advicesheet

radiationindentistry

All

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advicesheet

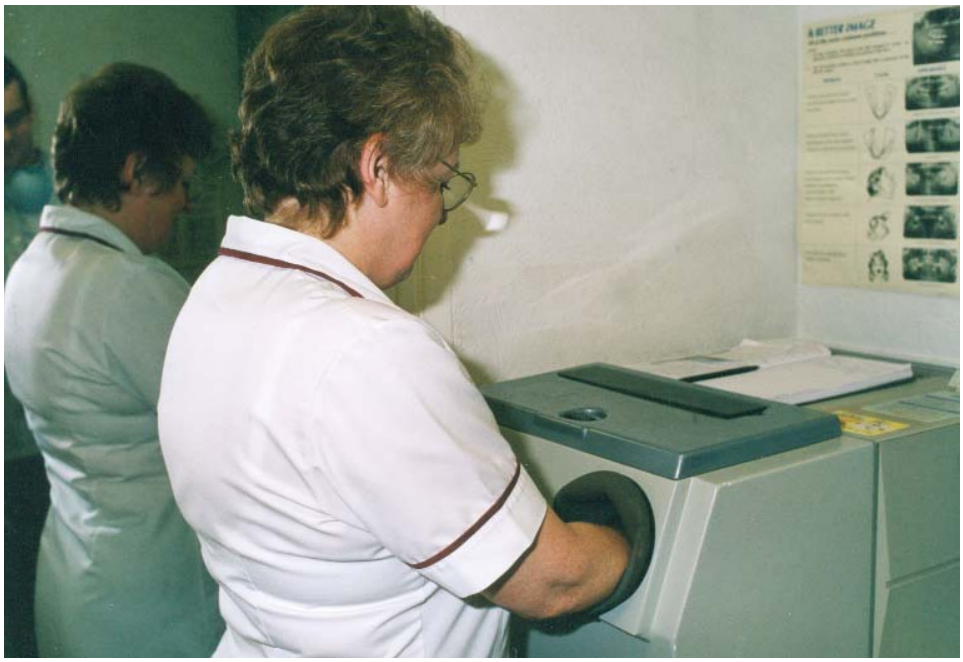
radiationindentistry

contents page

Dental radiographs are one of the most frequently undertaken radiological exposures in the UK. Although the dose delivered to individual patients is small, the collective dose is significant because of the large numbers of radiographs taken. This advice sheet summarises your obligations under current legislation and good working practice. More information about your requirements is contained in *Guidance notes for dental practitioners on the safe use of x-ray equipment* published by the National Radiological Protection Board and the Department of Health in June 2001.

The *Ionising Radiations Regulations 1999* (IRR99) are concerned principally with the protection of workers and patients, including the equipment aspects of patient protection. *The Ionising Radiation (Medical Exposure) Regulations 2000* (IRMER) impose significant new requirements for patient protection. These Regulations together with good working practice encourage dentists to eliminate exposures that have no merit and optimise all justified exposures.

Clinical governance is the linchpin of the delivery of high quality health care. Compliance with IRR99 and IRMER will help minimise risks from ionising radiation for both patients and health care workers. The aim is to make sure that patients are exposed only to radiation doses that are as low as reasonably practicable and consistent with the intended clinical outcome.



'Patients are exposed only to radiation doses that are as low as reasonably practicable'

Appointments

The Regulations introduce some new terminology to describe the various responsibilities of those involved with taking radiographs within the practice.

The **legal person** is responsible for implementing the requirements of the legislation and good working practice. In general dental practice, the legal person would normally be the practice owner. Practices with several dentists in partnership will have to decide who takes on this role.

A **radiation protection supervisor** must be appointed by the legal person to implement the Local Rules. The RPS can be an appropriately trained dentist or PCD.

A **referrer** is a dentist who refers patients for radiographs to an IRMER practitioner. A PCD cannot act as a referrer. In practice, the referrer and IRMER practitioner will be the same person. The distinction is important, however, where a patient is referred to another dentist, practice or hospital for a radiograph.

An **IRMER practitioner** is a dentist who takes responsibility for justifying an individual medical exposure to ensure that the benefit to the patient from the diagnostic information outweighs the detriment of the exposure (see page 4).

