

Guidance for appointed doctors on the Ionising Radiations Regulations 1999

Contents

Introduction	3
Background	3
General principles underlying medical surveillance	4
Roles and responsibilities	4
The employer	4
The employee	5
The radiation protection adviser (RPA)	5
HSE/Employment Medical Advisory Service (EMAS)	5
The appointed doctor (AD)	5
Administrative arrangements	6
Clinical records	6
Health record	6
Radiation passbook	6
Change of employment	6
Appeals	7
RIDDOR	7
Examination prior to designation as a classified person	7
Clinical records	7
Work environment and tasks	8
General medical history	8
Previous occupational history	9
Previous medical exposure to ionising radiations	9
Special considerations for female workers	9
Psychiatric illness	10
The clinical examination	10
Special investigations	11
Counselling	11
Periodic reviews of health	11
Work involving risk of high radiation doses to or overexposure of extremities	12
Counselling	12
Other situations which may require counselling	13
Exceeding the specified investigation level	13
Dose limitation for employees in special cases: regulation 11(2), Part II Schedule 4, L121	13
Risk estimates	13
Perception of risk	13
Cancer in a classified person	14

Overexposure – special medical surveillance: regulation 25	14
Whole-body overexposures exceeding 1Gy	14
Overexposures of the skin	15
Overexposures of the extremities	15
Blood test	15
Chromosome aberration dosimetry	15
Other tests	16
Whole-body monitoring	16
Decontamination	16
Counselling	17
Notifying the GP	17
Dose limitation for overexposed employees: regulation 26	17
Working with ionising radiation following an overexposure	17
Continuing health surveillance	18
Contingency planning and emergency preparedness	18
Radiation accidents and emergencies	18
Contingency planning	18
National arrangements for incidents involving radioactivity	18
Radsafe	18
Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPiR)	19
Appendix 1 Case histories	20
Appendix 2 Training syllabus for appointed doctors	24
Appendix 3 Examples of job descriptions	25
References	26
Further information	27

Introduction

1 This guidance informs appointed doctors (ADs) about how to conduct medical surveillance in workers exposed to ionising radiation (IR). It may provide useful information to health professionals, managers and classified persons (see paragraph 7). It could also be relevant to those providing occupational health services for people who work with IR but are not classified persons. Where the text refers to an AD, it also applies to a medical inspector (MI)/senior medical inspector (SMI) (formerly employment medical adviser/senior employment medical adviser) of the Health and Safety Executive (HSE). References to regulations in the text relate to the Ionising Radiations Regulations 1999 (IRR99),¹ unless otherwise specified. Appendix 1 contains a collection of case histories relevant to the work of ADs.

2 This guidance is not intended as a definitive statement or interpretation of the law. As an AD, you must be familiar with the Approved Code of Practice (ACoP) and guidance: *Work with ionising radiation* (L121).¹ You should also be familiar with your general responsibilities and rights as described in HSE's *General guidance for appointed doctors*.²

Background

3 Under Article 30 of the 1957 Euratom Treaty,³ the European Union (EU) is required to establish 'basic safety standards'. These include dose limits, maximum exposures, and the principles governing medical surveillance of workers. The EU published a revised directive on basic safety standards in 1996 as Council Directive 96/29/Euratom.⁴ IRR99 implements much of that Directive in British law. In 2007, the European Commission began the process of revising 96/29/Euratom with the intention of consolidating a series of radiation directives into one new Basic Safety Standards Directive. More information is available on HSE's IR website (see 'Further information').

4 IR is carcinogenic, and the risk of cancer induction cannot be excluded even at low doses. There is no 'safe level' of radiation exposure. Practices involving exposure to IR must firstly be **justified** – the benefits to society and exposed individuals must outweigh the health risk. Secondly, the protection provided to control radiation exposures must be **optimised**. Thirdly, there must be a system for **dose limitation for workers and the public**. The principles for restricting radiation exposures to as low as reasonably practicable are well established. For example, in relation to an external radiation hazard, they may involve restriction of the length of **time** of exposure, introduction of **distance** to separate the individual from the source of exposure, and use of **shielding** (regulation 8).

5 A multiplicative model has been adopted to predict the number of cases of cancer to be expected for a given exposure to IR. Therefore, IR is considered to increase the risk of cancer in proportion to the underlying natural risk – it multiplies that natural risk.

6 It is now accepted that medical surveillance of radiation workers should follow the same general principles of occupational medicine as applied to other groups of workers. **In most cases, the actual exposure to IR is so small that it will have little influence on decisions regarding medical suitability for employment.** The emphasis has moved to encompass the fitness for work aspect of the medical assessment.

General principles underlying medical surveillance

7 Under IRR99, only **classified persons** ('category A' workers in the Basic Safety Standards Directive) require medical surveillance. Classified persons are defined as those workers likely to receive an effective dose of radiation greater than 6 mSv per year, or an equivalent dose greater than three-tenths of any of the dose limits for other tissues (regulation 20).

8 In deciding which employees need to be classified, the employer has to take account of the overall potential for exposure to IR. This includes exposure which could arise from likely accidents and the use of sources which may produce high dose rates. Among groups of employees, there will be **different potentials for high radiation exposures to occur**. This is one factor which should be considered when the AD is arranging periodic reviews of health.

9 The full requirements of adequate medical surveillance are specified in the ACoP to regulation 24 of L121. These comprise:

- a medical examination before first being designated as a classified person in a post involving work with IR;
- periodic reviews of health at least once every year;
- special medical surveillance of an employee when a relevant dose limit has been exceeded;
- determining whether specific conditions are necessary; and
- a review of health after cessation of work, where this is necessary to safeguard the health of the individual.

Roles and responsibilities

The employer

10 The responsibilities of the employer, with regard to medical surveillance, include:

- designating workers as classified persons (regulation 20);
- consulting with the radiation protection adviser (RPA) about the doses of radiation to which female workers might be exposed;
- arranging for medical surveillance of classified workers (regulation 24(1));
- maintaining a valid health record for each classified worker (regulation 24(3));
- ensuring that any conditions specified in the health record are observed (regulation 24(6));
- furnishing the AD with relevant information before periodic reviews of health, the minimum being: the health record, summaries of dose records, and any relevant records of sickness absence (regulation 24(8));
- permitting the AD to view the workplace (regulation 24(7));
- providing facilities for medical examinations, or allowing workers to attend the AD's surgery to be examined (regulation 24(2));
- notifying the AD or MI of any suspected overexposures received by any of their employees arising as a result of their work (regulation 25(1)(a)(iii)); and
- co-operating with other employers as necessary (regulation 15).

