Kodak Dental Radiography Series

Radiation Safety in Dental Radiography

Dental

Radiation Safety in Dental Radiography

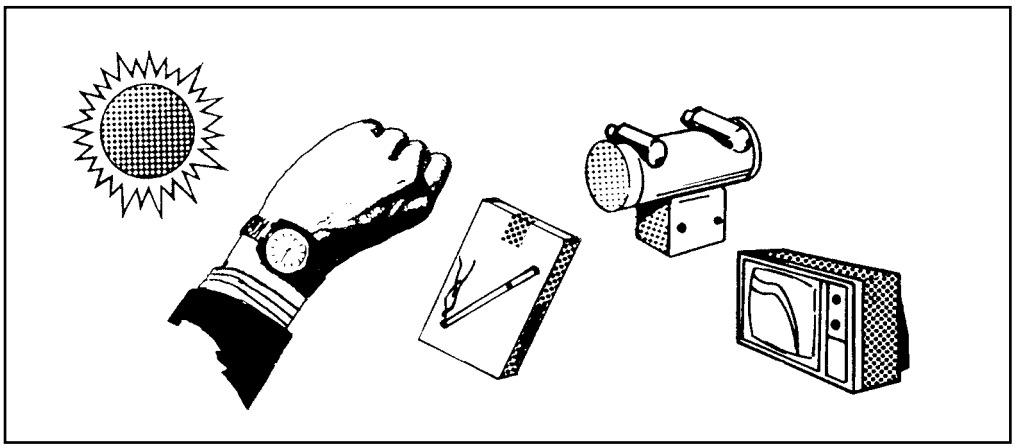
The goal of dental radiography is to obtain diagnostic information while keeping the exposure to the patient and dental staff at minimum levels.

We know that x-rays, in sufficient doses, may produce harmful effects in human beings. However, we do not know the size of the risk—or even if there is any risk at all—from small doses of x-rays such as those used in dental radiography. It is the consensus of dental radiologists that the dosage from dental x-ray exposure is not harmful. However, the absence of conclusive proof that establishes the absence of risk means we must assume that there is the potential of some risk from diagnostic exposure. KODAK Publication D3-70, Compendium reprint, *X-Rays: Detailed Answers to Frequently Asked Questions* (see last page of ordering information), addresses some of the critical questions asked by patients regarding x-rays.

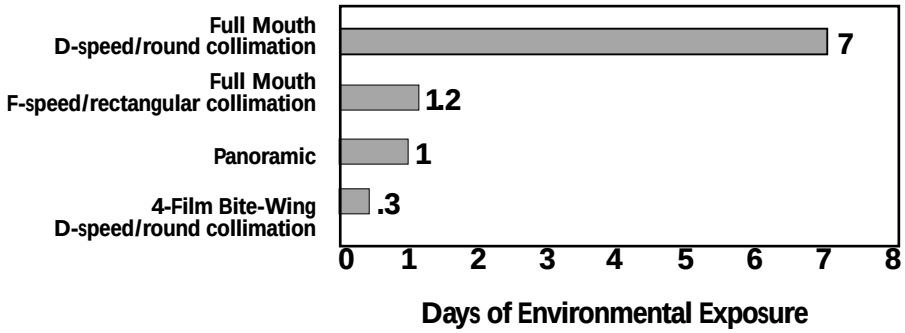
Whenever we consider exposing patients to x-rays, the **ALARA** principle (**A**s **L**ow **A**s **R**easonably **A**chievable) applies. Any dose that can be reduced without major difficulty, great expense or inconvenience, should be reduced or eliminated.

Exposure

Each of us is exposed to radiation from a variety of naturally occurring sources. Most exposure comes from breathing radon in the atmosphere. We're exposed to cosmic radiation from space and terrestrial radiation from radioactive isotopes in stone and building materials. We're even exposed from internal sources. A radioisotope of potassium is found in all living things.



In addition to these natural sources of radiation, we get small doses from miscellaneous sources including tobacco, watches with luminous dials, color television, and others. A significant source of man-made radiation is diagnostic exposure in the healing arts.



It is estimated that a typical full-mouth intraoral examination, using D-speed film and round collimation, gives the patient the equivalent of 7 days of environmental background exposure. In contrast, by using F-speed film and rectangular collimation for a full-mouth exam, the patient receives the equivalent of 1.2 days of background exposure.

