

# X-RAY AND RADIUM PROTECTION

## INTERNATIONAL RECOMMENDATIONS

We print below the recommendations for protection against dangers from  $\alpha$  rays and radium, as revised by the International X-Ray and Radium Commission at the Third International Congress of Radiology, held in Paris last July. The members representing Great Britain on the Commission are Dr. G. W. C. Kaye and Dr. Stanley Melville.

### GENERAL PRINCIPLES

The dangers of over-exposure to  $\alpha$  rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of  $\alpha$ -ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are: (a) injuries to the superficial tissues; (b) derangements of internal organs and changes in the blood.

### WORKING HOURS, ETC.

The following working hours, etc., are recommended for whole-time  $\alpha$ -ray and radium workers:

- (a) Not more than seven working hours a day.
- (b) Not more than five working days a week. The off days to be spent as much as possible out of doors.
- (c) Not less than four weeks' holiday a year, preferably consecutively.
- (d) Whole-time workers in hospital  $\alpha$ -ray and radium departments should not be called upon for other hospital service.
- (e) X-ray and particularly radium workers should be systematically submitted, both on entry and subsequently at least twice a year, to expert medical, general, and blood examinations. These examinations will determine the acceptance, refusal, limitation, or termination of such occupation.

### GENERAL X-RAY RECOMMENDATIONS

X-ray departments should not be situated below ground-floor level.

All rooms, including dark rooms, should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.

All rooms should be provided with adequate exhaust ventilation capable of renewing the air of the room not less than ten times an hour. Air inlets and outlets should be arranged to afford crosswise ventilation of the room.

All rooms should preferably be decorated in light colours.

A working temperature of about 18° C. (65° F.) is desirable in  $\alpha$ -ray rooms.

X-ray rooms should be large enough to permit a convenient lay-out of the equipment. A minimum floor area of 250 sq. ft. (25 sq. metres) is recommended for  $\alpha$ -ray rooms, and 100 sq. ft. (10 sq. metres) for dark rooms. Ceilings should be not less than 11 ft. (3.5 metres) high.

Wherever practicable the  $\alpha$ -ray generating apparatus should be placed in a separate room from the  $\alpha$ -ray tube.

### X-RAY PROTECTIVE RECOMMENDATIONS

An  $\alpha$ -ray operator should on no account expose himself unnecessarily to a direct beam of  $\alpha$  rays.

An operator should place himself as remote as practicable from the  $\alpha$ -ray tube.

The  $\alpha$ -ray tube should be surrounded as completely as possible with protective material of adequate lead equivalent.

The following lead equivalents are recommended under average conditions:

X Rays Generated by Peak Voltages	Kilovolts	Minimum Equivalent Thickness of Lead	Millimetres
Not exceeding	75	...	1.0
"	100	...	1.5
"	125	...	2.0
"	150	...	2.5
"	175	...	3.0
"	200	...	4.0
"	250	...	6.0
"	300	...	9.0
"	350	...	12.0
"	400	...	15.0

In the case of diagnostic work, the operator should be afforded protection from scattered rays by a screen of a minimum lead equivalent of 1 mm.

In the case of  $\alpha$ -ray treatment the operator is best stationed completely outside the  $\alpha$ -ray room behind a protective wall of a minimum lead equivalent of 2 mm. This figure should be correspondingly increased if the protective value of the  $\alpha$ -ray tube enclosure falls short of the values given in Table I. In such event the remaining walls, floor, and ceiling may also be required to provide supplementary protection for adjacent occupants to an extent depending on the circumstances.

Screening examinations should be conducted as rapidly as possible with minimum intensities and apertures. Palpation with the hand should be reduced to the minimum.

The lead glass of fluorescent screens should have the protective values recommended above.

In the case of screening stands the fluorescent screen should, if necessary, be provided with a protective "surround," so that adequate protection against direct radiation is afforded for all positions of the screen and diaphragm.

Screening stands and couches should provide adequate arrangements for protecting the operator against scattered radiation from the patient.

Inspection windows in screens and walls should have protective lead values equivalent to that of the surrounding screen or wall.

Efficient safeguards should be adopted to avoid the omission of a metal filter in  $\alpha$ -ray treatment.