The employee

11 The responsibilities of the employee in relation to medical surveillance include:

- presenting themselves for medical examination and co-operating with the reasonable requests of the AD (regulation 34(5)); and
- for female employees – notifying their employer as soon as possible if they become pregnant or if they are breast feeding (paragraph 239 of L121).

The radiation protection adviser (RPA)

12 The role of the RPA with regard to medical surveillance includes:

- advising the radiation employer on the observance of the regulations. In order to do this, the RPA must have specific knowledge of the particular working conditions, or experience and competence relevant to the particular working conditions (regulation 13); and
- advising the employer whether it is likely that any female employees may receive an equivalent dose to the abdomen of 13 mSv, in a three-month period.

HSE/Employment Medical Advisory Service (EMAS)

13 Among the responsibilities of HSE/EMAS in this context are:

- appointing suitable doctors as ADs to undertake statutory medical surveillance;
- overseeing a process of monitoring and reviewing the work of ADs;
- providing advice to ADs on difficult or unusual cases;
- collating national statistics on medical examinations conducted under IRR99 (in liaison with the Health and Safety Laboratory (HSL));
- receiving appeals against the decisions of ADs to forward to the Medical Review Panel at the Radiation Protection Division (formerly the National Radiological Protection Board (NRPB)) of the Health Protection Agency (HPA); and
- facilitating training of ADs by producing a training syllabus which complies with the requirements of EU Council Directive 96/29/Euratom.⁴

The appointed doctor (AD)

14 In order to fulfil the requirements for adequate medical surveillance, the AD will need to:

- liaise with the employer to ensure they have an understanding of the nature of the work to be done and the hazards/risks associated with exposure to IR in that work;
- liaise with the MI and in particular advise them of any known or suspected overexposures;
- maintain adequate clinical records for the medical examinations completed;
- provide counselling and advice to individuals regarding medical aspects of their work with IR;
- submit statistical returns to HSL, specifying the number and results of medical examinations completed; and
- undergo appropriate training (see Appendix 2) and maintain up-to-date knowledge.

Administrative arrangements

Clinical records

15 See paragraphs 25–26.

Health record

16 The information that should be in the health record is listed in Schedule 7 of IRR99 and a standard form for this purpose is available from HSE (Form F2067⁵). The record or a copy of it must be kept until the person to whom it relates has, or would have, attained 75 years of age, but in any event for at least 50 years from the date of the last entry.

17 On completing the medical examination prior to classification and after any subsequent review, the AD should record whether the person is considered fit, fit subject to conditions, or unfit.

Radiation passbook

18 Outside workers, ie classified persons who work in another employer's controlled area, require an entry to be made in their radiation passbook of the date and result of their last medical examination. This entry is completed by someone with access to the health record and does not need to be completed by the AD. Where a person is examined in Britain but will work in Northern Ireland or in another member state of the EU, they should be medically examined according to the standards set out in this guidance and the health record and radiation passbook completed. Other member states may have their own, different medical standards for category A workers.

Change of employment

19 When a classified person has changed employment and is to be classified by the new employer, a further medical examination does not necessarily have to be carried out. This applies if that person has been certified as fit within the preceding 12 months and a copy of the certificate is obtained and kept with the new health record. In such circumstances, any conditions already imposed will continue to apply unless removed or varied at the next periodic health review. However, if the change in employment entails a significant change of duties or work environment (eg a move from work involving sealed sources to work involving unsealed sources), the new employer should consult their own AD. They should ensure there is nothing in the classified person's medical history that warrants a further medical examination or review to be carried out before the new employment commences. This will also apply when a classified person remains with the same employer but their duties or work environment change.

20 On change of employment, it will be appropriate for the AD to obtain, with the consent of the classified person, relevant clinical information and records held by the AD(s) who previously assessed that person.

Appeals

21 A person who is aggrieved by a decision of an AD has the right to apply for the decision to be reviewed (see regulation 24(9) and case history 2 in Appendix 1). Such an application must be made in writing to the Head of EMAS within three months of being informed of the AD's decision. The HPA provides the secretariat for the Medical Review Panel. The latter comprises three physicians, including a chairman appointed by the HPA. Of the other two physicians, one is nominated by the Royal College of Physicians and one by the Trades Union Congress, and they have specialist knowledge appropriate to the case under consideration. The Panel will seek evidence from the AD who made the original decision, and will offer the doctor the opportunity to appear if a formal meeting is convened. The location of such a meeting is at the discretion of the members of the Review Panel, and may be arranged to be near the appellant's place of work. The AD will automatically be informed of the result of the Panel's review.

22 In any case, where there is doubt or possible dispute about the result of a medical examination, the AD should discuss the clinical issues with the local SMI. At this time, the procedure for an appeal can be discussed and the appropriate information and forms provided by the SMI. It is preferable if an appeal can be avoided as these are time-consuming for all concerned, not least the appellant.

RIDDOR

23 Under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR),^{6,7} employers and self-employed people have a duty to report certain diseases where it is believed they may have resulted from work involving exposure to IR. The diseases include inflammation, ulceration or malignant disease of the skin, malignant disease of bone, blood dyscrasias (the dyscrasias historically linked to IR exposure are leukaemia (apart from chronic lymphatic leukaemia) and aplastic anaemia) and cataract. ADs should familiarise themselves with the relevant requirements of RIDDOR so they can advise the employer or self-employed person.

Examination prior to designation as a classified person

24 The primary purpose of this examination is to assess the fitness of the individual to carry out the tasks involved in their job, including the wearing of respiratory protective equipment (RPE), if that is required. Additional and unique objectives are:

- to establish the physical and temperamental suitability of the individual to work with IR; and
- to record the presence of any abnormality which may render the individual especially sensitive to the effects of IR or be confused, at some future date, with the possible effects of exposure to IR.

Clinical records

25 Any suitable form, such as one based on that used by MIs (FODMS101⁸) can be used for this purpose. The clinical record, unlike the statutory health record, is confidential. Access to the information it contains must be restricted, in accordance with well-established principles of medical ethics governing occupational health practice.^{2,9} Classified persons may request access to their clinical records under the Data Protection Act 1998.¹⁰

26 If the doctor's appointment under IRR99 ceases, with the consent of the classified person, they should consider transferring their clinical records. It is preferable to transfer them to the AD's successor if there is one. Otherwise, the records should be given to the classified person's GP.

Work environment and tasks

27 When conducting the examination, the AD should apply the principles of good occupational health practice. To do this effectively, **the AD needs to be familiar with the work environment where the classified person is to be employed and the nature of the tasks to be carried out.** Examples of job descriptions can be found in Appendix 3.

