identification or Social Security number). Individual responsible for radiation protection (Radiation Safety Officer), name of licensed practitioner (for healing arts radiation use only), radiation service companies used, radiation procedures performed at the facility, radiation machine registration fee category and modalities used, radiation machine equipment inventory and status, signature of owner/operator.

   - Applicants are instructed to mail a copy of the completed application to the address specified on the application form, and retain a copy of the application for their records.

2. Application to register a new radiation machine facility (renovation or new construction):

   - A request that a registration permit be issued by filing the appropriate, official application form (ORC-R1).

   - Submission of a Shielding Plan for all facilities planning to use radiation machines with maximum energy exceeding 70 kVP, by filing the appropriate, official Minimum Shielding Requirements Report form (ORC-R15A), completed by a Radiation Service Provider registered by the Office of Radiation Control. A pre-operational inspection will be scheduled, and when successfully completed, an Approval to Operate letter will be issued to the facility. The new facility is not authorized to operate radiation equipment until this Approval to Operate letter has been issued.

- Submission of a Floor Plan, with radiation machine and remote operational switch location specified, for facilities planning to use radiation machines with maximum energy below or at 70 kVP.

- Upon receipt of a complete application package and conclusion of pre-operational inspection (if required), the Office of Radiation Control will issue the new radiation machine facility permit, and mail it to the facility address specified under item no. 1 on the application form (Facility address).

C. Renewal of Radiation Machine Source Permit

1. Radiation Machine Source permits must be renewed prior to the expiration date specified on the permit, to remain in full compliance with the regulations.

2. Radiation Machine Source facilities will be mailed a form populated with information from the most recent application on file, prior to their expiration date. Facilities are instructed to review the information for accuracy, make changes where needed, sign, date and mail the form back to the address noted on the form, allowing at least three weeks for processing prior to the expiration date.

3. Radiation Machine Source facilities who fail to renew their permit prior to the expiration date, are subject to being issued a Notice of Violation citation under the Delaware Radiation Control Regulations.

D. *Annual Radiation Machine Source Permit Fees*

1. Each radiation machine source permit-holders shall pay an annual fee, based on the fee schedule established in Delaware Senate Bill 108, signed into law in June 2008:

Category	Fee ($)	Description
I	1,370	Facilities with a total of five or more of the medical modalities or non-medical modalities listed below.
II	1,030	Facilities with a total of three or four of the medical modalities or non-medical modalities listed below.
III	690	Facilities with two of the medical modalities listed below.
IV	275	Facilities with one of the medical modalities listed below, **and** an annual patient workload of 750 examinations or more.
V	140	Facilities with one of the medical modalities listed below, **and** an annual patient workload of less than 750 examinations, **or** all other radiation installations with one or two of the non-medical modalities listed below except as listed under Category VI.
VI	75	Dental, podiatric, bone densitometry or veterinary installations.

For purposes of the fee schedule set out above, the following definitions apply:

"Medical Modalities" means radiography, fluoroscopy, computed tomography, angiography, stereotactic breast biopsy systems, and radiation therapy, utilized in humans.

"Non-medical Modalities" means radiography, fluoroscopy, analytical equipment (including electron microscopes, fluorescence analysis and x-ray diffraction equipment), computed tomography, and particle accelerators, not utilized on humans.

Owner/Operators must pay radiation machine source fees for all fee categories which apply to their facilities. For example, a facility performing medical modalities and dental modalities in the same facility would be obligated to pay the appropriate medical category fee, and the dental category fee.

2. Radiation machine source permit-holders will be mailed an invoice for their annual fee, in the fall of each calendar year, with bill payable within 30 days of invoice date. Owner/Operators are instructed to make check payable to "Delaware Office of Radiation Control," and mail the check AND copy of invoice to the attention of the Office of Radiation Control, to the address specified on the invoice (417 Federal Street, Dover, DE 19901).

3. Radiation machine source permit-holders who do not pay their permit fee within 30 days following the invoice date will receive a reminder letter, with instruction to pay their fee immediately, or risk issuance of an administrative penalty.

4. Radiation machine source permit-holders who do not pay their permit fee within 60 days will be issued an administrative penalty by the Authority on Radiation Protection.

5. Radiation machine source permit-holders who do not pay their permit fee AND the administrative penalty amount within 10 days of the date on the administrative penalty letter will be forwarded to the Department of Justice for enforcement action through the Office of the Attorney General.

