Introduction

These guidance notes have been prepared for those who use ionising radiation for diagnostic purposes in veterinary practice, either in private practices or in larger institutions. Ancillary activities such as the testing and calibration of equipment are also covered by these notes so far as they are carried out on the same premises. The guidance notes indicate procedures for the protection of all persons who may be exposed as a result of these practices, that is to say all employed and self-employed persons, apprentices and students, and members of the public.

Ionising radiations can destroy cells or alter them in a permanent heritable manner. Very large doses to all or most of the body if received in a short time, may lead to early death; smaller doses may lead to the development of leukaemia or other malignant diseases. Local irradiation may cause skin damage resulting in ulceration or dermatitis, or may produce cataract if the eyes are exposed. Developmental disturbances may be produced by irradiation of the embryo or foetus. Irradiation of germ cells can induce mutations, which may lead to foetal death or be transmitted to succeeding generations.

Radiation exposure passes unnoticed, because there is no physical sensation and because the effects of tissue damage do not become evident immediately. Some effects are permanent and cumulative and any dose, even down to the lowest levels, is assumed to entail some risk. It is important to recognise these risks and to employ protective measures which will reduce them to an acceptable level.

Ionising radiations are used in veterinary practice mainly for X-radiography. The principal hazard with this technique arises from the possibility of exposure to the useful beam, although appreciable doses may also be received from leakage and scattered radiation. Veterinary surgeons in general practice are known to have been injured as a result of receiving excessive doses.

Users of ionising radiations in veterinary practice must comply with the Ionising Radiations Regulations 1982. They are also required to follow the Approved Code of Practice on Ionising Radiations (5) issued by the Health and Safety Commission, unless it can be shown that a legislative requirement has been met in some other equally effective way. These guidance notes have been harmonised with the guidance notes for the protection of persons against ionising radiations arising from medical and dental use(6) and in research and teaching(7) prepared by the National Radiological Protection Board, and those using ionising radiations which touch on those subjects should also consult those publications.

These guidance notes give detailed advice as to how the requirements of the approved code can be met and are intended to form a comprehensive guide to the subject for workers in the veterinary field. The requirements of the regulations and approved code are quoted, summarised or referred to. However, the guidance notes should not be considered as giving an exact legal interpretation of these documents; it will sometimes be necessary to consult the original text. Absence of a reference should not be taken as meaning that there is no legislative or approved code requirement.

The word ‘must’ is used in these guidance notes only where there is a legal requirement; a reference to the source is given. The word ‘should’ is used in referring to an approved code, in which case the relevant reference is made. It is also used to indicate a desirable requirement. The two senses can easily be distinguished. Some recommendations which are considered to be of particular importance, but which do not appear in the regulations or approved code, are identified by the words ‘it is essential that’. These forms of use are summarised in the note on page iv.

It is realised that some of the recommendations may need to be adapted to local circumstances. It is recommended that a departure from an ‘essential’ recommendation, or ‘should’ when stemming from an approved code, should be permitted only when specifically authorised by the principal. It is highly desirable that the decision should be made only on the advice of a radiation protection adviser and that it should be recorded.
1 Summary of essential precautions in radiography

Always

— Ensure that the equipment is suitable and in good order.
— Use a partially lead-covered table for radiographing small animals.
— Make sure that only essential persons are present and that they know what to do.
— Wear a protective apron and make use of protective panels.
— Ensure that the beam is no larger than necessary — and never larger than the film — and on each occasion —
  use the smallest suitable cone,
  or adjust the diaphragm opening.
— Ensure that the hands, and any other part of the body, are not in the useful beam.

— Do not hold the animal unless other means of immobilisation are impracticable.
— Protect the hands if holding cannot be avoided - but still avoid the useful beam.

— Make use of personal dosemeters including those for the hands.
— Verify that the beam is switched off after the exposure.
— Pay attention to radiographic and film processing techniques to avoid wasted exposures.
— Have local rules.

*For large animals*
— Use cassette holders with sufficiently long handles.
— Use a light beam delineator if possible.
— Take special care when the useful beam is horizontal.
— Tranquillise the animal to help restrain it.
— Employ the minimum number of assistants and issue them with protective clothing.
— Make sure that assistants are not in the useful beam and are as far from it as possible.

— Make sure that no-one else is in the area.
2 The limitation of radiation dose

2.1 Radiological protection is based on three general principles. Firstly, the use of ionising radiation should be justified; secondly, all exposures should be kept as low as reasonably achievable; and thirdly, the doses received by individuals should not exceed certain dose limits.

2.2 The practice of veterinary radiology is considered to be justified in general; but, since it inevitably causes some radiation exposure of those taking part, it is necessary to consider each individual case before deciding whether a particular radiological examination should be made.

2.3 The second principle underlies these guidance notes. The Ionising Radiations Regulations [4] require the 'responsible person' to 'take all reasonably practicable steps to restrict the extent to which all persons are exposed to ionising radiation' (Reg 7(1)). In addition to the initial measures, all procedures should be kept under regular review, and equipment frequently re-examined to ensure that this requirement is being complied with. There should be a continuing appraisal of the doses being received, or likely to be received, to help in ensuring that they are as low as reasonably practicable (AC1/23). Workers must not expose themselves or others to ionising radiation to a greater extent than is reasonably necessary for the purposes of their work (Reg 7(2)).

2.4 Requirements on dose limits in Reg 8 give effect to the third principle. Dose limits apply both to persons at work and to members of the public. Medical exposure and exposure to natural background radiation are excluded. The dose limits for occupationally exposed workers aged 18 years or over are given in Table 1. They apply also to adults under training for employment involving occupational exposure. For those between the ages of 16 and 18 who are under training for veterinary radiology, the annual limits are $3/10^*\text{ of those in the table;}$ for all other persons, including all members of the public, the annual limits are $1/10^*\text{ of those in the table. The term 'members of the public' includes}$

*Whether or not these particular fractions should apply to the dose limit for the lens of the eye is under discussion by HSE and NRPB — see note to Table 1.

Radiography of small animals showing types of radiation
the owners of animals which have been brought for examination. Annual limits are for a calendar year.

Table 1  Dose limits for occupationally exposed workers aged 18 years or over

<table>
<thead>
<tr>
<th>Annual limit</th>
<th>Other limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole body</td>
<td>50 mSv (5 rem)</td>
</tr>
<tr>
<td>Effective dose (from partial body exposure)</td>
<td>50 mSv (5 rem)</td>
</tr>
<tr>
<td>Abdomen of woman of reproductive capacity</td>
<td>13 mSv (1.3 rem) in any consecutive period of three months</td>
</tr>
<tr>
<td>Abdomen/fetus* of pregnant woman</td>
<td>10 mSv (1 rem) between declaration of pregnancy and delivery</td>
</tr>
<tr>
<td>Lens of the eye</td>
<td>*</td>
</tr>
<tr>
<td>Skin</td>
<td>500 mSv (50 rem)</td>
</tr>
<tr>
<td>Hands, forearms, feet and ankles</td>
<td>500 mSv (50 rem)</td>
</tr>
<tr>
<td>Any other organ or tissue (average in organ)</td>
<td>+500 mSv (50 rem)</td>
</tr>
</tbody>
</table>

*Subject also to the limit on effective dose. The limits for the gonads, breast, red bone marrow and lung will therefore be lower than 500 mSv.

*Certain differences between Schedule 1 of the regulations (schedule of dose limits) and the requirements of the Council of the European Communities Directive [19] are under discussion by HSE and NRPB:

<table>
<thead>
<tr>
<th>Pregnant women</th>
<th>Regulations</th>
<th>Directive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose limit for lens of the eye:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workers</td>
<td>150 mSv (15 rem)</td>
<td>300 mSv (30 rem)</td>
</tr>
<tr>
<td>Trainees (16-18 years)</td>
<td>50 mSv (5 rem)</td>
<td>90 mSv (9 rem)</td>
</tr>
<tr>
<td>Members of the public</td>
<td>30 mSv (3 rem)</td>
<td>30 mSv (3 rem)</td>
</tr>
</tbody>
</table>

2.5 The effective dose referred to in Table 1 is the weighted sum of the doses to individual organs or tissues of the body when it is irradiated non-uniformly or partially. For exposure to external radiation the detailed distribution of dose in the body will not normally be known, in which case the dose limit for the whole body applies to the 'deep dose equivalent' and the dose limit to the skin to the 'shallow dose equivalent' (see Appendix 2). These quantities may be taken to be the quantities measured by personal dosimeters.

2.6 A person who is thought to have received a dose exceeding any of the dose limits must not, during the remainder of the current period, continue to receive a dose of more than 0.1 mSv (10 mrem) in any week or to enter a controlled area (see 3.4) (Reg 8) (see also 3.3.1 regarding the investigation of the overexposure). However, where an annual limit has been exceeded these restrictions may be removed if, with the agreement of the appointed doctor (see 4.8) and after the radiation protection adviser (see 3.2.2) has been consulted a certificate of exceptional exposure has been obtained from the Health and Safety Executive* (Reg 8 and 10 and AC1/55). The conditions for entering controlled areas (see 3.4.7) will still apply and the person must be a volunteer; he must not receive, in the calendar year, a dose greater than twice any dose limit applicable to him (Reg 10).

