



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

Authority on Radiation Protection

Radiation Technologists/Technicians Certification Manual

BASED ON THE

“REGULATION FOR THE CERTIFICATION OF RADIATION
TECHNOLOGISTS/TECHNICIANS”

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**STATE OF DELAWARE
RADIATION TECHNOLOGIST/TECHNICIAN CERTIFICATION MANUAL**

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MESSAGE TO DELAWARE RADIATION TECHNOLOGISTS/ TECHNICIANS

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

There is no doubt that determining the amount of radiation to be applied to a person, and the way it is applied, is the prerogative and responsibility of the licensed practitioner, for instance, a physician or a dentist. However, applying radiation in a way that is safe for the patient, the staff, and the general public is the personal responsibility of each individual involved in the process. To exercise that responsibility, each person who applies ionizing radiation in Delaware must have a basic understanding of how the equipment works, of safety principles and practices, and of the Delaware regulations about ionizing radiation.

To assure that proper safety standards are met, Delaware's Authority on Radiation Protection requires that all Radiation Technologists/Technicians be certified as competent in the knowledge and principles of radiation protection. This manual contains necessary safety information, and guidance explaining how non-state-licensed health care professionals can become certified as Radiation Technologists/Technicians by the 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	The unit of measure of the amount of current flowing in an electric circuit. The unit milliamperere (mA) is 1/1000 of an ampere, and is the usual unit used to measure the current supplied to the x-ray tube. The milliamperere is used to determine the amount of radiation emitted from the x-ray tube.
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 <u>Del. Code</u> 7404.
<u>BARRIER</u>	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 applies radiation to humans for diagnostic purposes in dentistry. This category includes both Dental Assistants and Dental Hygienists.
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 (milliampereseconds) 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.
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.
MILLIAMPERE (mA)	One one-thousandth (1/1000) of an ampere. This unit of measurement predetermines the amount of radiation delivered over a prescribed time (workload). The workload when coupled with kilovoltage determines the quality and quantity of radiation a patient is exposed to and needed to produce the desired diagnostic image.
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 Gray = 1 Rad). In radiation protection, a rad or rem is approximately equal to a roentgen.
RADIATION EXPOSURE	The process of being struck by radiation, either primary or secondary.
RADIATION TECHNICIAN	Section IV, M, 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 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 basic unit for measuring x-rays (ionizing radiation) exposure in air. It is the amount of radiation needed to produce one electrostatic charge in one cubic centimeter of air. The milliroentgen (mR) is 1/1000 of a roentgen (R).

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 struck by 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.
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	A measure of the amount of use (high or low) of an x-ray tube in one week and is used to determine appropriate shielding when building a new room. The amount of time that an x-ray tube is used during a week based on the type of exposures performed in a room. Product of x-ray tube "ON" time in a week; milliamperes x seconds, i.e., milliamp seconds per week (mAsec/wk).
X-RAYS	Penetrating electromagnetic radiation. X-rays travel in a straight line from the source and are invisible.

I. CERTIFICATION

A. *The Certificate*

The Delaware Radiation Technologist/Technician Certificate is a permit/license to practice Radiation Technology in Delaware, as required by Delaware Radiation Control Regulations. It is issued to qualified individuals who meet the requirements of the Radiation Technologist/Technician Certification Regulation, as amended, by the Office of Radiation Control (ORC) in the Division of Public Health, the Administrative Agent of the Authority on Radiation Protection.

- ▶ The certificate is valid only when signed by the Radiation Technologist/Technician to whom it has been issued.
- ▶ Under the provision of the Delaware Radiation Technologist/Technician Certification Regulation, "holders of a certificate under these regulations shall display the official certificate or a verified copy in each place of regular employment."
- ▶ The certificate is valid for four (4) years from date of issue.
- ▶ The certificate is renewable by application to the Office of Radiation Control, accompanied by payment of the prescribed renewal fee.

B. *Who Must be Certified?*

Each Radiation Technologist/Technician in Delaware must be certified in order to practice, according to the "Radiation Technologist/Technician Certification Regulation", as established by Delaware's Authority on Radiation Protection on February 27, 1989. **THIS IS A LEGAL REQUIREMENT.** Individuals administering radiation to patients who do not hold a current Radiation Technologist/Technician Certificate in good standing can subject their employer (registered radiation facility) to citation under the Delaware Radiation Control Regulations, as amended.

Students, who administer radiation under the direct supervision of a Licensed Practitioner or certified Radiation Technologist as part of their training, will not be certified while they remain in training. This applies to a student enrolled in and attending a school or college of medicine, osteopathy, chiropractic, podiatry, dentistry, radiation technology, dental assisting or dental hygiene.

C. *Requirements for Certification*

1. Application Requirements for all applicants:

- ▶ Applicant's full name, home address, date of birth, social security number and daytime/evening phone number as required on the application form. **Applicants should retain a copy of their completed application.**
- ▶ Applicant's acknowledgement of their "Duty to Report" obligation to file a written report with the Board of Medical Licensure and Discipline within 30 days of becoming aware of or having reason to believe that any medical practitioner may be guilty of unprofessional conduct, as specified on the application form.
- ▶ Applicant's acknowledgement of their "Duty to Report" obligation to make an immediate oral report to the Department of Services for Children, Youth and Their Families if they become aware of, know of or suspect child abuse or neglect and follow up with a written report, as specified on the application form.
- ▶ Applicant's acknowledgement of their obligation to disclose whether they have been convicted of a felony within the last 10 years, as specified on the application form.
- ▶ Applicant's signature and date, attesting to the accuracy of information provided, as specified on the application form.

2. Application/Request for Radiation Technologists holding a National Credential:

Each Radiation Technologist who holds an approved national credential, or has confirmation for national registry testing must submit the complete, signed, official application form (R16N) to the address below. Current forms are available on the ORC webpage.

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

The application must meet requirements for all applicants specified in section C.1 above, and include:

- ▶ A photocopy of an approved National Credential membership card, OR a photocopy of an official seat reservation for a national examination (see Appendix IX for list of National Credentials recognized by Delaware).
- ▶ A nonrefundable/nontransferable application fee in the form of check or money order made payable to the Delaware Office of Radiation Control

(cash will not be accepted). Please allow a minimum of three (3) weeks for processing. **Incomplete applications will be returned.**

3. Application/Request for State Exam - Medical Radiation Technician or Bone Densitometry Radiation Technician:

The application must meet requirements for all applicants specified in section C.1 above, and consist of:

- ◆ A request that the Certificate be granted by filing a complete, signed, official application form (**R16S**) to the address below. Current forms are available on the ORC webpage.

