

# Guidance for appointed doctors on the Work in Compressed Air Regulations 1996

## Introduction

1 This guidance provides information for appointed doctors on how to conduct medical surveillance on employees working in compressed air, for the purposes of the Work in Compressed Air Regulations 1996.<sup>1</sup> Appointed doctors should be familiar with this guidance and further guidance on working in compressed air produced by the Health and Safety Executive (HSE)<sup>2</sup> and the British Tunnelling Society.<sup>3</sup> They should also be familiar with the HSE document *General guidance for appointed doctors*.<sup>4</sup> References to specific regulations in the text below relate to the Work in Compressed Air Regulations 1996.

## Background

2 The Work in Compressed Air Regulations 1996 provide a framework for the management of health and safety risks by those in charge of tunnelling and other construction work in compressed air. Regulation 10(1) requires employers to make sure all employees working in compressed air are under adequate medical surveillance by an appointed doctor or employment medical adviser (Medical Inspector).

3 The health effects associated with work in compressed air include:

- barotrauma – this happens when a change in surrounding pressure causes direct damage to air-containing cavities in the body, which are directly connected with the surrounding atmosphere, principally the ears, sinuses and lungs;
- decompression illness – this predominantly occurs as a condition involving pain around the joints, or more rarely, as a serious, potentially life-threatening condition which may affect the central nervous system, heart or lungs; and
- dysbaric osteonecrosis – a long-term, chronic condition which damages the long bones, hip or shoulder joints.

4 Barotrauma, decompression illness and osteonecrosis are all reportable under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995.<sup>5</sup> In addition, they are prescribed industrial diseases (under the term 'dysbarism') for which statutory compensation may be paid.

## Role of the appointed doctor

5 The appointed doctor must be competent in occupational medicine and have specialist knowledge of hyperbaric medicine. The minimum requirement is a Diploma in Occupational Medicine. Knowledge of hyperbaric medicine can be gained from appropriate courses in diving medicine. In this context, the appointed doctor should have the same level of training as an HSE Approved Medical Examiner of Divers.<sup>6</sup>

6 The appointed doctor's duties are:

- examining all those proposed for work in compressed air and certifying medical fitness before each worker is initially exposed to increased pressure. With the written, informed consent of the individual, the appointed doctor may inform their GP that a medical examination for work in compressed air has taken place and the outcome of assessment of fitness;
- assessing and certifying continuing fitness of all workers at a suitable frequency (see paragraphs 11 and 16); and
- maintaining accurate and comprehensive clinical records, ensuring they are kept safe for 40 years after the last exposure to compressed air on the contract.

7 Employers normally seek to have the contract medical adviser appointed to undertake medical surveillance. This may help with continuity between conducting surveillance and providing treatment. If the appointed doctor also acts as the contract medical adviser, and may therefore personally supervise hyperbaric treatments, they must be medically fit to enter the hyperbaric chamber, if required.

### Medical surveillance

8 The objective of the medical examinations is to make sure, as far as possible, that an employee is fit to work in compressed air. The opportunity can be taken to make sure that any worker exposed to compressed air is aware of the risks of decompression illness. In addition, it is recommended that the appointed doctor makes sure all workers certified fit are aware of the special risks of respiratory disorders and have received written advice on work in compressed air. Such advice is contained in the *Compressed air worker's health and exposure record*.<sup>7</sup>

9 All those working in compressed air also need to be fit for construction site and tunnel work. In particular, they should be fit enough to get themselves quickly to an area of safety in case of an emergency, such as fire or collapse.

10 Adequate medical surveillance includes a pre-exposure medical examination followed by a full medical examination, at least once in every 12-month period an individual is employed to work in compressed air.

11 Medical surveillance is not adequate unless further assessments are also made:

- at a frequency related to the working pressure (see paragraph 16);
- following illness or incapacity causing an inability to work for three or more days; or
- following any episode of ill health related to work in compressed air.

12 The complexity of the medical examinations recommended in paragraphs 18-54 means it is impractical for one doctor to examine large numbers of workers at short notice. However, the appointed doctor needs to have access to any of the special examinations required, and should not base decisions on inadequate or incomplete information, no matter how urgent the apparent need. Medical examinations should be arranged well before work begins. Employers should not assume that any individual, including those with professional involvement in the contract, will be found fit for this type of work.

