

Laboratories

Under Revision see DR 84050

AS 2243, Part 4—1979
UDC 614.8.006.25

Australian Standard 2243, Part 4—1979

SAFETY IN LABORATORIES PART 4—IONIZING RADIATIONS



STANDARDS ASSOCIATION OF AUSTRALIA
Incorporated by Royal Charter



THE FOLLOWING SCIENTIFIC, INDUSTRIAL AND GOVERNMENTAL ORGANIZATIONS and departments were officially represented on the committee entrusted with the preparation of this standard:

Agricultural and Veterinary Chemicals Association of Australia
Australian Chamber of Commerce
Australian Chemical Industry Council
Australian Council of Trade Unions
Australian Institute of Petroleum
Australian Medical Association
Australian Road Transportation Federation
Board of Fire Commissioners of New South Wales
Confederation of Australian Industry
Department of Defence
Department of Labour and Industry, New South Wales
Department of Minerals and Energy
Department of Productivity
Department of Science and the Environment
Department of Transport
Health Commission of New South Wales
Insurance Council of Australia
Metropolitan Fire Brigade Board, Melbourne
Public Health Department, Western Australia
National Health and Medical Research Council
Railways of Australia Committee
University of Sydney

This standard prepared by Committee CH/26, Safety in Laboratories, was approved by the Chemical Standards Board on behalf of the Council of the Standards Association of Australia on 11 October 1979, and was published on 1 November 1979.

To keep abreast of progress in industry, Australian standards are subject to continuous review and are kept up-to-date by the issue of amendments or revised editions as necessary. It is important therefore that standards users ensure that their standards are up-to-date. Full details of all SAA publications will be found in the Annual List of Australian Standards; these details are supplemented by monthly listings in the SAA Monthly Information Sheet. Information on the Annual List and the SAA Monthly Information Sheet may be obtained from any sales office of the Association, where details are also available of the current status of individual standards.

This standard was issued in draft form for public review as DR 78088.

AUSTRALIAN STANDARD

**CODE OF PRACTICE FOR
SAFETY IN LABORATORIES**

**Part 4
IONIZING RADIATIONS**

AS 2243, Part 4—1979

First published 1979

**PUBLISHED BY THE STANDARDS ASSOCIATION OF AUSTRALIA
STANDARDS HOUSE, 80 ARTHUR ST, NORTH SYDNEY, N.S.W.**

ISBN 0 7262 1805 7

PREFACE

This standard was prepared by the Association's Committee on Safety in Laboratories, under the direction of the Chemical Standards Board.

It represents the fourth part in a series aimed at full coverage of the safety function in laboratories and deals specifically with laboratories in which ionizing radiations are used, stored or generated. It is intended that it be used in conjunction with other parts in the series, as the material in each Part augments that contained in the others; in particular the provisions of Part 1—General are applicable to all laboratory situations. Part 4 provides essential safety procedures and recommended practices relevant to ionizing radiations; appendices providing supplementary information on the measurement and protective requirements for radiation hazards.

Other parts are as follows:

Part 1—General

Part 2—Chemical

Part 3—Microbiology

Part 5—Non-ionizing Radiations

Part 6—Mechanical Aspects

Part 7—Electrical Aspects

It will be noted that although SI units have been preferred for expressing activity and dose measurements, the older units have been included in parentheses to assist the conversion process and in

deference to entrenched practice. Where traditional units have been used, as in Table A2, a conversion key has been given.

Attention is drawn to the loose-leaf format of this standard, which is intended to facilitate rapid revision by substitution of replacement pages or addition of new ones. Users wishing to suggest revisional material are invited to submit the full wording of replacement pages or clauses, to assist in the process of prompt revision.

Grateful acknowledgement is made of the contribution made to this standard from authoritative sources, such as the publications of the International Commission on Radiological Protection, the National Radiological Protection Board (U.K.), Her Majesty's Stationery Office (U.K.) and the International Atomic Energy Agency.

This part makes reference to the following Australian standards:

| | |
|------------|-----------------------------------------------------------------|
| AS 1319 | Design and Use of Safety Signs for the Occupational Environment |
| AS 2211 | Laser Safety |
| AS K185 | Colour for Specific Purposes |
| AS | Laboratory Design and Construction for Safe Working Conditions* |

*In course of preparation.

©Copyright — STANDARDS ASSOCIATION OF AUSTRALIA 1979

Users of standards are reminded that copyright subsists in all SAA publications. No part of this publication may be reproduced, stored in a retrieval system in any form or transmitted by any means without prior permission in writing of the Standards Association of Australia.