Protective gloves, which should be suitably lined with fabric or other material, should have a protective value not less than 1/3 mm. lead throughout both back and front (including fingers and wrist). Protective aprons should have a minimum lead value of 1/2 mm.

### ELECTRICAL PRECAUTIONS IN X-RAY ROOMS

The floor covering of the  $\alpha$ -ray room should be of insulating material, such as wood, rubber, or linoleum.

Overhead conductors should be not less than 9 ft. (3 metres) from the floor. They should consist of stout metal tubing or other coronaless type of conductor. The associated connecting leads should be of coronaless wire, kept taut by suitable rheophores.

Wherever possible earthed guards or earthed sheaths should be provided to shield the more adjacent parts of the high-tension system. The use of  $\alpha$ -ray equipment having the high-tension circuit completely enclosed in earthed conductors is specially recommended. Unless there are reasons to the contrary, metal parts of the apparatus and room should be efficiently earthed.

The use of quick-acting double-pole circuit breakers is recommended. Over-powered fuses should not be used. If more than one apparatus is operated from a common generator, suitable overhead multi-way switches should be provided.

Some suitable form of kilovoltmeter should be provided to afford a measure of the voltage operating the  $\alpha$ -ray tube.

Special electrical precautions should be taken in rooms where anaesthetics are used in conjunction with  $\alpha$  rays.

### FILM STORAGE PRECAUTIONS

The use of non-inflammable  $\alpha$ -ray films should be encouraged. In the case of inflammable films, suitable precautions should be taken as regards their use and storage. Large stocks should be kept in isolated stores, preferably in a separate building or on the-roof.

### RADIUM PROTECTIVE RECOMMENDATIONS

#### (a) Radium Salts

Protection for radium workers is required from the effects of: (a) beta rays upon the hands; (b) gamma rays upon the internal organs, vascular and reproductive systems.

In order to protect the hands from beta rays, reliance should be placed, in the first place, on distance. The radium should be manipulated with long-handled forceps, and should be carried from place to place in long-handled boxes, lined on all sides with at least 1 cm. of lead. All manipulations should be carried out as rapidly as possible.

Radium, when not in use, should be stored in a safe as distant as possible from the personnel. It is recommended

that radium tubes or applicators be inserted into separate lead blocks in the safe, giving a thickness of protective wall amounting to the values given in the following table.

TABLE II.

Maximum Quantity of Radium Element	Thickness of Lead
0.2 grams ... ..	8.5 centimetres
0.5 " ... ..	10.0 "
1.0 " ... ..	11.5 "
2.0 " ... ..	13.0 "
5.0 " ... ..	15.0 "
10.0 " ... ..	17.0 "

A separate room should be provided for the "make-up" of screened tubes and applicators, and this room should only be occupied during such work.

In order to protect the body from the penetrating gamma rays during handling of the radium, a screen of not less than 2.5 cm. of lead should be used, and proximity to the radium should only occur during actual work, and for as short a time as possible.

The measurement room should be a separate room, and it should preferably contain the radium only during its actual measurement.

Nurses and attendants should not remain in the same room as patients undergoing radium treatment with quantities exceeding 1/2 gram.

All unskilled work or work which can be learnt in a short period of time should preferably be carried out by temporary workers, who should be engaged on such work for periods not

exceeding six months. This applies especially to nurses and those engaged in "making up" applicators.

Discretion should be exercised in transmitting radium salts by post. In the case of small quantities it is recommended that the container should be lined throughout with lead not less than 3 mm. thick. It is more satisfactory to transport large quantities by hand in a suitably designed carrying case.

#### (b) Radium Emanation

In the manipulation of emanation, protection against the beta and gamma rays has likewise to be provided.

The handling of emanation should be carried out, so far as possible, during its relatively inactive state.

The escape of emanation should be very carefully guarded against, and the room in which it is prepared should be provided with an exhaust fan.

Where emanation is likely to come into direct contact with the fingers, thin rubber gloves should be worn to avoid contamination of the hands with active deposit. Otherwise, the protective measure recommended for radium salts should be carried out.