28 The AD should enquire about (and record) the following (it will be necessary in most instances to obtain the information from the employer or RPA):

- What is the source of IR? Is the IR electrically generated or from sealed or unsealed radioactive materials? What type of radiation might the employee be exposed to (alpha/beta/gamma/neutrons/X-rays)? What are the risks of internal (inhalation, ingestion or absorption through the skin or breaks in it) and external exposures?
- What is/are the likely annual dose(s) to be received by the classified person and by which exposure route? By what methods will these doses be assessed?
- A description of the task(s) involved – Is the work done in a purpose-built facility with appropriate engineering controls and shielding to restrict exposures such as an enclosure/room with a maze entrance or interlocked doors? Is the work peripatetic and done on several different sites? Are large quantities of sealed or unsealed radioactive materials handled?
- Is there potential for significant exposure or overexposure of the extremities (head, hands, feet) or skin surface?
- Is the wearing of RPE or other personal protective equipment (PPE) necessary?

General medical history

29 Obtaining a full and accurate medical history is a vital component of the examination prior to designation as a classified person. For the most part, the information obtained will be relevant to the general duties of the post. Of particular relevance to those aspects of work involving IR will be a history of:

- chronic skin disease;
- chronic pulmonary disease;
- psychiatric illness or personality disorder;
- blood disorder;
- inherited predisposition to malignancy;
- medical exposure to IR; and
- treatment with cytotoxic drugs.

30 However these should not be regarded as reasons for automatically excluding an individual from classified work. The AD's decision regarding fitness must always be based on the merits of a particular case (see paragraphs 21–22). Where doubt exists, the AD should discuss the matter with an MI before coming to a final decision.

31 The sex of a classified person is not relevant in establishing the likelihood of deterministic effects (threshold related – eg cataract, skin erythema) or stochastic effects (based on probability of occurrence – eg malignancy, genetic) other than breast cancer.

Previous occupational history

32 In addition to obtaining general information about previous employment, it is important to establish and document whether there has been any previous occupational exposure to IR or other known carcinogenic agents (eg asbestos).

33 For individuals who were classified by their previous employer, details of previous exposure to IR should be set out in the dosimetry termination record (regulation 21(3)(d)). The worker should receive a copy of this record from their previous employer (regulation 21(6)(b)). When such an individual is to be classified by a new employer, the prospective employer should ensure a copy of this record is made available to the AD. For individuals who have not previously been classified, but have worked in controlled areas and/or been subject to personal dose monitoring, the (previous) employer should be able to provide the individual with monitoring results or assessments for at least the past two years (regulation 18(5)).

Previous medical exposure to ionising radiations

34 It is important to establish and document as much information as possible about previous diagnostic and therapeutic exposures to IR. This is particularly so where haemopoietic, or other tissue sensitive to radiation, is likely to have received a significant dose.

35 Even though a significant previous occupational or other exposure(s) to IR has occurred, this may not be of paramount importance in deciding on the fitness of a particular applicant for employment as a classified person. To put the issue into perspective, a course of radiotherapy for carcinoma of the prostate commonly requires a total dose of 60 Gy to be delivered to the bladder over a six-week period. This will result in an effective dose of a few Sv. In contrast, the lifetime occupational effective dose received by a classified worker may be no more than 30 mSv. The nature of the work and/or general health or special skills of the individual may be of greater relevance.

Special considerations for female workers

36 The AD must take note of the employer's statement in the health record concerning the likely abdominal dose for that worker. For women of reproductive capacity, a maximum external equivalent dose limit of 13 mSv to the abdomen in any consecutive period of three months applies concurrently with the whole-body dose limit of 20 mSv per annum (paragraphs 5 and 11 of Schedule 4 of L121).

37 Women of reproductive capacity should receive advice about the risks to the fetus and nursing infant arising from exposure to IR. They should be informed of the need to **notify the employer in writing and without delay if they become pregnant or start breast feeding** (regulation 14(c)).

38 When an employee has notified her employer in writing that she is pregnant or breast feeding, the employer should ensure that:

- the equivalent dose to the fetus is not likely to exceed 1 mSv during the remainder of the pregnancy (ie a dose limit similar to that applying to members of the public); and
- in the case of an employee who is breast feeding, the conditions of exposure are restricted to prevent significant bodily contamination of that employee (regulation 8(5)).

39 The vast majority of occupational doses of radiation currently received by females are very low and less than the contribution from background radiation. In 2004, the mean annual whole-body dose for female classified persons was 0.4 mSv. It is known that exposure to large doses of radiation can result in early death of the conceptus, the development of malformations, or severe mental retardation. These effects have thresholds which are of the order of 200 mGy or higher, and are dependent on gestational age. Therefore, they are not a consideration except in the event of a serious overexposure to radiation. The employer should take account of this when a woman of reproductive capacity is to have a role in implementing contingency plans for accidents or contamination incidents.

40 The doses received by any fetus from occupational exposure of the mother will be well below the threshold for deterministic effects following irradiation in-utero. The risks of cancer (including leukaemia) or severe mental retardation will be very small compared with the normal risks to the fetus during pregnancy and the first 15 years of life. More information is given in the HSE leaflet: *Working safely with ionising radiation: Guidelines for expectant or breast feeding mothers*.¹¹

Psychiatric illness

41 The way in which classified persons carry out their duties is often critical to their own safety and that of their colleagues. Therefore, the AD must be alert to the presence of any psychiatric illness or personality disorder inconsistent with the need for mental stability and self-discipline in such workers.

The clinical examination

42 The precise format of the clinical examination will depend on the information obtained from the medical and occupational history. In general, similar standards of medical fitness will apply to work involving all sources of IR. However, the AD must bear in mind that some medical conditions (eg dermatoses) are of particular significance where the work involves, or might involve at some future date, exposure to unsealed radioactive materials.

The skin

43 Exposed areas of the skin should be examined to identify lesions which would allow entry of radioactive materials into the body and be difficult to decontaminate. Information should be sought on the protective measures that may be implemented. For example, appropriate use of PPE, and monitoring of PPE, clothing and skin for contamination.

44 Some individuals who suffer from a chronic skin condition (eg eczema or psoriasis) may be deemed unfit for work with unsealed sources. Others with less severe disease may be found fit to work with unsealed sources, subject to special conditions such as regular clinical examinations. These special conditions should be recorded in the health record.

