

RADIATION PROTECTION

*Recommendations of
the International Commission on
Radiological Protection*

ICRP PUBLICATION 3

Report of Committee III
on
Protection Against X-Rays up
to Energies of 3 MeV and Beta- and
Gamma-Rays from Sealed Sources
(1960)

PUBLISHED FOR
The International Commission on Radiological Protection
BY
PERGAMON PRESS

OXFORD · LONDON · NEW YORK · PARIS

PERGAMON PRESS LTD.
Headington Hill Hall, Oxford
4&5 Fitzroy Square, London W.1.

PERGAMON PRESS INC.
122 East 55th Street, New York 22, N.Y.
P.O. Box 47715, Los Angeles, California

PERGAMON PRESS S.A.R.L.
*24 Rue des Écoles, Paris V**

PERGAMON PRESS G.m.b.H.
Kaiserstrasse 75, Frankfurt am Main

Library of Congress Card Number 59-10730

First Published 1960

Printed in Northern Ireland at The Universities Press, Belfast

PREFACE

THE Report of Committee III on Protection against X-Rays up to Energies of 3 MeV and Beta- and Gamma-Rays from Sealed Sources is the result of the work of the Committee during and after the regular meeting in Geneva in 1956. Since 1956, some members of the Committee have met in New York in 1958, and the report has been reviewed at meetings in Geneva 1958 and Munich 1959. The report indicates the requirements necessary for ensuring adequate protection in the various uses of the radiations to which it relates. In respect of industrial applications, the report is in conformity with the 1958 revision of Chapter XI. Section 2, of the Model Code of Safety Regulations for Industrial Establishments published by the International Labour Office.

The co-operation of the 1958 Publication Committee is gratefully acknowledged. The Committee also greatly appreciates the assistance of Mr. Lars Lorentzon in collecting and preparing the Appendix material and the help of Dr. L.-E. Larsson who assisted the Publication Committee in the Editorial preparation of the report.

The 1956–1959 Membership of the Committee was as follows:

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Also contained in this publication is a reprint of the Recommendations of the International Commission on Radiological Protection (September 9, 1958) (I.C.R.P. Publication 1) together with an addendum which was adopted in July 1959 and which consists largely of explanatory statements and amendments to the 1958 Recommendations. The Report of Committee III is in conformity with both the 1958 Recommendations and the 1959 Amendments.

Chairman Committee III	R. G. JAEGER
Vice-Chairman Committee III	E. E. SMITH

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REPORT OF COMMITTEE III
ON
PROTECTION AGAINST X-RAYS UP TO ENERGIES OF
3 MeV AND BETA- AND GAMMA-RAYS
FROM SEALED SOURCES

A. INTRODUCTION

(1) In this report, which is based upon the codes of practice in operation in various countries, the main emphasis has, in accordance with the Commission's policy, been placed on the basic requirements of radiation protection, leaving the expansion of detailed technical requirements to national committees. It has, however, been considered desirable to add an appendix containing certain graphs, tables and examples from which the necessary numerical values for radiation protection can be obtained.

(2) It will be noted that the upper limit for this report has been extended to 3 MeV. This value is regarded by the International Commission on Radiological Units and Measurements (ICRU) as the upper limit of the energy range over which the röntgen should be used. It therefore provides a logical division between the scope of Committees III and IV.

(3) In addition to the revision of the previous report (1 December 1954), sections have been added on the use of sealed beta- and gamma-ray sources, including gamma-ray beam equipment. The sub-section on X-ray analysis equipment has been considerably expanded.

(4) The maximum permissible doses which are recommended for external radiations are given in Section C of ICRP Publication 1 as amended and reprinted on pages 61-84 in this book. For the purposes of this Report, the organ or tissue dose in rads (or rems) is assumed to be numerically equal to the exposure dose in röntgens measured in air.

