4.5.2 Potential for radiation exposure from reasonably foreseeable accidents

Accidents that should be considered to be reasonably foreseeable for hand-held dental X-ray equipment include the following:

a Damage to the equipment affecting the shielding

b Accidental exposure of a person (other than the patient) to the X-ray beam

c Failure of the timer to terminate the exposure after the pre-set time has elapsed

d Loss or theft of the equipment

This list is not exhaustive. In common with other forms of dental X-ray diagnostic equipment, it is not usually considered reasonably foreseeable that accidents could give rise to effective doses exceeding 6 mSv, or equivalent doses exceeding 3/10th of the relevant dose limit. However, it should be recognised that accidental doses to the operator from the use of hand-held X-ray equipment could be higher than from traditional equipment under equivalent conditions, due to the proximity of the operator's body and hands to the X-ray beam. For instance, if the operator's hands were accidentally exposed to the main beam at the end of the director cone for 10 seconds in the event of the failure of the timer to terminate the exposure, the equivalent dose to the hands could exceed 30 mSv. Assuming the X-ray beam was not directed towards the operator's body, the effective dose from scattered X-rays under the same conditions should not be more than a few microsieverts.

The findings of the risk assessment with regard to reasonably foreseeable accidents should be incorporated into the contingency plans (see Section 4.11).

4.6 Personal protective equipment (PPE)

If operators use hand-held X-ray equipment designed and constructed to appropriate standards, and following the working procedures recommended in this guidance, the use of PPE should not normally be necessary. Effective doses to employees would be expected to be very low, certainly less than 0.25 mSv a year. Equivalent doses to the hands should similarly be restricted to a small fraction of the statutory dose limit. Where the use of lead aprons is required (for instance, by people supporting or reassuring patients, or where it is necessary for the X-ray beam to depart from the horizontal plane), these must be stored appropriately when not in use. Lead aprons should be hung on rails of sufficiently large diameter to avoid creasing, and should never be folded. Lead gauntlets would only be appropriate in circumstances where there was a risk of the hands being exposed to the X-ray beam, which should only be considered acceptable if the information provided by the radiograph was essential for directing the care of a patient, eg during surgical procedures. It would be necessary to weigh the advantages of the protection provided against any disadvantages; for instance, reduced dexterity. Alternative methods of avoiding exposure of the hands should also be considered; for instance, by the use of long-handled forceps. As far as possible, all these factors should be identified and considered in advance, during the risk assessment process. Each item of PPE should be visually examined at frequent intervals. Thorough examinations for cracks in the protective material should be made annually and the results recorded to assess when PPE should be replaced.

4.7 Designation of areas

Once a hand-held dental X-ray unit is switched on, pressing an 'enable' key followed by pressing the exposure button are often the only actions required to initiate X-rays. In some cases, pressing the exposure button alone is sufficient to trigger an exposure. Therefore, operators are required to follow special procedures to restrict their own exposure and those of anyone else who might be in the vicinity. It follows that, as required by IRR99 regulation 16, a controlled area should always be designated and should be considered to exist whenever the unit's power is switched on. Within the dental practice setting there are two options for designating the controlled area, as follows.

4.7.1 Option A

The whole room is designated as a controlled area during radiography where this is reasonably practicable. This is the preferred approach for hand-held X-ray equipment as the walls of the room physically demarcate the controlled area, access to which can then be more easily restricted.

The following points should be noted:

a Access to the controlled area should be restricted by either locking doors or positioning another member of staff outside the door

b Use of room warning lights (ie outside each of the surgery entrances) is only practicable for hand-held equipment where the operator can switch the warning lights on and off between periods of radiography

4.7.2 Option B

Where it is impracticable to follow option A, a controlled area could be designated that extends to not less than 1.5 m from the X-ray tube head and patient, and includes the primary beam until suitably attenuated. The operator should restrict access to the area by continuous supervision, be able to see the boundaries of the controlled area and be able to terminate the exposure if someone tries to enter.

Whether option A or B is chosen, no person other than the operator and the patient should remain in the controlled area during an exposure, unless this is necessary to assist or support the patient. In either case the operator's work in the controlled area should be under suitable written arrangements (as part of the local rules) similar to those used for traditional dental X-ray equipment, unless the operator is a classified person (see Section 4.8).

4.7.3 Special cases

Where a hand-held X-ray set will be used at other premises, such as at a care home or patient's private residence, some flexibility of approach will be necessary to take account of the circumstances in each case, while still complying with the requirements of IRR99 with regard to the designation and demarcation of a controlled area, and restriction of access. This is discussed further in Section 4.18 dealing with co-operation between employers. Appendix C provides a form for risk assessments for work on remote sites.