The respiratory system

45 If there might be a need to use breathing apparatus or impervious protective clothing, whether routinely or in an emergency, the AD should carefully assess the respiratory system. It may be inappropriate to deploy an individual with chronic respiratory disease (eg asthma) in such a workplace. The reasons for this are twofold: firstly, the increased respiratory effort involved in using such apparatus may trigger an episode of respiratory distress; secondly, if such an episode

were to occur in a contaminated area, removal of the apparatus in an effort to gain immediate relief or to administer first aid, would inevitably result in internal contamination of the worker.

Special investigations

Blood test

46 There is no requirement for a full blood count (FBC) to be carried out routinely as part of the initial examination or at periodic review, unless there is a clinical indication.

Chest X-ray

47 Chest X-rays should not be carried out as part of the initial examination or periodic review, unless justified on individual clinical grounds. ADs must take account of the Ionising Radiation (Medical Exposure) Regulations 2000 (as amended 2006).^{12, 13}

Counselling

48 The stochastic nature of the health effects which may result from exposure to IR can contribute to anxiety, particularly when any positive findings from new research are reported in the media. The fact that epidemiological studies of large populations of radiation workers consistently show a healthy worker effect can be overlooked at such times. The AD must be prepared to address any such concerns which become apparent during the course of medical surveillance, whether or not these arise directly from a clinical finding. The AD should ensure the individual is aware of the purpose of medical surveillance and should confirm that they know how to obtain further help if concerns arise at a later date.

49 The AD must be familiar with basic information about radiation and its biological effects. They will need an understanding of the comparative risks arising from other work activities and from activities in daily life. They should possess an ability to present and interpret these risks in the context of an individual worker's employment. The opportunity should be taken to identify if the worker has any particular concerns about the nature of their proposed duties and consequent exposure to IR.

50 Reproductive risks from exposure to IR are of particular, but not exclusive, interest to female classified persons (see paragraphs 36–40). The AD should be familiar with the magnitude of these risks and be able to put them into context with other risks associated with reproduction.

Periodic reviews of health

51 IRR99 require the state of health of all classified persons to be reviewed by an AD every 12 months, or after a shorter period as may have been specified at the time of the last examination or review. In practice, the review may be carried out from one month before to one month after the expiry date of the last entry on the health record. It will be treated as if carried out on that expiry date (regulation 24(5)). The next periodic review would ordinarily fall due 12 months after that date. However, where a period of more than 13 months has passed since the last review or examination, a medical examination should be carried out.

52 The purpose of the periodic health review is to reassess the general state of health of the classified person and confirm their continued medical suitability for the work in which they are employed. When conducting the review, the AD should take particular account of:

- the recorded doses of radiation exposure and their nature;
- the sickness absence record and/or other medical concerns brought to their attention;
- matters requiring follow up from an earlier examination/review; and
- any change(s) in duties since the last examination/review.

53 **A formal medical examination or personal interview with the worker should not be regarded as an automatic element of the periodic health review.** Whether this is necessary will usually be a matter of clinical judgement based on the issues referred to in paragraph 52 and the assessment of risk. Where there is a high risk of exposure, (eg X-ray and gamma radiography without use of an interlocked shielded enclosure, or persons working in areas of significant surface or airborne contamination), a personal interview will often be required. Even where the work environment is well controlled and considered to be of low risk, classified persons require a face-to-face medical review at least once every five years.

54 The AD should enter the result of the periodic review in the health record. Details of clinical findings or other confidential information should be kept in a separate clinical record. It would be helpful if classified workers were made aware of the next date of their periodic review and given the opportunity to provide any relevant input.

Work involving risk of high radiation doses to or overexposure of extremities

55 It is recognised that, in some cases, the radiation dose received by the peripheral tissues of workers may not be accurately reflected by the whole-body dose recorded on their dosimeter. Examples of such work are **industrial radiography and interventional radiology/surgery**. Other workers at similar risk might be identified through risk assessment. If there is such a risk, the employer should make arrangements with the Approved Dosimetry Service for the routine monitoring of extremity doses. It is generally recommended that the periodic health review of classified persons at risk of high doses to extremities should include a clinical examination (see paragraph 56).

56 For industrial radiographers, the following guidance should be followed:

- Enclosure workers and X-ray radiographers should have an initial face-to-face medical examination by the AD then annual paper reviews of health up to a maximum of four. Face-to-face medical examinations should be conducted at intervals not exceeding five years.
- 'Gamma' industrial radiographers should have an initial face-to-face medical examination by the AD then annual reviews of health including a medical examination.

Counselling

57 At periodic review, counselling may be indicated where a significant cumulative dose of radiation has accrued, or where an episode of ill health that could be caused by radiation has occurred.

Other situations that may require counselling

Exceeding the specified investigation level

58 The employer is required to set an effective dose which, if exceeded by any of their employees for the first time in a calendar year, triggers an investigation. The dose is set at a level which must not exceed 15 mSv and must be entered in the local rules (regulation 8(7)). Typical investigation levels are usually in the range 2–8 mSv. The AD may be asked to counsel employees who have exceeded the investigation level, some of whom may not be classified persons.

Dose limitation for employees in special cases: regulation 11(2), Part II Schedule 4, L121

59 In certain special cases (having given prior notice to HSE), this permits an effective dose in excess of 20 mSv to be received by an employee in one calendar year. This is subject to a maximum effective dose of 50 mSv in any single calendar year and 100 mSv averaged over five consecutive calendar years. The classified person should have the opportunity to discuss this with the AD prior to these special limits being applied. In these circumstances, if a dose greater than 20 mSv has accrued in a calendar year, an investigation is required and HSE must be notified.

Risk estimates

60 Where the issue in question is **accumulated dose**, then an estimate of the lifetime risk of cancer can be made using the risk factors which are widely published. For example, a worker who has a total occupational dose of radiation of 100 mSv has a lifetime risk of cancer (in addition to their background risk) of 0.4% (based on the current estimate of risk of 4% per Sv). This information is not of great value until put into context. For example, more than 1 in 3 British people will develop some form of cancer during their lifetime. Studies of workers in British nuclear industries have consistently shown a healthy worker effect, with a lower overall mortality than the general population. Occupational exposure to radiation is responsible for only a relatively small proportion of total cancers. Even workers who have received a significant dose of radiation are not at greatly increased risk of developing cancer.

Perception of risk

61 It is known that attitudes to risk depend on a number of factors, such as whether or not that risk is voluntary. Where an individual is concerned about continuing employment as a result of accumulated doses of radiation, the following factors should be considered:

- What work patterns contributed to the accumulated dose being received?
- What likely dose will be received in future, ie how can work patterns be altered, if necessary?
- What other skills and opportunities for work does the person have?
- What other work is available in the same company or elsewhere?
- What hazards may exist in alternative employment?