*In Northern Ireland, the Department of Manpower Services
3 Administrative measures for radiological protection

3.1 Responsibility

3.1.1 The ultimate responsibility for radiological protection measures lies with the person or persons responsible for the control of the veterinary practice or establishment. These persons are collectively called the 'principal' for the purposes of these guidance notes. The principal is responsible for the protection of all persons who may be affected by the work including staff, trainees, members of the public and himself. (Sections 2(1), 3(1), 3(2) and 4 of the Health and Safety at Work etc. Act 1974[1]). He is the 'responsible person' as defined in the Ionising Radiations Regulations 198. These regulations distinguish between the responsibilities of the responsible person and the employer and this is explained in the approved code; apart from the general advice given in 3.1.2 and 3.1.3, this distinction is not made in these guidance notes. (See Reg 3 and AC1/7-13, 23, 30, 48 and 102 regarding co-operation between the employer and the responsible person).

3.1.2 Where contractors are involved, Section 4 of the Act (Article 6 of the Northern Ireland Order) says that such people are to be treated as if they were 'persons having control' of the matters covered by their contractual obligations. As such they have a duty to take measures to ensure that their undertaking is safe and without risks to health but only to the extent to which they are obliged by their contracts. The principal will also have his own duties to discharge in respect of Section 4 and therefore when contractual arrangements are entered into it will be necessary to ensure that each party fully understands the extent of its own responsibility. Such arrangements will be necessary in respect of, for example, maintenance contractors and agency staff.

3.1.3 A division of responsibility may also be necessary in respect of Section 6 of the Act (Article 7 of the Northern Ireland Order) which deals with the general duties of manufacturers, importers and suppliers as regards articles for use at work. For example, the point at which responsibility for new equipment passes to the principal will need to be understood since an employer's general duties under Section 2 of the Act extend to the provision of plant. This is particularly important if on the basis of a written undertaking the principal wishes to relieve the supplier, contractor, etc., from the duty imposed by Section 6. Some arrangements may also be necessary when equipment is transferred from one establishment for use in another. The duties of manufacturers, importers and suppliers under Section 6 of the Act are extended by Regulation 34 to ensure that radiation protection is a factor designed and built into the articles supplied (AC1/227).

3.1.4 In multi-surgeon practices it should be clear to all concerned who is the principal.

3.2 Notifications and appointments

3.2.1 The principal must give notice to the Health and Safety Executive† (normally 28 days in advance) before commencing work involving radioactive substances or the operation of a machine or apparatus in which charged particles are accelerated through a potential difference of more than 5 kV (Reg 5(1)). This will include the veterinary use of X-ray equipment. If such work is already being done when the Ionising Radiations Regulations come into force the Health and Safety Executive† must be notified within 28 days (Reg 5(3)). Certain particulars have to be given and Form No. 00‡ must be completed in accordance with the notes attached to it (Reg 5(1) and AC1/16). Some additional particulars may be asked for by the Health and Safety Executive. There will normally be no need to report if X-ray facilities are extended or replaced by others.

3.2.2 A radiation protection adviser should be appointed if advice is needed on radiation safety or on methods of complying with the regulations, particularly if the work gives rise to a controlled area (see 3.4) which anyone needs to enter (AC1/78). A radiation protection adviser must be suitably qualified and experienced in radiation protection (Reg 13); the most appropriate arrangement for a small establishment is to appoint an outside consultant or specialist organisation, whose services can be called on as and when required. Subjects on which his advice should be sought are listed in AC1/82.

3.2.3 The name, qualifications, experience and status of the radiation protection adviser who has been appointed, and the scope of the advice that he may be called on to give, must be notified to the Health and Safety Executive§ (Reg 13(3)). If the radiation...

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*In Northern Ireland, Articles 4(1), 5(1) and 6 of the Health and Safety at Work (Northern Ireland) Order 1978.[2]
†As enforcing authority of the Health and Safety at Work etc. Act for the type of premises where work covered by these Guidance Notes is carried out. In Northern Ireland, the Department of Manpower Services must be notified.
‡Obtainable from the Health and Safety Executive.
§In Northern Ireland, the Department of Manpower Services.
protection adviser is a corporate body or partnership the same particulars of individuals who would give that advice should be supplied (AC1/83). Any changes should be notified.

3.2.4 The principal should appoint a person from his staff, who has a sound working knowledge of radiological protection, as a radiation protection supervisor (AC1/93). Alternatively, he may assume the duties himself. If there is a radiation protection adviser he should be consulted regarding the appointment (AC1/95). The principal function of the radiation protection supervisor is to ensure that the protection measures are carried out. He should report immediately to the principal on unsatisfactory conditions and propose measures to remedy them. The principal, in consultation if necessary with the radiation protection adviser, should decide what action is to be taken. The appointment, and termination of appointment, should be in writing and the name of the radiation protection supervisor should be displayed where those employed can see it (AC1/93 and 96).

3.2.5 If classified persons are to be employed (see 3.5), the principal must arrange for their medical surveillance by an ‘appointed doctor’ or employment medical adviser*. The local office of the Employment Medical Advisory Service† will supply the names of doctors who may be approached. The functions of the appointed doctor‡ are described in Chapter 4.

3.2.6 The principal must notify the Health and Safety Executive§ of any overexposure, or suspected overexposure, of a worker or member of the public (see 3.3.1).

3.3 Investigations

3.3.1 If any person thinks that he or another person has received a radiation dose exceeding any of the relevant dose limits, he must inform the principal (Reg 9(2)). Such information might come from the approved laboratory (see 5.1.6). Unless an immediate investigation shows that the report was false, the principal must arrange for a detailed investigation after first notifying HSE (see 3.2.6) and (if the person is a worker) the appointed doctor (see 4.7) (Reg 9). The investigation should involve the radiation protection supervisor and the radiation protection adviser; its objective should be:

(a) to obtain the best estimate of the dose,

(b) to determine (if a significant dose has been received) what action is necessary to prevent a recurrence,

(c) to indicate whether any persons need to be classified (see 3.5). (AC1/48 and 49).

To assist in achieving objective (a), it may be advisable to take a blood sample from the affected person and send it to an approved laboratory¶ able to carry out chromosome examinations and the estimation of biological dose**. The results of the investigation must be sent to HSE, the person affected and (if he is a worker) the appointed doctor (Reg 9). The estimated dose must be entered in the dose record where one exists (see 5.1.6) (Reg 9(6)); if this affects an existing entry in the record, approval of a special entry will be required (see 5.1.9). A record of the investigation must be kept for 50 years (Reg 9(6)).

3.3.2 In order to ensure that doses are as low as reasonably achievable, the principal must also arrange for an investigation by the radiation protection adviser if any worker receives an effective dose during the calendar year exceeding 15 mSv (1.5 rem) (Reg 7 and AC1/24 and 25). The radiation protection adviser should, if appropriate, recommend any reasonably practicable measures that would reduce future exposures.

3.3.3 The Health and Safety Executive will be informed about doses exceeding 30 mSv (3 rem) in a calendar quarter (see 5.1.6) and may initiate a special enquiry whether or not a dose limit has been exceeded.

3.4 Designation of areas

3.4.1 The principal must designate as a ‘controlled area’ any area under his control where any person might receive a dose other than from natural background, exceeding three-tenths of any of the annual dose limits for adult workers (Reg 12(1)). Where conditions are such that persons might receive more than one-tenth but less than three-

*See Appendix 2.
†In Northern Ireland, the Employment Medical Advisory Service for Northern Ireland.
‡This term will be used in these guidance notes to include an employment medical adviser.
§In Northern Ireland, the Department of Manpower Services.
¶It is suggested that the laboratory should be approved by HSE.
**The National Radiological Protection Board provides this service.
tents of the annual dose limits the principal must designate that area as a 'supervised area' unless it has been designated as 'controlled' (Reg 12(1)).

3.4.2 In order to determine whether or how an area needs to be designated, the principal should consult the radiation protection adviser. (One may need to be appointed temporarily for this purpose, continuation of the appointment depending on his recommendations.) An assessment is necessary for all new installations and should be repeated periodically, or after a significant change in equipment or methods of work, as recommended by the radiation protection adviser.

3.4.3 The doses which might be received are those which would be received by a person, not wearing protective clothing, who spends the whole of his working time (usually considered to be 40 hours per week and 50 weeks per year) in the area. The work load may be taken into consideration by the radiation protection adviser as long as it is spread over the week. Where an X-ray room is used for only, say, one day per week, it must be assumed that similar work is carried out on the other days (Reg 12 refers to 'the pattern of operation of any source of ionising radiation, were it to be continued').

3.4.4 The full extent and precise location of controlled or supervised areas should be described in the local rules (see 3.6.4) by reference, so far as is practicable, to fixed features such as walls and other barriers; for mobile sources the description should refer to distances from the source and, if necessary, the animal under examination (AC/64 and 65). An area larger than strictly necessary may be designated as a controlled or supervised area in order to make use of natural boundaries. A supervised area will not be needed if the whole area is controlled.