E. Inspections

1. Periodic, routine inspections of registered machine source facilities shall be performed at frequencies established by the Authority on Radiation Protection:

   Annual - Hospital, Irradiator, or Accelerator Facilities
   Biennial - Medical Facilities
   Triennial - Academic, Bone Densitometry, Dental, Industrial, Podiatry or Veterinary Facilities

2. Additional inspections of registered radiation machine source facilities shall be performed based on criteria established by the Authority on Radiation Protection:

   Follow-Up Inspection – to verify compliance after a notice of violation is issued, after complaint or investigation inspections, or after administrative hearings.

   Complaint Inspection – in response to formal or informal complaints against registered facilities. A complaint inspection may be performed by the Agency in the interest of protecting the public.

   Investigation Inspection – performed on non-registered radiation facilities for determining whether compliance with the regulations is required.

3. Correction of Violations

   Severity Level 1 Violations;
   The Owner/Operator of the permitted facility shall inform the Agency in writing within 10 days of issuance of Notice of Violation of the proposed method or means of correcting the Severity Level 1 violation, and of the date when the correction will be made. Correction must be made within 30 days of the issuance of the violation.

   Severity Level 2 Violations:
   The Owner/Operator of the permitted facility shall correct the violation as soon as possible, and is allowed up to 60 days to make the correction.

F. *Administrative Penalties*

Whomever violates any rules, regulations or orders of the Authority shall be assessed an administrative penalty in an amount not to exceed $ 500 for a first offense, or an amount not to exceed $ 750 for any subsequent offense. Each violation shall be considered a separate offense.

II. FUNDAMENTALS OF X-RAYS

Radiation Physics

X-rays are electromagnetic waves, like visible light, microwaves, and radio waves. The difference between these different types of electromagnetic radiation is in their wavelengths, the distance between adjacent peaks of the waves. Our eyes are equipped to see radiation in a certain range of these wavelengths which we call visible light. Radiation at other wavelengths, invisible to the human eye, can only be detected by means of special sensors. Electromagnetic radiation of most wavelengths passes through some materials, for example through air, without either being absorbed or reflected. When visible light passes through such a material we call it transparent. Other materials pass only a fraction of the radiation incident on them and either absorb or reflect the rest (we call such materials translucent or attenuating) and still others absorb or reflect most the radiation incident on them (we call these opaque).

The shorter the wavelength of the radiation is the more energy it carries and the greater is the chance of its passing through various materials without being absorbed or reflected. X-rays have very short wavelengths. They thus carry considerable more energy and are able to pass through many materials without a large fraction of them being absorbed. In fact, the fraction of incident x-rays that is absorbed by a given material depends mostly on the material's density. Thus, dense materials such as lead and gold absorb a much greater fraction of incident x-rays, at a given thickness of the material, than do "light" materials, such as water. Similarly, x-rays, pass mostly unabsorbed through most biological tissues such as muscle and various organs, but they are more strongly absorbed by bone, which has a higher density. X-ray imaging takes advantage of this difference in the x-ray attenuating properties of various tissues in the body.

What we finally see as a finished radiograph is the result of variations in the intensity of the x-ray beam due to differences in attenuation by different tissues. After passing through the body, the x-rays, which have passed through without being attenuated, impinge on fluorescent screens between which a photographic film is sandwiched. The fluorescent screens are made of a dense material designed to absorb most of the incident beam and, on absorbing the x-rays, emitting visible light to which the photographic film is sensitive. They thus expose the film, which is then developed to display the radiograph.

How X-rays Are Made

An x-ray tube is a special case of electronic vacuum tube. It always has a glass envelope with several electrical leads sealed into it, enclosing several electronic elements, with the air removed from it as completely as possible. A schematic diagram of a tube head, which includes the tube itself (glass envelope + contents), is shown as Figure II-1; a typical control panel is shown as Figure II-2.

This section describes how x-rays are generated. Though somewhat oversimplified, the concept is accurate. These steps always occur, though in some modern equipment some of them may happen in a rapid and automatic sequence.

1. The x-ray machine's main power switch is turned ON and the "X-ray Ready" light comes ON. Ordinarily, this is done at the beginning of the workday.

2. The current is adjusted to the value called for by the technique chart, using the current (mA) adjustment control knob. This current heats the filament of the negatively charged cathode, which begins to give off electrons when it gets hot enough. Once the filament gets hot enough to begin emitting electrons (its threshold temperature), it emits them more rapidly, the hotter it gets. A higher current produces a hotter filament which in turn produces a higher rate of electron emission.