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

4. Application/Request for State Exam - Dental Radiation Technician:

The application must meet requirements for all applicants specified in section C.1 above, and submit an application as instructed below:

- ◆ **Applicant must contact the Dental Assisting National Board (DANB) directly** to register for the Delaware Dental Radiologic Technology Exam (DDRT), by visiting www.DANB.ORG or calling 1-800-CALL-DANB.
- ◆ **Applicant must schedule the exam with DANB, and *after passing the exam***, submit a complete, signed, official application form (**R16S**) as described below, with payment of nonrefundable/nontransferable application fee of \$ 10 in the form of check or money order made payable to the Delaware Office of Radiation Control, *(cash will not be accepted)*, **and a photocopy of your DANB test result letter** showing a passing score on the exam. Please allow a minimum of three (3) weeks for processing. Incomplete applications will be returned.
- ◆ Upon receipt of complete application, application fee and proof of passing the DDRT exam, the Office of Radiation Control will mail the applicant their certificate.

A nonrefundable/nontransferable application fee in the form of check or money order made payable to the Delaware Office of Radiation Control must be submitted with each application form *(cash will not be accepted)*. Please allow a minimum of three (3) weeks for processing. **Incomplete applications will be returned.**

Certificates will be sent to the home address of the applicant given on form no. R16B, R16S or R16N. Certificate holders are required to notify the Office of Radiation Control in writing of any **change in name, address or other contact information** to

ensure that Agency records remain accurate throughout the four-year certification cycle. **If requesting name change, applicant is required to submit supporting documentation with change of name form, e.g. copy of marriage license, judgment of divorce or other court papers.** The Change of Address or Name Form No. R16A is available on the ORC webpage.

Failure to provide change of name information in a timely manner may jeopardize your certification standing.

2. Certification

Certification will be granted if any one of the following criteria is satisfied:

- a. The applicant presents evidence of possessing a current credential granted by a recognized national voluntary credentialing body (see Appendix IX), issued on the basis of an examination satisfactory to the Authority. **Note that the Authority will not accept any certification, registration, or license/permit issued by another state.**
- b. The applicant presents evidence of completing an appropriate course of study, approved by the Joint Review Committee on Education in Radiologic Technology/Therapy, the Joint Review Committee on Education in Cardiovascular Imaging or the Commission on Dental Accreditation (CODA), or an equivalent course of study acceptable to the Authority, and has a seat reservation to take the appropriate national credentialing examination for which a temporary state certificate will be granted.
- c. The applicant passes the Authority approved state examination, AND is at least 18 years of age. In cases where the applicant passes the exam, but is less than 18 years of age, the certificate will be held back and mailed on the applicants 18th birthday, as required by regulation.

3. Examination

The Authority has authorized the use of examinations specified below:

- a. The American Registry of Radiologic Technologists Limited Scope State Licensing Examination: This test consists of 6 parts: 100 "CORE" questions that every medical radiation technician takes about general radiation safety and patient care. Five additional parts are provided for specific body part (anatomical) areas. An examinee may choose from Chest, Ankle and Feet, Skull/Sinuses, Extremities, and/or Spine. This computer-based, Limited Scope exam is administered by the American Registry of Radiologic Technologists (ARRT), through local computer test centers, specifically for State licensing requirements. It is non-transferable to other states. Prior to taking medical x-rays, the applicant must successfully pass the 100-question core part and at least one other

body part exam before a certificate will be issued. Technicians will only be certified to x-ray body parts based on the test parts passed.

- b. The American Registry of Radiologic Technologists Bone Densitometry Operator's Examination: This test consists of 60 questions, in 8 parts: Basic Concepts, Equipment Operation & Quality Control, Radiation Safety, and DXA Scanning of Finger, Heel (Os Calcis), Forearm, Lumbar Spine and Proximal Femur. This computer-based exam is administered by the American Registry of Radiologic Technologists (ARRT), through local computer test centers, specifically for State licensing requirements. It is non-transferable to other states. Prior to taking bone densitometry x-rays, the applicant must successfully pass the exam, before a certificate will be issued.
- c. The Delaware Dental Radiation Technician (DDRT) Examination, is administered by the Dental Assisting National Board (DANB) through local computer test centers, specifically for State Licensing Requirements. It is intended for dental examinees and covers aspects of radiation technology and practice pertaining to radiation safety of the dental patient. The Authority intends that passage of this examination will assure that the applicant has sufficient knowledge of radiation principles, with regard to basic theory and equipment operation, to responsibly and safely administer radiation to patients. The Delaware Radiation Technologist (DDRT) exam is equivalent to the DANB Radiation Health & Safety Examination (DANB RHS) exam, and this examination may be recognized by other states, for licensure (eg. New Jersey and Maryland).

D. Taking the Examination

1. The examination process is administered by the Division of Public Health, Office of Radiation Control. Tests are provided based on arrangements made with each test administration organization under contract. The Test administration organization will provide specific information to each applicant on scheduling, and sites for testing.

Applicants are responsible for registering with the test administration organization to schedule to sit for an exam on a given date.

If you do not hear from the test administration organization regarding your exam within three weeks of registering with the test administration organization to sit for an exam, you are responsible for contacting them directly to determine the status of your registration. Contact the Office of Radiation Control at (302) 744-4546 immediately if you experience any customer service issues with a test administration organization.

2. The initial examination must be taken within six (6) months of the date the application form is signed. After the six-month period has expired,

applicants must submit a new application with application fee, as described in Section C.1 above. See application for specific fee amounts.

3. DENTAL APPLICANTS

- Stage 1: Applicant contacts the Dental Assisting National Board (DANB) directly to apply for the Delaware Dental Radiologic Technology Exam (DDRT), by visiting www.DANB.ORG or calling 1-800-CALL-DANB.
- Stage 2: Applicant schedules the DDRT exam directly with DANB, and receives a Test Admission Notice from DANB.
- Stage 3: Applicant takes the Test Admission Notice to the test site, and completes the exam.
- Stage 4: DANB notifies the examinee of official pass/fail test results. Examinees who have passed the examination and are at least 18 years of age are eligible to receive a certificate to practice as a Dental Radiation Technician.
- Stage 5: Applicant submits a complete Delaware application (ORC-R16S form), with payment of nonrefundable/nontransferable application fee of \$ 10 in the form of check or money order made payable to the Delaware Office of Radiation Control, (*cash will not be accepted*), and a photocopy of the DANB test result letter showing a passing score on the exam. Please allow a minimum of three (3) weeks for processing. Incomplete applications will be returned.
- Stage 6: Unsuccessful examinees will be provided information from DANB on how to apply to retest.

NOTE: UNTIL EXAMINEE APPLIES FOR AND RECEIVES A DENTAL RADIATION TECHNICIAN CERTIFICATE FROM THE STATE OF DELAWARE (ORC), THE EXAMINEE SHALL NOT PERFORM ANY RADIOGRAPHIC PROCEDURES.

