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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

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AUSTRALIAN STANDARD

CODE OF PRACTICE FOR
SAFETY IN LABORATORIES

Part 4
IONIZING RADIATIONS

AS 2243, Part 4—1979

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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	Colours for Specific Purposes
AS	Laboratory Design and Construction for Safe Working Conditions*

*In course of preparation.

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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 occuring 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 $\simeq 2.7 \times 10^{-11}$ Ci. 1 Ci = 3.7×10^{10} Bq exactly.

1.2.6 Designated radiation area—an area where the occupational exposure of personnel to radiation or radioactive material 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, radiations 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.