3.4.5 In order to restrict access to a controlled area there should, where reasonably practicable, be an effective barrier at its boundary. Notices should be displayed, particularly at entry points, warning that it is a controlled area (AC/67). A notice should incorporate a radiation warning sign (see Appendix 3).

3.4.6 An area does not necessarily have to remain continuously designated as a controlled area. If an X-ray set has been isolated from the electricity supply the designation may be temporarily withdrawn.

3.4.7 Access to controlled areas must be restricted to classified persons (see 3.5), workers and trainees who are covered by a 'scheme of work' and visitors as permitted by the local rules (Reg 12 (3)). No person who has received an overdose is allowed to enter a controlled area unless a certificate of exceptional exposure has been issued (see 2.6). Pregnant women should not enter controlled areas as classified persons but may do so under a scheme of work.

3.4.8 Entry under a scheme of work is appropriate if the principal is satisfied that the operating and working conditions and the system of control and instruction are such that a person working in accordance with the scheme is most unlikely to receive doses more than three-tenths of the annual dose limits for adult workers. The wearing of protective clothing, where it is a condition of the scheme of work, may be taken into account. The scheme of work should be drawn up in consultation with the radiation protection adviser and should take account of any other work with ionising radiation by persons to whom the scheme applies, such as entry of other controlled areas (AC1/70).

3.4.9 The scheme of work should include personal monitoring of all, or a representative sample of, the persons covered (see 5.1.14) or some other way of monitoring their exposure, possibly including control of the time they spend in the area (AC1/71). Records should be kept for two years (AC1/72).

3.4.10 If this monitoring indicates that any person might receive doses greater than three- tenths of the annual dose limits an investigation should be held; the scheme of work should then be modified and/or persons who are operating under it designated as classified persons (AC1/73).

3.5 Designation of classified persons

3.5.1 The principal must, after consulting the radiation protection adviser, determine in respect of all occupationally exposed persons aged 18 years or more for whom it is responsible, whether or not they shall be identified as 'classified persons'; these are persons whose work or training involves exposure to ionising radiations to such an extent that the resulting annual doses might exceed three-tenths of any of the dose limits (Reg 14). It
should be considered that any worker or trainee who enters a controlled area, except under a scheme of work, might receive a dose exceeding three-tenths of a dose limit and so he should be designated as a classified person (AC1/85).

3.5.2 Though it may be necessary to ‘classify’ a worker who spends a considerable part of his time in a controlled area, the alternative procedure of a scheme of work should be considered, particularly for workers who spend much shorter times in these areas. This will avoid unnecessary classification.

3.5.3 A person may be designated as a classified person only if he has been certified fit (possibly subject to conditions) by the appointed doctor (see 4.3). He may be employed as a classified person only when arrangements have been made for assessing his individual radiation dose (see 5.1).

3.5.4 In view of the lower dose limits for persons under the age of 18 years, they cannot be classified persons. During pregnancy women should be restricted to working conditions which would not require them to be ‘classified’ in order to ensure that the dose limit to the fetus is not exceeded.

3.5.5 A person should cease to be designated as a classified person if an entry is made in the health record (see 4.9) that he becomes unfit to be designated (AC1/89). He may also cease to be designated when he leaves the practice. Otherwise he should remain designated throughout the calendar year although personal monitoring may be stopped if he ceases to enter controlled or supervised areas. His exposure to ionising radiation should be reviewed at the end of the year, in consultation with the radiation protection adviser; designation may be withdrawn if it is considered most unlikely, because of changed circumstances, that he will receive doses greater than three-tenths of the annual dose limits.

3.6 Instruction and training and local rules

3.6.1 The principal must ensure that all members of staff liable to be involved in radiological procedures are adequately instructed about the hazards they may meet and the precautions to be observed; where necessary special training must be given (Reg 16 and AC1/98-102).

3.6.2 The principal should ensure that the radiation protection supervisor receives any training needed to fit him for his duties. His knowledge will need to be kept up to date.

3.6.3 The principal must arrange for local rules to be drawn up in consultation with the radiation protection adviser and the radiation protection supervisor (Reg 15(1) and AC1/92). It is essential that these rules set out clearly and precisely the procedure in force in the establishment and the names and duties of the persons who are concerned with health and safety, such as the radiation protection adviser, the radiation protection supervisor and the appointed doctor. (See Appendix 4 for specimen local rules.)

3.6.4 The local rules must include a description of each controlled or supervised area (see 3.4.4) (Reg 12 (3)).

3.6.5 The essential features of any scheme of work should be incorporated in the local rules (AC1/69). The local rules should also include ways of ensuring that if visitors enter controlled areas the doses they receive are as low as is reasonably practicable and in any case below the dose limits for members of the public (AC1/74). ‘Visitors’ will include owners who might be asked to hold their animals during radiography (see 7.1.10).

3.6.6 It must be impressed on each member of staff working with radiation sources that he has a duty to protect himself and others from any hazard arising from his work (HSW etc. Act 1974, Section 7*). The principal will therefore need to ensure that each member of staff reads and understands the sections of these guidance notes which apply to him and the he also knows the local rules.

3.6.7 All visitors to controlled or supervised areas should be informed of any precautions which they need to observe (AC1/103).

3.7 Planning

3.7.1 The principal, in planning new X-ray facilities or modifying existing facilities, should consult the radiation protection adviser about the suitability of the location, design and construction of the premises and equipment. If no radiation protection adviser has

* In Northern Ireland, Article 8 of the Health and Safety at Work (Northern Ireland) Order 1978.)
been appointed, advice should be sought from an organisation such as the National Radiological Protection Board*.

3.7.2 Account should be taken of the expected work-load of the equipment, the orientation factors of the barriers, and (if desired) the occupancy factors of the adjacent areas (although the occupancy factors will not affect area designation). Allowance should be made for possible future increases in these factors and for future modifications in technique.

3.7.3 The installer of equipment must make a critical examination of the way that it has been installed before it is used for the first time and must supply the user with adequate information to enable the equipment to be properly used (Reg 34(2)). The installer may use the services of his own radiation protection adviser in carrying out the examination but if the principal has a radiation protection adviser he should be consulted when the new installation is accepted.

4 Medical surveillance

4.1 Medical surveillance by the 'appointed doctor' must be arranged for all classified persons and for other workers if they receive an overdose (Reg 19(1) and (3) and AC1/119-121). Guidance for appointed doctors on their duties in connection with ionising radiation is given in 'Guidance Notes for Appointed Doctors' (10) issued by the Health and Safety Executive.

4.2 The persons concerned must present themselves for medical examinations and make available to the appointed doctor information about their health (Reg 19(7)).

4.3 Before a person is designated as a classified person for the first time, or redesignated after an interval and there is no longer a valid entry in the health record (see 4.9), he should be medically examined and certified by the appointed doctor as fit to be designated (AC1/122). The examination is unnecessary if the person has been declared fit by another appointed doctor during the preceding 14 months and a copy of the previous certificate has been obtained. This certificate may relate either to a medical examination or to a health review (see 4.6). The examination may also be dispensed with if, on the day that the regulations come into force, the person is already employed in work which would require him to be a classified person (AC1/123).

4.4 The pre-employment medical examination may include an enquiry into the worker's medical history including all known previous exposures to ionising radiation resulting either from his employment or from medical examination or treatment. The form of the examination is otherwise at the discretion of the appointed doctor. Information about the working environment should be made available to the appointed doctor so that he can take account of this information in assessing fitness; he must be allowed to inspect the workplace if he asks to do so (Reg 19(8)). He must also be given copies of the relevant dose summaries (see 5.1.6) and allowed to see other records (Reg 19(6) and (9)).

4.5 If the classified person is declared fit subject to conditions, the controlling authority and the worker must observe these conditions (Reg 19(5)). The worker has rights of appeal against a medical decision, to be exercised within three months (see Reg 19(10)). Appeals will come before a medical tribunal.

4.6 The state of health of each classified person should be reviewed annually by the appointed doctor (AC1/124 specifies that intervals should not exceed 14 months), or more frequently if specified by the doctor, to determine whether he remains fit for his duties. The form of the review will depend on the type of exposure and the doses received as well as on the classified person's state of health. In some cases the appointed doctor may recommend that medical surveillance continues after the person concerned ceases to be a classified person.

4.7 The appointed doctor must be informed if an overexposure of a worker is suspected, whether or not the person concerned is a classified person (see 3.3.1). A special medical examination should be made if the investigation confirms that the dose received may have been more than twice an annual dose limit for adult workers (AC1/125).

4.8 If a person has received an overexposure, the agreement of the appointed doctor should be obtained before the controlling authority makes an application for a certificate of exceptional exposure (see 2.6).

*In Northern Ireland, the Northern Ireland Radiation Protection Service.
4.9 The controlling authority must keep a health record for every person under medical surveillance containing the results of all medical examinations and periodic review of health in respect of radiological protection (Reg 19(2)). It must indicate whether a person is fit, fit subject to conditions, or unfit to be designated as a classified person (AC1/127). An official form obtainable from HMSO, or another form which has the same headings, should be used (AC1/126). Copies of previous certificates referred to in 4.3 should also be kept in the health records. An entry in the health record remains valid for 14 months (unless the appointed doctor specifies a shorter period) or until it is superseded by a further entry (AC1/128). Health records, which are to be distinguished from the doctor's clinical records, must be retained for 50 years after the last entry (Reg 19(2)).