An **operator** is any person who carries out all or part of the practical aspects associated with a radiographic examination including:

- patient identification
- positioning the film, the patient, the x-ray tube head
- setting the exposure parameters
- pressing the exposure button to initiate the exposure
- processing films
- evaluation of radiographic quality
- exposing test objects as part of the QA programme.

Any single radiograph could involve a number of different operators performing the various tasks.

A dentist could therefore be the referrer, the IRMER practitioner and an operator. Many dental nurses or other PCDs will also undertake some of the tasks of an operator. All operators must be adequately trained to undertake their individual duties.

A **radiation protection adviser** must be appointed in writing to provide advice on complying with legal obligations including the periodic examination and testing of all radiation equipment, the risk assessment, contingency plans, staff training and the quality assurance programme. The person or organisation that provides routine radiation surveys would normally act as the practice RPA. If appointed on an ongoing basis, advice from the RPA is always available and the continuity of advice is assured. It is possible, however, to appoint the RPA on a temporary basis to obtain specific advice.

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General requirements

Notify HSE

The Health and Safety Executive must be informed of the use of ionising radiation at the practice. If you have already done this under the previous legislation, there is no need to do so again. HSE should be re-informed if there is a change in ownership of the practice or if the practice relocates.

Risk assessment

A risk assessment should be carried out, with the help of your RPA, to identify the precautions necessary to restrict the exposure of those involved with taking radiographs and patients. If five or more employees are involved in taking or processing radiographs, the risk assessment must be recorded (although it is good practice to record the findings of the risk assessment if there are fewer than five employees).

Your risk assessment should be reviewed at least every five years and more frequently if there are changes to working methods or new types of equipment are used in the practice. Changes in legislation may also require a risk assessment review.

Training

The legal person must ensure that every IRMER practitioner and operator has received adequate and appropriate training and undertakes continuing education. An up to date record of training must be maintained and be available for inspection. Female employees involved in radiography must be made aware of the risk to a foetus should they become pregnant.

- **IRMER practitioners** (dentists) should attend formal courses on radiation protection as part of their five-yearly recertification cycle, providing at least five hours of verifiable CPD.

- **Operators whose duties include setting exposure parameters and/or positioning the film, the patient and the tube head**: dental nurses undertaking these duties should possess a Certificate in Dental Radiography and hygienists and therapists should have received an equivalent level of training. Operators must update their knowledge at least every five years.

As an interim measure, dental nurses who were competently undertaking radiography prior to 13 May 2000 and had only received the 'core of knowledge' training, may continue to take radiographs until 12 May 2005, by which time they should have obtained the Certificate in Dental Radiography. The legal person must record all the training and relevant experience of dental nurses using this interim measure.

'An up to date record of training must be maintained'

- **Other operators** whose duties include film processing and quality assurance should preferably possess the Certificate in Dental Nursing or NVQ equivalent. Failing this, they must have received adequate and documented training for the tasks that they undertake, which may be provided in-house.

  Dental nurses who 'press the button' may only do so in the presence of the operator who physically sets up the patient for a radiograph. They must have received appropriate training, which should be documented.

- **Non-clinical staff** may carry out some of the more straightforward operator duties (patient identification, for example) and be aware of the need to avoid unnecessary personal exposure.

- **Appropriate training courses** for IRMER practitioners and operators would cover:
  - the principles of radiation physics
  - risks of ionising radiation
  - radiation doses in dental radiography
  - factors affecting doses in dental radiography
  - the principles of radiation protection
  - statutory requirements
  - quality assurance
  - selection criteria (IRMER practitioners only).

Radiation Protection File

Your Radiation Protection File should hold as much information as possible about the procedures in place to ensure radiation protection within the practice. It will include local rules and written procedures for patient protection to provide a working framework for the practice. See page 7 for more information on what should be included in your Radiation Protection File

Patient protection

Referral

If you decide to refer a patient to another dentist or to a hospital for a radiograph, you must provide sufficient clinical information to enable the person taking the radiograph to decide whether the exposure is justified. As a minimum, this information should include:

- unique identification of the patient
- clinical information to justify the requested exposure
- unique identification of the referrer
- if relevant, information on pregnancy.

You should establish guidelines for referring patients for radiographs, which should be kept in your Radiation Protection File.

Justification

Before taking a radiograph you must assess whether an individual exposure is justified - the benefit should outweigh the detriment of the exposure. The radiograph would normally provide new information.