13 On any contract, some staff may be recruited several months in advance, building up a reserve of fit workers. Health changes in the intervening months may be significant.

14 A thorough annual medical examination, and reporting of minor illnesses that may affect fitness for work, will help ensure individuals are not at risk of hyperbaric illnesses as a result of underlying medical conditions. However, it is advisable for the appointed doctor to monitor continuing fitness of individuals for work in compressed air during the course of a contract.

15 Monitoring needs to comprise a review of the individual's health based on sickness absence records, compressed air work history and any reported discomfort or ill health from exposure to compressed air. The review needs to take place at the compressed air site, where detailed records of exposure are available and where information can be obtained from lock attendants, those in charge and individual workers. The review may include examining the ears, nose and throat, or other systems, at the discretion of the appointed doctor.

16 Appropriate intervals for such assessments of fitness are as follows:

- once every three months for work taking place at pressures up to but not including 1.0 bar;
- monthly when pressures are 1.0 bar or over;
- more frequently, at the discretion of the appointed doctor, when the work involves arduous physical activity or mixed gas applications.

17 Any employee whose continuing fitness for work in compressed air is called into question, should be examined. No one should be further exposed to compressed air following an episode of decompression illness without having a medical assessment by the appointed doctor.

## **Medical examinations**

18 The first examination for an individual about to work in compressed air on any contract, and the annual full examination should include:

- a health questionnaire;
- a full clinical examination;
- pure tone audiometry;
- spirometry.

19 Where work is to take place at 1.0 bar or over, the examination should also include:

- at initial examination:
  - chest X-rays – these are not required routinely, but may be performed on individual compressed air workers, based on the appointed doctor's clinical judgement, taking into account medical history and results of the medical examination, including spirometry;
  - baseline full blood count and haemoglobin – these are recommended as an indication of general medical fitness;
- at initial and subsequent examinations:
  - an exercise tolerance test.

## **Questionnaire and interview**

20 It is advisable to check all points of the questionnaire used since not all workers fully understand the importance of some injuries and accidents. Assess the amount of previous exposure to compression. The interview also allows some assessment of character and understanding. Evaluate the willingness of the individual to undertake the proposed work. Discuss any doubts about this with them – it may contribute to reaching a decision of 'unfitness'.

21 At the start of a contract, a number of workers who genuinely fear work in compressed air may appear for examination. The appointed doctor should identify where this is the case, perform a proper physical examination, and if satisfied that individuals are not psychologically suited to work in compressed air, certify them as unfit.

22 The worker should be able to read written instructions and notices, and demonstrate familiarity with the underground construction industry. For some posts, a good standard of written and spoken English is necessary.

23 Workers should be aged 18 years or more. New starters will normally be aged 35 years or under. For experienced workers, the only real bar on age is an inability to meet the medical requirements. However, susceptibility to decompression illness increases with age.

### ***Physical examination***

24 The appointed doctor should assess weight from several aspects. Physique needs to be commensurate with weight. Height/weight ratios such as Body Mass Index (kg/m<sup>2</sup>) and careful assessment of body fat by skinfold measurement can be useful. The appointed doctor may also wish to consider screening with waist circumference or waist to hip ratio. Further information is available in the NICE clinical guideline on obesity.<sup>8</sup>

### ***Clinical examination***

#### ***Special considerations for women of reproductive capacity***

25 There is no experience of the outcome of pregnancy in women who have worked in compressed air. However, theoretical considerations and experimental results indicate there could be a risk of serious harm to the foetus from the presence of gas bubbles in the circulation. Therefore, pregnant women should not work in compressed air.

26 At the time of the medical examination, the appointed doctor should discuss with female workers the potential risk to a foetus from the effects of decompression and explain the need to declare a pregnancy early.

#### ***Ears, nose and throat***

27 Individuals exposed to compressed air must be able to clear their ears and should be free from relevant ear disease.

28 The external auditory meatuses need to be clean and free of excessive wax and infection. A small amount of wax may be left in situ. The tympanic membrane should be intact even if scarred from previous infection. The middle ear cleft should be patent and free of effusion and infection. A dry perforation of the eardrum should not disbar. Previous difficulty with either flying, sport or professional diving, or tunnel work, suggests caution is needed in the compression test.