A typical panoramic examination gives the equivalent of about one day; and the usual 4-film (D-speed film) bite-wing study (round collimation), the equivalent of 7 hours or approximately three tenths of a day. Note that other common procedures in medical radiology deliver much larger doses to the patient than dental x-ray studies.

The *benefits* of the use of x-rays in dentistry certainly *outweigh* the *risks* when proper safety procedures are followed.

The dentist is responsible for all aspects of safe radiation exposure in the dental office.

The dentist selects the patient who needs radiographs, determines which radiographs are needed, takes or supervises the exposure of the films and interprets the images.

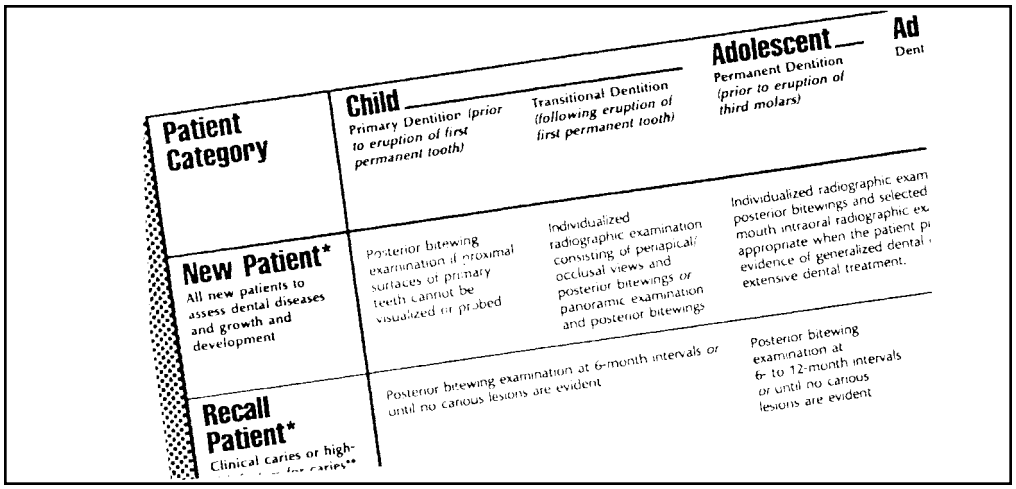
An important method for keeping patient exposure as low as reasonably achievable is the appropriate prescription of radiographs.

Radiograph Guidelines

One way to do this is with the use of radiographic patient selection criteria.

Guidelines for the prescription of dental radiographs have been developed by an expert panel of dentists sponsored by the Public Health Service.

A free brochure is available from Eastman Kodak Company (see last page for ordering information) as KODAK Publication N-80A *Guidelines for Prescribing Dental Radiographs.* The guidelines are voluntary and are intended only as a decision-making aid for the dental practitioner. They are used only in conjunction with a carefully taken medical and dental history and a clinical examination.



Patient Category	Child — Primary Dentition (prior to eruption of first permanent tooth)	Child — Transitional Dentition (following eruption of first permanent tooth)	Adolescent — Permanent Dentition (prior to eruption of third molars)	Ad — Dent
New Patient* All new patients to assess dental diseases and growth and development	Posterior bitewing examination if proximal surfaces of primary teeth cannot be visualized or probed	Individualized radiographic examination consisting of periapical/ occlusal views and posterior bitewings or panoramic examination and posterior bitewings	Individualized radiographic exam posterior bitewings and selected mouth intraoral radiographic ex appropriate when the patient pr evidence of generalized dental extensive dental treatment.	
Recall Patient* Clinical caries or high-	Posterior bitewing examination at 6-month intervals or until no carious lesions are evident		Posterior bitewing examination at 6- to 12-month intervals or until no carious lesions are evident	

Radiation Level Factors

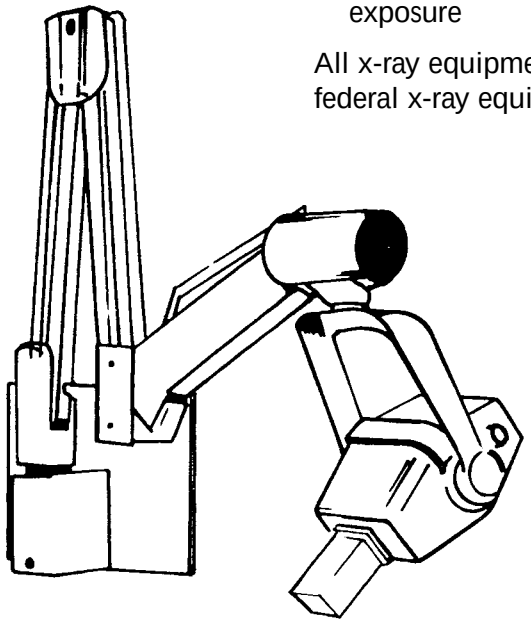
In any case, once the decision has been made to prescribe x-rays, every reasonable effort must be made to minimize exposure to the patient and dental office personnel.