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In deciding to take a radiograph, you should take account of:
- previous radiographs
- the reason for taking the radiograph
- diagnostic benefit to the patient
- the radiation risk
- alternative techniques that might achieve the same purpose.

The booklet *Selection Criteria for Dental Radiography* published by the Faculty of General Dental Practitioners (UK) and *Guidelines for the use of radiographs and orthodontics* published by the British Orthodontic Society (2001) are useful references for assessing whether an exposure is justified.

Every decision to take a radiograph should be recorded in the patient's notes. It should be clear who carried out the clinical examination and who authorised the radiograph.

Medico-legal exposures

You should consider the need for and usefulness of radiographs requested for medico-legal and other third-party purposes when assessing whether they are justified - there is often no direct health benefit to the patient. You should obtain the patient's written consent before undertaking these radiographs.

Optimisation (ALARP)

For every radiograph, the dose from the exposure should be kept as low as reasonably practicable (ALARP) for the intended diagnostic purpose. Written guideline exposure settings must be in place for every type of radiograph that can be taken at the practice. These should be kept close to the x-ray equipment; a copy can also be kept in the Radiation Protection File.

Each radiograph must be subject to a clinical evaluation, which is recorded in the patient's notes. The clinical evaluation must provide enough information to be audited at a later date and might include the charting of caries and findings relevant to the patient's management or prognosis. In the case of a pre-extraction radiograph, it may be sufficient to record either 'root form simple' or 'nothing abnormal diagnosed'.

'Each radiograph must be subject to a clinical evaluation'

Lead aprons and thyroid collars

In dentistry, there is no justification for the routine use of lead aprons where modern equipment and techniques ensure there is minimal scatter towards the trunk of the body. Furthermore, they do not protect against radiation scattered internally within the body. Lead aprons only provide some protection for the vertex occlusal projection and should be used only if the patient is, or may be, pregnant.

Lead aprons should be provided for a member of staff or other person who assists a handicapped patient or child during radiography. The assisting person should not be pregnant. The lead apron should have a lead equivalence of not less than 0.25mm and, when not in use, should be stored over a suitable hanger, not folded. The lead apron should be visually inspected annually.

Thyroid collars should be used in those few cases where the thyroid may be in the primary beam.

Female patients of child-bearing age

It is not usually necessary to ask a patient if she is pregnant before you take a dental radiograph because the pelvic area is not usually irradiated and the dose involved is very small. You should explain that the risks to the foetus are negligible and give the patient the option of delaying the radiograph.

If the type of radiograph required means that the pelvic area might be irradiated (the vertex occlusal projection, for example) and the patient is or might be pregnant, you should consider whether the radiograph can be deferred until after delivery. If you decide to take the radiograph, the foetal dose must be kept to a minimum and a lead apron used.

Excessive exposure of patients

Where a patient has received an exposure that is 'much greater than intended', the legal person should consult an RPA without delay. 'Much greater than intended' is suggested as being 20 times the intended dose.

Where the cause of overexposure is due to a malfunction or defect in equipment, the local Health and Safety Executive should be notified. Where the cause is the result of clinical or operator error, the IRMER Inspectorate should be notified.

The detailed investigation will aim to establish what happened, identify the failure, decide on remedial action to minimise the chance of a similar failure and estimate the doses involved. The legal person must keep this report for 50 years.

Quality assurance

Quality assurance programmes must be in place to ensure consistently accurate diagnostic information and keeping radiation doses to the patients as low as reasonably practicable. Page 9 gives more information on developing your own QA programme.