29 All workers need to have a pure tone audiogram conducted according to accepted technical standards (see the HSE publication *Controlling noise at work*).<sup>9</sup> Noise-induced hearing loss (NIHL) is common in compressed air workers and baseline investigations are necessary. Severe NIHL may be a cause for rejection, particularly if it leads to communication difficulties.

30 Hearing loss typical of auditory barotrauma is less frequently seen but can be recognised in the 6-8 kHz range, usually as unilateral losses of 25 dB upwards. Assessing abnormalities of balance may require careful enquiry, and electronystagmography and caloric studies.

31 The nasal airways should be clear and free of infection and the sinuses free of disease. Any acute illness should be treated and any chronic illness carefully assessed. Nasal abnormality is associated with Eustachian tube dysfunction.

32 The mouth, tonsillar fauces and gums should be healthy, especially in those selected for emergency rescue and breathing apparatus duties. There should be no obvious dental cavities where air can get trapped. Full dentures are permitted.

#### ***Lungs and respiratory function***

33 The lungs should be clinically normal with normal chest development.

34 Imaging of the chest may be required, depending on a specific clinical indication arising out of the history and/or clinical examination.<sup>10-12</sup> Old primary foci are acceptable. Bullae and evidence of old lung disease or serious chest injury are unlikely to be acceptable. Chest surgery may be acceptable if the reason for the surgery would not itself disbar. Where doubt arises over the relevance of these conditions, the appointed doctor should seek the opinion of a consultant chest physician with an interest in hyperbaric/diving medicine.

35 Spirometry values for FEV1 and PEF should normally be 80% of the predicted values for age, height and sex. The FEV1/FVC ratio should normally be greater than 70%, although some men may have high FVC values permitting lower ratios after careful assessment. For further information, appointed doctors may wish to refer to the *British Thoracic Society guidelines on respiratory aspects of fitness for diving*.<sup>13</sup>

#### ***Heart and circulation***

36 The pulse should be in the normal range at rest. Sitting blood pressure should be no greater than 145/90 mmHg, with lower levels preferred in younger workers.

37 The heart should be normal in size and the heart sounds should be normal. The significance of any murmurs deemed not physiological requires assessment. The peripheral circulation should be normal.

38 An ECG should be recorded, if clinically indicated. Where a clinical need is established, conduct the ECG before exercise testing.

39 Perform a suitable exercise test which provides a result in a standardised and comparable manner (such as in METS, VO<sub>2</sub> uptake capacity in ml/kg/min or watts per kg body weight). While it may be difficult to advise on a minimum level of fitness required for this work, the appointed doctor should take into account the fitness required to get out quickly in case of an emergency and/or to rescue a colleague. For further information, appointed doctors may wish to consider the HSE document *The medical examination and assessment of divers (MA1)*,<sup>14</sup> which also includes a section on exercise testing. There may also be similar (non-HSE) guidance available on the fitness of firefighters.

40 Before undertaking exercise testing, the appointed doctor should consider the risk of a cardiac event during the test. There is further information in the section on exercise testing in MA1<sup>14</sup> and from the Resuscitation Council (UK).<sup>15</sup>

#### ***Abdomen and urine***

41 The abdomen should be normal to palpation. There should be no herniae.

42 The urine should be free of abnormal constituents. Where abnormalities are found, the appointed doctor should refer the individual for investigation.

#### ***Nervous system***

43 A full clinical neurological examination should be conducted.

44 The cranial nerves should be intact. All motor function should be normal, but stable abnormalities which do not interfere with safety may be acceptable. There should be no abnormalities in coordination and balance.

45 A history of spinal or cerebral decompression illness may disbar. Epilepsy, schizophrenia or other chronic psychological diseases such as serious mood disorder, bipolar disease, alcohol or drug abuse, and claustrophobia are likely to be contraindications. The appointed doctor should give special consideration to the safety of a worker who is using psychotropic medication.

46 Corrected distance vision should be 6/12 or better using both eyes. Near vision should be N8 using both eyes. Colour vision requires checking where this is relevant to the work.

#### ***Endocrine function***

47 Active thyroid disease, parathyroid disease and insulin-controlled diabetes are not acceptable. Any disease that may mimic one or more aspects of decompression illness, such as coma, should disbar. Maturity onset diabetes, controlled by diet, may be acceptable for some work that does not involve heavy physical exercise.