5 Operational measures for radiological protection

5.1 Personal monitoring

5.1.1 The dose of ionising radiation received by each classified person must be systematically assessed and the principal must make arrangements for personal monitoring to be carried out by an approved laboratory† (Reg 17(1) and (4)). Where exposure is from external sources, as in radiography or fluoroscopy, this monitoring should be by means of one or more dosemeters worn on an appropriate part or parts of the body. The advice of the radiation protection adviser should be sought on the most appropriate measurement(s) and type(s) of dosemeter for each classified person (AC1/111). Dosemeters are supplied by the approved laboratory.

5.1.2 For veterinary radiology each dosemeter is normally worn for four weeks. The length of each monitoring period should depend on the doses likely to be received during the period (AC1/106). Dosemeters should be returned promptly after use to the approved laboratory for dose assessment and replaced with new ones.

5.1.3 A person who has been issued with a dosemeter must wear it as instructed all the time that he is in a controlled or supervised area and return it at the end of the period (Reg 17(3) and AC1/110). Care should be taken to prevent the dosemeter, while not being worn, from being exposed inadvertently to ionising radiation. An individual dosemeter should normally be worn on the trunk at chest or waist height, the latter being recommended in the case of women of reproductive capacity. It may then be interpreted as monitoring the dose to the whole body. However, if there is any reason to suspect that doses to other parts of the body may exceed three-tenths of the appropriate dose limit, it may be necessary to arrange for the wearing of additional dosemeters.

5.1.4 When a protective apron (see 6.5) is worn the dosemeter should be moved to a position outside the apron where it may best monitor dose to exposed parts of the body. The choice of position may depend upon the character of radiological work undertaken and should be made after consideration of this with the radiation protection supervisor and/or the radiation protection adviser. The radiation protection adviser may recommend that two dosemeters should be worn, for example, one under the apron and one on the collar, and that a formula should be used for evaluating the effective dose.

5.1.5 A dosemeter should be worn on a finger or other part of the hand while holding or manipulating animals during radiographic or fluoroscopic examinations and if the dose to the hands and forearms is liable to exceed three-tenths of the dose limit shown in Table 1. It should be worn under a protective glove (see 6.5).

5.1.6 The approved laboratory will maintain a dose record for each classified person and keep it for 50 years after the last entry. Summaries of the dose records will be supplied regularly and the principal must keep them for two years (Reg 17(6)). He may also ask at any time for a copy of the dose record relating to a member of his staff. The Health and Safety Executive‡ will receive from the approved laboratory annual summaries of the dose records, details of any person whose dose in a calendar quarter exceeds 0.03 Sv (3 rem) and, on request, a copy of a particular dose record.

5.1.7 In order that dose records may be reasonably complete, the principal should, as soon as reasonably practicable after the regulations come into force, send to the approved

* The addresses of approved laboratories may be obtained from the Health and Safety Executive or, in Northern Ireland, the Department of Manpower Services.
laboratory suitable summaries of any dose records he holds relating to any of his staff who are, or may become, classified persons (ACI/115).

5.1.8 If a dosemeter issued to a classified person is lost or damaged the principal must make an investigation with a view to estimating the dose received during the monitoring period. If there is enough information to estimate the dose he must ask the approved laboratory to enter this estimate in the dose record; if not he must ask for a notional dose, which is pro rata the annual dose limit, to be entered (Reg 17(9)). The advice of the radiation protection adviser should be taken when making dose estimates.

5.1.9 The principal must also make an investigation if he has reason to believe that the dose received by one of his staff is much greater or much less than shown in the dose record. If the investigation confirms this, he must apply to the Health and Safety Executive for approval of a special entry in the dose record (Reg 17(10)). The investigation should include:

(a) a survey of the person’s work activities and of his exposure to ionising radiation during the period concerned;

(b) an estimate of the dose(s) likely to have been received;

(c) an explanation, with supporting evidence, for the supposedly wrong value in the dose record (ACI/117).

5.1.10 If more than one approved laboratory is concerned in the monitoring of a classified person, arrangements should be made for one of them to co-ordinate the measurements made by the others and maintain records of total doses received (ACI/112). This would apply, for example, if a radiographer works at more than one practice, each with its own system of monitoring.

5.1.11 If a member of his staff leaves, the principal must ask the approved laboratory to send a ‘termination record’ to the Health and Safety Executive‡ with a copy to himself; he may do this earlier if the person concerned ceases to be a classified person (Reg 17(4)).

5.1.12 The principal must provide a member of his staff with a copy of:

(a) his dose record, on request or if it is amended (see 5.1.9),

(b) his termination record (Regs 17(7), (10), (11), (12)).

Dose information should also be available to the appointed doctor, the radiation protection adviser and the radiation protection supervisor.

5.1.13 Before designating an employee as a classified person, the principal should ask him about any previous work he has done involving ionising radiation and the employee should then provide any information he can about his previous dose (ACI/116). This information, which might be merely that the person had at some time been classified, should be passed to the approved laboratory.

5.1.14 The radiation protection adviser may recommend that unclassified staff and visitors who enter controlled areas in accordance with local rules (see 3.6.5) should wear dosemeters (see also 7.1.10(v)). These dosemeters must be obtained from an approved laboratory and dose assessment reports issued by the laboratory must be kept for two years (Reg 17(5)). No dose records will be kept by the laboratory.

5.1.15 Dosemeters may also be worn by staff who work in supervised areas, but not in controlled areas, to ensure that their doses are as low as reasonably achievable. Monitoring need not necessarily be continuous. Personal dose records for such workers are unnecessary but the monitoring results should be kept as environmental records.

5.1.16 The principal should draw up a personal dosimetry schedule which shows the names of persons whose doses are assessed, the type of dosemeters, the place on the body where they are worn, and the times and working areas in which they should be worn; the schedule should be available for inspection (ACI/118).

5.2 Environmental monitoring

5.2.1 It is essential that any new or modified installation is surveyed under the guidance of the radiation protection adviser before it is put into routine use in order to verify that the planned radiation protection (see 3.7.1) is effective and the area designation (see 3.4) is

‡In Northern Ireland, the Department of Manpower Services.
correct. Alternatively, the results of the survey may be used for deciding the designation of the area. 'Modified' means an increase in the radiation output of the X-ray tube or a change in the manner of its use, so that the original protection may no longer be adequate.

5.2.2 A controlled or supervised area must be monitored in accordance with monitoring procedures which should be drawn up in consultation with the radiation protection adviser and specified in the local rules* (Reg 22(1) and AC1/154 and 155). X-ray rooms should be surveyed regularly and whenever personal monitoring results shown that unusually high doses are being received. A radiation survey is essential if individual monitoring indicates that the doses received exceed or are likely to exceed the dose limits, and if enquiries have failed to reveal the cause.

5.2.3 If a radiation survey indicates that any person is liable to receive a dose in excess of the dose limits, it is essential to consult the radiation protection adviser about the measures to be adopted to remedy the situation and that the installation is not used until the protection is satisfactory.

5.2.4 Suitable monitoring equipment must be provided (Reg 22(2)). For veterinary radiology it is not obligatory to have an instrument on the premises all the time and this requirement may be satisfied by making an arrangement with the radiation protection adviser to carry out monitoring bringing the necessary instruments. The radiation protection adviser should be asked to ensure that the instruments meet the relevant requirements of the approved code (AC1/157 to 166).

5.2.5 Environmental monitoring results must be recorded and kept for two years from the date of the last entry in the record (Reg 22(1)).

*See AC1/155 regarding the details of the monitoring procedures which are to be shown.
6 Premises and equipment for radiography

6.1 Premises

6.1.1 Radiography should, if reasonably practicable, be carried out in a room from which all unnecessary persons are excluded while X-rays are being produced (AC 2/9). This room, which will be referred to as the X-ray room, may be a veterinary surgery or a separate examination room. A room in which separate work may be in progress, or through which people may need to pass, is unsuitable. It is essential that the X-ray room is large enough to provide adequate working space and safe accommodation for those persons who have to be in the room during examinations.

6.1.2 The X-ray room should provide appropriate shielding for all persons outside the room (AC 2/9). It should be planned so that adjacent areas which may be occupied do not need to be controlled or supervised areas, even with the maximum expected workload. Factors influencing this will include the directions of the useful beam (see 6.3.2), the distance of such areas from the X-ray equipment and the nature of the intervening barriers. If the normal structural materials of the X-ray room do not afford sufficient shielding (e.g. a lightweight partition wall), protective material such as lead ply should be applied to the wall, door, etc., concerned. Advice on the assessment of existing shielding or the planning of additional shielding should be sought from the radiation protection adviser (if one has been appointed) or from a specialist in the subject.

6.1.3 If the X-ray room needs to be designated as a controlled area warning notices will have to be displayed (see 3.4.5) but it is recommended that there should be a warning sign to indicate ionising radiations (see Appendix 3) at the entrance to all X-ray rooms. The sign should be accompanied by the legend: 'X-rays, do not enter when warning signal is displayed'. This additional warning signal, which may be a notice, a light or other device, should be displayed during radiography and should forbid entry. It will usually be unnecessary to arrange for this signal at the entrance to be given automatically (as referred to in AC 2/13); an automatic signal, which is given when the X-ray tube is prepared or energised, may be recommended by the radiation protection adviser for some X-ray rooms which are controlled areas and have a high workload.