NOTE: Examinees who pass the examination but are under 18 years of age may submit an application to ORC, but will not be issued a certificate to practice until their 18th birthday has elapsed

MEDICAL LIMITED SCOPE AND BONE DENSITOMETRY APPLICANTS

- Stage 1. Applicant contacts the Office of Radiation Control at the above number and submits application ORC-R16S, the nonrefundable/nontransferable application fee and the exam fee..See application for specific fee amounts. Application and fees are received and processed by the Agency. Please allow a minimum of three (3) weeks for processing. Incomplete applications will be returned.
- Stage 2. Applicant reviews the Radiation Technologists/Technicians Manual on the ORC webpage.
- Stage 3. Applicant's name added to ORC candidate list for the requested ARRT Examination
- Stage 4. ORC submits list of candidates to ARRT.
- Stage 5. ARRT sends candidate's admission ticket for examination to

- examinee.
- Stage 6. Candidate sits for requested examination, as scheduled.
- Stage 7. Candidate test scores received by State (ORC).
- Stage 8. The Office of Radiation Control notifies the examinee of pass/fail results. Examinees who have passed the examination will receive a certificate. Examinees who are unsuccessful will be provided information on how to apply to retest.

NOTE: UNTIL EXAMINEE RECEIVES FINAL WRITTEN NOTIFICATION OF A PASSING GRADE FROM THE STATE OF DELAWARE (ORC), THE EXAMINEE SHALL NOT PERFORM ANY RADIOGRAPHIC PROCEDURES.

E. Scoring the Examination

Test Administration Organizations report test scores to the Office of Radiation Control. Passing rates are determined based on the particular scoring mechanism used by each Test Administration Organization. The Authority on Radiation Protection determines specific passing rates for each examination consistent with scoring mechanism used by each Test Administration Organization. **The Office of Radiation Control issues certificates to examinees who earn a passing score on their examination, and are at least 18 years of age.**

F. Retesting Privileges

Examinees may be re-examined twice per 12-month period, following the initial examination.

Examinees who hold a temporary state certificate based on having qualified to sit for their national board exam, and fail to pass their national Credentialing Examination will lose their temporary state privileges, and are not permitted to perform radiographic procedures. Examinees may be re-examined twice per 12-month period, following the initial examination. However, only one temporary state certificate will be issued.

G. Renewal of Certification

1. Permanent Radiation Technologist/Technician Certificates are valid for a period of four years, and must be renewed no later than 30 days following the expiration date printed on the certificate in order for the certificate holder to continue to operate radiation equipment. Radiation Technologist/Technician Certificates are required to be posted in their place of employment.
2. Radiation Technologists/Technicians are responsible for submitting a renewal form, and payment of a nonrefundable/nontransferable renewal fee (see application for specific fee amounts) prior to the expiration date on their certificate, in the form of check or money order made payable to

the Delaware Office of Radiation Control (cash will not be accepted). Please allow a minimum of three (3) weeks for processing. Incomplete renewal forms will be returned.

3. Radiation Technologists/Technicians who fail to renew their certificate within the grace period of 30 days following the expiration date, and who continue to operate radiation equipment, will subject their employers (registered radiation facilities) to citation under the Delaware Radiation Control Regulations.
4. Radiation Technologists/Technicians who fail to renew their certificate within 180 days following the expiration date on their certificate will have their certificate terminated, and must re-apply for certification and qualify based on recognition of an existing national credential, or by passing a state radiation technician examination (see Requirements for Certification Section, 1.C).

H. PENALTIES

Whoever shall:

1. Sell or fraudulently obtain or furnish any radiation technology diploma, certificate, or renewal, or record of the same, or aid or abet therein; or
2. Practice radiation technology and/or hold or claim to be a registered or certified radiation worker under cover of any diploma, certificate, or record illegally or fraudulently obtained, signed, or issued; or
3. Practice radiation technology without certification under this regulation; or
4. Use, in connection with his/her name any designation tending to imply that the person is a registered or certified radiation worker, without certification under this regulation; or
5. Practice radiation technology when his/her certificate is suspended or revoked; or
6. Violate these regulations in any other manner,

Shall be fined not more than \$500, or be imprisoned not more than one year. 16 Del. C. §7416.

