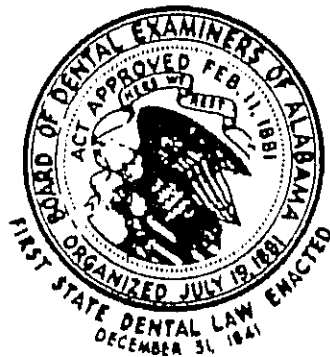


RADIATION PROTECTION AND SAFETY IN THE DENTAL OFFICE



A Manual for Dental Office Personnel

RADIATION PROTECTION IN DENTAL PRACTICE Section I

This booklet has been prepared for the practicing dentist and his or her employees. Section I provides information emphasizing the necessity for eliminating unnecessary radiation in the dental office and explains methods for accomplishing this. Section II contains those portions of the Alabama Regulations for Control of Radiation that pertain to the use of dental X-rays and also an interpretation of the more complex standards.

WHY SHOULD DENTISTS BE CONCERNED ABOUT RADIATION EXPOSURE?

Any exposure to X-radiation may involve some risk of harm to human tissues. The degree of risk increases as the amount of radiation exposure increases. Consequently, it is imperative that we reduce radiation exposure to maintain the minimum amount that is consistent with diagnostic requirements.

X-ray equipment is used in dental offices on a daily basis and accounts for a significant source of patients' radiographic exposure histories. It is therefore a professional obligation of the individual dentist to eliminate unnecessary radiation in his or her practice. It is also his or her responsibility, both morally and legally, to make certain that the X-ray equipment and the procedures utilized are the safest possible. Dentists must always be cognizant of their obligations and responsibilities to protect themselves, their employees, and their patients from excessive exposure to X-radiation.

WHAT CAN THE DENTIST DO TO REDUCE RADIATION EXPOSURE IN HIS OR HER OFFICE?

If in the dentist's judgment an X-ray procedure is necessary to properly diagnose and treat a patient, there should be no hesitation about its use. Once such a decision has been made, however, every reasonable effort should be made to eliminate *unnecessary* radiation exposure to the patient and office staff.

Fortunately, only a few relatively simple steps are required to eliminate the major portion of unnecessary radiation exposure from the use of X-rays in the dental practice. The following pages describe these steps.

REDUCTION OF RADIATION DELIVERED TO PATIENTS

I. *Reduce the Number of Radiographs Taken*

The number of radiographs taken and the frequency with which they are taken on a patient is, and should be, determined by the dental practitioner's judgment. Such judgment should be based on the need for radiographs so that the expected possible beneficial information obtained from the radiographs out-weighs the possible hazards resulting from the radiation exposure involved. The use of "routine surveys" must be avoided and a practitioner's request for radiographs should be made only after a preliminary clinical examination that suggests a need for a radiographic examination. Prescribing radiographs should follow recommended guidelines published by the U.S. Department of Health and Human Services' document The Selection of Patients for X-Ray Examinations: Dental Radiographic Examinations. Also, while some insurance carriers and remote parties have, in the past, required pre- and/or post-operative radiographs to monitor insurance claims or to satisfy a prerequisite for reimbursement, those requirements no doubt resulted in unnecessary patient exposure, and such practices have been eliminated.

II. *The Use of Fast Film*

The use of fast radiographic film is the most important factor in keeping the amount of radiation per radiograph to a minimum. Of the film speeds (D and E-Plus) presently available, the use of Speed E-Plus film requires approximately ½ the exposure of Speed D film. Therefore, the radiation dose for each film exposure will be reduced by one half.

III. *Restrict the Size of the X-Ray Beam*

In order to keep the volume of tissue exposed to a minimum, the size of the X-ray beam at the patient's face should be no greater than needed to feasibly expose an intraoral film. The size of the beam is determined by a process referred to as "beam collimation" which may be accomplished in a variety of ways including passing the X-ray beam through a round lead washer or diaphragm known as a collimator. Another method involves the use of a metal rectangular position-indicating device (PID) or a metal film holder with a rectangular "window" through which the beam passes. Rectangular collimation reduces the amount of patient radiation exposure, but the margin of error for cone cutting is also reduced. The size of a cylindrical beam at the patient's face can be no greater than 2.75 inches in diameter.