6.1.4 If it is necessary to carry out radiography outside the X-ray room, for example for examining large animals, an area should be chosen from which unnecessary persons can be excluded (as required by AC 2/9). This area may be a walled or fenced area on the premises designated for radiography; or it may be away from the practice, for example at a neighbouring farm, in which case temporary barriers should be erected. Where a horizontal X-ray beam is to be used, there should, on at least one side of the radiography area, be an adequately thick wall, towards which the beam can be directed in order to shield other persons in the vicinity.

6.2 X-ray equipment

6.2.1 It is essential that the X-ray tube housing is so constructed that, at the full rating of the manufacturer, the leakage radiation at a distance of 1 metre from the focal spot does not exceed 100 mR (equivalent to a free air kerma of 0.87 mGy) in one hour. In assessing compliance with this requirement measurements may be averaged over an area up to but not exceeding 100 cm².

6.2.2 There should be appropriate filtration of the X-ray beam, having regard to the requirements of the work (AC 2/15). This will include the inherent filtration of the X-ray tube assembly, added filters and filtration afforded by objects permanently intercepting the beam, e.g. the mirror of a light beam diaphragm. The total filtration of the beam should normally be equivalent to not less than the following:

(a) 1.5 mm of aluminium when voltages up to and including 70 kV are used
(b) 2.0 mm of aluminium when voltages above 70 kV and up to and including 100 kV are used
(c) 2.5 mm of aluminium when voltages above 100 kV are used.

Filters should not be removed from the apparatus except under conditions agreed with the radiation protection adviser; it is essential that there is some visible indication on the tube housing when an added filter has been removed.

6.2.3 The X-ray tube aperture should be limited so as to permit the emission of a beam of no larger cross-section than the maximum required in practice.

6.2.4 The X-ray tube assembly should be equipped with an adjustable beam-limiting device or a radiographic cone to keep the useful beam within the limits of the film.
selected for an examination. More than one cone may be needed for different field sizes. All such devices and cones should give the same degree of protection as is required for the tube housing. It is essential that cones are correctly fitted to avoid leakage at the interface. When an adjustable beam-limiting device is used, the field size should preferably be indicated by a light beam (see 7.1.7 and 7.2.2); light-beam indication is particularly valuable* when manual restraint is used (see 7.1.10).

6.2.5 It is essential that the equipment has an exposure switch which has to be pressed throughout an exposure and which is spring-biased so that irradiation is terminated if pressure is released (see 6.2.6); the switch should be designed so as to reduce, as far as reasonably practicable, the likelihood of X-radiation being produced inadvertently (AC 2/16(a)). On fixed equipment, the exposure switch for radiography should be at the control panel; for mobile and portable equipment, its position should be such that the operator can be at least two metres from the tube housing and the animal being examined.

6.2.6 There should be 'effective means ... for automatically terminating the production of X-rays when the desired exposure is complete' (AC 2/16(b)). 'Where it is reasonably foreseeable that failure of the normal means ... might occur, suitable alternative means should be provided' (AC 2/16(c)). For radiography, a single, reliable device which terminates the exposure after a pre-set time, mAs or quantity of radiation, backed up by the spring-biased exposure switch, is sufficient to comply with these requirements. The two means of termination should be as independent of each other as is reasonably practicable.

6.2.7 If a clock-work timer is used it should be capable of being returned automatically to zero without X-radiation being generated, in the event of the exposure being terminated before the end of the preset time.

6.2.8 'A device should be provided which will automatically give a signal to any person operating the main control panel of any X-ray equipment that an X-ray tube is energised to emit X-rays' (AC 2/12). This should take the form of a clearly visible light. If the exposure time is very short it is essential that the lamp remains lit for long enough to give a clear indication. It is recommended that there should be a lamp close to the tube housing arranged so that it is lit at the same time as the one on the control panel and will provide a warning to anyone near the X-ray tube. The significance of this signal should be explained to all members of staff.

6.2.9 There should also be a visible light on the control panel which is illuminated when the set is switched on, indicating that it is ready to emit X-radiation.

6.2.10 It is unlikely that more than one X-ray tube will be installed in the same room, but when there is a second tube additional warning signals may be required (see AC 2/14 for details).

6.2.11 All controls should be clearly marked (AC 2/17).

6.2.12 These requirements apply to all new equipment. Existing equipment which does not conform should be modified so as to comply with the approved code of practice and, if reasonably practicable, with the other recommendations.

6.2.13 Section 6 of the Health and Safety at Work etc. Act† places a duty on manufacturers, importers and suppliers to ensure that their products are safe when properly used and that adequate information about them is available. These duties are extended by Regulation 34 to ensure that radiation protection is a factor designed and built into the articles supplied (AC 1/227). However, the user should not assume that it is unnecessary for him to check that the requirements of Sections 6.2.1-6.2.11 have been complied with. It is particularly necessary to check second-hand equipment which may have originally been supplied for a different purpose.

6.3 Installation and ancillary equipment

6.3.1 A table should be used for radiography. A 1 mm sheet of lead, larger than the maximum beam size, should be placed on the table immediately under the cassette or film, in order to protect the feet of any person who may need to stand close to the table (see 7.1.10).

[*Consideration is being given to changing this recommendation to 'essential'.]
†In Northern Ireland, Article 7 of the Health and Safety at Work (Northern Ireland) Order 1978.
6.3.2 Equipment should be installed in an X-ray room so that the person operating it can be at least 2 m from the X-ray tube and from the animal and well outside the useful beam. The X-ray tube should be mounted so that the useful beam is or may be directed downwards on to the table. If the beam may need to be directed horizontally for certain examinations the equipment should be installed so that the beam is not directed at a window, if the space immediately beyond is occupied, nor at the door (see also 7.1.8).

6.3.3 A lead-ply panel incorporating a lead glass window\(^{(11)}\) is useful for protecting the radiographer against scattered radiation; one should be used if the radiographic work-load exceeds 30 mA min per week. The panel should not be less than 2 m high and should be sufficiently wide to shield a person effectively, taking into account the size of the control panel; typically a 1 m width is satisfactory. The lead-equivalent of the panel should be at least 0.5 mm and should be marked on it.

6.3.4 Suitable cassette holders, fitted with long handles if required, should be available when it is necessary for cassettes to be supported, as, for example, during horizontal radiography.

6.4 Maintenance

6.4.1 The radiation safety features of equipment should be maintained and checked in accordance with the advice of the manufacturer or supplier and of the radiation protection adviser. AC 2/10 requires shielding (see 6.3.4) to be maintained and AC 2/16 calls for maintenance of the normal and back-up means for terminating the exposure (see 6.2.6).

6.4.2 A record of defects and maintenance should be kept.

6.5 Protective clothing

6.5.1 Any person working in a controlled or supervised area and who is not adequately protected by the shielding referred to in 6.3.4 must be provided with, and must wear, protective clothing (Reg 23 and AC 1/170). Protective clothing should preferably be available for all persons who are likely to be present during radiography. It may take the form of a body apron or gloves but sheets of lead-rubber suitable for hand and forearm drapes will also be considered under this heading.

6.5.2 Protective clothing should have a lead-equivalent throughout of not less than 0.25 mm for X-rays excited up to 150 kV and should comply with current British Standards \(^{(12,14)}\) (see Appendix 5).

6.5.3 Each item of protective clothing should carry an identifying mark (AC 1/170).

6.5.4 Suitable arrangements should be made for storing protective clothing when it is not in use (AC 1/170). Aprons should not be folded but should be supported in a suitable manner when not in use so that they are not sharply creased.

6.5.5 Protective clothing (including hand and forearm drapes) should be examined visually at frequent intervals. If cracks are observed the item should be replaced. Each item should be thoroughly examined by, or under the supervision of, the radiation protection supervisor at least once every 14 months and a signed record should be made of the examination (AC 1/171). Any defects in protective clothing found by the wearer must be reported immediately (Reg 23).

6.5.6 Protective clothing is intended for protection against scattered radiation and provides inadequate shielding against the useful beam.
7 Procedures for radiography

7.1 General

7.1.1 In this chapter, the person supervising the radiographic examination is called the 'radiographer'. For radiological safety purposes he should have authority over all other persons present while the examination is being carried out.

7.1.2 Radiography should be undertaken only if the required information cannot be obtained by the use of other methods involving smaller risk, and if all the persons involved are adequately protected.

7.1.3 The radiographer and any other members of staff who need to be present will usually need to be classified persons or covered by a scheme of work (see 3.5 and 3.4.8).

7.1.4 All persons whose presence is not appropriate should be excluded from the X-ray room or radiography area while X-rays are being produced (AC 2/9). This applies not only during radiography but whenever the equipment is operated.

7.1.5 Those persons who need to be present (and this may include persons under training) should be properly instructed and understand their part in any procedure. They should wear protective aprons unless they are always in a fully protected area of the room and should remain as far as practicable from the path of the useful beam or position themselves behind protective panels. The general guidance on entry of controlled and supervised areas applies as well (see 3.4.7).

