



**Australian Government**

**Australian Radiation Protection and Nuclear Safety Agency**

**CODE OF PRACTICE AND SAFETY GUIDE**

Radiation Protection and  
Radioactive Waste  
Management in Mining and  
Mineral Processing  
(2005)

Radiation Protection Series Publication No. ??

Public Comment Version: December 2004

## Radiation Protection Series

The *Radiation Protection Series* is published by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) to promote practices which protect human health and the environment from the possible harmful effects of radiation. ARPANSA is assisted in this task by its Radiation Health and Safety Advisory Council, which reviews the publication program for the *Series* and endorses documents for publication, and by its Radiation Health Committee, which oversees the preparation of draft documents and recommends publication.

There are four categories of publication in the *Series*:

**Radiation Protection Standards** set fundamental requirements for safety. They are prescriptive in style and may be referenced by regulatory instruments in State, Territory or Commonwealth jurisdictions. They may contain key procedural requirements regarded as essential for best international practice in radiation protection, and fundamental quantitative requirements, such as exposure limits.

**Codes of Practice** are also prescriptive in style and may be referenced by regulations or conditions of licence. They contain practice-specific requirements that must be satisfied to ensure an acceptable level of safety in dealings involving exposure to radiation. Requirements are expressed in 'must' statements.

**Recommendations** provide guidance on fundamental principles for radiation protection. They are written in an explanatory and non-regulatory style and describe the basic concepts and objectives of best international practice. Where there are related **Radiation Protection Standards** and **Codes of Practice**, they are based on the fundamental principles in the **Recommendations**.

**Safety Guides** provide practice-specific guidance on achieving the requirements set out in **Radiation Protection Standards** and **Codes of Practice**. They are non-prescriptive in style, but may recommend good practices. Guidance is expressed in 'should' statements, indicating that the measures recommended, or equivalent alternatives, are normally necessary in order to comply with the requirements of the **Radiation Protection Standards** and **Codes of Practice**.

In many cases, for practical convenience, prescriptive and guidance documents which are related to each other may be published together. A **Code of Practice** and a corresponding **Safety Guide** may be published within a single set of covers.

All publications in the *Radiation Protection Series* are informed by public comment during drafting, and Radiation Protection Standards and Codes of Practice, which may serve a regulatory function, are subject to a process of regulatory review. Further information on these consultation processes may be obtained by contacting ARPANSA.



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This Code of Practice was approved by the Radiation Health Committee on dd mmmm yyyy. On dd mmmm yyyy the Radiation Health & Safety Advisory Council advised the CEO to adopt the Code of Practice.

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ISBN ? ??? ????? ?

ISSN 1445-9760

The mission of ARPANSA is to provide the scientific expertise and infrastructure necessary to support the objective of the ARPANS Act – to protect the health and safety of people, and to protect the environment, from the harmful effects of radiation.

Published by the Chief Executive Officer of ARPANSA in [month yyyy]

1 **Foreword**

2  
3 This Code was prepared under the provisions of the *ARPANS* legislation in  
4 consultation with industry, unions, and the Governments of the States and the  
5 Northern Territory. It is an amalgamation and extensive revision of the *Code*  
6 *of Practice on Radiation Protection in the Mining and Milling of Radioactive*  
7 *Ores 1987* (CoA 1987) and the *Code of Practice on the Management of*  
8 *Radioactive Wastes from the Mining and Milling of Radioactive Ores 1982*  
9 (CoA 1982). It has been necessary to publish new versions of these Codes, as  
10 there have been major changes in radiation protection philosophy and  
11 standards since the publication of the earlier Codes. In particular, the  
12 International Commission on Radiological Protection (ICRP) has released  
13 revised recommendations (ICRP 1991) and subsequent guidance on a number  
14 of relevant matters, and the International Atomic Energy Agency (IAEA) has  
15 published its new Basic Safety Standards (IAEA 1996).

16  
17 This Code provides for radiation protection in mining and mineral processing  
18 industries and for protection of human health and the environment from the  
19 effects of radioactive waste from mining and mineral processing.

20  
21 Publication of this Code is intended to foster uniform high standards of  
22 radiation protection and radioactive waste management in mining and  
23 mineral processing throughout Australia. While requirements for regulation  
24 of mining are generally applied through the different State and Territory  
25 jurisdictions, this Code has been written to allow adoption into regulatory  
26 instruments (such as conditions on licences or mining tenements) which are  
27 common to all jurisdictions.

28  
29 This Code was prepared under the direction of the Radiation Health  
30 Committee. A draft was prepared by a group consisting of representatives of  
31 Commonwealth, State and Territory regulatory authorities, and of the  
32 uranium and mineral sands mining and mineral-processing industries. The  
33 draft was released for comment, and comments received were considered in  
34 preparing this document.

