

U.S. DEPARTMENT OF COMMERCE

DANIEL C. ROPER, Secretary

BUREAU OF STANDARDS

LYMAN J. BRIGGS, Director

BUREAU OF STANDARDS HANDBOOK No. 18

RADIUM PROTECTION FOR AMOUNTS UP TO 300 MILLIGRAMS

[MARCH 17, 1934]



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1934

PREFACE

Upon the recommendation of the International X-ray Protection Commission in 1928, the Advisory Committee on X-ray and Radium was formed in the United States for the purpose of preparing a unified set of safety recommendations. In order to have a committee not too cumbersome and yet thoroughly representative of the several phases of the art, two members were appointed by each radiological society, two by the manufacturers of X-ray equipment, and one by the American Medical Association. The presidents of the radiological societies were each asked to appoint one physicist and one radiologist. The members representing the manufacturers were selected by the manufacturers through nomination and ballot.

The following members compose the committee:

Representing International Safety Committee and Bureau of Standards for X-rays: LAURISTON S. TAYLOR, physicist.

Representing the Bureau of Standards for Radium: L. F. CURTISS, physicist.

Representing American Roentgen Ray Society:

H. K. PANCOAST, M.D., University of Pennsylvania Hospital, Philadelphia, Pa.

J. L. WEATHERWAX, physicist, Philadelphia General Hospital Philadelphia, Pa.

Representing Radiological Society of North America:

R. R. NEWELL, M.D., Stanford University Hospital, San Francisco, Calif.

G. FAILLA, physicist, Memorial Hospital, New York, N.Y.

Representing the American Medical Association: FRANCIS CARTER WOOD, M.D., St. Lukes Hospital, New York, N.Y.

Representing X-ray Equipment Manufacturers:

W. D. COOLIDGE, director, research laboratory, General Electric Co., Schenectady, N.Y.

W. S. WERNER, vice president of Kelley-Koett Manufacturing Co., Covington, Ky.

Representing the American Radium Society:

SANFORD L. WITHERS, M.D., Denver, Colo.

CURTIS F. BURNAM, M.D., Howard A. Kelley Hospital, Baltimore, Md.

The committee's first report covering X-ray protection (including electrical protection and the storage of X-ray film)

was published in 1931 prior to the Third International Congress of Radiology in Paris. This was published originally by the Bureau of Standards as Handbook No. 15¹ and was subsequently reprinted by two Radiological Journals.^{2 3} That the committee's effort appears to have been worth while is evidenced by the fact that in addition to a thousand copies distributed by the American Roentgen Ray Society, the demand for copies from the United States Public Printer has necessitated a second printing, making a total of some 2,500 copies distributed.

In preparing the recommendations for radium protection, it was found, after considerable study, to be impractical at the present time to formulate protection specifications for large quantities of radium such as used in the so-called "packs" or "bombs". There are comparatively so few users of quantities of radium in excess of 300 mg that adequate practical experience is not sufficiently available to serve as a basis for a report. Moreover, it was found, in general, that where large quantities of radium are being used, its use is in the hands of competent physicians and physicists who are fully aware of the danger involved in its handling. The means of protection worked out by these individuals are at present too varied to permit of generalization.

Consequently, since the bulk of the users of radium employ amounts less than 300 mg, and since it is in this class that the making up of applicators largely falls, the committee decided to proceed with the publication of the present report. In the meantime, the question of protection for larger amounts of radium is under active consideration and it is hoped that a report may be prepared in the near future covering these points.

The committee recognized that future development of the art may require changes in these recommendations. Since the existence of the committee is not permanent, it recommends that any future changes be made by the Bureau of Standards after consultation with proper and recognized committees.

¹ Bureau of Standards Handbook No. 15, obtainable from the Government Printing Office, Washington, D.C. Price 10 cents.

² Radiology, vol. 17, p. 542, 1931.

³ Am. Jour. Roent. and Ra. Therapy, vol. 26, p. 436, 1933.

RADIUM PROTECTION FOR AMOUNTS UP TO 300 MILLIGRAMS

[This shall also apply to finished radon preparations]

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I. GENERAL

1.01. Protection for radium workers is required from the effects of (a) beta and secondary gamma rays especially upon the hands and (b) gamma rays upon the whole body.

1.02. Protection against gamma rays is most adequately secured by remaining as distant as possible from the radium. All storage containers shall be at least 3 meters (10 feet) distant from any place habitually occupied by any person.

1.03. Radium, when not in use or transit, shall be kept completely inclosed in a lead container of the following wall thicknesses on all sides:

Maximum quantity of radium element	Lead thickness
<i>mg</i>	<i>cm</i>
100	4
200	5
300	6

The total weight may be kept small by having the smallest possible inside dimensions for the storage container.

NOTE.—It is suggested that radium preparations be inserted into suitably designed grooves, slots, or holes in the lead storage block, with a special place for each needle, tube, or applicator. This serves the double purpose of permitting the larger amounts of radium to

have the greatest thickness of protective wall and the ready checking of the presence of each applicator, needle or tube.

II. TRANSPORTATION

2.01. Carrying containers shall be equipped with handles of such length that the hands cannot come nearer than 30 cm (12 in.) to the radium.

NOTE.—It is suggested that carrying containers have a conspicuous red sign reading "RADIUM—keep away!".

2.02. Containers for shipment by post, express, or messenger shall be lined with lead of at least 25 percent of the values given in paragraph (1.03). In addition, the lead box shall be so packed or supported that the hands cannot be brought nearer than 15 cm (6 in.) to the radium.