   At this stage, the electrons have nowhere in particular to go. Generally, they fly a short distance out into the vacuum, stay there awhile, and finally fall back into the surface of the cathode. This makes a sort of "cloud" of free electrons around the hot cathode, just waiting for something to happen.

3. The high-voltage supply is adjusted to the value prescribed by the technique chart (or by the Licensed Practitioner, in case of special radiography), using the kVp control knob. A typical value is 70,000 peak volts (70 kVp), nearly 1000 times the voltage of ordinary "house" voltage. (This voltage is lethally high; the leads are totally enclosed to protect anyone from touching them.

4. When the operator positions the patient (the object) for the radiograph, he sets the time knob to the appropriate time interval.

5. At this point, the x-ray machine is ready to be used. The electron cloud around the cathode is stabilized according to the mA setting; the high voltage has been set to the desired kVp setting; the time interval is set. **NO X-RAYS ARE GENERATED YET.**

6. When the operator (having taken a safe position behind a protection barrier or 12 feet from the x-ray tube presses the Remote Activator switch (Deadman Switch***/*** exposure button), (a) the high voltage is imposed between cathode and anode, (b) the automatic timer starts, and (c) the "X-ray ON" light comes ON.

The anode, now bearing a strong positive charge, attracts the free electrons in the cloud around the cathode. The electrons fly through the vacuum to strike (and stick to) the anode, striking the target with so much energy that it emits x-rays and gets quite hot. The higher the kVp, the faster the electrons move to the anode, the harder they strike the target, and the more energetic the x-rays are--that is, the more penetrating capability they have.

The rate at which the cathode emits electrons is a time function. It controls the rate at which x-rays are generated (x-rays per second) at the target--that is, the intensity of the x-ray beam.

The quantity of x-rays, or radiation exposure, is a function of mA x time interval. (This is often referred to in terms of milliampere-seconds (mAs) per radiograph, and relates proportionately to roentgens or to rem in human tissue.) Penetration is a sole function of kVp. The higher the kVp, the harder the beam, the more penetrating the x-rays.

When the exposure time interval (usually less than a second) has expired, a switch automatically opens to remove the high voltage from the tube electrodes. This instantly stops x-ray generation. (If the automatic timer switch malfunctions, the operator's manual Deadman Switch stops x-ray generation immediately when the operator releases finger pressure on the switch. This protects both patient and operator from overexposure.) Because the high voltage is removed from the tube electrodes,

a) Electrons stop moving from cathode to anode.
b) X-ray productions stops.
c) The “X-Ray ON” light goes out.

Figure II-1 shows the basic parts of the x-ray tube head, and their relation to each other:

1. Cathode: The negatively charged (-) side of the x-ray tube, which also includes the filament. Electrons are emitted from the cathode.

2. Filament: Wire in the cathode, which is heated to produce free electrons.

3. Focusing Device (Cup): A negatively charged deflector that directs (focuses) electrons into a beam directed at the target.

4. Anode: The positively charged (+) side of the x-ray tube. It contains the target.

5. Target: (See Definition) The part of the anode struck by the electron beam. It is usually made of tungsten, a heavy metallic element with a very high melting point to withstand the heat generated by electron bombardment.

A. Lead Shielding: Outer layer of lead within the tube head to absorb stray or scattered x-rays not exiting the tube window or port.

B. Vacuum: The interior of the tube. It has had all the air removed, and must remain sealed in order to function.

C. Beam-Limiting Device: Also known as a "collimator", used to limit the diameter of the useful beam.

D. Useful X-ray Beam: The part of the x-ray beam that goes where it is aimed, exposing the patient and the film.

E. Glass Envelope: The shell of the x-ray tube, vacuum-tight.

F. Position-Indicating Device: A device used to aim the primary x-ray beam.

Figure II-2 shows controls and meters. The components of this figure perform the following functions:

A. Remote Activator: Remote switch that activates the x-ray machine. This is preferably a Deadman Switch, i.e., a switch which is made so that it is activated only by the operator's continuous pressure, also known as the exposure button.

