



## **Radiography Quality Assurance in the Dental Practice: Meeting IR(ME)R 2017 Requirements**

**Aims:** This article aims to give an overview on the importance of developing a Quality Assurance (QA) programme in respect to dental radiography in the dental practice.

**Objectives:** On completion of this verifiable CPD article the participant will be able to demonstrate, through completion of a questionnaire, the ability to:

- Identify the legislation relating to dental radiography quality assurance in the UK, including the distinct roles of IRR2017 and IR(ME)R2017.
- Define quality assurance (QA) in dental radiography and describe its aims in relation to image quality, safety and ALARP principles.
- Have knowledge of the 2020 Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment.
- Apply image quality assessment methods (prospective and retrospective) and implement reject analysis to identify errors, reduce repeat exposure, and target training.
- Maintain compliance with CQC inspection expectations by demonstrating robust documentation, equipment testing, and radiation protection arrangements.
- Describe best practice for equipment testing (critical examination, acceptance testing, and routine testing).
- Outline training requirements for all IR(ME)R duty holders and maintain a training record for staff involved in radiography.
- Plan and conduct audits within the QA programme to monitor standards and drive continuous improvement.

### **Introduction**

Dental radiography can be considered to be one of the dental clinicians' most important diagnostic aids. However, radiography does come with a significant number of responsibilities to protect the patient, general public and workers.

Quality assurance in dental radiography is a critical aspect of modern dental practice and is aimed at ensuring the accuracy, safety, and consistency of dental images.

There are two sets of regulations in the UK governing the use of ionising radiation. Firstly, the Ionising Radiation Regulations 2017 (IRR2017), which are enforced by the Health and Safety Executive and are primarily concerned with the radiographic equipment, the workers and the public.<sup>1</sup> Secondly, the Ionising Radiation (Medical

Exposure) Regulations 2017 (IR(ME)R2017) which are governed by the Care Quality Commission and are primarily concerned with the protection of the patient.<sup>2</sup>

Both the IRR(17) and IR(ME)R 2017 place clear, but different responsibilities on the legal person to establish and maintain Quality Assurance (QA) programmes in respect of dental radiography. Thus, the establishment of a quality assurance programme is a mandatory requirement for dental practices.

This article will define quality assurance in respect of dental radiography and outline the components of a quality assurance programme which are based on the 2020 *Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment*.<sup>3</sup> These guidance notes can be downloaded in full from the further reading section of this article. (Northern Ireland IRR(NI)17 and IR(ME)R18 can also be downloaded from the further reading section).

### [The Care Quality Commission](#)



When inspecting dental practices, the CQC will consider x-ray use when reviewing if the practice is safe. This relates to:

- Regulation 12 (safe care and treatment)
- Regulation 15 (premises and equipment)

The CQC advise practices to consider the following:

- “How do you put arrangements for radiation protection into practice?
- Have you consulted a Radiation Protection Adviser (RPA) and Medical Physics Expert (MPE)?
- Have you registered with HSE? Where is your certificate?
- Have you documented the arrangements for radiation protection, for example, in a radiation file or folder?
- Do you **quality assure** / performance test the radiography equipment?
- Is the X-ray equipment maintained or serviced by an appropriate person? (This could be the organisation which installed the equipment)
- Does an appropriately trained staff member do a visual inspection of X-ray sets to identify any safety faults?
- Which staff are involved in taking X-rays and are they trained?
- Have staff been trained according to current professional guidelines?”<sup>4</sup>

All of this information should be available upon inspection and supporting records stored in the radiation protection folder.

## What is Quality Assurance (QA) in Dental Radiography?



The World Health Organisation defines QA in radiography as:

*"An organised effort by the staff operating a facility to ensure that the diagnostic images produced by the facility are sufficiently high quality so that they consistently provide adequate diagnostic information at the lowest possible cost and with the least possible exposure to radiation."*

The 2020 Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment state that the purpose of quality assurance in respect of radiography is "to ensure consistently adequate diagnostic information, whilst radiation doses to patients (and other persons) are kept As Low as Reasonable Possible (ALARP), taking into account the relevant requirements of IRMER17 and IRR17."<sup>3</sup>

Therefore, the aims of a QA programme are:

- To produce radiographs that are of a consistently high standard.
- Reduce the number of repeat radiographs.
- To highlight sources of error so that they can be rectified.
- Reduce costs.
- Increase efficiency.
- To ensure that radiation doses to patients (and staff) are kept as low as reasonably practicable. (ALARP).<sup>6</sup>

Employers deemed not to be keeping exposures as low as they reasonably can, could be at risk of prosecution.