Interestingly, the same safety procedures that minimize exposure for both patient and operator can also increase the quality of the radiographic images.

There are many factors that determine the level of radiation received by the patient during a radiographic examination. These include:

- The selection of the x-ray machine
- The use of technique factors that result in low patient exposure
- The use of fast films and screen/film combinations
- Adherence to correct film processing methods
- The use of collimators and filtration
- The use of lead aprons to protect the patient from unnecessary radiation exposure

All x-ray equipment, regardless of date of manufacture, is subject to state and federal x-ray equipment regulations.



Although proper filtration is not usually a problem with modern equipment, older x-ray machines should be tested by a radiation physicist or qualified technician to verify the presence of the correct amount of filtration.

The kilovoltage or kVp setting is one of the most important factors that determines the image contrast, as well as dosage to the patient. In the 70-90 kVp range, biological risk estimates from dental radiology are essentially the same and, therefore, the diagnostic need should be the determining factor for which kVp setting to use. Settings below 65 kVp are not recommended for routine dental radiography because of higher patient exposures.

Rectangular Collimation

Collimators, when installed properly, serve to limit the size and shape of the useful x-ray beam reaching the patient. This will not only reduce dose, but may also improve image quality.

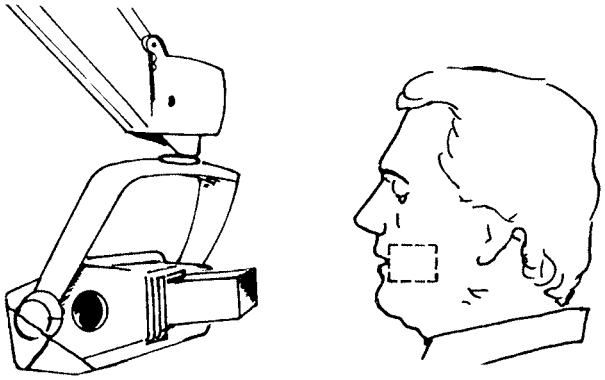
The American Dental Association (A.D.A.) and the American Academy of Oral and Maxillofacial Radiology recommend the use of a shielded, open-ended, position-indicating device, or PID, preferably with rectangular collimation.

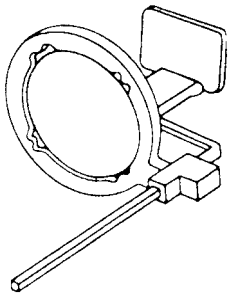
This is an example of a rectangular collimator that restricts the beam to the size and shape of the dental film. Round collimators can be converted to a rectangular shaped opening by using an insert available through a manufacturer of dental radiographic products (see last page for suggested resource). This technique significantly reduces the volume of tissue exposed during intraoral radiography.

Rectangular collimators reduce patient exposure by restricting the beam size to that of the film used. These devices will increase subject contrast by reducing excessive scatter radiation.

The area and volume of tissue exposed to the primary x-ray beam should not exceed the minimum coverage required to image the anatomical area in question. Periapical radiographs should, in general, demonstrate 1/4-inch of alveolar bone beyond the apex of each tooth, 1/8- to 1/4-inch margin between the crowns of the teeth and the edge of the film; the occlusal plane should be straight or slightly curved upward toward the distal.

In bite-wing views, the occlusal plane should be straight or slightly curved upward toward the distal. There should be equal distribution of maxillary and mandibular crowns and maxillary and mandibular alveolus, and the interproximal spaces should be open. These criteria can be met successfully by careful execution of correct periapical and bite-wing techniques.





Film holding devices are recommended for intraoral radiography to eliminate the need for the film to be held in place by the patient's finger. These film holding devices also provide for the film to be placed parallel to the teeth, resulting in a less distorted image. The holders recommended today incorporate beam guiding devices which make PID alignment a simpler task.