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

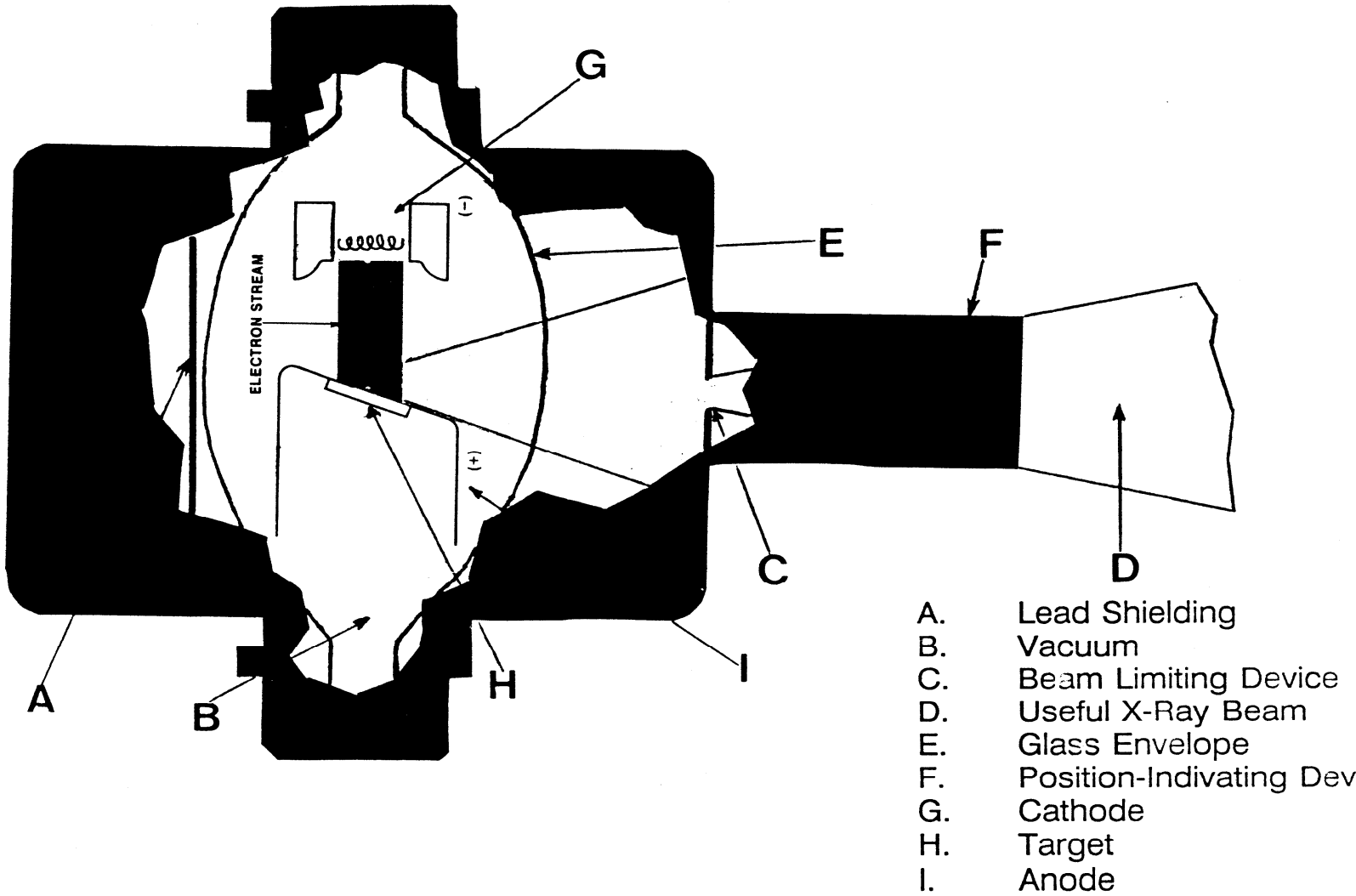
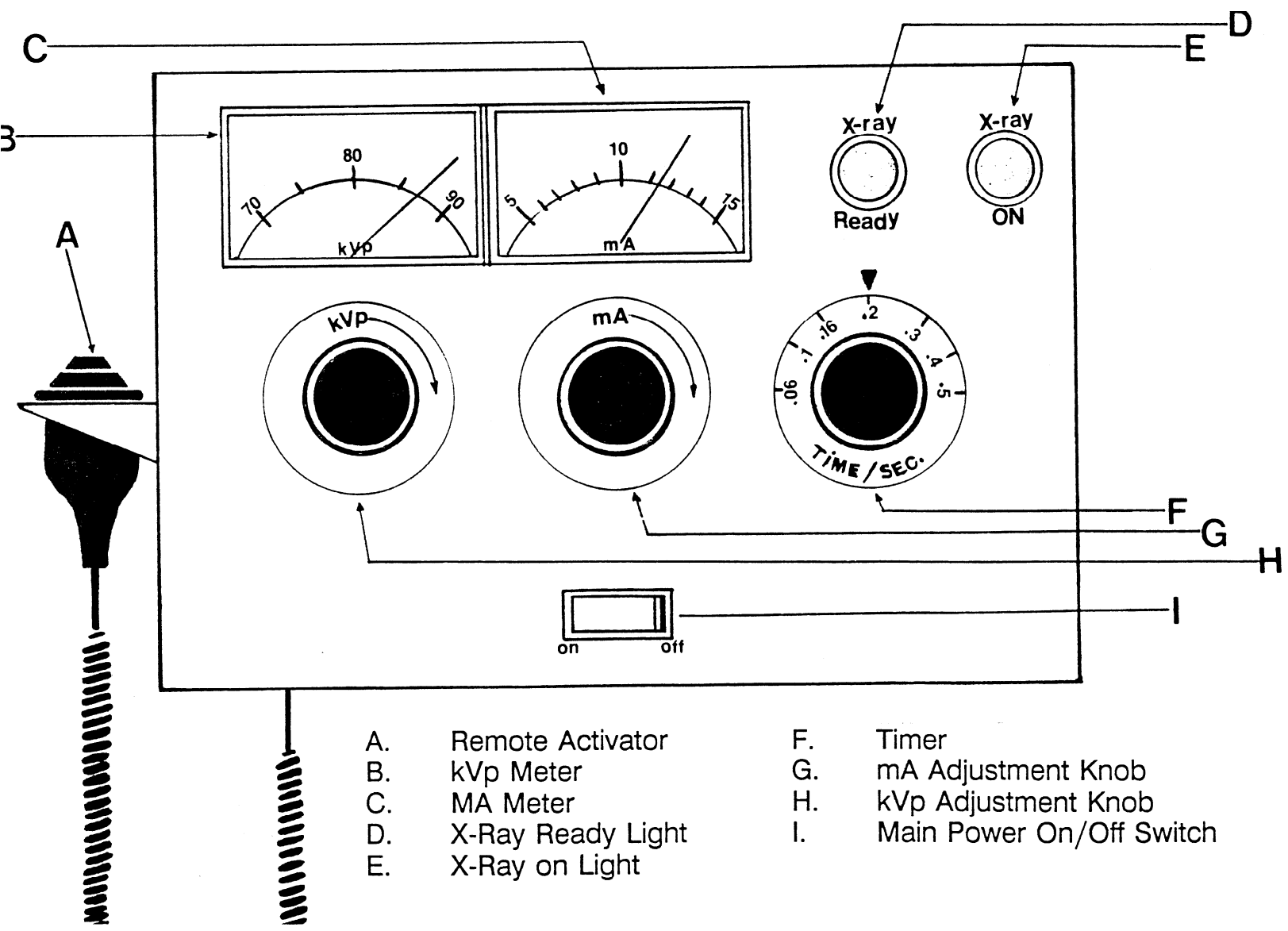


FIGURE 11 - 2



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

III. DENTAL X-RAYS

The following list of "helpful hints" has been compiled for the dental assistant. However, its general good sense makes it useful to anyone administering radiation. Many of these axioms may seem to have more to do with technique than (directly) with safety, but the technician must always bear in mind that a major cause of overexposure is the need to repeat x-rays that could have been done right the first time.

A lead apron should be placed on the patient to protect the patient from unnecessary exposure.

Have the patient remove eyeglasses, dentures, partials, earrings, and/or other removable metal objects which may produce scatter or block film images that could cause a retake.

Communicate with the patient for better cooperation when placing a film in a particular area.

The patient needs to be reminded to hold still during exposure.

A position-indicating device (PID) may be used to take x-rays more accurately.

The long cylinder (or "long cone") technique can also be used to limit exposure to the part needed.

The film should always be placed with the plain white side facing the cylinder; otherwise a herringbone pattern will appear.

The raised dot (dimple) on the film should always go towards the occlusal or incisal edges.

The film should not be creased; a crease will cause distortion or artifacts to appear on the processed x-ray.

A fast speed film in the "D" group is suggested to lessen patient exposure.

The operator should always stand behind a barrier to observe the patient through a window or mirror and **NEVER** stand in the line of sight of the x-ray source tube during exposure.

Dental x-ray film (prior to exposure) should be stored in a shielded container, such as a lead or lead-lined box, if it is kept in the room where x-ray exposures are performed, and at normal or lower temperature. Manufacturer's expiration date should be noted.

Radiographs (processed films) should be labeled and stored away from light, heat and moisture in order to preserve the diagnostic images.

Darkroom Procedure

Label the picture mount and envelop before turning ON the safe light.

Keep the darkroom counter clean and dry.

The safelight used in the darkroom should be no more than a 7-watt bulb.

Make sure your developing chemicals are fresh.

The solutions and the water should be at room temperature, between 68-72° F.

For offices that use an automatic processor for developing dental x-rays, be sure that you are familiar with the appropriate procedures for your processor. Don't guess.

For manual processing:

Place film in developer for prescribed time.

Rinse.

Place in the fixer for prescribed time.

Rinse.

Dry.

In all steps, use the times recommended by the manufacturer, appropriate to the temperature of your solutions.

IV. RADIATION HAZARDS

The Delaware Radiation Control Regulations specify the maximum permissible dosage limits, shown in Section VII of this manual, for persons whose occupations require them to be near or proximal to radiation sources, as well as for members of the general public.

Special precautions are needed for the radiographer, because the effects of radiation exposure are cumulative. However, by observing the standard safety precautions as discussed in this Manual, all of which keep the radiographer well away from the x-ray beam, experience has proved that the radiographer will be exposed to less than 25% of the maximum permissible dose in any three-month period.