The QA programme should be "comprehensive, based on evidence-based guidance where possible, and convenient to operate and maintain."<sup>3</sup>

The basic principle of a QA programme is that within the overall QA programme all necessary procedures should be laid down in writing, such as:

- The implementation should be the responsibility of a named person - This is often a senior partner.
- The frequency of operations should be defined.

- The content of the essential supporting records should be defined, as should the frequency for the formal checking of such records.

### Which Areas Should the Quality Assurance Programme Cover?



- 1) Image quality.
- 2) Patient dose and x-ray equipment.
- 3) Image processing and display equipment.
- 4) Employers' procedures required by IRMER17.

The overall programme should be drafted with the MPE.<sup>3</sup>

#### 1) Image Quality

One of the most important parts of the QA programme is to ensure that consistently high-quality images are produced. These images must support accurate clinical diagnosis and treatment while simultaneously minimising patient radiation exposure.<sup>3</sup> To achieve this, images should be regularly monitored, and efforts should be made to improve quality where necessary.

It is recommended that image quality analysis occurs at intervals of no greater than six months, using a sample size of at least 100 images. The person conducting this evaluation must be appropriately trained and experienced in taking radiographs or CBCT images.<sup>3</sup>

#### **Methods of Evaluation:**

There are two key methods of evaluating image quality:

- 1) **Prospective Evaluation** - Radiographs are assessed at the point of viewing, using image quality ratings in real time.
- 2) **Retrospective Evaluation** - A representative sample of radiographs is drawn from clinical records at regular intervals. Image quality ratings are then assigned and analysed to detect patterns or recurring issues.<sup>3</sup>

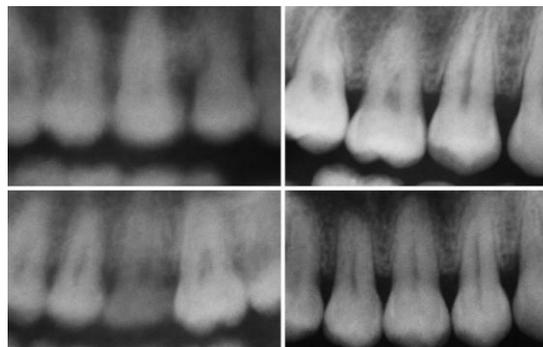
The 2020 Guidance Notes updated the image quality rating system from a 3 point scale (as used in the 2001 guidance notes) to a simplified 2 point scale for both dental radiography and dental CBCT imaging.<sup>3</sup>

Table 1, below, shows the image quality targets that are expected to be achievable in the majority of well-managed dental practices.

Quality Rating	Quality Criteria	Targets: Percentage of DIGITAL IMAGING radiographs or CBCT images in sample	Targets: Percentage of FILM IMAGING radiographs or CBCT images in sample
Diagnostically acceptable ('A')	No errors or minimal in either patient preparation, exposure, positioning, image (receptor) processing or image reconstruction and of sufficient image quality to answer the clinical question.	Not less than 95%	Not less than 90%
Diagnostically Unacceptable ('N')	Errors in either patient preparation, exposure, positioning, (receptor) processing or image reconstruction which render the image diagnostically unacceptable	Not greater than 5%	Not greater than 10%

Table1: image quality targets<sup>3</sup>

### The Role of Reject Analysis



An essential part of image quality assurance is reject analysis which is the process of identifying and evaluating the images that are considered diagnostically unacceptable.<sup>3</sup> This not only supports compliance with national guidance but also serves several key functions:

- **Targeted Training and Skill Development**

By identifying recurring issues, such as poor positioning, incorrect exposure settings, or motion artefacts, reject analysis allows practices to pinpoint the specific skills or knowledge gaps contributing to unacceptable images. For instance:

- If a pattern of incorrect angulation is noted, this may indicate the need for training in patient positioning.
- A high number of underexposed images may indicate the need for training in correct exposure parameter selection or equipment calibration checks.

This information allows training to be tailored to the specific needs of individual staff members or the team as a whole, making professional development more efficient and relevant.