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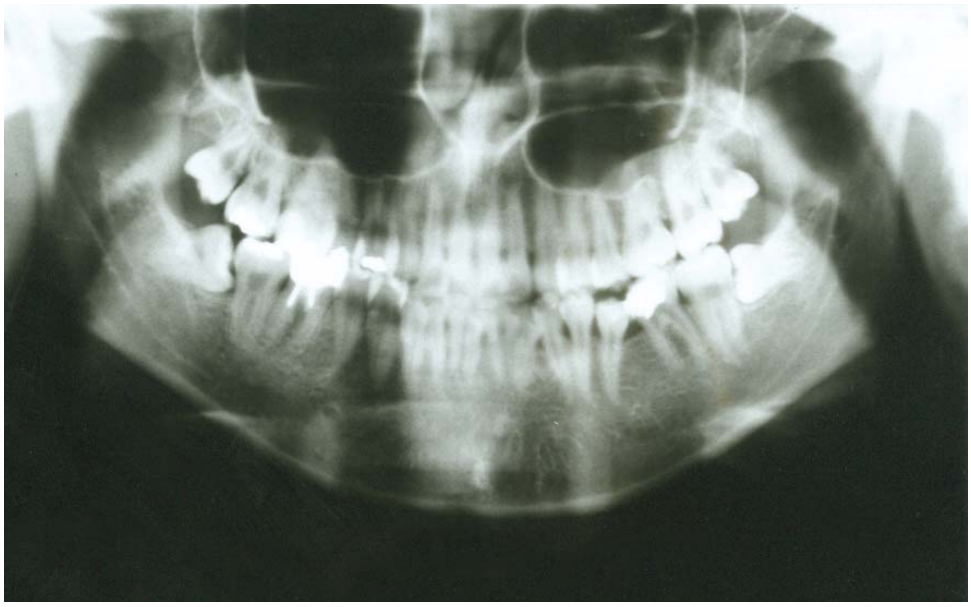
Equipment



Controlled area

You should define a controlled area around the dental x-ray equipment and, with the exception of the patient, prevent anyone entering this area when radiographs are being taken. Your RPA will help you to define your controlled area, which will normally be within 1.5m of the x-ray tube and the patient and within the primary x-ray beam until it has been sufficiently attenuated by distance or shielding. The controlled area should not normally extend beyond the x-ray room or surgery.

Dentists and their staff should stand well outside this controlled area - preferably 2 m or more from the x-ray tube and the patient and well out of the direction of the primary beam. Alternatively, a protected area can be provided for the operators.

The operator should be able to see the x-ray tube warning light and the patient throughout the radiograph and also be able to prevent anyone entering the room whilst an radiograph is being taken.

Dosemeters

As staff will not routinely enter the controlled area, personal dosemeters are not normally required. It is, however, good practice to provide dosemeters if the weekly workload of an individual exceeds 100 intra-oral or 50 panoramic films, or a pro-rata combination of each type. The dosemeter wear period may be up to three months and the results should be recorded and discussed periodically with your RPA. The results of any personal monitoring should be kept for at least two years.

Maintenance and testing

Suppliers and installers of dental x-ray equipment are required to provide adequate information about its proper use, testing and maintenance. Dental x-ray equipment must be subject to the following tests:

Critical examination by the installer and a report produced. The critical examination report will include

- a description of the equipment and where it is installed
- an evaluation of the equipment location, the equipment's warning signals and the exposure control
- confirmation that sufficient radiation protection and safety features are in place and operating correctly.

Acceptance test to provide baseline values for subsequent routine tests. It uses the results of the critical examination report and includes measurements to determine whether the equipment is operating within agreed performance parameters and assessment of the typical patient dose. This test can be combined with the critical examination.

Routine tests to confirm that there have been no significant changes to the equipment or its location, compare the results of technical tests with previous results. These tests should be carried out at least every three years. Annual testing is required only in certain circumstances, for example, if previous test procedures have shown a fault.

Representative patient doses tests should be carried out as part of each routine test.

Intra-oral radiography

The nominal tube potential for intra-oral x-ray sets should not be lower than 50 kV. New equipment should operate within the range 60 to 70 kV. Intra-oral sets operating at less than 50 kV should be withdrawn from use, as soon as practicable.

The fastest available films consistent with satisfactory diagnostic results should be used; ISO speed group E or faster is preferred. Instant process films should only be used in specific essential situations.

Rectangular collimation is recommended for new equipment and should be retro-fitted to existing equipment. It should be combined with beam-aiming devices and film holders. The beam size at the end of the collimator should not exceed 40 by 50 mm (so does not overlap the dimensions of the standard ISO film size 2 by more than 5 mm at any edge). Ideally, it should be 35 by 45 mm.

Beam collimators/directors should be open ended and provide a minimum focus-to-skin distance of 200 mm for equipment operating at 60 kV or greater and 100 mm for equipment operating at below 60 kV.

Film holders should be used for accurate alignment with the intra-oral film to reduce patient dose and improve diagnostic quality. The patient should only hold a dental

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film when it cannot otherwise be kept in position. If a film is to be held by anyone else, forceps or an alternative appropriate holder should be used to avoid irradiation of the fingers.