62 Stopping work will not reduce the risk of the dose already received. The AD's role is to provide an opportunity for discussion, to ensure the classified person has considered these factors and they have access to all the necessary information on which to base their decision.

Cancer in a classified person

63 Where a case of cancer occurs in a classified person, there are two key issues: firstly, whether the cancer may have been caused by radiation; and secondly, whether it is safe for the individual to continue as a classified person. The question of causation can be approached by means of a formal calculation of the **probability of causation**. This is the ratio of the risk of the condition arising from radiation divided by the risk from radiation added to the background natural risk. It requires special expertise to calculate and forms the basis for the compensation scheme agreed between some nuclear employers and their trades unions.

64 The decision about continuing employment as a classified person can only be taken in the light of full information about the disease and its treatment. The AD will want to know the type and histology of the tumour, whether it may be induced by radiation, what treatment has been given and, if this includes radiotherapy, whether that entails a secondary risk of cancer. It will be important to know whether the person's condition is now stable and whether the cancer has been cured or is in remission (see paragraphs 35 and 60).

65 Of equal importance to medical details will be the individual's psychological response to the illness. Some will not want the condition to interfere with their customary occupation, while others will want to avoid any further risk, however tiny. It may be appropriate to apply a restriction in the dose record – for example, to limit the annual dose of radiation to be received, or to certify the person as unfit for a short period. This will allow further time for reflection by the classified person.

Overexposure – Special medical surveillance: regulation 25

66 When it is suspected that a classified person or any other person has been subjected to an overexposure, regulation 25(1) specifies that, as soon as practicable, the radiation employer should notify HSE and, where the person in question is their employee, the AD. The AD should then contact the local HSE MI. They will work in consultation with the AD and others to determine whether a special medical examination will assist in establishing the likelihood of an overexposure having occurred and whether active medical intervention is indicated.

67 The majority of such examinations will follow an overexposure of 100 mSv or more of assumed whole-body radiation identified on a personal dosimeter (eg a film badge or TLD) or other monitoring device. Some examinations will be as a result of significant external extremity exposure, significant contamination of an area of skin or an intake of airborne contamination. The purpose of the special examination is to look for clinical evidence of radiation exposure and take appropriate action. An essential first step is for the AD to establish, usually through discussions with the employer and RPA, full details of the circumstances of the suspected overexposure. Clearly, the form that the clinical examination takes will be dependent on this information.

Whole-body overexposures exceeding 1Gy

68 Where the overexposure is known or believed to have exceeded 1 Gy and to have been received over a brief period, the individual should be kept under careful observation, in an appropriate hospital, for signs of acute radiation syndrome.

Overexposures of the skin

69 Overexposures of uncertain magnitude which are localised to the skin (as may happen with beta radiation or exposure to 'soft' X-rays) will necessitate close surveillance by the AD for a minimum of 2–3 weeks. During this time, further exposure to radiation should be avoided. The threshold for deterministic effects is 2–3 Gy and, if such effects are to occur, it should become evident during this period. A worker who develops skin erythema should be referred to an appropriate specialist (eg a radiotherapist or dermatologist) and remain under their care until the effects on the skin have stabilised.

Overexposures of the extremities

70 It is possible, particularly in regard to incidents involving radiographic equipment or sealed sources, that the overexposure will be largely confined to an extremity, not uncommonly the fingers. In such a case, the dose received may be considerable, ranging up to several Sv. Local erythema will become apparent within a few days and will be followed by swelling and tenderness of the affected digits. Blister formation and breakdown, and intractable ulceration of the skin, are likely to follow. Gangrene, resulting from endarteritis obliterans, may necessitate amputation. In less severe cases, radiation dermatitis may appear and then either slowly regress or progress with fissuring, keratosis and possibly epithelioma formation.

Blood test

71 This should be regarded as mandatory where it is believed that a radiation dose from X-rays, gamma rays or neutrons exceeding 250 mSv, has been received. However, apart from an early fall in the number of circulating lymphocytes, it is likely that several days will elapse before obvious abnormalities appear in the peripheral blood. Nevertheless, this initial blood examination by an experienced haematologist will provide a useful baseline. If the overexposure is less than 250 mSv, abnormalities in the FBC and film will not appear. However, the AD may feel it is still a useful baseline assessment.

Chromosome aberration dosimetry

72 The presence of chromosome aberrations in peripheral blood lymphocytes may be used as a biological dosimeter following radiation overexposure. On a routine basis, the lower limit of detection is equivalent to a whole-body dose of about 100 mSv for gamma rays. The technique is a little more sensitive for X-rays, while neutron doses of 10–20 mSv may be detected. This means that a 'negative' test result can be used to reassure the individual that they have not been exposed to greater than 100 mSv (which is five times the annual dose limit). Further interpretation of the result based on statistical analysis will often be provided by the organisation performing the test. The AD should discuss this with the MI, radiation specialist or health physics assessor.

73 This technique is relatively expensive and only available at a few specialist facilities (eg the HPA). Structural aberrations arise as the result of discontinuities or breaks in the DNA and typically take the form of dicentric, ring and fragmented chromosomes. Dicentric aberration is almost unique to radiation, with a low frequency (about 1 per 100 000) in persons exposed solely to background radiation.

Timing of the sample

74 It is advisable, particularly in the case of partial-body or non-uniform exposure, to wait 24 hours after radiation exposure before taking the blood sample. This will allow circulating and pooled lymphocytes to mix and equilibrate, ensuring that the sample contains a representative proportion of irradiated cells. After the initial 24-hour delay, the sample should be taken as soon as possible. In persons with normal haematology, delays of a few weeks can be tolerated. After this time, the aberration yield will fall, thus reducing the accuracy of the dose estimate. In serious cases, where there is a likelihood of a severe drop in white cell count, there may only be a period of a few days when a viable blood specimen may be taken. Furthermore, medical treatment may include blood transfusion and it is essential that the sample is obtained before this occurs. It is important the sample reaches the laboratory as soon as possible after it has been taken, to minimise deterioration of the specimen. The result of the analysis can be available 72 hours after the laboratory receives the sample.

75 If whole-body radiation has been insignificant (less than 20% total body area), chromosome aberration testing is unlikely to be helpful, even if there has been sufficient local irradiation to cause injury. When counselling the individual prior to arranging the test, consideration should be given to the psychological effect of a positive test result. In deciding whether such a test is appropriate, the AD should consult with the HSE MI and relevant medical specialists.