#### ***Skeleton***

48 Carefully assess old injuries and arthritic changes for their effects on safety, and liability to cause pain which could be confused with decompression illness.

49 Examine the back and obtain any history of back injury. Back surgery requires careful assessment. Severe, persisting pain or evidence of a prolapsed intervertebral disc should disbar, the latter at least temporarily.

50 For work at 1.0 bar or over, conduct imaging of the hips and shoulders for evidence of dysbaric osteonecrosis in all workers with previous experience (unless it is certain that no work has been undertaken at pressures of 1.0 bar or over). Access to the results of recent imaging may avoid the need for re-examination. Where there are lesions, the worker must be informed and disbarred if they are juxta-articular. Further details are given in paragraphs 55-60.

#### ***Haematology***

51 A haematological examination should be carried out, as clinically indicated.

#### ***Application of findings***

52 As a result of the medical examination, an individual may be found fit or unfit for work in compressed air or fit subject to limitations, for example on the pressure or duration of exposure. The findings of the examination need to be recorded in the statutory health record and in the individual's health and exposure record.

53 Susceptibility to decompression illness is generally thought to be related to body fat content. Increasing age and body fat content are both associated with an increased incidence of osteonecrosis. However, these associations are not clear-cut. In judging fitness for work in compressed air, the appointed doctor should consider clinical findings, age and body fat content. In addition, it is important to consider general physical fitness in relation to the work to be undertaken and previous experience of work in compressed air. The appointed doctor has to make an overall judgement on whether an individual is likely to be fit for the intended work and exposure to compressed air.

54 Casual visitors to compressed air should be discouraged. Medical standards should not be lowered for 'VIPs', including those with professional involvement in the contract.

## Screening for osteonecrosis

55 As a matter of routine and to avoid exposure to ionising radiation,<sup>10-12</sup> Magnetic Resonance Imaging (MRI) is now the preferred initial screening method to detect the presence of abnormalities in the long bone, which could be indicative of aseptic necrosis. Exposure to X-rays carries some risk from exposure to ionising radiation. However, the serious nature of the damage caused by osteonecrosis may justify the use of radiology to further confirm abnormalities detected with MRI in individual cases and at the discretion of the appointed doctor. This is especially so where MRI findings suggest the individual may not be fit to work in compressed air. Sufficiently robust staging criteria to help assess fitness for further exposure to work in compressed air are not available for MRI, whereas there is more experience with X-ray results. Appointed doctors/contract medical advisers may need to discuss the staging or assessment criteria for MRI with consultants responsible for evaluation of the imaging results. It is recommended that whenever possible, MRI investigations are conducted in the same facility and evaluated by the same consultants, to ensure consistency of reading.

56 Radiological skeletal surveys for the detection of osteonecrosis should be conducted according to guidance prepared by the Medical Research Council Decompression Sickness Panel<sup>16</sup> (shown in Appendix 1). It is preferable that the doctor reporting on the films has knowledge of the characteristic features of osteonecrosis.

57 The frequency at which the bones are examined should be related to the pressure to which an individual is exposed during the course of a contract, as follows:

- for pressures below 1.0 bar, there is no recorded case of dysbaric osteonecrosis and routine screening is not justified;
- where there has been no previous exposure to compressed air or diving, and for pressures of 1.0 bar or over, it is recommended that a skeletal survey is undertaken within three months of initial exposure to compressed air. This will provide a baseline for future reference;
- thereafter, screening at the discretion of the appointed doctor or contract medical adviser, should be repeated on an annual basis during the course of work and repeated one year after exposure to compressed air has ceased. Some work patterns at pressures in excess of 2.0 bar may require more frequent examinations.

58 At any working pressure, a repeat examination may be necessary if there are clinical indications of bone or joint disease or after a significant decompression incident.

59 The need for a follow-up survey can be entered on the health record by the examining doctor under the provision of regulation 10(5). Where a worker remains with the same employer after completion of a period of work in compressed air, the employer should arrange for any such follow-up examination to be performed.

60 The appointed doctor or contract medical adviser needs to retain the original MRI scans and radiographic plates, or digital records of them, for the same period as other clinical records.