The A.D.A. and the Academy discourage the use of short, closed, pointed plastic cones because of the increased scatter radiation and unnecessary radiation close to the face and surrounding areas of the patient. As shown in the drawing, the rectangular collimator restricts the x-ray beam to an area just slightly larger than the intraoral film itself.

It is estimated that the radiation dosage from use of both *F-speed* film and *rectangular collimation* is minimal, less than *one-fifth* that from D-speed film and round beams. On the other hand, beam energy ranging from 70 to 90 kVp, short cone versus long cone, and paralleling versus bisecting angle projection make little difference in patient exposure.

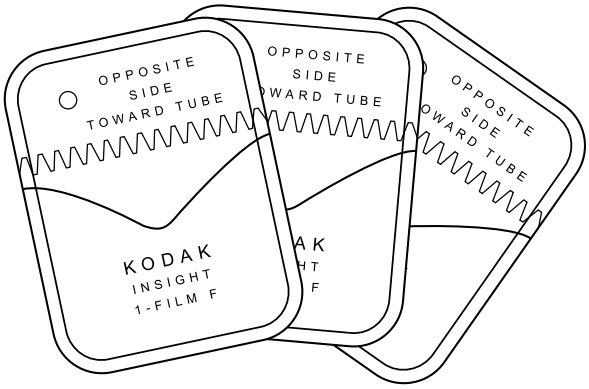
Image Density

A significant factor contributing to image density is the quantity of x-rays reaching the film. This is controlled by combining milliamperage and exposure time as milliampere-seconds or mAs. Correct mA and timer settings are established using a technique chart such as the *Exposure Guidelines for KODAK Intraoral Dental Films* (KODAK Publication D6-40).

Unnecessary radiation exposure to patients results when films need to be retaken due to faulty radiographic or processing techniques.

The speed, or sensitivity, of dental x-ray film is another important factor responsible for controlling patient exposure.

The three speeds used for intraoral radiography are Group D, Group E and Group F.



KODAK EKTASPEED Plus Dental Film, an E-speed film, is 40% faster than KODAK ULTRA-SPEED Film, a D-speed film. EKTASPEED Plus Film is designed for reduced-exposure intraoral radiography.

KODAK INSIGHT film, an F-speed film is 20% faster than KODAK EKTASPEED Plus, and 60% faster than KODAK ULTRASPEED film. Its increased speed makes it ideal for long cone paralleling techniques and for use with x-ray equipment designed for short exposures.

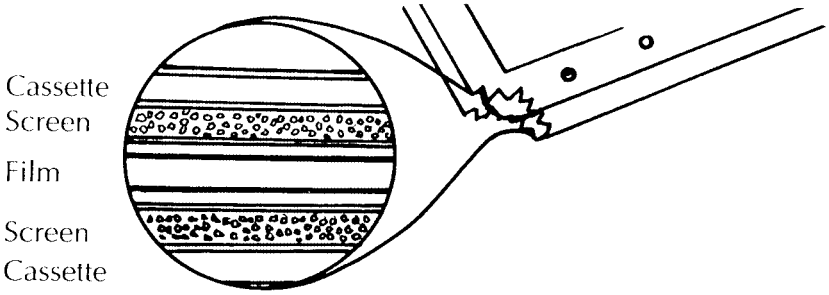
Film Cassettes

Film cassettes are used for extraoral techniques such as panoramic and cephalometric radiography.

Cassettes serve as lighttight film holders and are equipped with two intensifying screens that convert x-ray energy to light energy. This feature enables image formation to occur with less exposure than is possible with direct x-rays alone. Patient exposure can be reduced by up to 100 times when compared to direct exposure film techniques.

To minimize the needs for retakes, it is important to utilize the proper film/screen combination with a cassette that provides pressure uniformity and lighttight integrity.

Film/screen combinations are used to image the mandible, the maxilla, the temporomandibular joint and the orofacial complex.



Since different film/screen combinations result in various speed systems, the practitioner can choose the speed system that will allow the patient to be exposed to the least amount of radiation while still providing the diagnostic information required.

Minimal Exposure

KODAK LANEX Regular Intensifying Screens are used with a green sensitive film, such as KODAK T-MAT G/RA Film. Exposures are usually one quarter to one half those needed with the earlier generation blue-light emitting phosphors. Beside dose reduction, the newer phosphors maintain excellent image detail, help eliminate motion unsharpness by the use of shorter exposure times, and produce less wear on the x-ray tube.