35  
36 The *Code of Practice and Safety Guide on Radiation Protection and*  
37 *Radioactive Waste Management in Mining and Mineral Processing* (the  
38 "*Mining Code*") was adopted on (date) following the recommendation of the  
39 Radiation Health Committee and endorsement of the Radiation Health and  
40 Safety Advisory Council.

41  
42  
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44 [signature]

45  
46  
47  
48 John Loy  
49 CEO of ARPANSA

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# 1. Introduction

## 1.1 BACKGROUND

1.1.1 The *Environment Protection (Nuclear Codes) Act 1978* authorised the development of Codes of Practice regulating nuclear activities in Australia, in consultation with the States and Territories. This *Act* is now repealed. Three codes were published:

- *Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1987* (CoA 1987) (the “Health Code”), which was an extensive revision of the earlier *Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1980*;
- *Code of Practice on the Management of Radioactive Waste from the Mining and Milling of Radioactive Ores 1982* (CoA 1982) (the “Waste Code”); and
- *Code of Practice for the Safe Transport of Radioactive Substances, 1990* (CoA 1990), a revision of the 1982 Code of the same title (the “Transport Code”).

1.1.2 The Health and Waste Codes defined the objectives, scope and application and specified the responsibilities of owners, operators and managers for radiation protection of employees and members of the public, and for the management of radioactive waste, respectively. Further detail on the technical requirements for the application of these Codes was provided through guidelines. Fourteen guidelines were published for the Health Code (CoA 1987) and seven guidelines were published for the Waste Code (CoA 1982).

1.1.3 The Codes have now been revised, as there have been major changes in recent years in radiation protection and waste management philosophies and standards. The International Commission on Radiological Protection (ICRP) has released revised recommendations (ICRP 1991) and subsequent guidance on a number of relevant matters, and the International Atomic Energy Agency (IAEA) has published its new Basic Safety Standards (IAEA 1996). There has also been an emerging recognition in radiation protection of the employer’s “duty of care” and ultimate ownership of occupational risks, while working in cooperation with the employees and the regulator rather than within a prescriptive enforcement regime.

1.1.4 There have also been developments in radioactive waste management since the publication of the Waste Code. IAEA *Safety Series No. 111-F* (IAEA 1995) discusses the principles of radioactive waste management, while IAEA *Safety Standards Series No. WS-G-1.2* (IAEA 2002) discusses the specific case of radioactive waste management in mining and milling. Other references on radioactive waste management are IAEA Safety Standards Series No. RS-G-1.6 (IAEA 2004a) and No. WS-R-3 (IAEA 2003).

100  
101 1.1.5 In 1998 drafting groups were set up by the Nuclear Codes Committee  
102 to revise both the Health and Waste Codes. In 1999, as a result of the  
103 new *Australian Radiation Protection and Nuclear Safety Act 1998*  
104 (*ARPANS Act*), this work was continued by the Radiation Health  
105 Committee.

106

## 107 **1.2 STRUCTURE**

108

109 This publication consists of two Parts:

110 Part I - Code of Practice for the mining and mineral processing industries  
111 which sets out the essential requirements that are necessary for the  
112 control of occupational and public radiation exposures; and the  
113 management of radioactive waste arising from these industries.

114

115 Part II - Safety Guide which provides further information and guidance to  
116 assist in meeting the objectives and requirements of the Code of Practice,  
117 and in particular in the development of a radiation protection plan and a  
118 radioactive waste management plan.

119

## 120 **1.3 PURPOSE**

121

122 1.3.1 The purpose of this Code and Safety Guide is to provide a uniform  
123 framework for radiation protection in the mining and mineral  
124 processing industries, and for the safe management of radioactive  
125 waste arising from mining and mineral processing. The objectives in  
126 developing this Code include:

- 127 • encouraging the application of uniform standards in the mining  
128 and processing industries for the radiation protection of employees  
129 and the public and in the management of radioactive waste,  
130 consistent with current international standards and by use of  
131 appropriate best-practicable technology;
- 132 • fostering uniform outcomes in radiation protection and the  
133 management of radioactive waste in the mining and processing  
134 industries; and
- 135 • providing an appropriate legal framework, including the clear  
136 allocation of responsibilities and provision for independent  
137 regulatory functions.

138

139 1.3.2 It is intended that this Code can be incorporated into regulatory  
140 instruments, such as conditions attached to licences or mining  
141 tenements as appropriate.

142

## 143 **1.4 SCOPE**

144

145 1.4.1 This Code addresses the regulatory and organisational aspects for the  
146 control of occupational and public radiation exposures in the mining  
147 and mineral processing industries, and for the management of  
148 radioactive waste generated in those industries. It describes the

149 system of radiation protection to be applied in operations of the  
150 mining and mineral processing industries, and to waste generated by  
151 them, and identifies the roles of the various stakeholders.