Extra-oral radiography

For panoramic and cephalometric radiography with manual control, a range of tube potential settings should be available, preferably from 60 to 90 kV. There should be provision for the selection of a range of tube currents so that full advantage can be taken of the sensitivity of modern film/screen combinations.

For extra-oral radiography, the fastest available film and intensifying screen combination consistent with satisfactory diagnostic results should be used; the system speed should be at least 400.

Panoramic equipment should have patient positioning aids and incorporate the use of light beams to be effective.

Field limitation can significantly reduce patient exposure when specific diagnostic information is required. New equipment should have an automatic selection of beam limitation, although manual selection is acceptable. All primary beam defining slits should be accurately aligned with the receiving slit.

If, with panoramic radiography, the rotational movement fails to start or stops before the full arc is covered, the exposure switch should be released immediately to avoid high, localised exposure of the patient.

A **cephalostat** should be used in cephalometric radiography to ensure precise alignment of x-ray beam, film cassette and patient. A light beam diaphragm should be provided so that the beam can be accurately collimated to include only the diagnostically relevant area.

Digital detectors

The digital equipment selected should offer the sensor sizes that are required clinically and be available in a range that compares with dental film.

'Dedicated viewing facilities should be available'

The sensitivity of the detector system should be compatible with the x-ray set for which it is to be used. Ideally the x-ray set should have an effectively constant operating potential with the ability to select sufficiently low exposure settings to enable the full extent of available dose savings to be realised. Exposure settings should be reduced to the minimum compatible with the diagnostic quality of the image.

Warning signals

The control panel of the equipment should have a light to indicate that the main power is switched on. A warning light should be fitted to give a clear indication that an exposure is taking place and remain illuminated for the duration of the exposure. Audible warnings should work in the same way as the visual warning light.

Film processing

Film processing should consistently produce good quality radiographs and avoid the need for radiographs to be repeated. Where automated processing is used, the processor should be properly cleaned and maintained. With manual processing, the temperature of the developer should be checked prior to film processing and the development time adjusted.

Dedicated viewing facilities should be available so that the full diagnostic information can be obtained from the radiographic films. Suitable film masking should be used to optimise the viewing conditions by cutting out stray light.

Radiation Protection File

Your Radiation Protection File should contain

- Local Rules, which contain the working instructions, contingency arrangements and dose investigation level
- written procedures for patient protection.

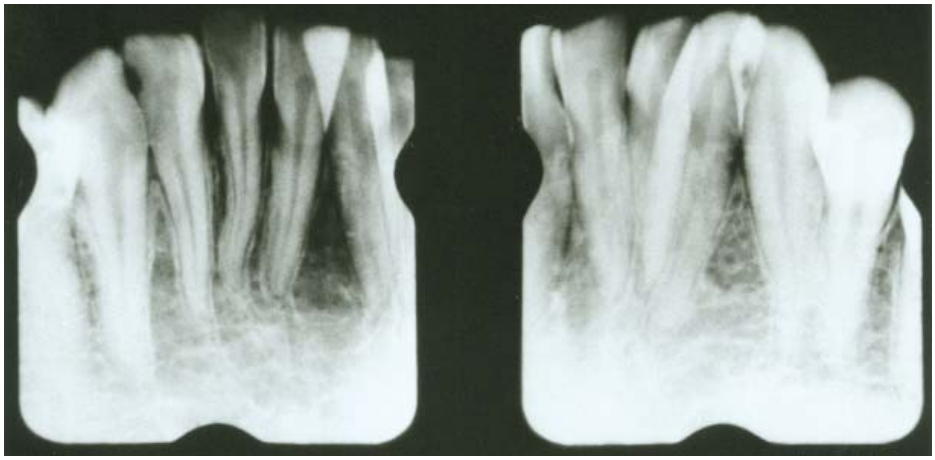
Your Radiation Protection File might also contain information on the training and information that each member of the practice has received and any update courses attended. You might decide, however, to keep this information with the individual personal development folders, in which case you should reference this where relevant.

Your Radiation Protection File should be reviewed regularly to ensure that it remains relevant and effective. Keep a log to show how and when you reviewed or modified it and make sure that everyone in the practice is aware of the File and any amendments that are relevant to them.