CONTENTS

| | <i>Page</i> | | |
|-------------------------------------------------------------------------------------------------|-------------|--------------------------------------------------------------------------------------------------|----|
| FOREWORD | 4 | 6.3 Ionizing Radiation Protection— Sealed Sources and Radiation- producing Apparatus | 10 |
| SECTION 1. SCOPE AND DEFINITIONS | | 6.4 Ionizing Radiation Protection— Unsealed Radioactive Materials | 12 |
| 1.1 Scope | 5 | | |
| 1.2 Definitions | 5 | SECTION 7. STORAGE, TRANSPORT AND WASTE DISPOSAL | |
| SECTION 2. HAZARDS AND THEIR CONTROL | | 7.1 Storage of Radioactive Materials | 14 |
| 2.1 The Hazards from Ionizing Radi- ations and Their Control | 6 | 7.2 Transport of Radioactive Materials | 14 |
| 2.2 Legislation | 6 | 7.3 Disposal of Radioactive Waste | 14 |
| SECTION 3. RESPONSIBILITIES | | SECTION 8. MONITORING IONIZING RADIATION | |
| 3.1 General | 7 | 8.1 General | 16 |
| 3.2 Radiation Safety Officer | 7 | 8.2 Personal Monitoring | 16 |
| 3.3 Radiation Worker | 7 | 8.3 Area Monitoring | 16 |
| SECTION 4. PRIMARY DOSE LIMITS | | SECTION 9. TRAINING, INSTRUCTION, ACCIDENT AND EMERGENCY PROCEDURE | |
| 4.1 General | 8 | 9.1 Training and Instruction | 17 |
| 4.2 NHMRC Recommendations | 8 | 9.2 Accidents and Emergency Procedures | 17 |
| 4.3 Other Recommendations | 8 | APPENDICES | |
| SECTION 5. ADMINISTRATIVE CLASS- IFICATION OF PERSONS EXPOSED TO IONIZING RAD- IATIONS | | A Hazards from Ionizing Radiation and Derived Protection Standards | 19 |
| 5.1 Persons Exposed in the Course of Work | 9 | B Radiotoxicity Classification and Radiological Laboratory Grading | 23 |
| 5.2 Individual Members of the Public | 9 | C Design of Radiological Laboratories | 25 |
| SECTION 6. IONIZING RADIATION PROTECTION | | D Measurement of Ionizing Radiations | 28 |
| 6.1 General | 10 | E Ionizing Radiation Warning Sign | 30 |
| 6.2 Radiation Warning Signs | 10 | F Transport of Radioactive Materials | 31 |
| | | G Bibliography | 32 |

STANDARDS ASSOCIATION OF AUSTRALIA

**Australian Standard
CODE OF PRACTICE FOR
SAFETY IN LABORATORIES****PART 4—IONIZING RADIATIONS****FOREWORD**

Radiation is the emission of energy, in the form of rays, wave motion or particles, from a source. The various kinds of radiation can be broadly sub-divided as follows:

- (a) *Ionizing radiations*—radiations that, by reason of their nature and energy, interact with matter to remove electrons from (i.e. ionize) the atoms of substances, including those in the human organism, through which the radiations pass. Sufficiently energetic radiations may also cause permanent changes in the nuclei of the atoms in the substance. Ionizing radiation is propagated in the forms of X-rays, gamma rays, alpha particles, beta particles (i.e. high energy electrons), neutrons, protons and other nuclear particles. Ultraviolet radiation, under some circumstances, can also cause ionization.
- (b) *Non-ionizing radiations*—radiations that do not cause ionization or nuclear changes, but can harm the human organism in other ways. Potentially harmful non-ionizing radiations are propagated in the forms of electromagnetic waves (in particular, when the wavelength is between about 1 m and 300 nm), and acoustic noise (i.e. unwanted sound). Refer to Part 5 of this code.

Although referred to in (a) above, ultraviolet radiation is generally classified as non-ionizing radiation and is therefore treated in Part 5 of the code. Lasers can emit both ionizing and non-ionizing radiation and are in AS 2211.

Radiation protection is concerned with the protection of individuals, their progeny, and mankind as a whole, while still allowing necessary activities from which radiation exposure might result.

It should be noted that various forms of high voltage apparatus may produce ionizing radiations and that various chemicals and minerals may be radioactive by virtue of the fact that they contain naturally radioactive elements.

SECTION 1. SCOPE AND DEFINITIONS

1.1 SCOPE. This Part of the code sets out the precautions needed to prevent both unnecessary exposure of workers using ionizing radiation sources in laboratories and persons outside the laboratory from being harmed by accidental or planned releases of radioactive materials or external beams of radiation. It also describes the important characteristics of ionizing radiation-producing materials and apparatus, the nature of the hazards, laboratory design requirements, and other essential radiation protection information.