KODAK EKTAVISION Extraoral Imaging System also provides a similar exposure reduction, while providing a further increase in sharpness resulting from new film and screen technology.

Proper exposure and processing of film is another factor in keeping exposure as low as reasonably achievable. Errors can result in the need for additional radiographs and increased exposure.

Quality assurance is any systematic action to ensure that a dental office will produce consistently high-quality images with minimal exposure to patients and personnel. When operators are presented with clear guidelines for quality assurance, patient exposure is dramatically reduced.

Besides diagnosis, films are used for insurance claims, teaching, patient referrals and legal purposes. The use of duplicate radiographs reduces patient x-ray exposure because the need to re-expose patients is eliminated. When duplicate radiographs are needed, there are several methods available to produce them. Kodak offers duplicating film, in a variety of film sizes that range from size 2 to an 8 x 10-inch size.

Kodak also offers two-film dental packets that contain two separate intraoral dental films together for producing two identical radiographs with one exposure. The two-film packet requires no adjusting or resetting of equipment or additional exposure to the patient. The same double loading technique can be done with extraoral film by using a combination of TMat H film and Lanex Regular screens.

Exposure Protection

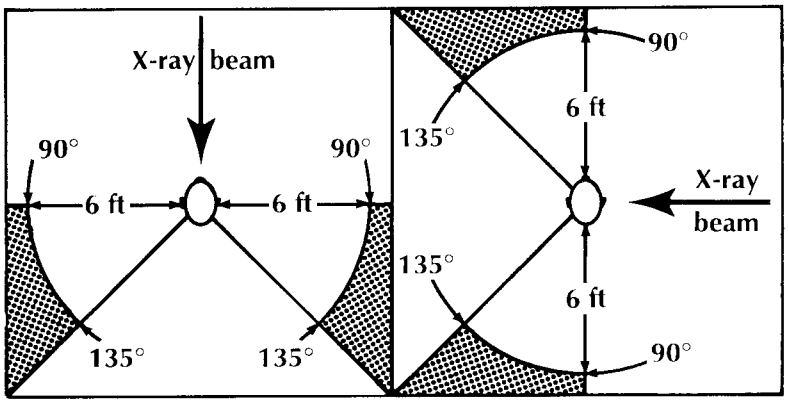
Even though the thyroid gland may be out of the primary beam path when rectangular collimation is used, exposure of that gland may be significant when the round positioning device is used. Lap aprons are available with thyroid collars attached. Separate thyroid collars are also available.

The most commonly used leaded aprons cover the entire chest and lap, effectively reducing scatter radiation reaching underlying tissues. Lap aprons should be used for all dental radiographic procedures.

The *best* way of limiting the possibility of occupational exposure is the establishment of radiation safety procedures that are understood and *followed by all* personnel.

The most important factor in reducing personnel exposure to radiation is for the operator to stand behind a radiation barrier during the exposure. This is usually accomplished by installing the exposure button in a location outside the dental operatory.

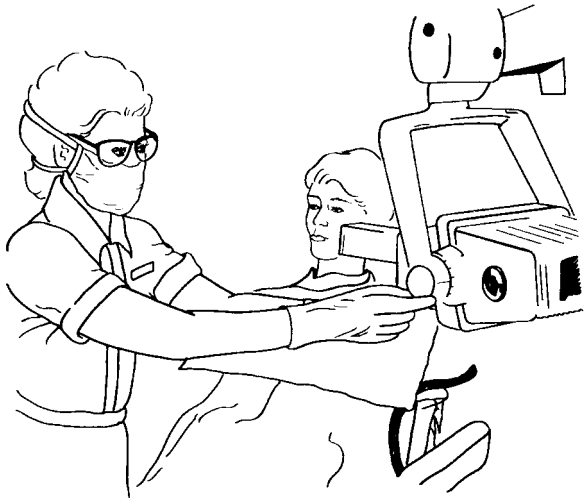
If a protective barrier is not available, the operator should be positioned at least six feet from the x-ray tube head at an angle of from 90 degrees to 135 degrees to the central ray of the x-ray beam. Six feet (2 m) is considered safe as long as the operator is not positioned in the path of the primary x-ray beam.