Local Rules

The Local Rules must contain at least the following information:

- name of the appointed Radiation Protection Adviser



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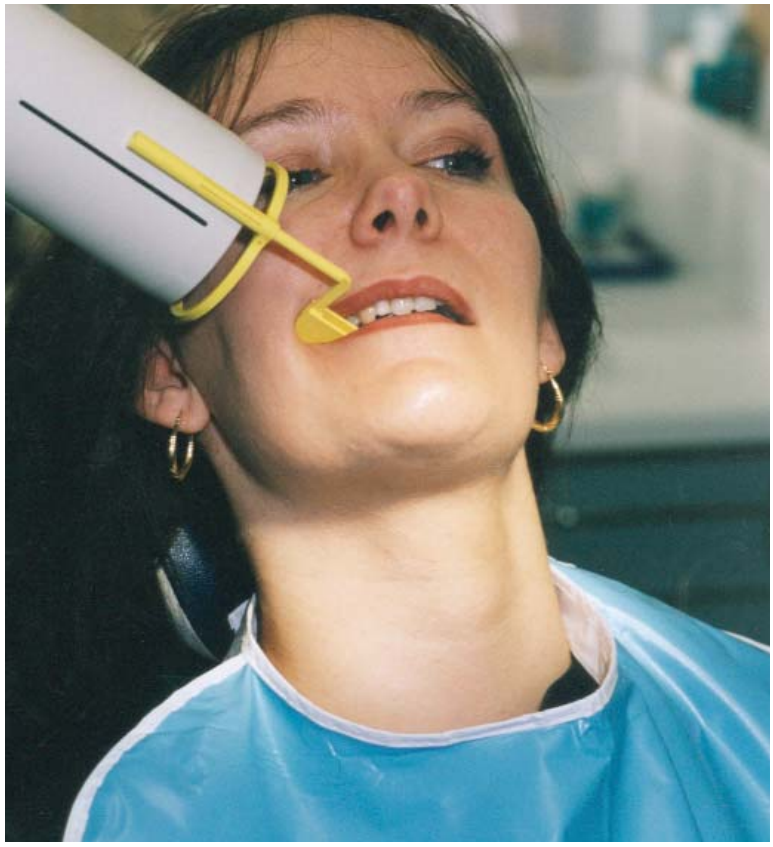
- the identification and description of each controlled area and a summary of the arrangements for restricting access
- an appropriate summary of the working instructions - for example, the need to stand outside the controlled area or behind protective panels
- identification or summary of any contingency arrangements - for example, failure of the x-ray control to stop after a preset exposure
- the dose investigation level to decide whether personal monitoring is needed.

It is recommended that you also include the following information:

- the legal person (usually the practice owner or employing dentist)
- contact details of the RPA
- arrangements for personal dosimetry (if required)
- arrangements for pregnant staff
- reminder to employees of the need to report any problems with the x-ray equipment or if there has been a case of overexposure
- a brief mention that the following can be found elsewhere in the Radiation Protection File:
  - arrangements for the maintenance and testing of equipment
  - the significant findings of the risk assessment
  - staff instruction and training
  - review programme to ensure Local Rules remain up to date
  - arrangements for investigating and reporting incidents.

Model Local Rules can be found in the BDA's Practice Compendium.

'Ensure Local Rules remain up to date'



Written procedures for patient protection

The legal person is required to have written procedures to describe the protocols for patient protection that are in place. These include:

- correct identification of the patient prior to radiography
- identification of individuals entitled to act as referrer or IRMER practitioner or operator
- medico-legal exposures
- making enquiries of female patients of child bearing age whether they are or may be pregnant
- ensuring that quality assurance programmes are followed
- the assessment of patient dose
- the use of diagnostic reference levels
- the carrying out and recording of a clinical evaluation of outcome of each exposure
- ensuring the probability and magnitude of accidental or unintended doses to patients are reduced so far as reasonably practicable
- provision for the carrying out of clinical audits as appropriate

The legal person is also required to establish:

- guidelines for referral criteria for radiographic examinations
- written protocols (guideline exposure settings) for every type of standard projection for each item of equipment
- quality assurance programmes
- diagnostic reference levels
- the method for authorising each exposure, to ensure that there is a record that justification has taken place.

Example protocols for patient protection can be found in the BDA's Practice Compendium.

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Quality assurance in dental radiology

Quality assurance (QA) is concerned with achieving consistently adequate diagnostic information whilst controlling radiation doses to the patient to as low as reasonably practicable. Your QA programme should be comprehensive but inexpensive to operate and maintain. Records will need to be maintained and checked - an essential feature of QA.