## Health record

61 The results of medical surveillance are recorded in a health record maintained by the employer for each worker. The health record contains personal details of the worker and space to record the date, type and result of each medical assessment.

The outcome may be that a person is fit to work in compressed air, fit to work subject to certain restrictions or is unfit to work either temporarily or permanently in compressed air. The health record needs to contain information on the items listed in the first four bullet points in paragraph 67.

62 The health record is the employer's statutory record (regulation 10(3)) of the results of medical surveillance and they must keep it at the end of a contract for 40 years. The appointed doctor's duties include keeping the detailed clinical records. Individual employees should be given a personal health and exposure record that summarises the results of medical surveillance, hyperbaric experience and training. The health section in the individual health and exposure record duplicates the employer's health record. Personal copies of the health record describe part of an individual's medical history and workers may find it useful to bring it to their GP's attention.

#### ***Work restrictions specified in the health record***

63 Restrictions that may be placed on workers include those on:

- the maximum pressure to which a person should be exposed;
- the maximum duration of exposure per shift;
- the number of entries to be made per day; or
- the date of the next assessment.

64 Employers are required to ensure that any restriction is brought to the attention of the compressed air contractor, so they can notify lock attendants. Any list of those fit to enter compressed air needs to be clearly marked to indicate that a restriction applies to the worker concerned, and include a note of the nature of the restriction, for retention.

#### ***Availability of medical records***

65 The findings of an earlier medical examination by another appointed doctor in the immediately preceding four weeks may be accepted as proof of fitness, if no restriction has been imposed. For work at pressures below 1.0 bar, this period can be extended to 13 weeks. Where longer periods have elapsed, another examination needs to be conducted. Its content depends on the intended working pressure and availability of information from the previous medical examination. Appointed doctors should cooperate to make the results of previous medical surveillance available, to minimise unnecessary examinations. Records should be held on site to facilitate this.

#### ***Maintenance of a compressed air worker's health and exposure record***

66 Employees have a personal responsibility to safeguard their health and exposure record and to present it to their employer, so it can be updated and checks made before entering compressed air. All lists of personnel fit to enter the workings need to be kept up to date.

67 The compressed air worker's health and exposure record needs to contain the following information:

- personal details of the employee – name; national insurance number; date of birth; address (permanent);
- details of the employer – name; address; contracts at which the employee is exposed to compressed air;
- details of the appointed doctor – name; address; telephone number; name and address of the contract medical adviser, if different;
- details of medical surveillance – date, type and result of each assessment, including any restriction imposed on the exposure of the employee;
- details of exposure – date; shift; maximum working pressure; working period for each exposure;
- details of training – date of the instruction and training required by regulation 15.

68 The compressed air contractor should retain the health and exposure record until work in compressed air is completed or the individual leaves employment. During that time, it should be readily available to the worker named on it or their employer.

69 At the end of a contract or when workers leave employment, their compressed air worker's health and exposure records must be returned to them, updated to include:

- the name and details of the appointed doctor or employment medical adviser (Medical Inspector);
- details of all medical surveillance;
- details of exposures, decompressions and any decompression illness.

## Appendix 1: Radiological skeletal survey for aseptic necrosis of bone in compressed air workers<sup>16</sup>

- 1 While MRI imaging is now the preferred initial screening method, the criteria and guidelines for X-ray investigations are given below for reference until sound criteria are available for grading MRI imaging in relation to fitness for work.
- 2 The historical skeletal survey included antero-posterior projections of the heads and proximal shafts of both humeri and both femora together with antero-posterior and lateral projections of the distal two-thirds of both femora and proximal third of both tibiae, including the knee joints. **Examination of the knee joints, as described, is no longer necessary.**
- 3 The radiological diagnosis of early lesions of aseptic bone necrosis required high quality radiographs which demonstrated the bone trabeculae clearly. The optimum screen-film combination (using rare-earth intensifying screens, if available) and good screen-film contact was required, together with a grid of adequate ratio and a focal spot of 0.6 to 1.2 mm. A tube with a high speed rotating anode and 0.6 mm target, if available, was recommended.
- 4 Exposures should always be adequate. Probably the greatest fault lies in underpenetration of the bone tissue. Computerised techniques compensate for poor exposure.
- 5 The recommendations in the *Guidance notes for the protection of persons against ionising radiations arising from medical and dental use*<sup>17</sup> should be followed. **Gonads must always be protected by a lead shield when radiographing the hips.**