Potential hazards to the patient, which could unintentionally increase his exposure during application of medical or dental radiography, are:

- * Excessive voltage (kVp), which will damage more deep cells than needed. Care must be taken to set the voltage appropriate for the body part.
- * Excessive current (mA) which will cause excessive cell damage. The first symptom is usually skin burns or surface reddening. It may also cause film overexposure; a dark image with poor contrast.
- * Excessive exposure time, which will have the same effect as excessive current.
- * Underexposure (low current and/short time), which will produce a light, underexposed, non-diagnostic film. This requires one or more retakes, perhaps the greatest source of patient overexposure. (This is one area where "technique" and "safety" overlap.)
- * Scattered radiation from improperly adjusted or maintained equipment, which will cause unnecessary--and often unsuspected--exposure to the patient (and also to staff members and others). Note that the intensity of scattered radiation decreases with the square of the distance, and about 1000-fold for each scattering event.

Potential hazards to the operator or third parties:

- * Scattered radiation (See above).
- * Holding x-ray films in place by hand while the exposure is being performed.
- * Failure to stand behind a protective barrier several feet from the useful beam.

- * Positioning the x-ray tube so that its primary (useful) beam is pointed at a non-shielded occupied area (such as a waiting room or a secretary's office).

V. OPERATING HAZARDS

This list may seem to cover some things that have already been discussed in earlier parts of this Manual. It is presented here from the perspective of the operator. Remember--as the operator, you must protect yourself as well as your patients. **SAFETY IS EVERYONE'S RESPONSIBILITY!**

- A. Persons other than the patient should not be allowed in the restricted area. (Except for mobile or portable systems, where special rules and precautions apply.)
- B. Failure of operator and other staff to be in a protected area. (Again, except for mobile or portable systems, as above.) The barrier may be in a normal interior wall; distance should be at least several feet from the tube head and out of sight of the tube head.
- C. Holding films in place by hand during exposure.
- D. If the film must be hand-held, it should be done by a relative or friend of the patient, NOT someone who routinely may be exposed to radiation. The holding person must be provided with shielding (a lead apron).
- E. Holding the tube housing or the position-indicating device by hand during exposure.
- F. Misalignment of the primary beam.
- G. Failure to accurately align the primary beam with the film or image receptor.
- H. Failure to process exposed film appropriately. (Usually, that means failure to follow the film manufacturer's recommendations, including chemical solutions and temperature control. Developing apparatus needs as much attention as the x-ray apparatus.)
- I. Using film with unnecessarily slow speed, requiring excessive exposure. The most general--hence, most important means of minimizing patient exposure is the use of the optimal film speed consistent with diagnostic quality.
- J. Malfunctioning equipment. Examples could be inadequate filtration or collimation, or a faulty timer. If an operator has ANY REASON to doubt the equipment is operating properly, he/she must resolve that doubt promptly by taking the problem to knowledgeable individuals.
- K. Failure to take an adequate medical/dental history, including such items as:
 - ▶ Is the patient pregnant? Trying to become pregnant?
 - ▶ Has the patient had radiation therapy?
 - ▶ Are recent x-rays of the area of interest available, so that new exposures do not need to be made?
- L. Using over-age x-ray film. Film which has passed its expiration date (as indicated by the manufacturer on the box) will have lost speed and is likely to be underexposed, thus failing to yield a picture of diagnostic quality. That event, of course, forces a retake, leading to additional patient exposure.
- M. Failure to store developed x-ray pictures under conditions that are protected from heat, light, and moisture. Such neglect causes the pictures to deteriorate, forcing the Licensed Practitioner to order retakes.

- N. In general, failure to follow the "Safety Rules and Operating Procedures" that apply to the radiation machine in use. Each operator is responsible for understanding and complying with these rules and procedures, as tailored to the situation in his own workplace. Actually, these rules and procedures are the first thing to be consulted by any operator who is unsure of proper procedure, because they are - when properly written - specific to his equipment and location.

VI. FEDERAL STANDARDS

The Consumer-Patient Radiation Health and Safety Act of 1981 (Title IX of Public Law 95-35) directs the U.S. Department of Health and Social Services to issue standards for the credentialing of individuals who perform radiologic procedures. Details are found in the Federal Register, 42CFR Part 75, published on July 12, 1985, which became final on Jan. 13, 1986. Portions of this document are attached to this manual as Appendix I; refer especially to its Appendix G. "Standards for Licensing Dental Hygienists and Dental Assistants in Dental Radiography."

VII. DELAWARE REGULATIONS

A. *Office of Radiation Control*

The Office of Radiation Control (ORC) of the Division of Public Health, Department of Health and Social Services, is the Delaware agency that administers the Delaware Radiation Control Regulations (DRCR) and the Radiation Technologist/Technician Certification Regulation (RTCR), acting on behalf of Delaware's Authority on Radiation Protection.

B. *Posting Requirements*

The following items are required by appropriate sections of the DRCR to be posted in every radiation machine facility:

1. Registration Certificate for a Radiation Machine Facility, Form ORC-R21, (Appendix II)
2. Notice to Employees, "Standards for Protection Against Radiation, Notices, Instructions and Reports to Workers, Inspections," ORC-R20, Appendix III.
3. Any Notice (s) of Violations received by the Facility.
4. Technique Chart: post at each x-ray button. (Appendix IV)
5. Warning Label (Appendix V)
6. Individual Radiation Technician/Technologist Certificate issued by the Delaware Authority on Radiation Protection.

C. *Availability of Key Information*

The Delaware Radiation Control Regulations require that the following items may be posted, but in any case must be provided in a readily accessible location for all persons using radiation machines:

1. A copy of your facility's **SAFETY RULES AND OPERATING PROCEDURES**, prepared in conformance with the ORC's "Guide for the Preparation of Safety Rules and Operating Procedures for Dental Facilities", or ORC-R19, "Guide for Preparation of Safety Rules and Operating Procedures for the Healing Arts".) See Appendices VI and VII.
2. A copy of the Delaware Radiation Control Regulations provided at time of registration.
3. All information required by DRCR shall be available and kept current. See Appendix VIII.

4. Each facility must have a written policy for evaluating the exposure to individuals in instances where the examination is not specified in its technique chart, or where the patient and/or the film is supported by a human holder.

In addition, you should keep a copy of the RTCR, which is part of this Manual.

D. *Monitoring Requirements (DRCR D.202)*

Each licensee or registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

1. Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25% of the applicable value specified in Section D.201, see below..
2. Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5% of the adult values specified, see below:

<u>Specific Reference</u>	<u>Maximum Permissible Doses</u>
D201 Whole body: head and trunk, active Blood-forming organs; gonads	1250 mR/QTR (Equivalent to 5000 mR/year, or 5 Rem/yr)
Skin of whole body	12500 mR/QTR
Hands and forearms/Feet and ankles	12500 mR/QTR
D207: Pregnant Radiation Workers	500 mR during gestation period
D301: General Public	100 mR/year

Exception: when radiography is ordered by Licensed Practitioner.