'Ensure good diagnostic quality radiographs'

Someone within the practice should oversee the implementation of a QA programme, which for dental radiology should include image quality, patient dose and x-ray equipment, film processing, training and audits.

Image quality

Image quality should be monitored on a regular basis to ensure good diagnostic quality radiographs. A simple subjective image quality rating can be used:

Rating	Quality	Basis
1	Excellent	No errors of patient preparation, exposure, positioning, processing or film handling
2	Diagnostically acceptable	Some errors of patient preparation, exposure, positioning, processing or film handling but which do not detract from the diagnostic utility of the radiograph
3	Unacceptable	Errors of patient preparation, exposure, positioning, processing or film handling, which render the radiograph diagnostically unacceptable.

You should then aim for the following performance targets within three years of the start of your QA programme. The interim targets are a minimum for the shorter term.

Rating	Percentage of radiographs taken	
	Target	Interim target
1	Not less than 70%	Not less than 50%
2	Not greater than 20%	Not greater than 40%
3	Not greater than 10%	Not greater than 10%

You need to rate the image quality of the radiographs and compare this against these targets. It is for you to decide how many radiographs to assign quality ratings to but the larger the sample, the more accurately it will reflect the image quality of your radiographs. You might assign a rating to the radiograph as it is viewed, recording the rating and then analysing the results. Selecting a representative sample from clinical records at regular intervals to assign quality ratings would fail to take account of rejected (unacceptable) films and consequently gives inaccurate results.

You should keep a record of each analysis of the results together with a record of any action arising from the analysis. Corrective action should be taken where the performance targets are not being achieved.

Unacceptable ratings should be further assessed and the reason recorded. Your record should include the date of the radiograph, why it is unacceptable, the cause and the number of repeat radiographs taken. This type of assessment can help to identify a range of problems including the need for equipment maintenance, improvements in techniques or improved staff training.

Patient dose and x-ray equipment

Patient radiation doses must be kept as low as reasonably practicable and so should be monitored on a regular basis. Patient doses can only be kept to a minimum if the x-ray equipment complies with recommended standards for equipment performance and diagnostic reference levels (DRL). You should seek advice from your RPA for the level of the adopted DRL. If the representative doses to patients are consistently above the DRL a thorough review must be

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undertaken to either improve, or to justify keeping, the current techniques.

An equipment log should be maintained to record the results of these checks in chronological order. This log should include details of routine or special maintenance of the x-ray equipment.

Day to day checks of the warning lights and audible alarms, correct operation of safety devices and correct position of the counterbalance for maintaining the position of the x-ray tube should be undertaken and periodically (every six months is suggested) the results of these checks should be recorded in the equipment log.

You should also maintain an up-to-date inventory of each item of x-ray equipment, which should include:

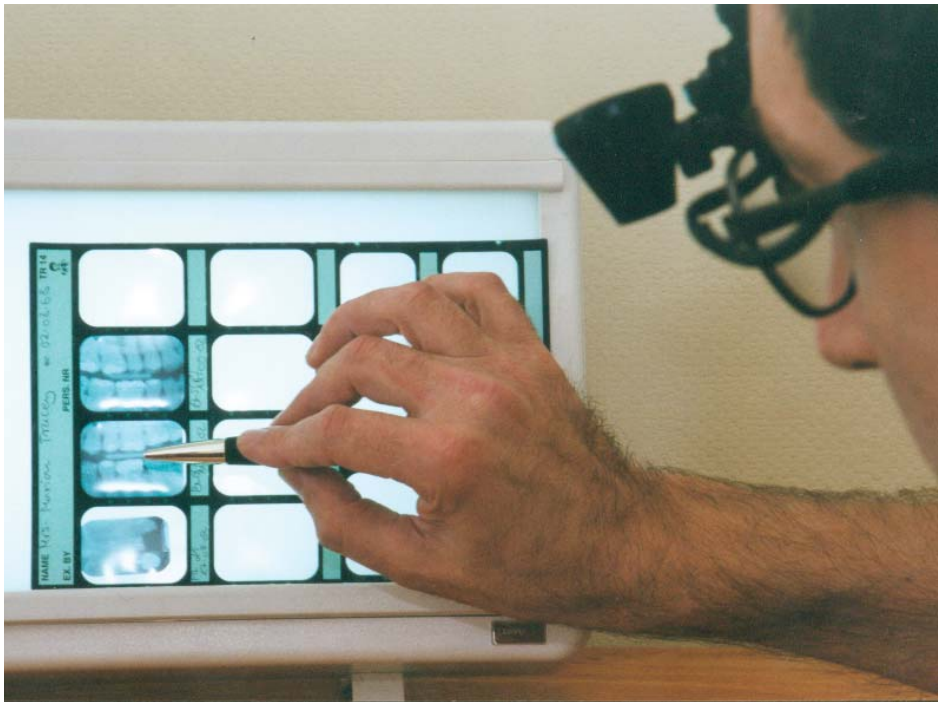
- name of manufacturer
- model number
- serial number or other unique identifier
- year of manufacture
- year of installation.