- **Reduction in Repeat Exposures and Radiation Dose**

Each diagnostically unacceptable image potentially results in a repeat exposure, increasing the patient's cumulative radiation dose unnecessarily. By identifying the root causes of image rejects and implementing corrective actions, such as retraining or process changes, practices can reduce the frequency of repeat imaging. This contributes directly to:

- **Lower radiation exposure for patients**, in line with the ALARP (As Low As Reasonably Practicable) principle.
- **Improved efficiency**, as few images need to be retaken, reducing chair time.

### **Documentation and Analysis of Rejects**

To ensure the process is meaningful, all image quality assessments and reject analyses should be carefully documented, including:

- The date of assessment.
- Nature of the deficiency.
- Known or suspected cause.
- Number of repeat radiographs (if taken).<sup>3</sup>

This data should then be analysed over time to identify trends or repeated failures. Common issues might include:

- Patient movement.
- Incorrect receptor placement.
- Errors in exposure selection.
- Poor image processing technique.

By categorising these errors, practices can develop targeted action plans, which may include revising protocols, updating equipment, or delivering focused training sessions.<sup>3</sup>

A more comprehensive list of possible image quality deficiencies can be found in the Guidance Notes which can be accessed in the further reading section.

## 2) Patient Dose and X-ray Equipment



As previously mentioned, one of the main aims of a quality assurance programme is to ensure doses to patients are kept **As Low As Reasonably Practicable**. Patients' doses should be monitored regularly to ensure they stay below the national diagnostic reference levels. In order to achieve this, it is important that X-ray equipment complies with current recommendations and is appropriately maintained.

IRR17<sup>1</sup> came into force on January 1st, 2018. The main change to affect dental practice was how you tell the Health and Safety Executive (HSE) that you work with ionising radiation. Employers must apply to the HSE for certain work they do with ionising radiation. The HSE has developed a graded approach to registration perceived on the risk associated with using ionising radiation.

Depending on the level of risk of the ionising radiation work, the employer may need to apply to:

- Notify.
- **Register** (Dental x-ray equipment has been put in the middle grade, requiring 'registration', and therefore dental practices are required to register with the HSE and pay a registration fee.)
- Get consent.

The application can be submitted by an authorised employee and must be applied for before work with ionising radiation is started.

IR(ME)R 2017 states that any employer who has control over any equipment must: "implement and maintain a quality assurance programme in respect of that equipment"<sup>1</sup>

This includes the requirement that an up-to-date inventory is held for each piece of equipment which will contain:

- Name of manufacturer.
- Model number.
- Serial number.
- Year of manufacturer.
- Year of installation.

There are three main phases of testing:

- Critical Examination.
- The Acceptance Test.
- Routine Test.

All dental X-ray equipment should be maintained regularly and critically examined every three years or sooner in accordance with manufacturer's recommendations. However, there are some circumstances in which annual testing is recommended, subject to advice from the MPE. This includes:

- Patient doses consistently exceed the relevant National Diagnostic Reference Levels despite previous recommendations to reduce the dose.
- Image quality analysis indicates a persistent failure to meet the targets.
- For dental CBCT equipment, where no suitable QA test object is available.
- For hand-held dental X-ray equipment, in all cases.

Routine surveillance should involve day to day checks of equipment. An equipment log should include a periodic record (6 months recommended) to confirm that the checks have been made.<sup>3</sup>

In addition to the equipment tests, safety and warning devices should be monitored daily. This should include:

- Correct operation of warning lights.
- Correct operation of the audible warning system (if applicable).
- Satisfactory performance of the counterbalance.
- Condition of the x-ray tube head.
- Condition of the backscatter shield for hand-held dental x-ray sets.<sup>3,7</sup>

## **Digital Imaging**



Digital imaging is also subject to quality assurance. The practice should consult with their Radiation Protection Advisor/Medical Physics Expert, but some of the specific requirements are as follows:

- The condition of digital systems should be checked every time the equipment is used. This will involve visual check on the digital detectors and cables or phosphor plates.
- Image quality should be checked as previously described.
- The digital system should be checked to confirm it produces a uniform image. The digital detector should be fully exposed, and the pixel value of the image determined at five positions.
- The system should be checked for the ability to produce a high contrast detail.
- The computer monitor should be regularly cleaned as per the manufacturer's instructions. The screen brightness and contrast should be set up properly.<sup>7</sup>

### **3) Image processing and viewing facilities**

Digital radiography tends to offer more consistent image quality with lower radiation doses and easier archiving, making it increasingly preferred. Film x-ray systems have become less common in modern practice; however, some radiographs are still produced on film. Reports in the 1980's and 90's found that 90% of film faults were as a result of processing errors. Poor quality film handling and processing will negate any advantages from good technique if it results in the image quality being compromised. The following should be implemented (if applicable):

- Routine checks to ensure darkrooms and processing units remain light tight and that safelights do not produce fogging of films (checks should be made at least annually and results recorded).
- Processors must be regularly serviced and undergo regular cleaning of rollers and chemical tanks.
- Solutions should be tested to ensure correct strength and changed when necessary.
- Films should be stored in a cool, dry place and rotated to ensure that older stock is used first.