The requirements of this Part of the code should be implemented in all laboratories in which—

- (a) licensable quantities of radioactive material are used or stored;
- (b) irradiating apparatus is operated.

As a guide to good practice, laboratories operating with sub-licensable quantities of radioactive material are invited to follow the principles contained in this Part of the code.

1.2 DEFINITIONS. For the purpose of this Part of the code, the following definitions apply:

1.2.1 Absorbed dose—the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The SI unit of absorbed dose is the gray (Gy).

1.2.2 Activity (of a quantity of a radionuclide)—the number of nuclear transformations of that radionuclide occurring in unit time.

1.2.3 Adequate protection—protection against ionizing radiations such that the radiation doses received by any person from external or internal sources, or both, are as low as reasonably achievable, and, in any event, do not exceed the maxima referred to in Section 4.

1.2.4 Background radiation—ionizing radiation, other than that to be measured, which contributes to the quantity being measured.

1.2.5 Becquerel (Bq)—the SI unit of activity, equal to the second to the power minus one, i.e. 1 Bq = 1 nuclear transformation per second. It replaces the curie (Ci), with 1 Bq \approx 2.7 \times 10⁻¹¹ Ci. 1 Ci = 3.7 \times 10¹⁰ Bq exactly.

1.2.6 Designated radiation area—an area where the occupational exposure of personnel to radiation or radioactive materials is under the supervision of a Radiation Safety Officer (see Clause 3.2).

1.2.7 Dose equivalent—product of absorbed dose and quality factor (QF). For radiation protection purposes, dose equivalent allows the dose received by exposed persons to be expressed on a scale common to all ionizing radiations. For mixed radiations, the dose equivalent is assumed to be equal to the sum of the products of the absorbed dose of each radiation and its QF. Where the term 'dose' is used without qualification, it shall be taken to mean 'dose equivalent'.

1.2.8 Exposure of X-radiation or gamma radiation—a measure of the radiation at a certain place, based upon its ability to produce ionization in air. The SI unit of exposure is the coulomb per

kilogram (C/kg). It replaces the roentgen (R), with 1 C/kg = 3876 R.

1.2.9 External radiation—ionizing radiation received by the body from sources outside the body.

1.2.10 Glove box—a closed box, having rubber gloves and viewing ports in one or more sides, which is used to completely enclose radioactive material and operations on the material.

1.2.11 Gray (Gy)—the SI unit of absorbed dose, equal to one joule per kilogram. It replaces the rad, with 1 Gy = 1 J/kg = 100 rad.

1.2.12 Half-life—the period of time in which half the nuclei in a given sample of a particular radionuclide undergo decay.

1.2.13 Internal radiation—ionizing radiation received by the body from sources within the body.

1.2.14 Ionizing radiation—electromagnetic or corpuscular radiation capable of producing ions directly or indirectly in its passage through matter; it includes radiations emitted by X-ray tubes and particle accelerators, and ions emitted by radioactive materials, and neutrons.

1.2.15 Irradiating apparatus—apparatus that is capable of producing ionizing radiation, or of accelerating atomic particles, for which a license is required by the appropriate Statutory Regulations.

1.2.16 Leakage radiation—all radiation except the useful beam coming from within a protective housing.

1.2.17 Licensable quantity—that amount of any radionuclide or mixture of radionuclides for which a licence is required by the appropriate Statutory Regulations.

1.2.18 Maximum permissible concentration—that concentration of a radionuclide in the air breathed (MPC)_a or the water ingested (MPC)_w which, if taken into the body during the course of work, would result in a radiation worker receiving the maximum permissible dose (to the whole body, or to a specific organ, depending upon the radionuclide in question). The recommended MPCs for a member of the general public are one-tenth of those for a radiation worker.

1.2.19 Natural background—ionizing radiation received by the body from natural sources, such as cosmic radiation, environmental radioactivity and radioactive potassium, or other naturally occurring radionuclides, within the body.

1.2.20 Non-stochastic effects—effects on a biological system in which the severity of the effect varies with the dose and for which a threshold is likely to occur.

1.2.21 Nuclide—a species of atom characterized by the composition of its nucleus, i.e. by the number of neutrons and protons in its nucleus.

1.2.22 Occupied area—an area that may be occupied by personnel and where there may be a radiation hazard.

1.2.23 Protective housing—a housing of an X-ray tube or of a sealed source intended to reduce the leakage radiation to a specified level.