7.1.6 No-one should be exposed to the useful beam (AC 2/18). This, of course, includes the hands. However, it is recognised in the approved code that a person may sometimes need to support the animal undergoing examination in such a way that part of his body may unavoidably be exposed to the useful beam. Appropriate measures should then be taken to keep the doses received by that person to the minimum reasonably practicable (AC 2/19) (see 7.1.10).

7.1.7 To avoid inadvertent exposure to the useful beam, it is essential that the beam is no larger than necessary and that its extent is known:

(a) If the equipment is supplied with interchangeable cones, the smallest suitable cone should be used.

(b) If there is an adjustable beam limiting device it should be properly set. This can be done more simply if a light-beam diaphragm is used.

(c) The film selected should be as small as possible consistent with the diagnostic requirements and the X-ray field should never be larger than the film. If the necessary radiographic information can be obtained with a field which is smaller than the film this smaller field size should be used.

(d) The centre of the beam should be aligned with the centre of the film. When the beam is directed vertically downwards onto the table use can be made of a plumb line.

7.1.8 Whenever it is reasonably practicable to do so, the useful beam should be directed away from adjacent occupied areas which are inadequately shielded (AC2/11). This should be remembered whenever the beam is in a generally horizontal direction.

7.1.9 The animal should not be held for radiography unless other means of immobilisation are impracticable. Immobilisation may be achieved by mechanical means, by tranquillisation or by anaesthesia. Any of these methods will eliminate or considerably reduce the hazards associated with manual restraint and should be used whenever practicable. The maximum use should be made of positioning aids such as sandbags or radiation-transparent cushions.

7.1.10 When manual restraint is necessary:

(a) The animal should be held by the minimum number of persons required to restrain it while allowing each person to position himself as far as practicable from the path of the useful beam.

(b) Persons unlikely to be exposed occupationally to ionising radiations, for instance the owners, should hold the animal, provided this does not increase the radiological hazards of the procedure; the same persons should not do this on repeated occasions. Pregnant women should not help.

(c) When it is necessary for the animal to be held by members of the staff, only classified persons or persons covered by a scheme of work should be employed. Persons under
the age of 18 and pregnant women are not allowed to be employed as classified persons and should not therefore hold animals except in accordance with conditions specified in a scheme of work.

(d) Those holding the animal should wear protective clothing (AC 2/9). Hand and fore-arm drapes may be more suitable and effective than gloves. Great care is necessary that no part of the body, even if covered by protective clothing, is placed in the useful beam (see 6.5.6).

(e) It may be necessary or advisable to measure the dose to the hands and forearms of those holding the animal. Thermoluminescent dosemeters, because of their smaller size, are more convenient than film badges for hand monitoring.

7.1.11 The radiographer should always:

(a) Take all practicable precautions to avoid having to repeat radiography. These will include use of the best technique and attention to film developing.

(b) Ensure that the useful beam is restricted to the area to be examined (AC 2/11). This will lessen the risk of exposure of the hands if manual restraint is needed and will also reduce the amount of scattered radiation.

(c) Use the fastest film or film-intensifying screen combination compatible with good radiography.

(d) Check that no unnecessary persons are in the X-ray room or radiography area and that those whose presence is necessary are suitably positioned and protected.

7.1.12 The film cassette should be laid on the table or held in a suitable holder (see 6.3.5). It is essential that cassettes are never held by hand.

7.1.13 The X-ray tube assembly should not be held during radiography. Preferably all persons should be at least two metres from it.

7.1.14 A notice detailing the procedures to be followed should be posted in the X-ray room (see Appendix 4).

7.2 Large animal radiography

7.2.1 The radiography of large animals, for instance horses or cattle, creates particular problems in relation to radiation hazards for the following reasons:

(a) It is seldom practicable to anaesthetise the animal and therefore some form of manual restraint is likely to be required.

(b) It is often necessary for the film cassette-holder to be supported in awkward positions.

(c) It is usually necessary for the useful beam to be directed horizontally and thus there is a greater risk of irradiating assistants.

(d) Those restraining the animal or supporting the cassette are more likely to have their attention concentrated on their task rather than on avoiding the useful beam.

(e) Radiography of areas other than the lower parts of the limbs requires the use of considerably increased exposure factors which will aggravate the hazard both from the useful beam and from scattered radiation.

(f) It may be impracticable to use an X-ray room.

7.2.2 Because of these additional hazards the radiographer has a particular responsibility to make sure that, in spite of any difficulties, the precautions already enumerated are observed. He should discuss the problems of restraint with the veterinary surgeon and they should decide on the safest procedure for the circumstances. In particular he should ensure that:

(a) A cassette-holder is always used and, if it is not self-supporting, that it is fitted with a sufficiently long handle so that the assistant can stand at a safe distance from the path of the useful beam.

(b) A light-beam delineator is employed, if reasonably practicable, to indicate the precise extent of the useful beam.

(c) Where it is likely to facilitate restraint the animal has been suitably tranquillised prior to radiography.

(d) The number of assistants employed is the minimum considered necessary for the purpose.

(e) All assistants clearly understand the procedure to be undertaken and their part in it.

(f) The assistants wear protective clothing in such a way as to give maximum protection from the radiation. (For instance, it may be necessary to protect their legs.)
(g) All other persons have withdrawn to a suitably protected area.
(h) The exposure is not made until the animal is properly restrained and positioned and all assistants are standing as far as practicable from the path of the useful beam.

7.3 Radiography undertaken outside the X-ray room

7.3.1 The performance of radiography in other parts of the premises or on domiciliary visits is liable to add to the radiation risks already listed for the following reasons:
(a) The usual ancillary and protective equipment may not be available when required.
(b) Untrained assistants may have to be employed.
(c) There is likely to be greater difficulty in excluding unauthorised persons and a greater risk of irradiating persons in nearby areas.

7.3.2 Radiography should be permitted outside the X-ray room only if the radiographer is able to ensure that:
(a) Necessary equipment, such as a suitable table and cassette-holders, is available.
(b) Sufficient protective clothing is available for all persons taking part.
(c) The number of assistants is kept to the minimum necessary and that the nature of the procedure, the precautions to be observed and the part to be played by each assistant is carefully explained.
(d) Adequate precautions are taken to prevent the access of unauthorised persons to the area during radiography, for instance by displaying warning signs.
(e) The dose to persons passing by the area or working in adjacent rooms is only a small fraction of the dose limits. These persons may be members of the public.
8 Fluoroscopy

8.1 Hazards

8.1.1 Fluoroscopy using a directly viewed fluorescent screen is more hazardous than radiography, because the product of exposure time and tube current is usually greater and because the operators stand nearer to the useful beam and the animal. It is sometimes used in veterinary practice as a substitute for radiography in order to save the time and expense involved in developing films. The equipment is often crude and inadequately protected. Hand-held fluoroscopes are particularly hazardous; their use in medical radiology has been condemned for many years and it is essential that they are not used in veterinary radiology.

8.1.2 Since less detail can be visualised by direct fluoroscopy than by radiography, the additional risks of using it cannot normally be justified. Fluoroscopy may, however, be necessary when it is essential to study movement. In these circumstances, the fluoroscopic examination should be carried out only with suitable equipment and under the supervision of veterinary or medical personnel trained and experienced in the technique; mobile or portable equipment is quite unsuitable for direct fluoroscopy.

8.1.3 The hazards of indirect fluoroscopy are much less. X-ray image intensifying systems, if properly used, can significantly reduce the dose to the fluoroscopist and attendants. Remote television presentation facilitates safe viewing by groups.

8.2 Premises

8.2.1 The premises should satisfy the requirements of 6.1.1–6.1.3.

8.2.2 It should be possible to darken the room in which direct fluoroscopy is carried out (see 8.5.4).

8.3 Equipment

8.3.1 The requirements of Section 6.2 (except 6.2.4 and 6.2.7) which are relevant should be met for fluoroscopy. The automatic signal referred to in 6.1.3 need not be given in the ‘prepare’ position.

8.3.2 The equipment should be constructed so that the entire cross-section of the useful beam is intercepted by a primary barrier formed by the image receptor. This may be either a directly viewed fluorescent screen with protective glass or an X-ray image intensifier. It is essential that the barrier has a lead equivalent of:

(a) 1.5 mm for apparatus capable of operating up to 75 kV.
(b) 2.0 mm for apparatus capable of operating up to 100 kV.
(c) An additional 0.01 mm per kV above 100 kV.

There should, where reasonably practicable, be some means of ensuring that a fluoroscopic exposure is not possible without the image receptor in place (AC 2/16(e)).

8.3.3 The X-ray tube mounting and the image receptor should be mechanically linked so that the axis of the X-ray beam coincides with the centre of the receptor and the useful beam cannot fall outside the latter under normal conditions of use. If, in special circumstances, such mechanical linkage is not present, it is particularly important that the precautions mentioned in 8.3.7 and 8.3.8 should be observed.

8.3.4 A table should be used for the fluoroscopy of recumbent animals, the useful beam being directed upwards or downwards through it. A protective beam enclosure should extend from the X-ray tube housing to as near the table top as possible; the walls of the enclosure should provide the same degree of protection as is required for the tube housing, taking into account the angle of incidence of the useful beam.