152

153 1.4.2 Radioactive waste will most usually arise from the mining and  
154 processing of ores containing uranium and thorium, but this Code  
155 may be applicable to the mining and processing of other materials  
156 where the waste arising from these operations require management  
157 because the radionuclides they contain may cause harm to humans or  
158 to the environment.

159

160 1.4.3 Many wastes arising from operations to which this Code applies will,  
161 in addition to their radionuclide content, contain other contaminants  
162 that can be harmful to human health or the environment. While this  
163 code does not address these matters, due regard for such other  
164 contaminants must be made in developing a system for management  
165 of radioactive materials and their waste.

166

167 1.4.4 This document reflects the information contained in  
168 *Recommendations for Limiting Exposure to Ionizing Radiation* and  
169 *National Standard for Limiting Occupational Exposure to Ionizing  
170 Radiation, Radiation Protection Series Publication No. 1 (2002)*  
171 (ARPANSA 2002/NOHSC 2002).

172

173 1.4.5 There are other national codes of practice relevant to various aspects  
174 of radioactive waste management and disposal. The *Code of Practice  
175 for the near surface disposal of radioactive waste in Australia (1992)*  
176 (NHMRC 1992) provides the basis for the near-surface disposal of  
177 solid radioactive waste including waste arising from processing of  
178 minerals remote from any mine site and where disposal at the mine  
179 site is inappropriate. The *Code of Practice for the Disposal of  
180 Radioactive Wastes by the User (1985)* (NHMRC 1985) provides for  
181 small amounts of solid, liquid or gaseous radioactive waste below  
182 defined limits to be disposed of by the user to an urban land-fill waste  
183 tip, or discharged to the sewerage system or into the air.

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**CODE OF PRACTICE**

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## 2. Code of Practice

### 2.1 CITATION

This *Code of Practice* may be cited as the *Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)* (short title: the “Mining Code”).

### 2.2 OBJECTIVE

The objective of this Code is to provide a regulatory framework to manage the protection of workers, members of the public and the environment from harmful effects of radiation exposures arising from mining or mineral processing and from the waste resulting from these activities both now and in the future.

### 2.3 APPLICATION

2.3.1 The provisions of this Code apply to the mining and processing of ores for the production of uranium or thorium concentrates, and the separation of heavy minerals from mineral sands ore.

2.3.2 The relevant regulatory authority (see Annex A) may direct that this Code be applied, in whole or part, to other mining and mineral processing operations that have the potential to produce significant occupational radiation exposures, or to generate waste having the potential to cause a significant increase in the radiological exposure of members of the public or the environment and which would therefore require specific management. These operations may include:

- (a) the mining and processing of other minerals that adventitiously contain uranium or thorium or their decay products; and
- (b) processes which lead to the production of waste not usually regarded as radioactive, but which contains naturally occurring radionuclides.

2.3.3 This Code applies to the control of occupational and public radiation exposures, and the management of radioactive waste generated, at all stages of mining and mineral processing from exploration to final site rehabilitation.

2.3.4 This Code applies to new operations, those established prior to its implementation, operations which are temporarily suspended, and such others as designated by the relevant regulatory authority.

2.3.5 This Code is not intended to be applied to the management of introduced radioactive sources used for process control, analysis or investigative purposes, or x-ray apparatus that might be used in an operation to which this Code applies.

**2.4 EXEMPTIONS**

In the application of this Code the relevant regulatory authority may grant exemptions from provisions of this Code, either for the whole operation, or for specified parts of the operation, where the material or practice meets the exemption criteria specified in the National Directory for Radiation Protection (ARPANSA 2004). In particular, for situations where the activity concentration or activity exceed the levels in Schedule 4 of the Directory, exemption would be considered where:

- (a) conditions in areas in which the exemption applies are such that it is unlikely that any worker will receive a dose arising from the operation greater than one millisievert per annum;
- (b) annual effective dose arising from the operation to an individual member of the public is less than 10 microsievert per annum; and
- (c) the collective effective dose to the critical group committed by one year of performance of the practice does not exceed 1 person-Sv or an assessment for the optimization of protection shows that exemption is the optimum option.

**2.5 INTERPRETATION**

2.5.1 In this Code, unless the contrary intention appears, a reference to a Clause is a reference to the relevant Clause of this Code; and a reference to a Schedule, or part thereof, is a reference to the relevant Schedule, or part thereof, of this Code.

2.5.2 Each of the terms set out in this Code has the meaning given in the Glossary together with any amplification stated here.

2.5.3 Where the term “must” appears in this Code, this indicates that the particular requirement is essential.

2.5.4 The ALARA principle has the meaning stated in Clause 117 of International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991, p.29, Item 4.3.2). The broad aim is to ensure that the magnitude of the individual doses, the number of people exposed, and the likelihood of incurring exposures where these are not certain to be received, are all kept as low as reasonably achievable, economic and social factors being taken into account.