Other tests

76 Fluorescence in Situ Hybridisation (FISH) is a test that looks at translocations that do not decline with time. It is appropriate for people who want to know their exposure to ionising radiation over preceding decades (eg when working abroad). It is rarely performed and is very expensive.

77 In a case where internal contamination is suspected, urine and faeces may be collected and analysed in order to estimate the uptake of radioactive materials and the magnitude of the resultant committed effective dose.

Whole-body monitoring

78 When following up cases where radioactive material is believed to have been deposited in the body, whole-body monitoring may be used to identify and quantify uptake and estimate doses. Again, this facility is only available at a few specialised centres.

Decontamination

79 Knowledge of procedures for decontamination is beyond that required of ADs. Expertise in this area is generally limited to those doctors who work in nuclear facilities where there is a particular risk of contamination. Techniques include skin and wound decontamination and the use of chelating agents. Even when the committed effective dose is thought to be small, individuals who have inhaled radioactive material may benefit from lung lavage, but this should only be performed at specialist respiratory centres.

Counselling

80 Receiving an overexposure, or the suspicion of such an event, is inevitably a stressful experience. Even when an effective whole-body dose of less than 100 mSv has been received, a face-to-face medical assessment of the worker may be indicated, to address any anxieties resulting from the experience. The greatest anxiety may well be in the early stages, when the dose is not known. Therefore, the AD might consider counselling the individual at this time, face-to-face, or by telephone. The concerns of the individual are likely to be even greater where the overexposure has involved internal contamination. It is also important to understand any possible anxieties in the worker's family as a result of the incident and consider how these may be addressed.

81 Once the immediate effects of the overexposure have been managed, it will be possible to consider the longer-term consequences for the individual. Here, the approach to calculation of lifetime risk is as for accumulated doses at periodic health review (paragraph 60). Advice should be taken on whether any dose rate correction should be applied to the risk estimate.

Notifying the GP

82 It may be appropriate, with the individual's consent, to notify their GP that an overexposure has occurred.

Dose limitation for overexposed employees: regulation 26

83 Regulation 26(2) states: 'The employer shall ensure that the employee to whom this regulation relates does not, during the remainder of the dose limitation period, receive a dose of ionising radiation greater than that proportion of any dose limit which is equal to the proportion that the remaining part of the dose limitation period bears to the whole of that period.' For example, a classified worker receives an effective dose of 32 mSv in the first three months of his dose limitation period (12 months in total). The annual dose limit is 20 mSv. For the rest of that dose limitation period, ie for the next nine months, he must not receive a dose of IR greater than $20 \times (9/12) = 15$ mSv.

Working with ionising radiation following an overexposure

84 A classified person who has received a significant overexposure should be kept under close surveillance by the AD in order to identify early deterministic effects. In most cases, the nature and extent of these effects will be the deciding factor in considering the individual's suitability for future employment as a classified person. In general, it is not justifiable to restrict subsequent employment solely because of the possibility of late stochastic effects. The additional doses of IR, which the individual will receive during the remainder of their working life, are likely to be comparatively small (see paragraphs 35 and 60). The only situation where it may not be appropriate for the individual to continue work with IR, is if they remain distressed by the experience. Then it may be necessary to declassify for a short period of time and review the situation.

Continuing health surveillance

85 A review of health after cessation of work is unlikely to be necessary in most instances. If it is thought that continuing surveillance is appropriate and the individual is no longer an employee, the best course of action may be to inform the GP. This should indicate that the individual has worked with IR and the special circumstances which have resulted in considering the need for continuing surveillance. The AD can advise the GP on interpretation of any changes they may observe in the context of the history of radiation exposure.

Contingency planning and emergency preparedness

Radiation accidents and emergencies

86 Radiation accidents are defined in IRR99 as accidents where immediate action is required to prevent or reduce exposure to IR of employees or any other persons. Under IRR99, where the prior risk assessment shows that it is reasonably foreseeable that a radiation accident may occur, the radiation employer is required to prepare a contingency plan (regulation 12(1)). Radiation emergencies are dealt with in the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPPIR)¹⁴ – see paragraphs 90–91).

Contingency planning

87 Only in special circumstances is the AD likely to be involved directly in dealing with the effects of exposure to radiation. However, their advice may be sought on the best procedures to adopt in preparing contingency plans. Radiation employers may be involved in, or asked for advice about, incidents involving radioactivity. The AD should be aware of the arrangements that exist for such events.

National arrangements for incidents involving radioactivity

88 The HPA co-ordinates and publishes details of the National Arrangements for Incidents involving Radioactivity (NAIR).¹⁵ The police may invoke NAIR when there is considered to be a need for radiological assistance. Appropriately qualified personnel from participating establishments will attend incidents. They will help delineate and contain contamination, initiate decontamination measures, and provide advice to the police and others concerning protection of the general public. The arrangements have been in existence for more than 30 years and have been used in over 350 incidents. Although many of these have been trivial, this does not diminish the importance of the arrangements. ADs should make themselves aware of the NAIR arrangements in their own locality.

Radsafe

89 These arrangements (previously known as the Nuclear Industry Road Emergency Response Plan (NIREP)) were devised by the nuclear industry to deal with transport emergencies involving radiation. Non-nuclear employers involved in the transport of radioactive materials may also be part of the scheme. The participants in this plan are also involved in the NAIR scheme.

Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR)

90 Radiation emergencies are defined in REPPIR¹⁴ as events which are likely to result in a member of the public receiving a radiation dose greater than those given in Schedule 1 of the regulations, and require emergency plans by the operator of the premises where the emergency could occur, and by the local authority. Workers who have sustained an emergency exposure are subject to medical surveillance (REPPIR regulation 14(1)(d)). Medical surveillance is defined as meaning surveillance carried out under the requirements of regulation 24 of IRR99. Effectively this will require a special medical examination to be made. It will be necessary for the employer to open and retain a health record. However, unless the individual is a classified person, periodic health surveillance will not be required.

91 Employers may seek advice from an AD about whether there are any medical contraindications in relation to fitness to receive an emergency exposure. Clearly, individuals will need to be fit to undertake duties which may be mentally and physically demanding. Concern may arise about permitting women who are trying to conceive, or individuals who have a history of malignant disease treated by radiotherapy, to be identified as employees who may be subject to emergency exposures. Some form of medical screen may be appropriate for such workers where they are not already classified.

Appendix 1 Case histories

Each of the case histories below is followed by questions for consideration by the AD. Responses to the questions are in a separate section below the case histories.