IV. *Filtration of the X-Ray Beam*

The primary radiation produced by a dental X-ray machine is made up of X-rays of many different wavelengths or energies. Those with long wavelengths or low energies cannot penetrate the tissues of the face to reach an intraoral film. These X-rays which produce unnecessary exposure to patients must be removed from the beam by the process of beam filtration. Beam filtration is accomplished by placing appropriate thickness of aluminum into the path of the beam. This aluminum is referred to as "added filtration" and is placed just outside of the X-ray machine tube head. This filtration plus the "inherent filtration" of the tubehead itself forms the machine's "total filtration". The total filtration for X-ray machines, which can operate at a kVp of 70, or above is 2.5mm. of Aluminum.

V. *Increased Target-to-film Distance*

When properly collimated, a round beam has a 2.75 diameter at the patient's face. If a short target-film distance or 8" is used, the beam must be allowed to diverge rapidly to have a diameter of 2.75" at the face. As the beam continues to diverge after it reaches the face, a large area of the head is exposed. With a longer distance or 16", the beam must diverge less rapidly to reach 2.75" at the face. As a result of the lesser amount of divergence necessary when the greater distance is utilized, a smaller volume of tissue is exposed to radiation. This procedure, along with proper collimation, also reduces and/or eliminates exposure of the thyroid

gland and the lens of the eyes which have been considered by some to be the two critical areas as far as the head and neck are concerned. Also, when an increased target-film distance is used, the resulting film image will be sharper, with less magnification. Therefore, long cones or position-indicating devices should be preferred over short cones.

VI. *The Use of Open-end Cylinders*

Beam alignment for intraoral radiography is facilitated by the use of cylinders, which are now commonly referred to as cones or beam position indicating devices. These devices must be open-ended so that the collimated beam does not strike or pass through its plastic walls and thus, produce scattered x-radiation near the patient's face.

VI. *Elimination of Retakes*

It is obvious that each retake, which must be made on a patient, results in an excessive exposure to the patient. Retakes may result from errors in exposure or film processing techniques. Errors in exposure techniques usually result from improper film placement and/or improper beam alignment. Such errors are less frequently the result of incorrect kVp, mA, distance or exposure time settings.

Errors in processing technique may result from a wide variety of mistakes, which may be made in a typical darkroom or, in the case of automatic processors, may result from a malfunctioning machine. Another very common source of darkroom error producing film retakes is film fog. The following are required to eliminate film fog in the darkroom:

- Eliminate all light leaks
- Darkrooms must have a functioning safelight
- Use appropriate safelight filters (the GBX-2 filter is the universal filter and is safe for all current dental films)
- Keep safelight at least 4 feet from working surface
- Use no higher than a 15 watt bulb within the safelight

The point again is that retakes for whatever reason must be eliminated to the greatest extent possible if we are to fulfill our

moral and legal obligation to keep the radiation that we deliver to our patients to a minimum.

VIII. *Use of Protective Aprons*

Protective x-ray body aprons with thyroid collars contain a lead equivalency of approximately 0.25 mm and should be used on all patients who are having radiographs made. When intraoral radiographs are made, the average amount of radiation that is scattered to the gonadal area of an adult male without such an apron is 1/10,000 of the amount to which the head and neck are exposed. In females, the reduction is 1/50,000. These doses are equivalent to one or two days of background whole body radiation in the United States. This amount is further reduced by 90% when a protective apron is employed.

IX. *Quality Assurance Program*

A quality assurance program should be established in dental offices to insure consistently high quality images. This includes routine monitoring of X-ray machines, exposure techniques and processing procedures.