It should not normally be necessary to designate any other areas as either controlled or supervised, outside a controlled area that has been designated in accordance with the guidance above.

4.8 Classified persons

Decisions regarding the designation of persons as classified and the provision of personal dosimetry should be made during the risk assessment process. It is unusual for dental practice staff to be classified, and this should not normally be necessary when hand-held dental X-ray equipment is used, as annual effective doses and doses likely to be received during reasonably foreseeable accidents should be well below 6 mSv, or 3/10th of any relevant equivalent dose limit*.

4.9 Personal dosimetry

Personal dosimetry in the form of whole body dosemeters is appropriate for operators of equipment meeting the recommended design standard (including service engineers and physicists testing the equipment), to ensure that the written arrangements are effective in restricting exposures (IRR99 regulation 18(3)). Owing to the anticipated low annual doses if proper procedures are followed, dosimetry could, if preferred, be provided for an initial trial period. The dosimetry method and wear period should be selected based on the advice of the RPA, and should be capable of determining compliance with the dose investigation level (see Section 4.9.2). If the trial period can establish that doses are adequately restricted, the RPA may advise that continuous monitoring is unnecessary. Any significant changes to workload, equipment or techniques should, however, trigger a review of the risk assessment, including whether a further fixed period or continuous personal monitoring is required.

Work with hand-held dental X-ray equipment that is designed, constructed and used in accordance with this guidance should not require the use of extremity dosimetry. In other circumstances, however, where the use of such equipment while being held in the hands is considered justified (see Section 3.3), extremity dosimetry should be considered as part of the risk assessment in consultation with an RPA. In such cases the RPA may advise that either whole body, extremity or both forms of dosimetry, should be provided on a continuing basis.

4.9.1 Pregnant employees

The effective dose received by an employee working with a model of hand-held equipment that complies with the recommended design standards in Section 3, and used in accordance with this guidance, is expected to be significantly lower than 1 mSv a year. This should be identified as part of the risk assessment process, in which case it can be concluded that the dose to the fetus should also be lower than this level and therefore no special protection measures are necessary. However, the legal person may consider a change of duties, or opt

* European Directive 2013/59/Euratom comes into legal force in the UK on 6 February 2018. Classification of workers will be required if effective doses are likely to exceed 6 mSv a year, or equivalent doses to the lens of the eye exceed 15 mSv a year, or equivalent doses to the skin and extremities exceed 150 mSv a year.

to provide personal dosimetry (and/or the use of a lead apron) for female employees for reassurance purposes, should they wish.

4.9.2 Dose investigation level

The annual effective dose to employees arising from work with a hand-held dental X-ray set meeting the conditions referred to in Section 3.3 should be well below 1 mSv a year. A dose of 1 mSv would therefore be an appropriate value for the dose investigation level required by IRR99 regulation 8(7), as above this level doses are unlikely to be ALARP.

4.10 Local rules

In consultation with the RPA, local rules specifically for the use of hand-held X-ray equipment should be produced. These local rules should describe, for the specific model of X-ray set, the clinical situations for which it would be appropriate to use it in a hand-held fashion, and when (if relevant) it should be used mounted on a tripod or a conventional fixed dental X-ray set be used instead.

The local rules should also include the following items, those highlighted in **bold type** will require special consideration for hand-held dental X-ray equipment:

a **Description of the extent of the controlled area, and the exact conditions under which it exists**

b **Means of restricting access to the controlled area**

c Name(s) of the radiation protection supervisor(s) for the dental team (RPSs)

d Means of preventing operation of the equipment by unauthorised people (see Sections 3.3 and 4.12)

e **'Key working instructions' setting out the safety precautions that the operator must follow to restrict exposures to themselves and other people (these will constitute written arrangements as the operator, who will not usually be a classified person, stands in the controlled area)**

f **Arrangements for ensuring the security of the equipment when not in use, when in transit and when used at other premises (if relevant)**

g Dose investigation level

h **Use of personal dosimetry**

i Circumstances (if any) under which PPE should be used, and what this should comprise

j **Contingency plans to be followed in the event of accidents**, including notifications to be made in the event of high doses to people, and **loss or theft of the unit**

4.11 Contingency plans

Incidents for hand-held dental X-ray equipment that are considered reasonably foreseeable are listed in Section 4.5.2. Items **a** (damage to the equipment affecting the shielding) and **b** (accidental exposure of a person to the X-ray beam) apply to both traditional dental X-ray