The QA standards will be laid down by the suppliers of the films, processing solutions and processing equipment. Records should be kept detailing the procedures in place to control film stock; records to control and validate the chemical changes; and cleaning procedures for automatic processors.<sup>3</sup> This can be achieved through recording everything in a simple log book.

Overall performance of processing should also be monitored. By radiographing a test object, such as a step-wedge and comparing the image with a reference film, changes in quality can be identified. It is recommended that these checks should be carried out at least after every change of the processing solution.<sup>7</sup> The results should be recorded.

With digital radiography, the digital sensor and phosphor plates are reusable, and are subject to wear and tear. This could potentially affect image quality. The following table denotes the recommended schedule of QA tests for digital image receptors:<sup>3</sup>

Test	Frequency	Fail Criteria
Visual Inspection	Three-monthly, or whenever damage is suspected	Damage to wires, casings or phosphor
Image Uniformity	Three-monthly, or whenever damage is suspected	Evidence of significant deterioration compared to baseline image. Any artefact that may affect clinical image quality
Subjective check of image quality	Three-monthly, or whenever damage is suspected	Evidence of significant deterioration compared to baseline image

#### 4) Employer's Procedures

These include:

- Local Rules, contingency plans and radiation risk assessment- Required in the UK under the IRR2017.<sup>1</sup> (further details can be found in the IRMER and IRR Radiation Protection CPD article).
- Employers' written procedures- Required in the UK under IR(ME)R2017.<sup>2</sup>
- Operational procedures or systems of work - Should be provided for all actions that indirectly affect radiation safety and diagnostic quality (i.e., actions not directly linked to use of x-ray equipment such as the correct preparation and use of processing chemicals)
- Procedures log - This should be used to record the existence of appropriate local rules, legal person's procedures and operational procedures, together with a record of each occasion on which they are reviewed or modified. Reviews should be undertaken whenever circumstances in the dental practice change, or otherwise not exceeding intervals of three years.<sup>3</sup>

- Radiation protection file - A complete and accessible radiation protection file is a statutory requirement and must be available for CQC inspectors. This file may be held in either hard copy or digital format but must be regularly reviewed and updated. It should include the following:
  - ✓ Practice declaration that it complies with the IRR2017 regulations.
  - ✓ Employer's procedures.
  - ✓ Record of all staff involved in radiography at the practice and details of training each person has taken part in.
  - ✓ Inventory of all x-ray equipment (including assessment reports/maintenance reports).
  - ✓ Reports from the RPA/MPE.
  - ✓ Operational procedures.
  - ✓ Details of all processing equipment and chemicals.
  - ✓ Evidence of safe disposal of developer chemistry and lead foil.
  - ✓ Radiography risk assessment.
  - ✓ Local rules for each controlled area.
  - ✓ Contingency plans.
  - ✓ Details of how patient safety is maintained.
  - ✓ Details of quality assurance (evaluation of radiographs, processing procedures, handling of chemicals, maintenance of processor equipment).
  - ✓ X-ray audits.<sup>8,3</sup>

The above is not an exhaustive list, and additional documents may be considered necessary for inclusion. The radiation protection file can be held in hard copy or stored electronically.<sup>3</sup>

## Training

IR(ME)R identifies the following 4 duty holders and each of these have clearly identified responsibilities under the regulations:

### 1) **The Employer**

**2) Referrer** - a referrer is a registered practitioner, "who is entitled in accordance with the employers' procedures to refer individuals to an IRMER practitioner for medical (or non-medical) exposure. The referrer is responsible for ensuring that sufficient clinical information is provided to enable the IRMER practitioner to decide whether the exposure can be justified."<sup>3</sup> In the dental practice it is likely that the referrer and practitioner will be the same person.