REDUCTION OF RADIATION DELIVERED TO THOSE WHO WORK IN DENTAL OFFICES

I. *Patient Radiation Reduction Steps*

All of the steps previously mentioned which reduce patient exposure obviously reduce the amount of radiation with which we are dealing and thereby serve to protect those of us who are occupationally exposed to radiation as a result of working in a dental office.

II. *Shielding*

Shielding may or may not be required in the walls of dental offices. The need for shielding is determined by the office hours per week, the kVp utilized, distance from the source of radiation to the area to be shielded, the lead equivalency of material of which the wall is built, the length of time someone occupies the area to be shielded, and whether or not the person being shielded is an occupationally or non-occupationally exposed person. Information on shielding

design and requirements are dealt with in detail in the N.C.R.P. Report #35 (Dental X-Ray Protection) (National Council on Radiation Production and Measurements, 7910 Woodmont Avenue, Washington, D.C. 20014). In addition, most reputable dental supply companies, which install X-ray equipment, are familiar with necessary shielding in dental offices. Shielding should be utilized at all times for operators exposing radiographs. The operator should be outside of the room that contains the X-ray machine when films are exposed.

III. Distance

In the event no shielding is available behind which the operator may stand, it is recommended that he or she stand at least 6 feet from the source of radiation.

IV. Radiation Monitoring

The use of some type of personnel radiation-monitoring system in the office may be used but is optional. A relatively inexpensive and reliable system that is in current use is the use of thermoluminescent dosimeter services, often referred to as film badges. Such service is available from a variety of companies that supply film badges to be worn by staff and read on a quarterly basis. Upon their return to the company, a printout of the amount of radiation received by each individual is calculated and reported back to the dental office. Persons who are occupationally exposed to X-radiation (anyone exposing films as part of their job duties) are allowed to receive no more than the following whole body doses:

- 50 milliSieverts (mSv.) per year
- 4 milliSieverts (mSv.) per month
- 1 milliSievert (mSv.) per week

Persons in the office who are considered to be non-occupationally exposed (fetuses of occupationally exposed pregnant dental auxiliary, receptionists, laboratory technicians, etc.) are allowed 1/10 of the occupational dose. It should be noted, however, that studies show that operators of dental X-ray equipment who observe the normal radiation safety techniques outlined above, routinely and consistently receive zero readings on film badges.

SUMMARY

The exposure of patients to radiation can be minimized while improving the quality of the radiographic examination if these following simple rules are followed:

1. Radiographs should be taken only when the dentist feels there is a need for them, based on selection criteria.
2. Use film with speed ratings D or faster. *The use of the fastest film available is the single most important means of patient protection.*
3. Properly restrict the diameter of the X-ray beam.
4. Properly filter the X-ray beam.
5. Use an increased target-to-film distance.
6. Use open end cylinders as position-indicating devices.
7. Eliminate retakes whether they be errors in exposure techniques or processing errors.
8. Use a lead protective apron with thyroid collar routinely.
9. Establish a quality assurance program.

The exposure of those who work in dental offices can be minimized if the following simple rules are followed:

1. Reduce patient exposure to a minimum as outlined above.
2. Use proper shielding procedures.
 - (a) Stand at least six feet from the source of radiation if no shielding is available.

Section 2

The remainder of this booklet deals with the majority radiation protection regulations in Alabama. The following sections are excerpted for the convenience of the dentist, since many portions of the regulations do not apply to the practice of dentistry. The publication from which these sections are taken is published by the State of Alabama Bureau of Radiological Health of the State Health Department and was last revised in 1981. Pertinent future revisions will be supplied to dentists in the state as they are available.