8.3.5 Fluoroscopy of standing animals may be carried out with or without a tilting table or stand, the useful beam being directed horizontally. The protective beam enclosure described in 8.3.4 should extend as near the animal as possible.

8.3.6 An adjustable diaphragm which can preferably be completely closed should be provided within the enclosure. The diaphragm should afford the same degree of protection as is required for the tube housing and should also confine the useful beam within the area of the barrier even when opened to its fullest extent.

8.3.7 When, under special circumstances, it is necessary to unlink the image receptor from the X-ray tube mounting:
(a) It may be advisable to override the adjustable diaphragm by placing an additional fixed diaphragm within the beam enclosure so that the dimensions of the useful beam are less than those of the image receptor at any practicable focal spot-to-receptor distance.

(b) Particular care should be taken that the useful beam does not extend outside the image receptor due to misalignment.

8.3.8 The table or stand used for fluoroscopy should be provided with adequate arrangements for protecting all those taking part in the examination against radiation scattered from the animal. To this end, shields of protective material having a lead equivalent of not less than 0.5 mm, should be interposed between the animal and the attendants. When the useful beam is directed vertically upwards, such shielding should be suspended from the edges of the image receptor. If the beam is in any other direction it is necessary to provide shielding that surrounds the animal in all directions in which persons may be exposed. These measures should be observed in addition to the wearing of protective clothing.

8.3.9 The spring-biased exposure switch (see 6.2.5) should be the primary device for terminating a fluoroscopic exposure. It may be hand-or foot-operated. If it is a foot switch it should be constructed so that an exposure does not take place if it is accidentally overturned.

8.3.10 As a back-up (see 6.2.6) there should be a cumulative timing device with a maximum time range of not more than 10 minutes and which is arranged to terminate the exposure automatically when the maximum time is reached. The timing device should be capable of being pre-set within a range of times up to the maximum and should give an audible and/or visible warning when the pre-set time has been reached.

8.3.11 The primary circuit of the generator should incorporate a device to limit X-ray tube currents to 5 mA during fluoroscopy. An over-ride switch may be provided for cinefluorography or for fluoroscopy of larger animals.

8.3.12 If there is another X-ray tube intended for radiography only, the fluoroscopy switches should be connected so that they cannot energise it (AC 2/16(d)).

8.4 Maintenance

8.4.1 The radiation safety features of equipment should be checked in accordance with the advice of the manufacturer or supplier and of the radiation protection adviser. AC 2/10 requires the shielding to be maintained and AC 2/16 calls for maintenance of the normal and back-up means for terminating the exposure. Particular care should be taken to ensure efficient operation of image intensifier systems. Old fluorescent screens should be replaced and also their protective glass if its optical density has increased significantly due to discoloration.

8.4.2 A record of defects and maintenance should be kept.

8.5 Procedures

8.5.1 The guidance given in Chapter 7 should be followed in so far as it is relevant to fluoroscopy. Because it is often necessary to be near the useful beam it is imperative that great care be taken to ensure that no part of the body is exposed to it except in the special circumstances of 8.5.5.

8.5.2 The fluoroscopist should be a veterinary surgeon who is a classified person or covered by a scheme of work.

8.5.3 Fluoroscopic examinations should be conducted with the minimum necessary X-ray tube current and field size and with the shortest practicable exposure time.

8.5.4 Fluoroscopy without image intensification should be performed in a dark room. The fluoroscopist's eyes should be previously dark-adapted for at least 10 minutes. When an image intensifier is used these measures are not needed but the ambient light level in the room should not be excessive since television monitors perform better when set to low-to-moderate brightness.

8.5.5 The fluoroscopist should not place any part of his body in the useful beam (AC 2/18). However it is recognised in the approved code that he may sometimes need to manipulate the animal undergoing examination so that part of his body is unavoidably
9 Other uses of ionising radiations

9.1 Other possible applications of ionising radiations are:
(a) The therapeutic use of X-rays.
(b) The use of sealed radioactive sources.
(c) The use of unsealed radioactive substances.

9.2 At present these techniques are used only to a very limited extent in veterinary practice. The precise nature of their use cannot be anticipated and it would be impossible, therefore, to treat them in detail in these guidance notes. If the need for such techniques arises, their employment should be under the close supervision of veterinary or medical personnel trained and experienced in such procedures, in collaboration with radiation physicists, since serious safety problems may be created. They should be carried out in accordance with the guidance given in 'Guidance Notes for the Protection of Persons against Ionising Radiations arising from Medical and Dental Use'\(^\text{(6)}\), except that some recommendations which are solely for the protection of the patient need not be followed. Such exceptions include, for example, the provision of a dual dosimetry/timing system for beam therapy. All references in the relevant chapters of those Guidance Notes to Regulations and to the approved code of practice will apply also to veterinary practice.

9.3 If radioactive substances are administered to animals special precautions will be needed in respect of transport, subsequent ownership, disposal of excreta, burial or cremation. It is essential that animals whose bodies contain radioactive substances cannot be used as food for humans or for other animals.

9.4 Advice may be sought from the National Radiological Protection Board\(^*\).

9.5 Where unsealed radioactive substances are administered to animals in veterinary research, or animals are irradiated with radiation beams, reference should be made to 'Guidance Notes for the Protection of Persons exposed to Ionising Radiations in Research and Teaching'\(^\text{(6)}\).

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*In Northern Ireland, the Northern Ireland Radiation Protection Service.*
Appendix 1

Advisory services

Radiation protection advisers

Radiation protection advisers should be appropriately qualified and experienced physicists or other specialists, and may be drawn from the following sources:

(a) Radiation protection advisers in universities or colleges of technology.
(b) Hospital physicists.
(c) The National Radiological Protection Board or the Northern Ireland Radiation Protection Service.

Names and addresses of their members may be obtained from the Association of University Radiation Protection Offices and the Hospital Physicists' Association. The addresses of the National Radiological Protection Board's centres and of the Northern Ireland Radiation Protection Service are as follows:

National Radiological Protection Board
Chilton
Didcot
Oxfordshire OX11 0RQ
Tel: Abingdon (0235) 831600

National Radiological Protection Board
Hospital Lane
Cookridge
Leeds LS16 6RW
Tel: Leeds (0532) 679041

National Radiological Protection Board
155 Hardgate Road
Glasgow G51 4LS
Tel: 041-440 2201

Northern Ireland Radiation Protection Service
Belvoir Park Hospital
Saintfield Road
Belfast BT8 8JR
Tel: Belfast (0232) 642942

Medical advice

The address of the local office of the Employment Medical Advisory Service (see 3.2.5) may be obtained from:

Health and Safety Executive
Baynards House
1 Chepstow Place
Westbourne Grove
London W2 4TF
Tel: 01-229 3456

Department of Manpower Services
Netherleigh
Massey Avenue
Belfast BT4 2JP
Tel: Belfast (0232) 63244

Other advice

It may be useful to take advice on radiological procedures, for instance from holders of the Diploma in Veterinary Radiology or from medical radiologists, since correct technique is an integral part of radiation safety.
Absorbed dose: quantity of energy imparted by ionising radiations to matter per unit mass of the matter. The special name of the unit of absorbed dose is the gray (Gy). The earlier special unit of absorbed dose is the rad.
1 Gy = 100 rad
Note: The absorbing matter should also be specified, for instance, gray in air or gray in tissue.

Appointed doctor: registered medical practitioner who has been appointed in writing by the Health and Safety Executive.

Approved laboratory: laboratory, approved by the Health and Safety Executive, which provides a personal dosimetry and dose record keeping service.

Classified person: member of staff who has been identified as being in conditions of work where doses might exceed three-tenths of the annual dose limits.

Controlled area: an area, subject to special measures for the purpose of radiation protection, to which access is restricted and inside which a person might receive an annual dose other than from natural background or medical exposure, exceeding three-tenths of the relevant dose limit for workers.

Deep dose equivalent: dose equivalent at a depth of 1 g cm\(^{-2}\) in material corresponding to soft tissue.

Dose: an imprecise term when used in isolation, although often used as an abbreviation for ‘absorbed dose’ or ‘dose equivalent’ (q.v). In these guidance notes the shorter term ‘dose’ is used instead of ‘dose equivalent’ for convenience.

Dose equivalent: quantity obtained by multiplying the absorbed dose (q.v) in tissue by the quality factor so as to take account of the differing biological effectiveness of equal absorbed doses and by other modifying factors. The special name of the unit of dose equivalent is the sievert (Sv). The earlier special unit of dose equivalent is the rem 1 Sv = 100 rem
Note: At present the product of the other modifying factors is 1. The quality factor for X-rays is 1 and therefore, in this case, the dose equivalent is numerically equal to the absorbed dose.

Dose (equivalent) limits: largest values of dose equivalent to the body, or to parts of it, intended to prevent certain effects of ionising radiation and to limit other effects to an acceptable level.

Employment medical adviser: person who has been appointed under Section 56 of the Health and Safety at Work etc. Act 1974 or Article 48 of the Health and Safety at Work (Northern Ireland) Order 1978.