Darkroom, films and processing

Darkrooms should remain light tight and safelights should not produce film fogging. Checks, for example a 'coin test' (see page 11), should be carried out at least once a year and the results recorded in a log. Desktop processing units should also be checked for light-tightness and the results recorded.

Inadequate film processing will compromise the diagnostic information. The QA standards will be provided by the suppliers of the films, processing solutions and processing equipment and will include:

- film speed, expiry date and recommended storage conditions
- processing conditions (times and temperatures)



'Monitor the processing of films'

- changing frequency for processing solutions
- cleaning instructions for automatic processors.

As part of your QA programme you should keep records to demonstrate control of your film stock, changes of processing solutions and cleaning of automatic processors.

After every change of solutions and before processing patients' films, you should monitor the processing of films by, for example, radiographing a test object and comparing the image with a reference film to detect variations in processing quality before they affect patient films.

Training

Those involved with the actual taking of radiographs (IRMER practitioners and operators) must have received appropriate training. The QA programme should include a register of all staff involved with any aspect of radiology and include the name, responsibility training received (and date) and training review date.

The training register should also include details of training provided for all staff or make reference to an alternative source for this information - individual training logs, for example.

QA audits

The responsible person should review all the records that are made as part of the QA programme at intervals not exceeding 12 months.

Clinical audits and/or peer reviews of radiography may include:

- the QA programme and associated records
- the justification and authorisation of radiographs
- the clinical evaluation of radiographs.

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Coin Test

This test is designed to show any problems with fogging of films, which makes films become progressively darker with reduced detail and poor contrast. It is most likely to occur to films that are sensitive to light, such as cassette films.

Fogging can result from light contamination in a darkroom, daylight in the loading bay of an automatic processor or poor safelights.

Technique

You will need at least six coins and a piece of opaque card, large enough to cover the film completely.

Using the most sensitive type of film used in the practice (for example, a cassette containing a blank film), flash expose it by placing it several feet from the intra-oral tube and exposing it to a lower incisor exposure setting; exposed film is more sensitive to light than unexposed film.

For darkrooms:

- turn off all the safelights, remove the pre-exposed film from the cassette and place it on the work surface. Arrange the coins at intervals across the film and then cover the film with opaque card
- turn the safelights on and move the card to reveal the first coin. Keep the first coin uncovered for 30 seconds and then reveal the second coin. After a further 30 seconds reveal the third coin and so on until all the coins have been revealed (at 30-second intervals). When the last coin has been revealed for 30 seconds cover the whole film with the opaque card
- turn off the safelights and process the film in complete darkness.

For automatic processors:

- set up the test in the daylight loading bay of an automatic processor by placing a cassette film or a number of periapical films, pre-exposed as before, together with a number of coins into the loading area. Cover the whole processor with a dark blanket to eliminate all light. Unwrap the film/films and lay them along the floor of the loading bay and place the coins at intervals across them. Cover with opaque card.
- remove the blanket and open the black-out window to reveal the red viewing window (if present). Move the opaque card to reveal the first coin for 30 seconds, then the second coin for 30 seconds etc. Continue until all the coins have been revealed and then return the card to cover the whole film / films.
- Cover the processor with the dark blanket and process the film / films in complete darkness.

Interpreting the results:

You can calculate your working time from the coin outlines present on the test film(s). If, for example, there are no coin outlines in the sections where they were revealed for two minutes or more, no fogging has occurred, so you know you have at least a two-minute working time available.

If there are outlines of coins revealed for only 30 seconds or one minute, your available working time will be insufficient to prevent fogging occurring. Safelights should be checked and/or light leakage identified.

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