**PART A
GENERAL PROVISIONS**

Sec. A. 1 Scope. Except as otherwise specifically provided, these regulations apply to all persons who receive, possess, use, transfer, own or acquire any source of radiation. The provisions of Part B of these regulations shall not be interpreted as limiting the intentional exposure of patients to radiation for the purpose of diagnosis or therapy by persons licensed to practice one or more of the healing arts within the authority granted to them by Alabama healing arts statute or persons licensed to practice dentistry or podiatry within the authority granted to them by Alabama licensing laws applying to dentists and podiatrists.

**PART B
STANDARDS FOR PROTECTION AGAINST RADIATION**

Sec. B.1 Purpose and Scope.

- (a) This Part establishes standards for protection against radiation hazards. Except as otherwise specifically provided, this Part applies to all licensees and registrants. It is the purpose of the regulations in this Part to control the possession, use, and transfer of sources of radiation by any licensee or registrant in such a manner that the total dose to an individual does not exceed the standards of radiation protection prescribed in this Part. Nothing in this Part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or therapy.
- (b) In addition to complying with the requirements set forth in this Part, every reasonable effort should be made to maintain radiation exposures, and releases

of radioactive materials in effluents to unrestricted areas, as far below the limits specified in this Part as practicable. The term "as far below the limits specified in this Part as practicable" means as low as is practicably achievable taking into account the State of technology, and the economics of improvement in relation to benefits to the public health and safety in relation to the utilization of atomic energy in the public interest.

**PART C
REGISTRATION OF X-RAY PRODUCING MACHINES
GENERAL**

Sec. C.1 Registration Requirement.

- (a) This Part provides for the registration of radiation machines capable of producing X-rays of less than 0.9 meV. Every person possessing an X-ray producing machine shall register in accordance with the provisions of this regulation. Except as specifically exempted in Section C.4, each person who receives, possesses, uses, or services a radiation machine shall register such machines with the Agency in accordance with the requirements of this Part.
- (b) In addition to the requirements of this Part, all registrants are subject to the requirements of Parts A and B. Registrants using radiation machines for the performance of industrial radiography are also subject to other requirements and registrants using radiation machines in the healing arts are subject to the requirements of Part D of these regulations.

Section C.3 Registration Procedure.

- (a) *Initial Registration*
Every person who possesses an X-ray producing machine shall register the machine with the Agency by June 1, 1965. Every person not already registered who acquires possession of an X-ray producing machine subsequent to June 1, 1965, shall register with the Agency within thirty (30) days of the date of acquisition.
- (b) *Renewal of Registration*
Every person possessing an X-ray producing machine shall renew such registration with the

Agency at such times as the Agency shall deem necessary.

- (c) *Registration Form*
Registration and renewal of registration shall be made on a form furnished by the Agency (Alabama State Board of Health). The registration shall set forth all information called for by the form.
- (d) *Report of change*
Within thirty (30) days of change, the registrant shall report to the Agency of any change in the name or address of the registrant or location of the installation, receipt, sale, or disposal of any reportable source of radiation.
- (c) *Report of Discontinuance*
Every registrant who permanently discontinues the use of, or permanently disposes of all his X-ray producing machines at an installation, shall notify the Agency within thirty (30) days of such action.
- (f) *Registration Shall Not Imply Approval*
No person, in any advertisement, shall refer to the fact that an X-ray producing machine is registered with the Agency and no person shall state or imply that any activity so registered has been approved by the Agency.
- (g) *Registration of Services*
Each person who commercially services an X-ray producing machine in this State, to an Agency registrant, shall apply for the registration of such services with the Agency not later than October 1, 1974, thereafter prior to furnishing or offering to furnish any such services. Such registration shall indicate the training of each individual in the subjects listed in Appendix A. Such registration is subject to the requirements of paragraphs (b), (c), (d), (e), and (f) of this section.

Sec. C.5 Vendor Obligations.