B. kVp Meter: Indicates the peak voltage (kilovolts) between cathode and anode.

C. mA Meter: Indicates the current (milliamperes) flowing between cathode and anode.

D. X-ray Ready Light: Indicates that the machine is warmed up and ready to operate.

E. X-ray ON Light: Lights only during the brief period when the x-ray machine operates.

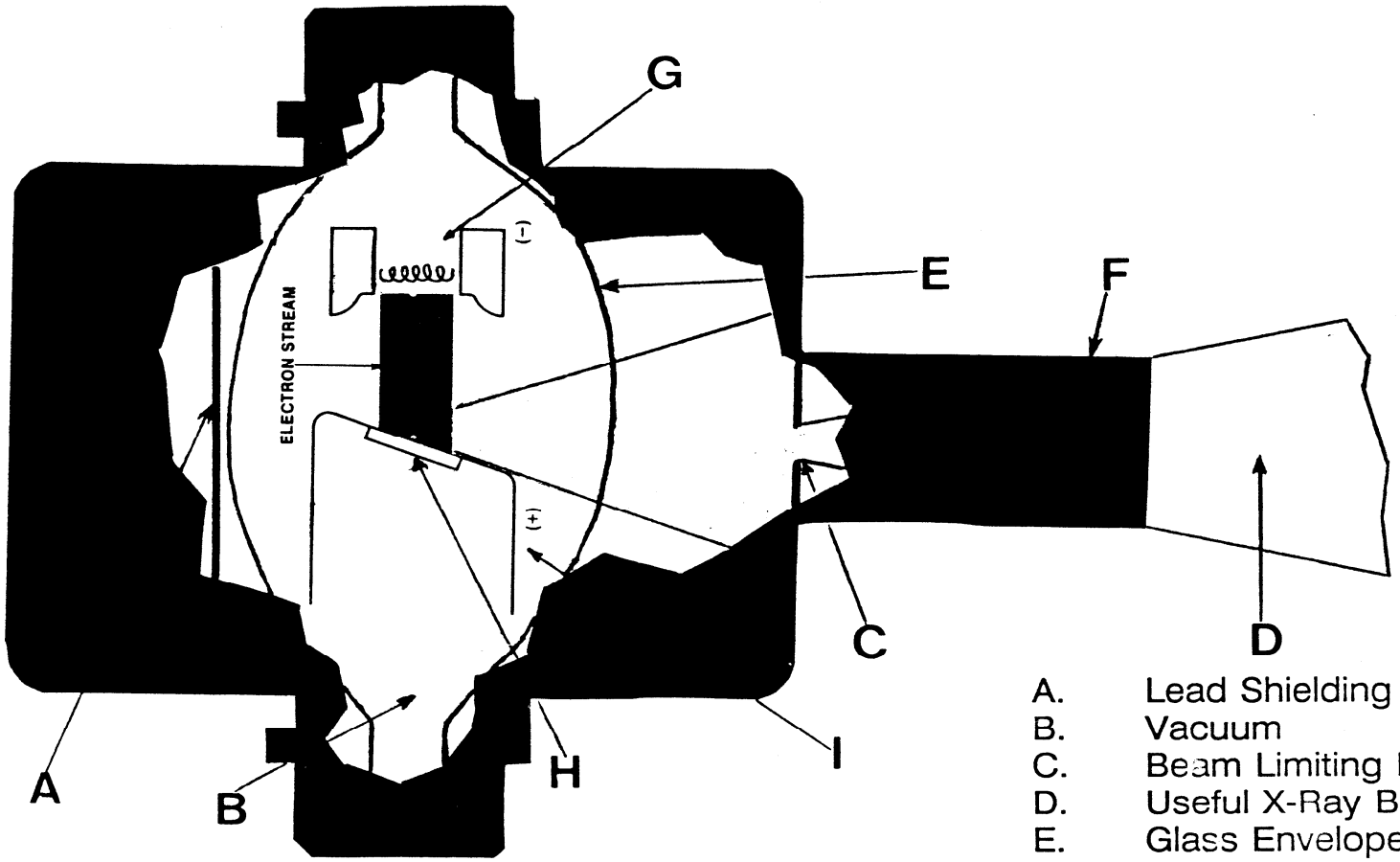
F. Timer: Sets the time interval during which the machine generates the x-ray beam. The timer is connected to the TIMER SWITCH. The operator turns the machine ON manually, using the Remote Activator, then the timer switch turns OFF automatically after the preset time interval has elapsed.

G. mA Adjustment Knob: Allows you to alter the tube current (mA), by controlling the input. The procedures for individual x-ray machines prescribe the normal range of current values.

H. kVp Adjustment Knob: Allows the operator to select the (operating) voltage across the x-ray tube needed to penetrate the part being x-rayed.