**3) Operator** - These are individuals who are entitled in accordance with the employer's procedures, to carry out all or part of the practical aspects that are associated with radiography. This could include any of the following:

- Patient identification.
- Positioning of the image receptor, the patient, and the x-ray tube head.
- Setting exposure parameters.
- Pressing the exposure button.

- Processing radiographs.
- Interpreting and reporting of radiographs or dental CBCT images.
- Exposing test objects as part of the quality assurance programme.

**4) Practitioner-** An IRMER practitioner is the person who takes responsibility for an individual's medical exposure. This would be the dentist or DCP that is qualified to take a dental radiograph. No exposure can take place unless it is justified by the IRMER practitioner.

IR(ME)R2017<sup>2</sup> stipulates that all practitioners and operators involved in exposing patients to x-rays must be adequately trained and that Continuing Professional Development is undertaken. The QA programme should incorporate a register of all staff involved in any aspect of radiography and should include the following information:

- Name.
- Responsibility.
- Date, nature and details of training received.
- Recommended date of review for training needs.

The Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment 2nd edition discuss training for dental professionals. The full document can be downloaded from the further reading section of this article but some points on training from the document are as follows:

### **Employees who operate dental x-ray equipment**

Employers must ensure that all of their staff who are trained and qualified to undertake X-ray exposures receive training that includes the following:

- Risks to health arising from exposure to dental X-rays.
- The significant findings of the risk assessment and precautions that need to be taken, in particular the specific requirements of the local rules and contingency plans at their place of work.
- The requirements of IRR17 relevant to dental radiography and the importance of complying with them.

IRMER Practitioners, referrers or operators that take radiographs, need to ensure that they complete 5 hours of IRMER training every 5 years and that the training **meets their needs**. The training that you complete depends on your needs at the time of completing it. Dental professionals must work within their scope of practice and ensure that they are adequately trained, competent, indemnified and entitled for their roles.

The recommended radiation content of verifiable CPD courses for IRMER practitioners and operators who undertake radiography are also set out in the 2020 Guidance notes as follows:

-  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.
- ✚ Selection criteria (IRMER Practitioners).
- ✚ Quality assurance.

You should source training in any new equipment or techniques that you introduce to your daily practice. All additional training that you complete should be logged and recorded.

### **Staff not directly involved with radiography**

Staff that assist in other duties related to radiography such as processing films or phosphor plates, or non-clinical staff, should carry out training sufficient to their role and safety. This may include:

- Awareness that X-rays are used, the benefits and risks, and the need to avoid any personal exposure.
- Training in the requirements of the local rules.

The General Dental Council highly recommend that dental professionals carry out 5 hours of verifiable CPD on the subject of radiography.

### **5) Audits**



Fig.4. The steps to a clinical audit

Each procedure within the QA programme will include a requirement for the written records to be made by the responsible person at varying intervals. <sup>3</sup>

The steps of an audit are detailed above in fig.4 and are recommended every 6 months. It is important that the data is analysed, and any changes identified are implemented in order to aim to improve current standards.

The Guidance Notes state that “clinical audits and/or peer review of radiography must be provided for, as appropriate, and should include:

- The QA programme and associated records.
- The justification and authorisation of radiographs.
- The clinical evaluation of radiographs.”<sup>3</sup>

## Conclusion

Radiography can be considered to be an essential tool in clinical diagnosis and treatment planning. However, radiography does come with a significant number of responsibilities to protect the patient, general public and workers. Quality assurance in dental radiography is fundamental for delivering accurate diagnoses and effective treatment plans whilst prioritising patient safety. Implementing an extensive QA programme with respect to dental radiography will help to ensure that any risk from ionising radiation is kept as **Low As Reasonably Practicable**.

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### **Personal Development Plan and Reflective Learning**

This CPD is linked to the following GDC Enhanced CPD Development Outcomes:

#### **C. Maintenance and development of knowledge and skill within your field of practice.**

Reflective learning is now a requirement of the GDC Enhanced Professional Development Scheme. As such, you will now need to answer some reflective learning questions, before your certificate is generated.

Examples will be provided. You do not need to fully complete this section at the time as you can update this at any time from your CPD log. However, if you take a few moments to write your reflection on completion, you will have fulfilled the Enhanced CPD requirements.

#### **Further Reading**

[Ionising Radiation Regulations \(2017\)](#)

[Ionising Radiation \(Medical Exposure\) Regulations \(2017\)](#)

[Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment](#)

[IRR\(17\) Northern Ireland](#)

[IR\(ME\)R18 Northern Ireland](#)

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