The pumping room should preferably be contained in a separate building. The room should be provided with a connecting tube from the special room in which the radium is stored in solution. The radium in solution should be heavily screened to protect people working in adjacent rooms. This is preferably done by placing the radium in solution in a lead-lined box, the thickness of lead recommended being according to Table II.

## Nova et Vetera

### ROUBILIAC, CHESELDEN, AND BELCHIER

A fortunate visit by Mrs. Esdaile to the Royal College of Surgeons of England to examine the portrait busts of English surgeons has resulted in the rehabilitation of the two fine terra-cotta busts of Cheselden and Belchier which now stand in the entrance hall of the building. The two busts had for many years been "skied" on brackets over the entrance to the Council room and the Examiners' room, and were described as plaster casts, for they had been repeatedly painted. Mrs. Esdaile, with the eye of an artist, recognized them as something more worthy, and, obtaining a ladder, industriously picked away nine or ten layers of paint until she found what she expected to find—a terra-cotta basis. Informed of this discovery, the President and Council ordered the busts to be stripped of the paint, and there has resulted two real works of art attributed unhesitatingly to Roubiliac, the master sculptor of his generation in England.

The busts were given to the College by Mr. Lucas on December 24th, 1804. The donor, William Lucas, was elected surgeon to Guy's Hospital in 1773, and retired in 1799. "A clever manipulator and a neat surgeon, but not an anatomist," according to Sir Astley Cooper, "he got £300 a year by bleeding, visited a hundred families, but never made more than £500 per annum." His son succeeded his father as surgeon at Guy's in 1799, and resigned in 1824. "He was neat handed but rash in the extreme, cutting amongst most important parts as if they were only skin, and making us all shudder from apprehension of his opening arteries or committing some other error," says Sir Astley.

William Cheselden (1688-1752) was surgeon to St. Thomas's Hospital from 1718 to 1738, and was also for a short time (1733-38) surgeon to St. George's Hospital, then newly founded. He was a man of many attainments, for he is said to have drawn the plans for old Putney Bridge; he was a friend of Addison, Pope, Mead, and Sir Hans Sloane; he was a first-rate pugilist, and he perfected the operation of lateral lithotomy. He was chosen Sheriff of London on June 24th, 1743, but was

allowed to "swear off" on the ground that his estate in lands and goods was not of the value of £1,500. He was a member of the United Company of Barbers and Surgeons, and it was partly due to his action that the Surgeons' Company came into existence and the old alliance of Barbers and Surgeons was dissolved.

John Belchier (1706-85) was a favourite pupil of William Cheselden, and was surgeon to Guy's Hospital (1735-68). In one of his papers read before the Royal Society he proved that madder given with food stains the bones bright red. He was a stout and heavy but active man, of whom the story is told that a patient came to him with a pretended complaint. Belchier assured him there was nothing the matter, and the man clapped a pistol to his breast, demanding money. Belchier offered him two guineas and his gold watch. The patient lowered his pistol to take them, and Belchier immediately knocked him down and sat upon him until assistance came. He was buried in the same vault as Guy in the hospital chapel.

Louis François Roubiliac (or Roubillac) (1695-1762) was born at Lyons, and came to London about 1738. He carved a statue of Handel, which was long one of the glories of the Vauxhall Gardens. About 1740 he was making busts, and among his sitters was Dr. Mead; the busts of Cheselden and Belchier were probably executed about this time. A few years later he was engaged on various funeral monuments, of which perhaps the best known are in Westminster Abbey—the Nightingale monument being probably his last work, for he died on January 11th, 1762. He was buried in the churchyard of St. Martin's-in-the-Fields, poor and in debt. Character rather than beauty seems to have been his aim, and the two busts at the College of Surgeons show this most remarkably now that the disfiguring paint of years has been removed. It is noteworthy, too, that at a time when everyone wore a wig neither Cheselden nor Belchier is represented with one, thus bearing out the statement of Nollekens, whose father was apprenticed to the sculptor, that, "notwithstanding his skill, he was not fond of introducing a wig, and endeavoured to persuade his sitters to take their wigs off. His busts of Pope, Lord Bolingbroke, Martin-Folkes, Drs. Mead and Frewin, and numerous others of men of literature are without wigs."

D'ARCY POWER.