2.5.5 In this Code, “radioactive waste” means material that contains or is contaminated with radionuclides at concentrations or activities greater than levels established by the relevant regulatory authority, and for which no use is foreseen.

2.5.6 In this Code “best practicable technology” is that technology available from time to time, and relevant to the project in question, which produces the minimum occupational doses, member-of-public doses both now and in the future, and environmental detriment that can be reasonably achieved, economic and social factors taken into account.

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**2.6 RADIATION PROTECTION STANDARDS**

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**2.7 RADIATION PROTECTION PLAN**

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2.6.1 This Code is to be interpreted in accord with the *Recommendations for Limiting Exposure to Ionizing Radiation* and *National Standard for Limiting Occupational Exposure to Ionizing Radiation, Radiation Protection Series Publication No. 1 (2002)* (ARPANSA 2002/NOHSC 2002). The relevant dose limits are given in Schedule 1, which is derived from the ARPANSA's *Recommendations for Limiting Exposure to Ionizing Radiation (2002)*.

2.6.2 All operations subject to this Code must be managed in such a way that any radiation doses to workers or members of the public arising from the operation must not exceed the relevant limits specified in Schedule 1. The relevant regulatory authority may impose dose constraints, discharge limits or other requirements on an operation in order to ensure adequate levels of radiation protection. Additional information on the health effects and standards for control of exposure of ionizing radiation are given in Annex B.

2.7.1 Before the commencement of any stage of an operation to which this Code applies, a Radiation Protection Plan (RPP) for that stage must be devised and presented to the relevant regulatory authority for approval. The Plan must be directed towards meeting the objectives of this Code and must be in accordance with best practicable technology and take into account the potential dose delivery pathways.

2.7.2 The Radiation Protection Plan must include measures that are intended to be taken to control the exposure of employees and members of the public to radiation at or from the practice including:

- (a) demonstrated access to appropriate professional expertise in radiation protection;
- (b) a plan for monitoring radiation exposure and for assessing the doses received by exposed employees;
- (c) the provision of appropriate equipment, staffing, facilities and operational procedures;
- (d) details of induction and training courses;
- (e) record keeping and reporting;
- (f) a plan for dealing with incidents, accidents and emergencies involving exposure to radiation; and
- (g) a system of periodic assessment and review of the adequacy and effectiveness of procedures instituted under the Radiation Protection Plan to ensure currency and to facilitate a process of continual improvement.

**2.8 RADIOACTIVE WASTE MANAGEMENT PLAN**

334 2.8.1 A Radioactive Waste Management Plan (RWMP) must be developed  
335 to provide for the proper management of radioactive waste arising  
336 from the operations. Before the commencement of any stage of an  
337 operation, a RWMP for that stage must be presented to the relevant  
338 regulatory authority (see Annex A) for approval. The Plan must be  
339 directed towards meeting the objectives of this Code and must be in  
340 accordance with best practicable technology and take into account the  
341 potential dose delivery pathways.

342  
343 2.8.2 The Radioactive Waste Management Plan must provide for the proper  
344 management of radioactive waste arising from the operation and will  
345 include:

- 346 (a) an outline of the processes generating waste, and a description of  
347 the waste generated;
- 348 (b) a description of the environment into which the waste will be  
349 discharged or disposed;
- 350 (c) a description of the proposed system for waste management  
351 including the facilities and procedures involved in the handling,  
352 treatment, storage and disposal of radioactive waste;
- 353 (d) prediction of environmental concentrations of radionuclides and  
354 radiation doses to people from the proposed waste management  
355 practices, including demonstration that the radiation protection  
356 requirements of this Code will be met both now and in the future  
357 as determined by the relevant regulatory authority;
- 358 (e) a program for monitoring the concentration of radionuclides in  
359 the environment and assessment of radiation doses to members of  
360 the public arising from the waste management practices;
- 361 (f) contingency plans for dealing with accidental releases, or  
362 circumstances which might lead to uncontrolled releases of  
363 radioactive waste, to the environment;
- 364 (g) a schedule for reporting on the operation and results of  
365 monitoring and assessments required by this plan;
- 366 (h) a plan for decommissioning the operation and the associated  
367 waste management facilities and rehabilitating the site; and
- 368 (i) a system of periodic assessment and review of the adequacy and  
369 effectiveness of procedures instituted under the Radioactive  
370 Waste Management Plan to ensure currency and to take account  
371 of potential improvements consistent with best practicable  
372 technology.

## 373 374 **2.9 APPROVALS AND AUTHORISATIONS**

375  
376 2.9.1 Prior to the commencement of any stage of an operation to which this  
377 Code applies, the operator must obtain approval for the Radiation  
378 Protection Plan and the Radioactive Waste Management Plan  
379 appropriate for the proposed activities at that stage.