Note that mR denotes dose in millirem, R denotes dose in Rem
1000 mRem = 1.0 Rem

Patient exposure is assessed by the Office of Radiation Control in terms of the Entrance Skin Exposure (ESE), measured in milliroentgens (mR). This is radiation exposure measured at or near the surface of the patient's skin at the location of the useful beam.

E. *Equipment Registration and Inspection*

Section B of the DRCCR requires registration of all radiation source facilities with the ORC. Important requirements of this regulation are summarized as follows:

1. If equipment is added to or deleted from this facility, the registration must be updated and renewed.
2. New equipment should not be placed in service until the ORC has been inspected the equipment and accepted the manner in which it has been installed.
3. A Radiation Technologist/Technician must be prepared to operate the equipment during any ORC inspection, and to demonstrate familiarity with the safety rules and with the operating procedures.

F. *Assessment of Procedures*

During the periodic ORC inspections of radiation facilities, procedures and techniques will be evaluated and rated by ORC inspectors, along with the positioning, safety, and operability of the equipment itself.

RECOMMENDED RADIOGRAPHIC STUDY MATERIALS

The following book was provided to the reference librarians at the following public libraries: Newark, Wilmington, Dover, Lewes, and Seaford:

1. The “State of Florida Examination Booklet for State Medical Examinees”

The following book was provided to the reference librarians at the following public libraries:

Newark, Wilmington, New Castle, Dover, Smyrna, Lewes and Seaford:

2. The DANB Review, 3rd Edition, “The Official Preparation Tool for DANB’s National Certification and Knowledge-Based Certificate of Competency Programs, 2005. “

The following can be obtained from the listed publishers and/or at bookstores:

1. Merrill’s Atlas of Radiographic Positions and Radiologic Procedures, Phillip W. Ballinger, C. V. Mosby Company, Volume 1 and 2;
2. Complete Review of Radiography, K.M. Marzano and P.D. Lyons, Delmar Publishing, ISBN #0-8273-4233-0;
3. Limited Radiography, Frances E. Campeau and M. Jeana Phelps, Delmar Publishers, Inc., ISBN #0-8273-3335-8;
4. Mosby’s Comprehensive Review of Radiography, William J. Callaway; Mosby-Yearbook, Inc., ISBN #0-8151-1389-7;
5. Prep Program Review and Exam Preparation-Radiography; D. A. Saia; Appleton & Lange, ISBN #0-8385-8244-3;
6. Medical Radiography Pre-Test Self Assessment and Review, Linda LeFave, M.Ed., R.T.(R)(M), McGraw-Hill, ISBN #0-07-052078-X
7. Principles of Imaging Science and Protection, Thompson, Hattaway, Hall and Dowd, W.B. Saunders Company, ISBN #7216-3428-1
8. Delmar Learning: www.edumed.com Online Radiologic Technology Courses

Radiographic references are listed in the Exam Candidate Guides or Factsheets issued by the testing firms who administer the examinations. In addition, Study Guides may be available for an additional fee from some testing firms that administer examinations; refer to the Exam Candidate Guide for the specific examination of interest.

APPENDIX I

50710 Federal Register/Vol. 50, No. 238/Wednesday, December 11, 1985

DEPARTMENT OF HEALTH AND
HUMAN SERVICES

Public Health Service

42 CFR Part 75

Standards for the Accreditation of Educational Programs for and the Credentialing of Radiologic Personnel.

AGENCY: Public Health Service, HHS.

ACTION: Final rule making

SUMMARY: These regulations establish standards for the accreditation of educational programs for radiologic personnel, and for the Credentialing of such persons. These standards are part of the implementation of the Consumer-Patient Radiation Health and Safety Act of 1981 (Title IX of Pub. L. 97-35), which required their promulgation by regulation. The standards are voluntary for States and mandatory for Federal agencies.

EFFECTIVE DATE: These regulations are effective January 13, 1986.

SUPPLEMENTAL INFORMATION:

The Consumer-Patient Radiation Health and Safety Act of 1981 (the Act) is Subtitle I of Title IX of the Omnibus Budget Reconciliation Act of 1981, Pub. L. 97-36. In accordance with section 979 of the Act, the Secretary of Health and Human Services is adding a new Part 75 to Title 42 of the *Code of Federal Regulations*, entitled "Standards for the Accreditation of Educational Programs for and the Credentialing of Radiologic Personnel."

The Department published in the Federal Register on July 12, 1983, a Notice of Proposed Rule-Making (NPRM) that provided for a 120-day

One of the expressed purposes of the Act is to "insure that radiologic procedures are consistent with rigorous safety precautions and standards." Section #72(2). The comments submitted revealed that attempts to use radiologic personnel standards to improve patient safety are exceedingly complex. In addition, the act requires that the standards be mandatory for Federal agencies employing radiologic personnel.

These regulations establish minimum standards for accreditation of educational programs for selected radiologic personnel and standards for Credentialing selected Radiologic personnel, as required by the Act. The standards apply to non-Federal personnel only to the extent to which States adopt them. Licensed practitioner (doctors of medicine, osteopathy, dentistry, podiatry, and chiropractic) are especially excluded from coverage by the Act. In addition, the Department has also chosen to exclude licensed pharmacists.

Compliance by the States with the standards is voluntary. However, the Secretary is required by Section 961(d) of the Act to monitor the States' compliance and to report to the Congress on January 1 of each year the status of that compliance.

50710 Federal Register/Vol. 50, No. 238/Wednesday, December 11, 1985

Appendix G ...Standards for Licensing Dental Hygienists and Dental Assistants in Dental Radiography.

The following section describes basic elements to be incorporated in Credentialing programs of States that choose to require personnel who perform radiologic procedures.

Currently, Dental Hygienists are credentialed through individual State Licensure processes, all of which includes assessment of competence in dental radiography. In all States, Dental Hygienists are required to be licensed prior to practicing. The existing State dental hygiene Licensure processes meet the intent and purpose of the Consumer-Patient Radiation Health and Safety Act of 1981 and the standards for licensing Dental Hygienists in dental radiography set forth below.

A. Licensure/Permit

1. To those who have passed a Licensure or designated dental radiography examination, a license

or permit shall be issued by the State entity responsible for Credentialing dental personnel.

2. License or permits shall be renewed at periodic intervals.

B. Eligibility

1. An individual shall provide proof of graduating student status or graduation from an accredited or approved dental hygiene or dental assisting education program.

2. For dental assistants, special eligibility to take the examinations shall be provided to applicants with appropriate combinations of training and/or experience.

C. Examination

An attention-referenced examination in dental radiography shall be utilized to test the knowledge and competencies of applicants.

D. Continuing Competency

The Dental Hygienist or Dental Assistant shall be required to maintain continuing competency in the area in which he/she is practicing.