III. MANIPULATION AND PREPARATION

3.01. A separate room shall be provided for the preparation and measurement of filtered tubes and applicators, and such room shall be occupied only during such work and by such personnel required therefor.

3.02. Radium measurements should be performed in a separate room. No radium should be kept in such a room except during its actual measurement.

3.03. The bench or table where radium applicators are prepared shall be provided with the following:

(a) Adequate light.

(b) A lead L, 4 cm in thickness and each face about 40 cm (16 in.) square. (Cast iron of equivalent thickness may also be used.) The side where the workers stands should have a pad or barrier to hold the body at least 20 cm (8 in.) from the point where the radium is handled.

(c) Suitable forceps, tongs, and pliers, the handles of which are either made of or covered with rubber, celluloid or other organic material. Forceps should be of such length as to permit easy manipulation without bringing the fingers nearer than 10 cm (4 in.) to the tips. Forceps shall be of such construction as to permit a secure grip on the radium containers with a minimum of force exerted by the

fingers. (Cross-action forceps are in general suitable). There should be available several pairs of forceps with cupped or notched tips for secure gripping of radium needles.

(d) A vise or clamp forceps, to hold a container which is to receive several tubes or needles.

(e) Vises mounted behind the protective L for holding radium tubes, needles, or applicators.

(f) A threading device for pulling string, wire, or thread through the eyes of needles or tubes. Such devices shall be so arranged as to permit ready use without bringing the hands nearer than 10 cm (4 in.) to the applicator.

IV. PERSONNEL

4.01. No person should remain constantly with or near:

(a) Radium in storage (minimum distance 10 feet).

(b) Radium during preparation; (see sec. III).

(c) A patient undergoing radium treatment.

4.02. An operator should never be permitted to touch a bare radium container with the fingers or hands.

4.03. Regular or permanent radium workers shall not remain nearer than 1 m (3 ft.) for more than 1 hour daily to a patient to whom is applied radium in quantities up to 300 mg.

NOTES (based on present knowledge):

(a) The safe general radiation to the whole body is taken as $1/10 r$ per day for hard X-rays and may be used as a guide in radium protection. $5 r$ per day has been taken as the tolerance for the fingers. It must be emphasized that the calculation of radium dosage is not easy and too great reliance is not to be put on the above figures.

(b) If, by chance, the hand comes closer to the radium than these requirements permit, then one can estimate the danger incurred by the following table of daily exposures which are considered dangerous:

(1) Holding bare 100 mg radium preparation filtered with at least 0.3 mm monel metal and 5-mm diameter—5 seconds.

(2) Holding 100 mg filtered radium preparation 20 mm diameter—1 minute.

(3) Holding 100 mg filtered radium preparation in forceps at 10 cm (4 in.) from the finger tips—2 hours.

Separate exposures incurred during the same day are to be added together in estimating the total daily exposure.

4.04. Permanent radium technicians should have at least 6 weeks vacation a year, preferably 4 weeks during the sum-

mer and 2 weeks during the winter. They should be urged to spend as much time as possible out of doors, both during vacation and after working hours.

4.05. Technicians shall not loiter in preparation rooms.

4.06. Before a technician is employed, he should be told very definitely about the possible dangers of radium work. Permanent employment as a radium technician should not be promised.

4.07. Before employing a technician for radium work, a complete physical examination and blood count should be made. If there are any unaccountable abnormalities, he should not be employed. Technicians with dry skin, having a tendency to crack, a skin with warts, or a skin showing signs of abuse (cuts, cracks, etc.), should not be employed in radium work. In the physical examination particular attention should be given to teeth, tonsils, and focal infections.

4.08. Frequent examination of the technician's hands should be made throughout employment. Any evidence of skin changes as a result of radiation should necessitate a change in employment.

NOTE.—Blood counts at regular intervals are highly desirable. In general, while a positive result is of some significance, a negative result should not be interpreted as a safety criterion. Under proper conditions and wise interpretation, the blood count can be used as a safety criterion.

4.09. A complete blood count consists of the following determinations: Hemoglobin test, red, white, and differential counts; the latter including percentages of polymorphonuclear cell, small and large lymphocytes (separately), eosinophiles and basophiles.

4.10. Blood counts should be made before employment of a permanent technician, and every month subsequently, always under the same conditions, i.e., same technique, hour of day, etc. Where the white blood count, below 4,000, is confirmed, the technician should be subjected to a thorough physical examination and his working conditions investigated.

V. EMANATION (RADON)

5.01. All preceding paragraphs also apply to the protection from radium emanation (radon).

5.02. The handling of emanation (radon) should be done as far as possible during its relatively inactive state (10 minutes after pumping).

5.03. Great care should be taken to prevent the escape of emanation (radon), and the room in which it is prepared should be provided with an exhaust fan, giving a complete change of air every 10 minutes. Working under a hood is to be recommended.

5.04. Where emanation (radon) 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.

5.05. The pumping room should be separate from the room in which the radium in solution is stored and should be connected thereto by a conducting tube adequately shielded with lead.

5.06. Radium in solution should be completely surrounded with lead or equivalent material of thickness in accordance with paragraph 1.03 above.

5.07. Only specially trained operators shall be employed in emanation (radon) pumping or measuring rooms.

5.08. Operation of pumping apparatus shall be carried out insofar as practicable with the operator at least 1.5 meters from the nearest apparatus containing emanation (radon). Remote control devices shall be used when practicable.

5.09. Suitable automatic indicators and regulators shall be used to prevent undue pressures in the pumping apparatus with consequent explosion.

5.10. Measurements, and handling during measurements, of emanation (radon) should be carried out with automatic or semiautomatic devices with remote control.