380  
381 2.9.2 An operator must not commence construction of any part of a mine,  
382 processing plant or waste management facility to which this Code

383 applies without authorisation from the relevant regulatory authority  
384 (see Annex A).

385

386 **2.9.3** An operator must not commence operation of any part of a mine,  
387 processing plant or waste management facility to which this Code  
388 applies without authorisation from the relevant regulatory authority.

389

390 **2.9.4** An operator must not commence rehabilitation of any part of a mine,  
391 processing plant or waste management facility to which this Code  
392 applies without authorisation from the relevant regulatory authority.

393

394 **2.9.5** The relevant regulatory authority must be informed of any proposal  
395 for significant changes to an operation to which an approved  
396 Radiation Protection Plan or Radioactive Waste Management Plan  
397 applies. The relevant regulatory authority may, on receipt of such  
398 notification, direct that a new Radiation Protection Plan and/or  
399 Radioactive Waste Management Plan or part thereof must be  
400 submitted, and that those changes must not be brought into operation  
401 without authorisation.

402

403 **2.9.6** The operator must review the Radiation Protection Plan and the  
404 Radioactive Waste Management Plan, and submit any revised plans  
405 for approval, at intervals determined by the relevant regulatory  
406 authority.

407

408 **2.9.7** Radioactive material, above the exemption limits defined in the  
409 National Directory for Radiation Protection (ARPANSA 2004), must  
410 not be removed from or brought into any operation to which this Code  
411 applies without authorisation from the relevant regulatory authority.

412

## 413 **2.10 RESPONSIBILITIES**

414

### 415 **2.10.1 Operator/Employer**

416

417 The operator and employer must:

418 (a) ensure that the workplace and work procedures are designed,  
419 constructed, and operated so as to keep exposures to ionizing  
420 radiation as low as reasonably achievable, economic and social  
421 factors being taken into account, and below the limits set in  
422 Schedule 1;

423 (b) ensure that waste is managed by means of best practicable  
424 technology, and that exposures to ionizing radiation resulting  
425 from waste are as low as reasonably achievable, economic and  
426 social factors being taken into account;

427 (c) obtain all necessary approvals and authorisations from the  
428 relevant regulatory authority (see Annex A) prior to commencing  
429 the operational aspects to which they apply;

430 (d) ensure that appropriate expertise in the fields of radiation  
431 protection and radioactive waste management is available, and

- 432           appoint a Radiation Safety Officer who shall have qualifications  
433           and experience acceptable to the relevant regulatory authority;
- 434           (e) construct and operate all facilities in accordance with the  
435           approved RPP and RWMP, and any other requirements of this  
436           Code;
- 437           (f) ensure that sufficient resources are available to allow the  
438           requirements of the RPP and the RWMP to be fully implemented;
- 439           (g) notify the relevant regulatory authority promptly of any changes  
440           in operation, or operating conditions or other matters which are  
441           likely to significantly increase radiation exposures to workers or  
442           members of the public, or requirements for the management of  
443           radioactive waste, and which are not provided for in approvals or  
444           authorisations;
- 445           (h) report any unauthorised effluent discharges to the relevant  
446           regulatory authority;
- 447           (i) investigate promptly any defect, due to design or malfunction  
448           discovered in plant equipment or working procedures which is  
449           likely to significantly increase radiation exposures to workers or  
450           members of the public, or endanger the security of waste  
451           management facilities, record the results of such an investigation;
- 452           (j) ensure that any defect referred to above is promptly remedied,  
453           and the situation resulting from the defect is brought under  
454           control;
- 455           (k) undertake ongoing reviews of the RPP and RWMP as determined  
456           by the relevant regulatory authority;
- 457           (l) ensure that all employees are, upon commencing work, properly  
458           instructed in the radiation aspects of their work, and in the  
459           precautions necessary to control their exposure to radiation, and  
460           to avoid radiation accidents; and ensure that reinstruction of  
461           employees is undertaken at appropriate intervals;
- 462           (m) ensure that employees are properly supervised in the performance  
463           of their work to ensure that they act in accordance with approvals  
464           and authorisations, and the requirements of this Code;
- 465           (n) keep records of results of all measurements, monitoring and  
466           assessments required by this Code or by approvals or  
467           authorisations;
- 468           (o) provide employees with copies of their dose records on request,  
469           and at termination of their employment; and
- 470           (p) encourage employees to inform the employer when they are  
471           pregnant, and when so informed, take steps to limit the exposure  
472           of the fetus as required in Schedule 1.