Case history 1: Pregnant woman

A female classified person, PW aged 28 years, working in a university research laboratory using an unsealed source (^{32}P which is a high energy beta emitter), tells the university occupational physician that she did a positive urinary pregnancy test using an over-the-counter kit at six weeks. She attended the hospital antenatal clinic at 12 weeks and is now 20 weeks pregnant. It is July. So far this year she has received 1 mSv whole-body radiation, 10 mSv to her right hand, and 8 mSv to the left hand. She says she didn't tell anyone of her pregnancy until it was well established. She thinks her job is low risk and intends to return to work when the child is three months old and will breast feed the baby in the university creche.

- 1) Is PW in breach of any regulation?**
- 2) What dose limits apply for the remainder of the pregnancy and after the baby is born?**

Case history 2: Dermatitis

This is based on a true case history. A 27-year-old plater, DD, who had never worked in the nuclear industry, attended for a pre-employment medical under IRR 1985. He said he was going to work as a plater for a company which would deploy him at a nuclear power installation. His general health was quite good but he suffered from severe eczema. On examination he had extensive eczema with thickening of the skin on the anterior trunk, his face and the dorsal surfaces of his feet. At the flexures there was considerable weeping and some areas of low-grade infection. The skin was so badly affected that it was impossible to identify a blood vessel in the antecubital fossa of either arm to obtain a blood sample. He had used steroid creams, particularly betnovate, for a long period of time, although was not on treatment at the time of the examination.

The doctor concluded he was unsuitable for work with IR, because if he became contaminated, the state of his skin would facilitate absorption. In addition, decontamination of his skin would be very difficult.

- 1) Which regulation(s), ACoP, guidance and guidance for ADs would apply if the situation was to occur now?**
- 2) What would be your response?**

Case history 3: Industrial radiographers

Three male site radiographers are employed by a pipe work manufacturer to perform non-destructive testing on weld joints. They have the use of a purpose-built lead and concrete enclosure with a shielded door. Inside is a 1.55 TBq Iridium 192 (gamma) source. They also have a portable 5.55 TBq Iridium 192 (gamma) source, which they use to examine larger segments in situ after normal working hours. Their employer submits their sickness absence records and dosimetry readings for their annual periodic review under IRR99. They last had a face-to-face medical two years ago. Their details are as follows:

A: Age 48 with 20 years' experience. Has had three days' sickness absence in the past year due to URTI and, up to September this calendar year, had received 4 mSv whole-body radiation.

B: Age 21 with two years' experience. Has had six days' sickness absence in the past year (all on a Monday) due to an upset stomach or headache and, up to September this calendar year, had received 11 mSv whole-body radiation.

C: Age 53 with 25 years' experience. Has had six weeks' sickness absence this year due to hernia repair and, up to September this calendar year, had received 2 mSv whole-body radiation.

- 1) What additional information do you need?**
- 2) Which regulation(s), ACoP, guidance and guidance for ADs apply?**

Case history 4: Previous cancer treatment

A 55-year-old man, OC, who had a course of radiotherapy for carcinoma of the prostate eight months ago, has applied for work as an engineer in a metal fabrication factory. His job will involve using an X-ray set in a purpose-built room with a set of interlocked doors. The controls are located on the outside, and he will use the facility to perform non-destructive testing of weld joints. He has done this type of work over the past 30 years, though has not worked for the past 10 months and says his cumulative exposure (whole-body), so far, is 15 mSv.

- 1) What additional information do you need?**
- 2) Which regulation(s), ACoP, guidance and guidance for ADs apply?**
- 3) Will you pass him fit for work?**

Responses to questions

Case history 1: Pregnant woman

1) The onus is on the employer to inform the employee of the risks to a fetus and of the importance of telling the employer if she is pregnant or breast feeding (regulation 14). Female employees should be urged to notify their employer of a pregnancy or if they are breast feeding, but this is not a statutory requirement (paragraph 239 (guidance) of L121 and paragraph 37 of this guidance). PW is therefore not in breach of any regulation.

2) The equivalent dose to the fetus should not exceed 1 mSv for the remainder of the pregnancy. When PW is breast feeding, significant bodily contamination must be prevented (regulation 8(5)). An employer should assume that any woman who returns to work within six months of having a baby is breast feeding, until it is established this is not the case. The equivalent dose limit to the hands and other peripheries of 500 mSv per calendar year remains the same during pregnancy and breast feeding (regulation 11). It should be noted that the 13 mSv dose limit to the abdomen of a woman in three consecutive months applies to a woman of reproductive capacity who is a classified person and not pregnant (regulation 11 and Schedule 4(5)).

Case history 2: Dermatitis

1) Determining fitness for work with IR is addressed in regulation 24(2). The elements of adequate medical surveillance are outlined in paragraph 446 (ACoP) of L121 and include determining whether specific conditions are necessary. Paragraph 447 (ACoP) of L121 states: 'The nature of the medical surveillance

for each individual should take account of the nature of the work with ionising radiation and that individual's state of health.' Paragraph 449 (guidance) of L121 states: 'The appointed doctor (or employment medical adviser) will need to take account of specific features of the work with ionising radiation, such as the fitness of the individual: ... (b) with a skin disease, to undertake work involving unsealed radioactive materials;'. Fitness for work subject to certain conditions is addressed in regulation 24(6). Examination of the skin and imposition of special conditions (eg regular clinical examination) are referred to in paragraphs 43–44 of this guidance.

2) DD appealed against the doctor's decision and a Medical Review Panel sat three months later. Their recommendations were: 'The extent of the eczema that the plater suffers from is variable in extent but work in the vicinity of open sources is inadvisable. Decontamination of the skin in the event of an accident could be difficult and the mechanical stress involved would be likely to exacerbate the condition. The skin condition is not considered sufficient reason to prevent the plater from working in radiation areas. The Review Panel therefore recommends that he should be permitted to work in radiation areas but that his medical records should indicate his work should not bring him into contact with open sources.' The findings of the Panel are still valid today. The appeals procedure is addressed in regulation 24(9) and in paragraphs 21–22 of this guidance.

Case history 3: Industrial radiographers

1) The employer has set the formal investigation level as 15 mSv and has specified it in the local rules.

A: His cumulative whole-body exposure for the past 20 years is 110 mSv. His whole-body exposure for the previous calendar year was 6 mSv. He is the radiation protection supervisor (RPS).

B: His cumulative whole-body exposure for the past two years is 25 mSv; for the previous calendar year it was 12 mSv.

C: His lifetime/cumulative whole-body exposure for the past 25 years is 120 mSv; for the previous calendar year it was 4 mSv.