Environmental monitoring: measurement of radiation quantities, such as dose equivalent or dose rate in an area, forming part of a radiation survey.

Film badge: pack comprising photographic film and appropriate filters used to measure dose from ionising radiations.

Filtration: modification of the characteristics of a beam of ionising radiation on passing through matter (usually before reaching the object); also its quantitative expression as the thickness of a reference material (e.g. aluminium) which has the same effect on the beam as the material under consideration.

Fluoroscopist: person carrying out a fluoroscopic investigation.

grey: see absorbed dose.

Inherent filtration: filtration due to the irremovable materials through which the X-ray beam passes before emerging from an X-ray tube assembly.
Ionising radiations: electromagnetic radiation (for instance X-rays) or corpuscular radiation (for instance beta particles), capable of producing ionisation.

Lead equivalent: thickness of lead affording the same protection as the material in question under similar conditions of irradiation.

Leakage radiation: ionising radiation which has passed through the protective housing of an X-ray tube but not through the radiation aperture.

Light-beam delineator (diaphragm): optical device, attached to an X-ray tube housing, which emits a beam of light outlining the area of the useful X-ray beam falling on the area to be examined.

Natural background radiation: radiation from natural radioactivity in the environment and from cosmic rays.

Occupancy factor: factor by which the workload may be multiplied for calculating protective shielding in order to take account of the degree or type of occupancy of the area to be protected. This factor should not be used when considering the designation of areas.

Orientation factor: factor by which the workload may be multiplied for calculating protective shielding in order to take account of that part of the workload during which the radiation beam is expected to be directed to the area to be protected. (This factor has formerly been known as the 'use factor'.)

Principal: person or persons responsible for the control of the veterinary practice or establishment.

Protective clothing: lead-rubber apparel worn during radiological procedures.

rad: see absorbed dose.

Radiation survey: investigation of the radiation hazards in and around an installation.

Radiographer: person supervising the radiographic examinations.

Radiation protection adviser: physicist or other specialist who may be consulted regarding radiological protection.

Radiation protection supervisor: member of staff appointed to supervise radiological protection procedures.

rem: see dose equivalent.

Residual beam: that part of the useful beam which remains after having passed the plane of the image receptor.

Scattered radiation: ionising radiation emitted by interaction of ionising radiation with matter, the interaction causing a reduction in energy and change in direction of the radiation.

Shallow dose equivalent: dose equivalent averaged between depths of 5 and 10 mg cm\(^{-2}\) in material corresponding to soft tissue.

sievert: see dose equivalent.

Supervised area: an area, not forming part of a controlled area, that is subject to appropriate supervision for the purpose of radiation protection, and inside which a person might receive an annual dose other than from natural background or medical exposure, exceeding one-tenth of the relevant dose limit for workers.

Thermoluminescent dosemeter: pack containing thermoluminescent material (for example, lithium fluoride) used to measure dose from ionising radiations and requiring a separate reader.

Useful beam: X-rays which come from the target and emerge through the aperture of an X-ray tube.

Workload: a measure in suitable units of the amount of use of X-ray equipment usually expressed in milliampereminutes per week.
Appendix 3
Signs to indicate ionising radiation

British Standard 3510 \(^{(13)}\) specifies a basic symbol (see Fig 1) to denote the actual or potential presence of ionising radiation. The Standard does not specify any radiation levels at which the symbol is to be used.

![Fig 1 Basic ionising radiation symbol](image)

The areas shown shaded in Fig 1 are black. The background should be yellow, of a colour approximating to colour No. 309 of British Standard 381C.

British Standard 5378 \(^{(10)}\) specifies various types of safety sign including a warning sign indicating ‘Caution, risk of ionising radiation’. This sign (see Fig 2) is triangular in shape, has a yellow background and a black border, and the radiation symbol is placed centrally on the background. At least 50% of the area has to be yellow.

![Fig 2 Warning sign — ionising radiation](image)

Any explanatory wording should be put on a supplementary sign. BS 5378 specifies that supplementary signs shall be oblong or square with the text in black on a background which is either white or of the same colour as the safety sign (i.e. yellow in the case of a warning sign).

For veterinary radiography and fluoroscopy, there should be a radiation warning sign at the entrance to the X-ray room or radiography area (see 6.1.3 and 7.3.2). A supplementary sign below it should bear the words: ‘X-rays. Do not enter when warning signal is displayed’, or (in the case of a radiography area): ‘X-rays. Do not enter.’ If the X-ray room is a controlled area the words ‘controlled area’ may also appear on the supplementary sign.

Signs which are put up after 1 January 1981 must comply with BS 5378: Part 1 (the Safety Signs Regulations 1980 \(^{(11)}\)). Existing signs do not need to be changed immediately but all signs must comply with the British Standard by 1 January 1986.
Appendix 4
Specimen local rules

The following form of local rules may be suitable for use in a practice when radiography is performed.*

1 These local rules are issued by the principal and are intended to ensure that the X-ray set is used safely and in accordance with the requirements of the Ionising Radiations Regulations 198- and the associated approved code of practice. They are consistent with the ‘Guidance Notes for the Protection of Persons exposed to Ionising Radiations arising from Veterinary Use’. They must be read and understood by all staff.

2 **Radiation protection adviser**
The principal has appointed the National Radiological Protection Board of 155 Hardgate Road, Glasgow as radiation protection adviser.

3 **Radiation protection supervisor**
The principal has appointed John Doe, radiation protection supervisor (RPS). He shall administer the local rules, the requirements of the regulations and approved code and the recommendations of the ‘guidance notes’ and shall report to the principal.

4 **Controlled area**
The X-ray room is designated as a controlled area. Staff who are not ‘classified persons’ may remain in this room during radiography only in accordance with the ‘scheme of work’ described below.

5 **Classified persons**
The following members of staff are designated as classified persons and may take part routinely in radiography: John Doe, Richard Roe are under medical supervision and wear personal dosemeters. They must read and understand the relevant sections of the ‘guidance notes’. Each classified person must bear in mind that it is his duty to protect himself and others from the hazards associated with radiography.

6 **Scheme of work**
Staff who are not classified persons may not take part routinely in radiography. Occasional participation, on not more than five occasions per month, must be authorised on each occasion by the RPS, who shall decide whether personal dosemeters should be worn.

7 **X-ray room**
Radiography shall be carried out, normally, in the room marked with the warning sign which incorporates the trefoil radiation symbol. During radiography, the ‘no entry’ sign shall be hung on the door of the X-ray room. Exceptionally, radiography may be carried out elsewhere, but only with the express permission of the RPS who shall specify the conditions of use.

8 **X-ray set**
The X-ray set may not be modified so as to alter its performance or shielding except with the express permission of the RPS. Any malfunction shall be reported immediately to him.

9 **Radiography procedures**
John Doe and Richard Roe are appointed ‘radiographers’ and shall supervise radiographic procedures; in that capacity they shall have authority over all persons present at an examination and shall exclude all unauthorised and unessential persons. The examination shall be carried out in accordance with Chapter 7 of the ‘guidance notes’. (A notice should be posted in the X-ray room detailing radiographic procedures as recommended in 7.1.4. The correct sequence of actions should be listed, for example: Immobilise the animal. Position the animal and cassette. Select exposure factors and beam size. Don protective apron and stand as far as practicable from the path of the useful beam. Warn persons present of imminent exposure and then take the radiograph. Switch off X-ray set so as to prevent unintentional exposure. Any special points, such as a restriction on beam direction specified by the radiation protection adviser, should also be included in the notice.)

10 **Personal dosemeters**
Persons issued with personal dosemeters must wear them at all times during work and report damage or loss of the badges to the RPS who shall replace them. When not in use, dosemeters must be kept outside the X-ray room, dry and away from heaters.

*The word ‘must’ may be used in local rules to refer to matters which the principal wishes to make obligatory.
11 **Protective clothing**
All persons authorised to be present during radiography must wear protective aprons which must be replaced on the rail after use. Persons who are asked by the radiographer to hold animals must cover their hands and forearms with protective drapes.

12 **Visitors**
No visitors shall be allowed to remain in the X-ray room or radiography area during radiography except for owners of animals when their assistance is needed for restraining the animal. They shall be given clear instructions on their role.
Appendix 5
References

1 Health and Safety at Work etc. Act 1974, HMSO, London.
3 The Ionising Radiations Regulations 198-.
4 (Corresponding regulations are expected for Northern Ireland.)
8 Guidance Notes for the Protection of Persons against Ionising Radiations arising from Medical and Dental Use, NRPB.
9 Guidance Notes for the Protection of Persons exposed to Ionising Radiations in Research and Teaching, NRPB and HSE. HMSO, London.
10 Guidance Notes for Appointed Doctors, 198-, HSE, London.
12 BS 2606: 1955 X-ray protective gloves for medical diagnostic purposes up to 150 kV peak.
13 BS 3510: 1968 A basic symbol to denote the actual or potential presence of ionising radiation.
14 BS 3783: 1964 X-ray lead-rubber protective aprons for personal use.
15 BS 4031: 1966 X-ray protective lead glasses.
16 BS 5378: Safety signs and colours
   Part 1: 1980 Specification for colour and design