### **2.10.2 Employees**

476           Employees who may be exposed to radiation, or perform duties which may  
477           affect the radiation exposure of others, must to the extent to which they are  
478           capable, comply with all reasonable measures to control and assess exposure  
479           to radiation, or to manage radioactive waste. The employee must:

- 480 (a) follow radiation protection and waste management practices  
481 specified in approvals or authorisations, and other regulatory  
482 requirements;
- 483 (b) comply with the legitimate instructions of the employer, or his  
484 agents;
- 485 (c) participate in training programs required under this Code, and  
486 make proper use of such training;
- 487 (d) make proper use of plant and equipment supplied for radiation  
488 protection, or for the monitoring or assessment of radiation  
489 exposures;
- 490 (e) not engage in any careless or reckless action which might result in  
491 unnecessary radiation exposure to themselves or others, or  
492 compromise the management of radioactive waste;
- 493 (f) report to the employer any defects of which they become aware, in  
494 plant equipment or procedures, which may compromise radiation  
495 protection or the management of radioactive waste;
- 496 (g) report all incidents or accidents to the employer; and
- 497 (h) advise the employer of previous employment involving  
498 occupational exposure to radiation, and cooperate in obtaining  
499 records of such previous exposure.

500

501 Female employees are encouraged to notify their employer if they become  
502 pregnant.

503

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**Australian Government**

**Australian Radiation Protection and Nuclear Safety Agency**

**SAFETY GUIDE**

Radiation Protection and  
Radioactive Waste  
Management in Mining and  
Mineral Processing  
(2005)

Radiation Protection Series Publication No. ??

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### 3. Safety Guide

#### 3.1 CITATION

This Safety Guide may be cited as the *Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)*.

#### 3.2 INTRODUCTION

The purpose of this Safety Guide is to assist in the interpretation and implementation of the *Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (referred to throughout as “the Code”), and in achieving compliance with its requirements. The information within this Safety Guide is intended to be advisory only, and does not form part of the requirements of the Code.

Radiation exposures arise in the mining and mineral processing industries through three principal pathways: external gamma radiation from ores, concentrates and the like; inhalation of dusts containing long-lived alpha-emitting radionuclides; and inhalation of the short-lived decay products of radon. In the past, inhalation of radon decay products in poorly ventilated underground mines led to exposures greatly in excess of current limits, and was associated with a high incidence of lung cancer. There is consequently a need to adopt careful radiological control measures in mining and mineral processing operations involving radioactive ores, in order to protect those involved and to meet dose limits.

Significant radiation exposures can also arise in the mining and processing of ores not generally considered radioactive, and from precipitates, scales, etc. that may accumulate in recovery of oil or natural gas. Such exposures can lead to doses in excess of the limits for members of the public, and radiological control measures may thus be required.

Mining and mineral processing of radioactive ores generally leads to the generation of large volumes of radioactive waste. The most important are uranium mill tailings and monazite wastes from mineral sand mining. These have the potential to generate radiation doses significantly in excess of the dose limit for members of the public if they are not managed appropriately. Wastes from other mining or mineral processing operations, including the recovery of oil or natural gas, can also result in significant exposures if not managed properly.

#### 3.3 OBJECTIVES

##### 3.3.1 Radiation Protection

552 The objective of radiation protection is to ensure that there is no unacceptable  
553 health risk to people, both workers and members of the public, from the  
554 operations to which the Code applies.

555

### 556 **3.3.2 Radioactive Waste Management**

557

558 The objective of radioactive waste management is to ensure that there is no  
559 unacceptable health risk to people, both now and in the future, and no long-  
560 term unacceptable detriment to the environment from the waste so managed,  
561 and without imposing undue burdens on future generations.

562

563 The ICRP notes that "Waste management and disposal are an integral part of  
564 the practice generating the waste. It is wrong to regard them as a  
565 free-standing practice, needing its own justification. The waste management  
566 and disposal operations should therefore be included in the justification of the  
567 practice" (ICRP 2000).

568

## 569 **3.4 APPLICATION**

570

### 571 **3.4.1 Operations**

572

573 The provisions of the Code are intended to apply to the control of occupational  
574 and public radiation exposures, and to the management of radioactive waste,  
575 arising from any stage of operation in the mining and mineral processing  
576 industries in Australia. The major activities covered will be those involved in  
577 mining and processing to produce uranium or thorium concentrates, the  
578 separation of heavy minerals such as ilmenite, leucoxene, rutile, monazite and  
579 zircon from mineral sands ore, and further processing of these minerals.

580

581 The provisions of the Code may also be applied to other mining or mineral  
582 processing facilities where significant quantities of uranium and thorium and  
583 their decay products occur in the minerals or appear in waste streams. This  
584 may include the mining and processing of phosphate ores, tin, tantalum, and  
585 other non-ferrous ores, coal, and oil and gas extraction.

586

### 587 **3.4.2 Criteria for Application**

588

589 The criteria on which the relevant regulatory authority may decide to require  
590 operations to comply with the Code will depend *inter alia* on potential doses  
591 to workers and to members of the public. Operations would generally be  
592 brought under the regulatory framework of the Code where doses to workers  
593 are expected to exceed the public limits, and doses to the critical group are  
594 likely to exceed some tens of microsievert.