The typical exposure for this industry is of the order of 5 mSv effective dose per year. Worker B has received significantly higher doses than workers A and C, which might be due to a number of reasons such as inadequate training, inexperience, recklessness, or an alcohol problem etc. In any event, the employer should have set the investigation level at a more appropriate dose such as 6 mSv.

2) The restriction of IR exposure for employees and others, so far as reasonably practicable, is addressed in regulation 8(1). The setting of an investigation level at an effective dose which is appropriate for the nature of the work, arrangements for reviewing unusually high doses and the elements of a formal investigation, are addressed in regulation 8(7) and paragraphs 154–157 (guidance) of L121. Paragraph 56 of this guidance recommends that gamma industrial radiographers have a clinical examination annually rather than a paper review as occurred in this case.

Case history 4: Previous cancer treatment

1) OC received 60 Gy to his bladder over a six-week period. This would have resulted in an effective dose of several Sv (whole-body) over the same period. Other engineers performing the same duties at the same factory receive annual effective doses of 0.1 mSv. OC's termination dosimetry record – 15 mSv whole-body.

2) Dose assessment and recording is addressed in regulation 21. The provision of a termination record is covered by regulation 21(3)(d), regulation 21(6)(b) and paragraph 397 (guidance) of L121. Paragraph 447 (ACoP) of L121 states: 'The nature of the medical surveillance for each individual should take account of the nature of the work with ionising radiation and that individual's state of health.' The issue of medical examination following change of employment is addressed in paragraph 452 (guidance) of L121 and paragraphs 19–20 of this guidance. The importance of establishing and documenting previous exposures to IR is covered by paragraphs 34–35 of this guidance.

3) The doses of ionising radiation which this individual is likely to receive over the rest of his working life will be minute in comparison to the doses which he received during his radiotherapy. They will not increase his risk of malignancy. Provided he is psychologically well adjusted to the prospect of work with IR again, he is fit for work.

Appendix 2 Training syllabus for appointed doctors

Doctors appointed under IRR99 are required to undertake specific training to perform this role. The main topic headings are:

- Introduction, legislation and the role and duties of the AD.
- Radiation – its nature, biological effects and measurement.
- Epidemiology of carcinogenesis and risk estimates.
- Deterministic and other effects of radiation and radiation protection.
- Assessment of fitness for work with IR.
- Response to overexposures, real or suspected, and emergencies.
- Counselling of workers and maintenance of knowledge.

Appendix 3 Examples of job descriptions

Engineer

An engineer about to work for a company that makes alloy components for the aerospace industry will use a 160 kV X-ray set to perform non-destructive testing on engineering components. His likely annual whole-body external radiation dose will be 0.1 mSv. The work will be carried out in a lead-lined room that has one set of interlocked doors and all exposures are controlled from outside the room. There is a small risk of high radiation exposures being received if safety systems fail. RPE is not required. Doses will be assessed by a TLD dosimeter worn on the trunk.

Contract welder

A contract welder is to be used to weld modified pipe work in close proximity to the reactor of a nuclear submarine. A risk assessment has revealed potential for significant exposure to IR from several likely exposure routes. They include external gamma and neutron exposure from the reactor compartment and internal exposure from surface contamination in the welding area leading to possible ingestion of radioactive materials. There is a small chance of intake through the skin and little chance of airborne contamination. The welder is likely to perform similar work in controlled areas at a number of sites in the course of a year. RPE, gloves and overalls are routinely worn. Other classified workers performing similar work receive total annual doses of the order of 2 mSv whole-body external gamma and neutron radiation. No internal dosimetry is routinely undertaken.

References

- 1 *Work with ionising radiation. Ionising Radiations Regulations 1999. Approved Code of Practice and guidance* L121 HSE Books 2000 ISBN 978 0 7176 1746 3 www.hse.gov.uk/pubns/priced/l121.pdf
- 2 *General guidance for appointed doctors. Role and responsibilities in statutory medical surveillance* HSE 2011 www.hse.gov.uk/pubns/ms30.pdf
- 3 *Treaty establishing the European Atomic Energy Community (signed in Rome on 25 March 1957)*. In: *Treaties Establishing the European Communities*. Office for Official Publications of the European Communities 1987 ISBN 92 825 7657 4
- 4 *Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation*. Official Journal of the European Community L159, 29/6/1996, pp1–114
- 5 Form F2067: www.hse.gov.uk/forms/health/f2067.pdf
- 6 *A guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995* L73 (Third edition) HSE Books 2008 ISBN 978 0 7176 6290 6 www.hse.gov.uk/pubns/priced/l73.pdf
- 7 *Incident at work?* Flyer MISC769 HSE Books 2007 www.hse.gov.uk/pubns/misc769.pdf
- 8 Form FODMS101: www.hse.gov.uk/forms/health/fodms101.pdf
- 9 *Guidance on Ethics for Occupational Physicians (Sixth edition)*. Faculty of Occupational Medicine of the Royal College of Physicians 2006 ISBN 1860162800
- 10 *Data Protection Act 1998* The Stationery Office 1998 ISBN 978 0 10 542998 2
- 11 *Working safely with ionising radiation: Guidelines for expectant or breastfeeding mothers* INDG334 HSE Books 2001 www.hse.gov.uk/pubns/indg334.pdf
- 12 *The Ionising Radiation (Medical Exposure) Regulations 2000* SI 2000/1059 The Stationery Office 2000 ISBN 0 11 099131 1
- 13 *The Ionising Radiation (Medical Exposure) (Amendment) Regulations 2006* SI 2006/2523 The Stationery Office 2006 ISBN 0 11 075114 0
- 14 *The Radiation (Emergency Preparedness and Public Information) Regulations 2001* SI 2001/2975 The Stationery Office 2001 ISBN 0 11 029908 6
- 15 *Technical Handbook on the National Arrangements for Incidents Involving Radioactivity (NRPB-W7)* National Radiological Protection Board 2002 ISBN 0 85951 478 1 Available to download from: www.hpa.org.uk

Further information

Further comprehensive information on ionising radiation and radiation protection can be obtained on HSE's ionising radiation website: www.hse.gov.uk/radiation/ionising/index.htm.

Additional information and advice on ionising radiation can be found on the Health Protection Agency's (HPA's) website: www.hpa.org.uk/Topics/Radiation/. The HPA's Radiation Protection Division (formerly the National Radiological Protection Board (NRPB)) has an extensive publications programme.

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This document is available at www.hse.gov.uk/pubns/ms33.pdf.

© *Crown copyright* This publication may be freely reproduced, except for advertising, endorsement or commercial purposes. First published 04/11. Please acknowledge the source as HSE.