### **Shoulder: Antero-posterior projection**

- The area to be examined is the head and neck of the humerus, including the proximal third of the shaft.
- The radiograph should show the articular surface of the humeral head unobscured by overlying bony structures, and should give good definition of the trabeculae of the head and shaft.
- A 24 cm x 18 cm screen film is recommended with high definition or rare-earth intensifying screens and a moving grid.
- The examination is best carried out on a horizontal table.
- From the supine position, the patient is rotated through about 45° towards the side under examination until the blade of the scapula is parallel to the table top. The raised shoulder is supported on sandbags.
- The arm under examination should be straight, supinated and abducted 10°. An extending pull should be applied to the arm so that the humeral head is clear of the bony processes of the scapula.
- The X-ray beam should be at right angles to the film and centred over the head of the humerus. The beam should be collimated to show only the head and proximal third of the humerus.
- The patient should hold their breath while the exposure is made.

### **Hip joint and proximal third of the shaft of the femur: Antero-posterior view**

- The radiograph should show good definition of the articular surface of the femoral head and of the trabeculae of both head and shaft. The underlying acetabulum cannot be avoided.
- A separate radiograph of each hip is required.
- A 30 cm x 24 cm screen film is recommended with fast tungstate or rare-earth intensifying screens and a moving grid. Fast tungstate screens are recommended in this situation to reduce the radiation dose and 2.5- 5.0 kV more than normal should be used to increase penetration.

- **The gonads must be protected**, but take care to ensure that the protection does not obscure the femoral head.
- With the patient supine, the plane across the anterior superior iliac spine should be horizontal. The foot of the side under examination should be at right angles to the table top and sandbagged into position.
- The X-ray beam should be at right angles to the film, centred over the head of the femur, and collimated to show the head and proximal third of the femur.

***Knee joint: Antero-posterior projection to show the distal two-thirds of the femur and the proximal third of the tibia – these projections are no longer routinely required***

- The radiograph should show clear trabecular detail in the lower two-thirds of the femur and the upper third of the tibia.
- There is a variation of density between the middle and lower thirds of the femoral shaft, so that it is necessary to increase the kilovoltage, reduce the milliamperage, and use a moving grid to produce a radiograph of even contrast. Take care not to underpenetrate the shaft of the femur.
- Either a 40 cm x 15 cm screen film with high definition is recommended or rare-earth intensifying screens and a moving grid.
- The patient should sit on the X-ray table with legs extended.
- Each knee should be examined separately.
- The X-ray beam should be at right angles to the table top. In order that the lower two-thirds of the femur are included, the beam should be centred at the upper border of the patella – not through the joint space. The beam should be collimated to show only the area under examination.

***Knee joint: Lateral projection to show the distal two-thirds of the femur and the proximal third of the tibia – these projections are no longer routinely required***

- A lateral radiograph of the lower femur and upper tibia may demonstrate slight variations in bone density and trabecular detail which are not apparent in the antero-posterior projection.
- The requirements of definition are the same as for the antero-posterior projection. The gradation of density along the femoral shaft is also evident in the lateral projection, and the exposure should be adjusted to give a radiograph of even contrast.
- Either a 40 cm x 30 cm or a 40 cm x 15 cm screen film with high definition is recommended, or rare-earth intensifying screens and a moving grid.
- Using the wide film, positioning should be as for a normal lateral projection of the knee with the knee flexed and the tibia parallel to the long axis of the film. Take care to include the distal two-thirds of the femur.
- If the narrow film is used, the leg should be straight and parallel to the long axis of the film, to include the distal two-thirds of the femur.
- The X-ray beam should be at right angles to the film and centred over the femur level with the upper border of the patella. The beam should be collimated to the area under examination.

## References

- 1 *The Work in Compressed Air Regulations 1996* SI 1996/1656 The Stationery Office [www.legislation.gov.uk/uksi/1996/1656/contents/made](http://www.legislation.gov.uk/uksi/1996/1656/contents/made)
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- 16 'Radiological skeletal survey for aseptic necrosis of bone in divers and compressed air workers: Notes prepared by the Medical Research Council Decompression Sickness Panel' *Radiography* 1981 **47**(558):141-143

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### **Further information**

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