(5) In view of the increasing use of radiation and of radiation producing equipment, it is now regarded as essential to consider not only radiation workers and patients, but also all other persons in the vicinity. Such persons are considered by the Commission to constitute special groups for whom lower maximum permissible levels have been recommended. These lower levels necessitate increased protection for some radiation installations, particularly those adjacent to living or other accommodation which may be occupied by the same persons for a considerable fraction of the entire week.

(6) It should be stressed that recommendations for the installation and operation of X-ray equipment, or for dealing with radioactive materials, are not in themselves sufficient to guarantee adequate protection. Such protection depends largely on the expert knowledge of the staff and on their co-operation in carrying out the instructions prepared by their supervisor in the interests of radiation protection.

(7) The responsibility of the head of the department for the provision of working conditions in accordance with any regulations, recommendations or codes of practice on radiation protection in operation in his own country has been dealt with in Section D of ICRP Publication 1. He shall also be responsible for ensuring that all instructions and operating conditions specified in the radiation survey report are complied with.

(8) The head of the department shall ensure that adequate medical examinations and radiation monitoring of personnel are carried out, as recommended in Section D of ICRP Publication 1.

(9) It is the duty of the workers, upon the instruction of a qualified expert or responsible supervisor, to follow the recommendations and instructions which have been drawn up in the interests of radiation protection; further, to use the protective devices provided for their welfare, and to bring to the notice of those in charge any defect that has been revealed.

(10) The genetic consequences of the medical uses of ionizing radiations have received much consideration recently and the importance of avoiding unnecessary exposure of patients has been stressed. Attention is therefore drawn to those recommendations which have the purpose of limiting this exposure.

(11) The radiological examination of human beings for non-medical purposes is undesirable and is not recommended. Examples of such examinations are shoe-fitting and anti-crime fluoroscopy.

(12) Further consideration has been given to the emission of X-rays from television equipment, and a reduction in the maximum permissible dose-rate close to the surface of home television sets has been recommended. This revision is required to limit the genetic dose to the population, in view of the widespread use of television. Most of the current types of home television receiver already comply with the new lower limit. Other types of television equipment have also received consideration in this report.

(13) In the previous report, reference was made to the question of introducing a radiation certificate upon which all doses of radiation received by a person from medical exposure to ionizing radiations are recorded. This question has been extensively studied jointly by the ICRP and the ICRU and the conclusion was reached that "the systematic recording and registration of the radiation received by every member of the population is not recommended".*

B. DEFINITIONS

(14) For the purposes of this report the following definitions are given:

Attenuation: decrease in dose rate of radiation in passing through a material.

(1) **Narrow beam attenuation:** attenuation obtained under conditions designed effectively to prevent the inclusion of scattered radiation in the transmitted beam.

* "Exposure of Man to Ionizing Radiation Arising from Medical Procedures". A report of the ICRP-ICRU, 1957. *Physics in Medicine and Biology*, p. 107, 2, 1957.

- (2) **Broad beam attenuation:** attenuation obtained under such conditions that the maximum amount of scattered radiation is included in the transmitted beam.

Collimation: the limiting of a beam of radiation to the required dimensions.

Half-value layer (HVL): the thickness of a specified absorbing material which, when introduced into the path of a beam of radiation, reduces the dose-rate to one-half of its original value.

Ionizing radiation: see **Radiation**

Lead equivalent: the thickness of lead, which, under specified conditions of irradiation, affords the same protection as the material under consideration. The lead equivalent of a substance, such as lead-glass or lead-rubber, which attenuates the radiation essentially by its lead content, is largely independent of the quality of the radiation. The lead equivalent of all other protective materials and also building materials for protective walls (concrete, brick, etc.) and barium protective glass show a dependence on the quality of the radiation.

Occupancy factor: the factor by which the work-load should be multiplied to correct for the degree or type of occupancy of the area in question. This factor may be based in general on the degree of occupancy averaged over a year.

Primary protective barrier: Barrier sufficient to attenuate the useful beam to the required degree.