595

596 All mines may contain substantial concentrations of radon in the air. In  
597 determining whether the Code should be applied, note should be taken of  
598 Annex C of Radiation Protection Series Publication No. 1  
599 (ARPANSA 2002/NOHSC 2002), which recommends that a program of  
600 radiation protection is not required where the long-term average  
601 concentration of radon-222 does not exceed 1000 Bq/m<sup>3</sup>.

602

### 3.4.3 Stages of Operation

The stages of mining and processing are drilling and exploratory excavation, development and construction, production, temporary cessation of operations, final decommissioning, and site rehabilitation.

The Code applies to exploration after the identification of the presence of radioactive mineralisation and all subsequent stages.

In regard to exploration activities, consideration needs to be given to core storage and sample preparation activities, and the handling of any waste arising.

### 3.4.4 Existing Operations

It is intended that the Code would be applied to operations that are in existence at the time that the Code is adopted. In some cases the operation may need to be brought into compliance over a timescale to be determined by the relevant regulatory authority.

The Code is not intended to be applied to operations that have been decommissioned or abandoned prior to the adoption of the Code. Nevertheless, aspects of the Code may be applied to such sites, as determined by the relevant regulatory authority – refer section 3.5.3, *Intervention*.

### 3.4.5 Application of Other Codes

The Code is not intended to apply to sources of radiation which are used in operations, but for which other Codes or requirements are applicable. Examples include sealed sources used in radiation gauges, industrial radiography and the like, unsealed sources used for tracer studies, or x-ray apparatus used for analysis (XRF).

The Code is intended to apply to the management of all radioactive wastes generated by operations to which the Code applies, but not to those wastes containing uranium or thorium which are covered specifically by the provisions of other codes, such as the *Code of practice for the near surface disposal of radioactive waste in Australia (1992)* (NHMRC 1992) and the *Code of practice for the disposal of radioactive wastes by the user (1985)* (NHMRC 1985).

The *Code of practice for the near surface disposal of radioactive waste in Australia (1992)* (NHMRC 1992) (“near-surface disposal Code”) provides the basis for the near-surface disposal of solid radioactive waste that has been classified as low-level and short-lived intermediate-level waste. The near-surface disposal Code is intended to apply to disposal of contaminated plant and equipment resulting from handling or processing of naturally occurring materials which contain radioactive contaminants in low but non-trivial amounts (for example, gypsum, phosphate, natural gas and crude oil), and to waste arising from processing of minerals remote from any mine site and where disposal at the mine site is inappropriate. The near-surface disposal

654 Code also applies to disposal of waste arising from the rehabilitation,  
655 decontamination or decommissioning of sites or facilities where radioactive  
656 materials have been produced, stored, used or dispersed.

657

658 Background and guidance to the near-surface disposal code is provided in  
659 ARPANSA's document *Classification and Disposal of Radioactive Waste in*  
660 *Australia - Consideration of Criteria for Near-Surface Burial in an Arid Area*  
661 **(currently in draft form – final document in 2005)**. As well as  
662 providing detailed criteria for site selection and repository design and  
663 operation, this document presents procedures for the categorisation of waste  
664 as recommended in the Code.

665

666 The *Code of practice for the disposal of radioactive wastes by the user (1985)*  
667 (NHMRC 1985) provides for small amounts of low-level solid radioactive  
668 waste below defined limits, including that containing uranium or thorium, to  
669 be disposed of by the user to an urban land-fill waste tip. Gaseous or liquid  
670 wastes below specified limits may be discharged into the air or to the sewerage  
671 system in accordance with provisions of the code. This code is currently under  
672 revision.

673

674 It is expected that radioactive waste arising from mining operations will be  
675 regulated within the framework of the Code. This includes on-site disposal of  
676 bulk waste and contaminated plant and equipment from operations to which  
677 the Code applies.

678

679 However, there will be situations where either the Code or one or other of the  
680 above-mentioned codes may be appropriately applied at the discretion of the  
681 relevant regulatory authority. An example is waste arising from handling  
682 naturally occurring materials which contains low levels of radioactive  
683 contaminants, particularly smaller quantities (eg. equipment from the oil and  
684 gas industries or from the fertiliser industry containing radioactive scale).  
685 Such waste material may be managed on-site under the provisions of the Code  
686 or disposed in accordance with the requirements of the near-surface disposal  
687 Code (NHMRC 1992).