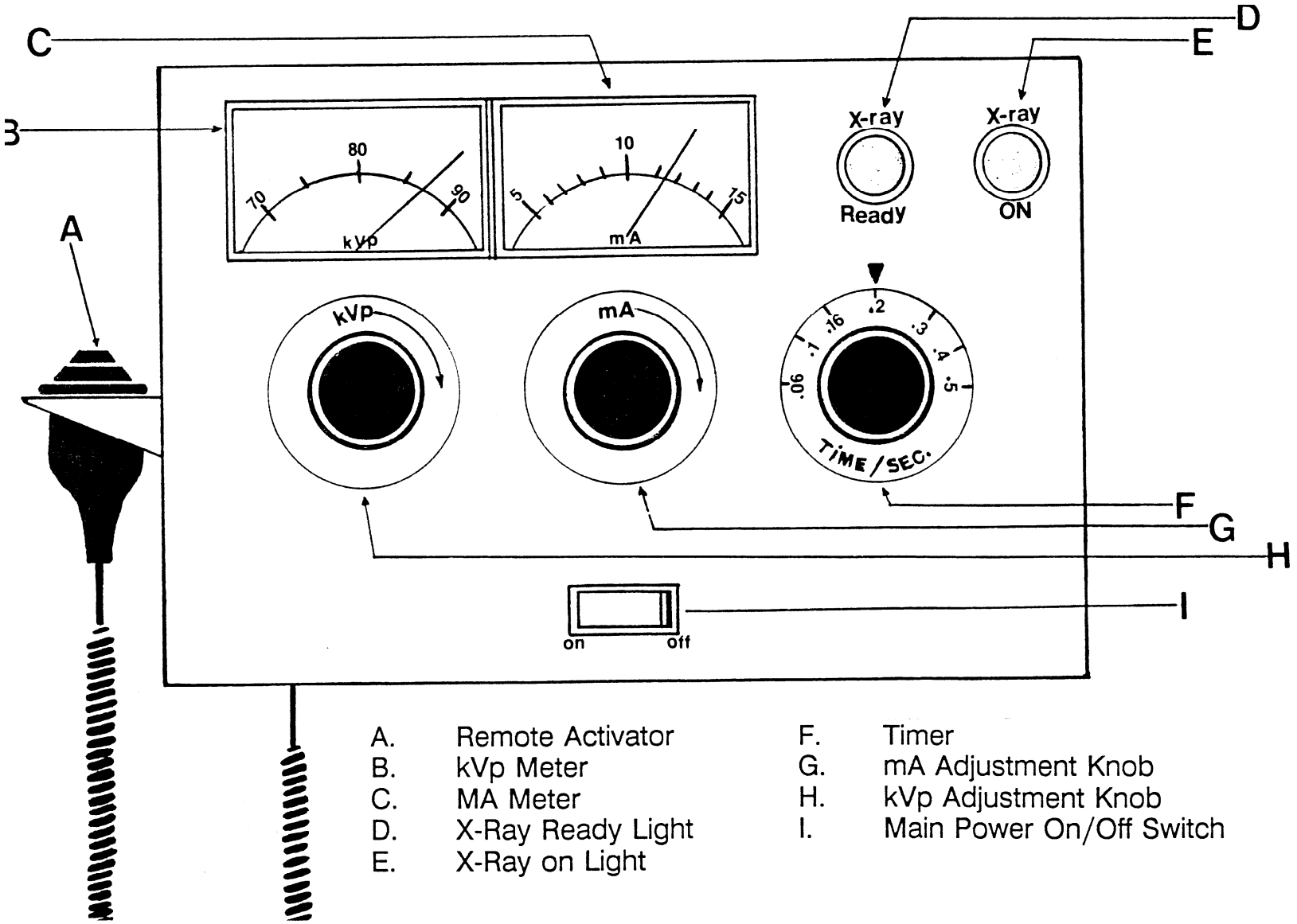
I. Main Power ON/OFF Switch: Connects/disconnects electrical power to the x-ray machine.

FIGURE 11 – 1



A. Lead Shielding
B. Vacuum
C. Beam Limiting Device
D. Useful X-Ray Beam
E. Glass Envelope
F. Position-Indivating Device
G. Cathode
H. Target
I. Anode

FIGURE 11 – 2



A. Remote Activator
B. kVp Meter
C. MA Meter
D. X-Ray Ready Light
E. X-Ray on Light
F. Timer
G. mA Adjustment Knob
H. kVp Adjustment Knob
I. Main Power On/Off Switch