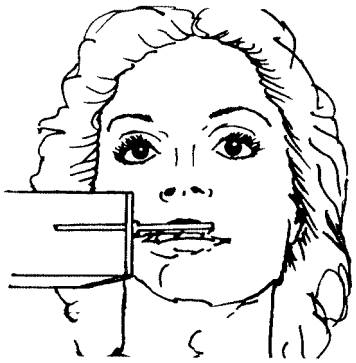
The proper installation of x-ray equipment and safety of operational procedures can be certified by a radiation physicist. Some states require a plan of review of an office before the installation of any x-ray equipment. This plan would include the location of x-ray equipment, the exposure button and composition of wall materials for radiation barriers.

The operator or patient should ***never*** hold films in the mouth during radiographic procedures. Serious radiation injuries of the fingers of dentists have occurred from prolonged holding of films for patients. Film holders used in modern dental radiography preclude the need for dental personnel or patients to hold films with their fingers.

Neither the operator nor the patient should stabilize the x-ray tube head during the procedure; rather the operator should make any adjustments **prior** to making exposures. Additional exposure may occur while attempting to stabilize the tube head during exposure. Slight amounts of radiation leakage occur through all x-ray tube heads and, therefore, contact with the tube housing during exposures must be avoided. Any instability of the tube head should be corrected by proper adjustment of the suspension arm.

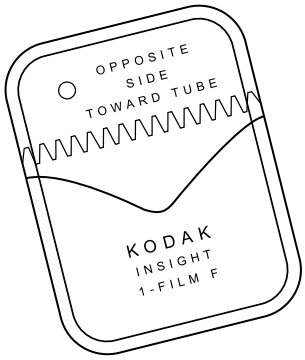


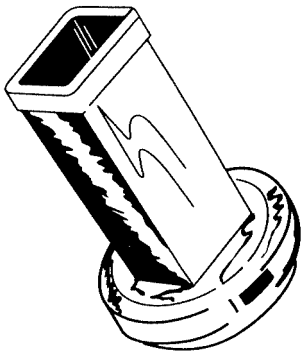
Summary



All of the well-intentioned efforts to keep patient exposure to a minimum must not be allowed to interfere with acquiring the needed diagnostic information. If a reduction in exposure results in radiographs that are difficult or impossible to interpret, then there is no benefit to the patient.

In summary, radiation exposure to the patient can be significantly reduced. Conversion from *D-speed film to F-speed film* alone, with no other changes, reduces exposure by up to 60%.





The value of using rectangular collimation is very important.

It is estimated that the radiation dosage from use of both *F-speed* film and *rectangular collimatio*n is minimal, less than *one-fifth* that from D-speed film and round beams. On the other hand, beam energy ranging from 70 to 90 kVp, short cone versus long cone, and paralleling versus bisecting angle projection make little difference in patient exposure.

Radiation doses to the patient from dental radiography, assuming optimum technique and state-of-the-art technology, are relatively small when compared to doses from other medical procedures and environmental sources. Thus, clinical need rather than patient dose should determine which radiographic examination, if any, is to be prescribed for a patient.

From the selection of patients for radiographic examination, through the exam itself, to the interpretation of the results, the dentist has a professional obligation to control radiation exposure in the dental office. The dentist must eliminate any unnecessary exposure and keep all necessary exposure **As Low As Reasonably Achievable.**

References: Technical Report of the Commission on Dental Products: Recommendations for radiographic procedures. *International Dental Journal*, June 1989.

White, S.C. 1992 Assessment of radiation risk from dental radiography. Dentomaxillofacial Radiology, 1992, V.21, Aug. 118-26.

To obtain a free copy of any of the KODAK Publications referred to in this pamphlet:

In the U.S.A., please call Kodak at **1-800-933-8031**

Order the publication by name and code number.

Outside the U.S.A., all publication requests should be directed to the nearest Kodak company, or write:

Eastman Kodak Company
Dental Business
Health Imaging Division
343 State Street
Rochester, New York 14650-1122 U.S.A.

To obtain inserts to convert round position-indicating devices to rectangular collimation, contact: Rinn Corp. Products for Dental Radiography at **1-800-323-0970 or 1-847-742-1115** or write:

Rinn Corporation
1212 Abbott Drive
Elgin, Illinois 60123-1819

To obtain assistance in converting to the F-speed films mentioned in this pamphlet, or to obtain further information on other Kodak products or recommendations:

- In the U.S.A., please call 1-800-933-8031
- In Canada, please call 1-800-465-6325

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