- (a) Any person who sells, leases, transfers, or lends X-ray producing machines in this State shall notify the Agency (Alabama State Board of Health) within thirty (30) days after the end of each calendar quarter of:

- (1) (i) The name and address of persons who have received these machines.
- (ii) The manufacturer and model of each machine transferred.
- (iii) The date of transfer of each X-ray machine.
- (2) Negative reports shall be furnished to the Agency (Alabama State Board of Health) within thirty (30) days after the end of each calendar quarter.
- (b) No person shall sell, lease, transfer, or install X-ray equipment or the accessories used in connection with such equipment unless such accessories and equipment, when properly placed in operation and properly used, will meet the requirements of these regulations. This includes responsibility for the delivery of cones or collimators, filters, adequate timers, and fluoroscopic shutters.

Sec. C.7 Plan Review.

- (a) Prior to construction, the floor plans and equipment of all installations (new modification of existing installations after January 1, 1997) utilizing X-rays for diagnostic or therapeutic purposes shall be submitted to the Agency for review and approval. The required information may be obtained from the Bureau of Radiological Health of the Alabama State Board of Health.
- (b) The Agency may require the applicant to utilize the services of a qualified expert to determine the shielding requirements prior to the plan review and approval.

Sec. C.8 Modification, Suspension, and Termination of a Registration or Activities Registered.

- (a) A registration or activity registered shall be subject to amendment, revision, or modification or such activities may be suspended or terminated by reason of amendment to the Act, or by reason of rule, regulations, and orders issued by the Agency.
- (b) Any registration or activity registered may be terminated, suspended, or modified in whole, or part, for any material false statement in the

application, or because of conditions revealed by such application or statement of fact or any report, records, or inspection or other means which would warrant the Agency to refuse to grant a registration on an original application, or for violation of, or failure to observe any of the terms and conditions of the Act, or the regulations, or of any rule, regulation, or order of the Agency.

- (c) Except in case of willfulness or those in which the public health interest or safety requires otherwise, no registration or activity registered shall be modified, suspended, or terminated, unless prior to the institution of proceedings therefore, facts or conduct which may warrant such action shall have been called to the attention of the registrant in writing and the registrant shall have been accorded an opportunity to demonstrate or achieve compliance with all lawful requirements.

PART D RADIATION SAFETY REQUIREMENTS FOR USERS OF X-RAY IN HEALING ARTS OR SERVICES OF X-RAY EQUIPMENT

Sec.D.1 Scope. Part B establishes standards for use of Xrays in the healing arts including but not limited to medicine, dentistry, osteopathy, chiropractic, podiatry, and veterinary medicine or servicers of X-ray equipment. The provisions of this Part are written in addition to, and knot in substitution for, other applicable provisions of these regulations. Periodic inspections will be performed of all registrants. The inspection frequency will depend upon available personnel and workload, but every X-ray ideally should be inspected not less than once every two years.

Sec.D.3 General Safety Provisions.

- (a) The agency may waiver compliance with the specific requirements of this Part by an existing machine or installation if (1) such compliance would require replacement or substantial modification of the machine or installation and (2) the registrant demonstrates, to the Agency's satisfaction, achievement through other means of

radiation protection equivalent to that required by these regulations.

- (b) Persons shall not be exposed to the useful beam except for healing arts purposes, each exposure of which has been authorized by a licensed practitioner of the healing arts. This provision specifically prohibits deliberate exposure for the following purposes:

- (1) Exposure of an individual for training, demonstration, or other purposes unless (a) there are also healing arts requirements and proper prescription has been provided, (b) the radiographs are made for the student's own training, (c) the radiographs are made only once with no more than two retakes and if only a small tissue volume (e.g., less than a skull) is exposed per radiograph, and (d) the films are properly interpreted and are made a part of the dental or medical record.

- (2) Exposure of an individual for the purpose of healing arts screening without prior written approval of the Agency. (Screening means an exposure of a person without prior examination of a determination of a specific individual need by a licensed practitioner.)