E. Policies and Procedures

An organization that seeks to be recognized for the certifying of personnel shall adopt definite policies to ensure validity, objectivity, and fairness in the certifying process. The National Commission for Health Certifying Agencies (NCHCA) has published suitable criteria for a certifying organization to adopt with respect to policies for: (1) Determination of appropriate examination content (but not the actual content for any specific occupation); (2) construction of examinations; (3) administration of examinations; and (4) fulfilling responsibilities to applicants. An organization (whether an NCHCA member or not) that adopts these or equivalent articles will meet all of the requirements of the section of these standards.

(FR doc "85-29363 Filed 12-10-85 8:45 am)

BILLING CODE 4180-16m

NOT OFFICIAL COPY - DRAFT EXAMPLE OF FEDERAL REGISTER.

APPENDIX II

OFFICE OF RADIATION CONTROL

NOTICE OF

REGISTRATION

NON-TRANSFERABLE

EXPIRATION DATE: 07/31/2007

EFFECTIVE: 08/01/2005

REGISTRATION NO: 1234

**JOHN DOE
123 MAIN STREET
WILMINGTON, DE 19800**

ATTN: RADIATION SAFETY OFFICER

PURSUANT TO THE RADIATION CONTROL ACT,
16 DEL.C., CHAPTER 74 AS AMENDED, THE DELAWARE
RADIATION CONTROL REGULATIONS, AND A DULY
FILED APPLICATION, REGISTRATION IS HEREBY
ISSUED TO THE REGISTRANT DESIGNATED ABOVE.
THIS REGISTRATION IS HEREBY MADE PUBLIC AND IS
SUBJECT TO ALL APPLICABLE RULES, REGISTRATIONS,
ORDERS, AND NOTICES NOW OR HEREAFTER IN EFFECT.

Director

Division of Public Health

POST IN A CONSPICUOUS PLACE FOR PUBLIC VIEW

Form ORC-R21

APPENDIX III

DELAWARE DIVISION OF PUBLIC HEALTH OFFICE OF RADIATION CONTROL

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION; NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

In Part D of the Delaware Radiation Control Regulations, the Authority on Radiation Protection has established standards for your protection against radiation hazards. In Part J, Delaware Radiation Control Regulations, the Authority on Radiation Protection has established certain provisions for the options of workers engaged in work under an agency license or registration.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to--

1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Delaware Radiation Control Regulations, and the operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post Notice of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the Delaware Radiation Control Regulations, and the operating procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of your co-workers.

WHAT IS COVERED BY THESE REGULATIONS

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas;
2. measures to be taken after accidental exposure;
3. personnel monitoring, surveys and equipment;

APPENDIX III (cont.)

4. caution signs, labels, and safety interlock equipment;
5. exposure records and reports;
6. options for workers regarding Agency inspections; and
7. related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Delaware Radiation Control Regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations of the license. The basic limits for exposure to employees are set forth in Sections D.201, D.202, and D.203 of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required, and if you request information on your radiation exposures,
 - (a) Your employer must give you a written report, upon termination of your employment, of your radiation exposures, and
 - (b) Your employer must advise you annually of your exposure to radiation.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Office of Radiation Control. In addition, any worker or representative of workers who believes that there is a violation of the Delaware Radiation Control Act, the regulations issued thereunder, or the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the Office of Radiation Control. The request must set forth the specific grounds for the notice, and must be signed by the worker as the representative of the workers. During inspections, Agency inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.

POSTING REQUIREMENT

COPIES OF THIS NOTICE MUST BE POSTED IN A SUFFICIENT NUMBER OF PLACES IN EVERY ESTABLISHMENT WHERE EMPLOYEES ARE EMPLOYED IN ACTIVITIES LICENSED OR REGISTERED, PURSUANT TO PART B OR PART C, BY THE OFFICE OF RADIATION CONTROL, TO PERMIT EMPLOYEES WORKING IN OR FREQUENTING ANY PORTION OF A RESTRICTED AREA TO OBSERVE A COPY ON THE WAY TO OR FROM THEIR PLACE OF EMPLOYMENT.

APPENDIX IV

TECHNIQUE CHART

<u>Exam</u>	<u>kVp</u>	<u>mA</u>	<u>Time</u>	<u>Distance</u>
Child BW	90	15	2/10 sec.	8"
Adult BW	90	15	3/10 sec.	8"
Adult PA	90	15	4/10 sec.	9"

NOTE: THIS IS ONLY AN EXAMPLE!

APPENDIX V

WARNING LABEL

WARNING: This x-ray unit may be dangerous to patient and operator unless safe exposure factors and operating instructions are observed.

APPENDIX VI

OFFICE OF RADIATION CONTROL DELAWARE DIVISION OF PUBLIC HEALTH GUIDE FOR THE PREPARATION OF SAFETY RULES AND OPERATING PROCEDURES FOR DENTAL FACILITIES

I. Introduction

The model procedures in this regulatory guide are generalized and must be made specific for each facility. Registrants must thoroughly review their written procedures since they will be held to the stipulations of their safety rules and operating procedures by Delaware Radiation Control Regulations (DRCR). These procedures must be posted or provided to all persons using the radiation machines.

II. Safety Rules and Operating Procedures

These instructions are provided to you in accordance with DRCR. The intent of this guide is to minimize radiation exposure of x-ray personnel and patients without interfering with the practice of the healing arts.

A. All x-ray examinations and retakes shall be ordered by (Name of Doctor)_____.

B. Operation of X-ray Equipment

1. A restricted area is to be maintained by the operator. The restricted area is the room in which the x-ray equipment is located. The only person allowed in the restricted area is the subject to be x-rayed (except for mobile or portable systems).
2. During each exposure:
 - (a) Employees shall stand in a protected area;
 - or (b) employees shall stand outside the exposure room;
3. Neither the dentist nor any employee should hold patients or films during exposures. If an individual must be used for the purpose of holding films or a patient, appropriate protective devices (lead gloves, apron, etc.) shall be used.
4. Neither the tube housing nor the Position Indicating Device (PID) shall be hand held during any exposure.
5. The primary beam shall be aligned with the film by utilizing the spacer frame or "PID".

APPENDIX VI (cont.)

6. The film manufacturer's recommendations, including maintenance of the developing solutions at a constant temperature, should be used for processing film as a matter of good practice to keep patient exposure to a minimum consistent with good diagnostic films.

"These Guides are issued to describe and make available to the public acceptable methods of implementing specific parts of Delaware Radiation Control Regulations. The Guides are not substitutes for regulations, and compliance with them is not required; however, other acceptable methods or solutions shall be available.

C. Personnel Monitoring

1. Where personnel monitoring equipment is provided for each individual who uses or operates any radiation producing machine, each employee shall wear his/her assigned monitor. These devices are to be stored away from radiation. The control badge shall be kept in an area free of radiation. (Name of individual) is responsible for maintaining exposure records and exchanging personnel monitors on a prearranged schedule. Exposure records will be kept (location). Exposure records will be made available to individuals who use or operate any radiation machines upon request.
2. No adult employee shall be allowed to receive radiation exposure in excess of 1250 millirem per calendar quarter. (. No employee under the age of 18 shall be allowed to receive radiation exposure in excess of 125 millirem per calendar quarter. In the event of radiation incident or an excessive exposure, the Office of Radiation Control shall be notified. The address is: Delaware Division of Public Health, Office of Radiation Control, 417 Federal Street, Dover, Delaware 19901. The telephone number is 302-744-4546.