Protective source housing: enclosure for one or more sealed sources, which limits the leakage radiation to a specified level.

Teletherapy protective source housing: housing so constructed that

- (A) With the beam control mechanism in the "OFF" position,
- (a) at 1 metre from the source, in any direction, the maximum dose-rate of the leakage radiation does not exceed 10 mr/h nor does the average dose-rate exceed 2 mr/h, and
 - (b) at 5 cm from the housing surface, in any readily accessible position, the respective dose-rates
 - (1) do not exceed 10 times the above values in the case of housings for sources with a useful beam dose-rate of more than 100 r/h at 1 metre from the source,
 - (2) do not exceed 20 times the above values in the case of housings for sources with a useful beam dose-rate of less than 100 r/h at 1 metre from the source.
- (B) With the beam control mechanism in the "ON" position,
- (a) in the case of housings for sources with a useful beam dose-rate of more than 100 r/h at 1 metre from the source,
 - (1) the maximum dose-rate of the leakage radiation at a source distance of 1 metre does not exceed either 1 r/h or 0.1 per cent of the useful beam dose rate at 1 metre from the source, whichever is the greater and
 - (2) adjustable beam defining diaphragms do not allow the transmission of more than 5 per cent of the useful beam dose-rate.

- (b) in the case of housings for sources with a useful beam dose-rate of less than 100 r/h at 1 metre from the source no values are recommended but in the design and use of such housings, consideration shall be given to minimizing the integral dose to the patient from leakage radiation.

Industrial protective source housing: housing so constructed that with the beam control mechanism in the "OFF" position, the dose rate conforms to the requirements of (A, a) and (A, b, 1) of the specification for teletherapy protective source housing. The protection to be afforded in the "ON" position is determined by operational requirements.

Protective tube housing: housing which surrounds the X-ray tube itself, or the tube and other parts of the X-ray apparatus (for example, transformer) and limits the major portion of the radiation emerging from the tube to the "useful beam". Each protective tube housing shall have its type marked upon it.

Diagnostic-type protective tube housing: housing so constructed that at every specified rating of the X-ray tube the leakage radiation at a focal distance of 1 metre does not exceed 100 mr in 1 hour.

Therapeutic-type protective tube housing: housing so constructed that at every specified rating of the X-ray tube the leakage radiation at a focal distance of 1 metre does not exceed 1 röntgen in 1 hour, nor 30 r in 1 hour at any point accessible to the patient at a distance of 5 cm from the surface of the housing or its accessory equipment.

Radiation (ionizing radiation): electromagnetic radiation (X-ray or γ -ray photons or quanta), or corpuscular radiation (α -particles, β -particles, electrons, positrons, protons, neutrons and heavy particles) capable of producing ions.

(1) **Primary radiation:**

- (a) **X-rays:** radiation coming directly from the target of the X-ray tube. Except for the useful beam, the bulk of this radiation is absorbed in the tube housing.
- (b) **β - and γ -rays:** radiation coming directly from the radioactive source.

(2) **Secondary radiation:** radiation, other than the primary radiation, emitted by irradiated matter.

(3) **Scattered radiation:**

- (a) **Side scattered radiation:** radiation which is scattered in directions approximately at right angles to the direction of the primary beam.
- (b) **Back scattered radiation:** radiation which is scattered in directions approximately opposite to the direction of the primary beam.

(4) **Useful beam:** That part of the primary and secondary radiation which passes through the aperture, cone or other device for collimation.

(5) **Leakage radiation:** All radiation, except the useful beam, coming from the tube or source housing.

(6) **Stray radiation:** Radiation other than the useful beam. It includes leakage radiation and secondary radiation.

Sealed source: A discrete amount of radioactive material within a tight, firm and inactive enclosure which effectively prevents the loss of radioactive substance during routine use. In the presence of gaseous radioisotopes (e.g. emanation) a source would be regarded as sealed only if the enclosure is gastight.