- (c) *Personnel Monitoring.* Each registrant shall provide personnel monitoring devices which shall be used by:

- (1) Each individual who receives, or is likely to receive, whole body dose in excess of 25 milliroentgens per weeks;
- (2) Each individual who enters a high radiation area;
- (3) Each individual who operates mobile X-ray equipment;

- (4) Each individual who operates photofluoroscopic equipment;
 - (5) Each individual while he services an operable X-ray producing machine.
- (d) Use
- (1) The registrant shall be responsible for assuring that all requirements of Part A are met.
 - (2) The registrant shall assure that all X-ray equipment under his control is operated only by individuals adequately instructed in safe operating procedures and competent in safe use of the equipment.
 - (3) After October 1, 1974, no registrant who services X-ray producing equipment shall permit any person to service such equipment, when operable, until such person has been appropriately instructed in the subjects outlined by the Bureau of Radiological Health and shall have demonstrated and understanding thereof.

- (e) Shielding
- (1) Each installation shall be provided with such primary barriers and/or secondary barriers as are necessary to assure compliance with Sections B.101 and B.103. This requirement shall be deemed to be met if the thickness of such barriers is equivalent to those computed in accordance with *National Council on Radiation*

Protection and Measurements Report No. 34.
 "Medical X-Ray Protection and Gamma-Ray Protection for Energies up to 10 Mev-Structural Shielding Design and Evaluation" and *National Council on Radiation Protection and Measurement Report No. 35:*
 "Dental X-Ray Protection."

- (f) *Darkroom Requirements.* To reduce unnecessary re-exposures of patients resulting from film processing problems:
- (1) The darkroom shall be lightproof;
 - (2) A safelight or light operable and appropriate for the type of film processing shall be provided in the darkroom;
 - (3) A thermometer and timer operable and appropriate to the type of film processing shall be in use in the darkroom. The use of properly maintained automatic film processing in equipment shall meet this requirement for all film so processed.

Sec.D.4 Dental Radiographic Installations.

- (a) *Equipment*
- (1) The tube housing shall be of diagnostic type.
 - (2) Diaphragms or cones shall be used for collimating the useful beam and shall provide the same degree of protection as the housing. The diameter of the useful beam at the cone tip shall not be more than three (3) inches.
 - (3) A cone or spacer frame shall provide a target-to-skin distance of not less than seven (7) inches with apparatus operating about fifty (50) kVp or four (4) inches with

apparatus operating at fifty (50) kVp or below.

(A) For equipment operating up to seventy (70) kVp, the total filtration permanently in the useful beam shall be equivalent to at least 1.5 mm of aluminum.

- (4) For equipment operating above seventy (70) kVp, the total filtration permanently in the useful beam shall be to at least equivalent 2.5 mm of aluminum.
- (5) A device shall be provided to terminate the exposure after a preset time or exposure.
- (6) The exposure control switch shall be of the dead-man type.
- (7) Each installation shall be provided with a protective barrier for the operator or shall be so arranged that the operator can stand at least six (6) feet from the patient and well away from the useful beam.

(b) *Structural Shielding*

- (1) Dental rooms containing X-ray machines shall be provided with primary barriers for all areas struck by the useful beam.
- (2) When dental X-ray units are installed, the rooms adjacent will be adequately protected.

NOTE: In most cases, structural materials or ordinary walls suffice as a protective barrier without addition of special shielding material.

(c) *Operating Procedures*

- (1) Neither the dentist nor his assistant shall be permitted to hold patients or films during exposure, nor shall any individual be regularly used for this service.
- (2) During each exposure, the operator shall stand at least six feet from the patient or behind a protective barrier.
- (3) Only the patient shall be in the useful beam.
- (4) Neither the tube housing nor the pointer cone shall be hand-held during exposure.
- (5) Fluoroscopy shall not be used in dental examinations.

bdeal@dentalboard.org

Board of Dental Examiners
5346 Stadium Trace Parkway
Suite 112
Hoover, AL 35244
205-985-7267
Fax 205-985-0674