D. A copy of Delaware Radiation Control Regulations is available, and operators shall be familiar with pertinent sections of parts A, B, D, F and J.

E. The x-ray machines are equipped with devices to limit the radiation exposure to patients and employees; these devices include filters which reduce unnecessary low energy radiation from the primary beam and collimators which restrict the size of the x-ray beam. Employees shall not alter, remove, tamper with, or in any way defeat these devices.

F. For offices using cephalometric units, the following statement should be included:

For cephalometric units, the useful beam shall be confined to the area of clinical interest or to the size of the film used.

APPENDIX VII

OFFICE OF RADIATION CONTROL DELAWARE DIVISION OF PUBLIC HEALTH GUIDE FOR THE PREPARATION OF SAFETY RULES AND OPERATING PROCEDURES FOR HEALING ARTS FACILITIES

I. Introduction

The model procedures in this regulatory guide are generalized and must be made specific for each facility. Registrants must thoroughly review their written procedures since they will be held to the stipulations of their safety rules and operating procedures by Delaware Radiation Control Regulations (DRCR). These procedures must be posted or provided to all persons using the radiation machines.

Procedures should be signed and dated on the last page.

II. Safety Rules and Operating Procedures

These instructions are provided to you in accordance with DRCR. The intent of this guide is to minimize radiation exposure of x-ray personnel and patients without interfering with the practice of the diagnostic quality.

A. All x-ray examinations shall be ordered by
(Name of Doctor)_____ .

B. "Retakes" shall be ordered by (Name of Doctor)_____ .

C. Operation of X-Ray Equipment

1. A restricted area is to be maintained by the operator using "Caution Radiation Area" signs and/or other methods designated by the registrant. (Area(s) to be specified by the registrant and inserted at this point) .
2. During each exposure, operators shall stand behind a protective barrier or have protective aprons.
3. The useful beam shall be restricted to the area of clinical interest or to the size of film used.
4. The useful beam shall be aligned with the film by using the (specify technique).

"These Guides are issued to describe and make available to the public acceptable methods of implementing specific parts of the Delaware Radiation Control Regulations. The Guides are not substitutes for regulations, and compliance with them is not required; however, other acceptable methods or solutions shall be available.

APPENDIX VII (cont.)

5. A technique chart which gives the appropriate exposure factors (mA, kVp, time, etc.) shall be provided near the control panel.
6. When a patient must be held in position for radiography, mechanical supporting and restraining devices should be used. If the patient must be held by an individual, that individual shall be protected with appropriate shielding devices such as protective gloves and apron, and shall be so positioned that no part of his/her body will be struck by the useful beam unless protected by 0.5 mm lead equivalent.

In no case shall a pregnant female be used for the purpose of holding or restraining a patient. (This is not a regulation, but every effort should be made to avoid unnecessary exposure of the fetus).

7. Except when it interferes with the area of clinical interest, gonadal shields with a minimum of 0.25 millimeters lead equivalence shall be used. This applies to adults of child-bearing age and all children.
8. The film manufacturer's recommendations, including maintenance of the developing solutions at a constant temperature, shall be used for processing film, (This is not a regulatory requirement, but is a statement of accepted good practice to keep patient exposure to a minimum consistent with good diagnostic films).

D. Personnel Monitoring

1. Personnel monitoring equipment is provided for each individual who uses or operates any radiation producing machine. Each employee shall wear his/her assigned monitor. The devices are to remain (location)_____ when not in use. The control badge (when it is supplied) shall be placed in an area free of radiation. (Name of individual) is responsible for maintaining exposure records and exchanging personnel monitors on a prearranged schedule. Exposure records will be kept (location)_____. Exposure records will be made available to occupationally exposed individuals upon request.
2. No adult employee shall be allowed to receive whole body radiation exposure in excess of 1250 millirem per calendar quarter. No employee under the age of 18 shall be allowed to receive radiation exposure in excess of 125 millirem per calendar quarter. In the event of radiation incident or an excessive exposure, the Office of Radiation Control shall be notified. The address is: Delaware Division of Public Health, Office of Radiation Control, 417 Federal Street, Dover, Delaware 19901. The telephone number is 302-744-4546.

E. A copy of Delaware Radiation Control Regulations is available (location) and operators shall be familiar with pertinent sections A, B, D, F and J.

F. The x-ray equipment in this facility was installed following the manufacturer's specifications. The equipment has appropriate collimation which, if used properly, will limit the size of the useful beam to the area of clinical interest. In addition, this equipment has aluminum or equivalent filtration which will remove unnecessary low-energy radiation from the x-ray beam and shall not be removed or altered except for mammography.

G. Mobile Procedures (If Applicable)

1. The operator shall stand behind a protective shield, or at least twelve feet from the patient and well away from the useful beam. If a protective shield is not used, the operator shall wear a lead apron.
2. The useful beam shall not be directed toward other patients that may be present in the room. Other patients should not be located closer than 2 meters from the tube head.

APPENDIX VIII

DELAWARE RADIATION CONTROL REGULATIONS SECTION F

Information and Maintenance Record And Associated Information.

The registrant shall maintain the following information for each x-ray system for inspection by the Agency:

- (i) Maximum rating of technique factors;
- (ii) model and serial numbers of all certifiable components;
- (iii) aluminum equivalent filtration of the useful beam, including any routine variation;
- (iv) tube rating charts and cooling curves;
- (v) records of surveys, calibrations, maintenance, and modifications performed on the x-ray system(s) with the names of persons who performed such services;
- (vi) a scale drawing of the room in which a stationary x-ray system is located with such drawing indicating the use of areas adjacent to the room and an estimation of the extent of occupancy by an individual in such areas. In addition, the drawing shall include:
 - (a) The results of a survey for radiation levels present at the operator's position and at pertinent points outside the room at specified test conditions, or
 - (b) the type and thickness of materials, or lead equivalency, of each protective barrier; and
- (vii) a copy of all correspondence with this Agency regarding that x-ray system.

APPENDIX IX

NATIONAL CREDENTIALING ORGANIZATIONS RECOGNIZED FOR DELAWARE CERTIFICATION

1. American Registry of Radiologic Technologists (ARRT)
2. Dental Assisting National Board Certified Dental Assistant (CDA) Examination
3. Dental Assisting National Board Radiation Health and Safety (RHS) Examination
4. Nuclear Medicine Technologist Certification Board (NMTCB)
5. Cardiovascular Credentialing International (CCI)

Applicants may obtain information from the following office:

Delaware Division of Public Health
Office of Radiation Control
417 Federal Street
Dover, Delaware 19901

Telephone (302) 744-4546
Fax (302) 739-3839

ORC Forms and Instructions are posted on the internet:

<http://www.dhss.delaware.gov/dhss/dph/hsp/orc.html>

or

*Enter "Office of Radiation Control" into an internet search engine
Click on Office of Radiation Control link*