688

### 689 **3.5 EXEMPTIONS**

690

#### 691 **3.5.1 Exemptions of Whole Operation**

692

693 International Basic Safety Standards (BSS), Safety Series No. 115 (IAEA 1996)  
694 gives guidance on the general principles for exemption of practices, including:

695

- the radiation risks to individuals caused by the exempted practice be sufficiently low as to be of no regulatory concern;

696

697

- the collective radiological impact of the exempted practice be sufficiently low as not to warrant regulatory control under the prevailing circumstances; and

698

699

700

- the exempted practice is inherently safe with no appreciable likelihood of scenarios that could lead to a failure to meet the above criteria.

701

702

703

704 The exemption provisions of the National Directory for Radiation Protection  
705 (ARPANSA 2004) are based on these IAEA principles.

706

707 Exemption on the basis of provision 2.4(b) of the Code would rely on  
708 calculation of doses from applicable scenarios, subject to the agreement of the  
709 relevant regulatory authority on the applicable scenarios and method of  
710 calculation to be applied.

711

712 In relation to optimization of protection, exemptions may be granted on the  
713 basis of an assessment to be agreed between the operator and the relevant  
714 regulatory authority that the radiation protection is optimized. Such an  
715 exemption may be subject to monitoring and reporting conditions to ensure  
716 that the basis for the exemption remains in place.

717

718 The National Directory also includes provision for material or practices  
719 otherwise exempt to be subject to regulation if the relevant regulatory  
720 authority can demonstrate that the magnitude of individual doses, the number  
721 of people exposed and the likelihood that potential exposure will occur  
722 significantly exceed the values on which the exemption levels in Schedule 4 of  
723 the Directory are based.

724

725 The exemption provisions of the Directory also make clear that when a  
726 practice is not exempt, the regulatory measures to be applied are to be  
727 proportionate to the degree of risk associated with the material.

728

729 The IAEA has also published a new Safety Guide, RS-G-1.7, *Application of the*  
730 *Concepts of Exclusion, Exemption and Clearance* (IAEA 2004b), to provide  
731 guidance to national authorities, including regulatory bodies, and operating  
732 organizations on the application of these concepts as established in the BSS  
733 (IAEA 1996). RS-G-1.7 includes specific values of activity concentration for  
734 both radionuclides of natural origin and those of artificial origin that may be  
735 used for bulk amounts of material for the purpose of applying exclusion or  
736 exemption. It also elaborates on the possible application of these values to  
737 clearance.

738

### 739 **3.5.2 Partial Exemptions**

740

741 The relevant regulatory authority may decide that the exemption criteria are  
742 met within a part of an operation which falls generally within the scope of the  
743 Code. Exemption of that part of the operation from compliance with the Code  
744 could then be given. Alternatively for example, exemption from the  
745 requirement to prepare a Radiation Protection Plan could be granted, but a  
746 Radioactive Waste Management Plan might still be required. Such an  
747 exemption could be given subject to conditions (such as monitoring) to ensure  
748 that the criteria continue to be met.

749

## 750 **3.6 RADIATION SAFETY STANDARDS**

751

### 752 **3.6.1 System of Radiation Protection**

753

754 The Radiation Safety Standards imposed by the Code are those set out in  
755 Radiation Protection Series Publication No.1 (ARPANSA 2002/NOHSC  
756 2002). These in turn are based on the “System of Radiation Protection”  
757 recommended by the International Commission on Radiological Protection  
758 (ICRP) in its Publication 60 (ICRP 1991).

759

### 760 **3.6.2 Practices**

761

762 The ICRP uses the term “practice” for an activity which causes (or has the  
763 potential to cause) an increase in the overall exposure to radiation. Activities  
764 to which the Code applies will generally be “practices”.

765

766 For continuing and proposed practices, the system of radiation protection is  
767 based on the following general principles, referred to in abbreviated form as  
768 ‘justification’, ‘optimisation’, and ‘limitation’:

769

- No practice involving exposures to radiation should be adopted unless it produces sufficient benefit to the exposed individuals or to society to offset the radiation detriment it causes (the ‘justification’ of a practice);

770

771

772

773

- In relation to any particular source within a practice, the magnitude of individual doses, the number of people exposed, and the likelihood of incurring exposures where these are not certain to be received should all be kept as low as reasonably achievable, economic and social factors being taken into account. This procedure should be constrained by restrictions on the doses to individuals (dose constraints), or the risks to individuals in the case of potential exposures (risk constraints), so as to limit the inequity likely to result from the inherent economic and social judgements (the ‘optimization’ of protection); and

774

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783

- The exposure of individuals resulting from the combination of all the relevant practices should be subject to dose limits, or to some control of risk in the case of potential exposures. These are aimed at ensuring that no individual is exposed to radiation risks that are judged to be unacceptable from these practices in any normal circumstances. Not all sources are susceptible to control by action at the source and it is necessary to specify the sources to be included as relevant before selecting a dose limit (individual dose and risk limits).

784

785

786

787

788

789

790

791

792

### 793 **3.6.3 Intervention**

794

795 The ICRP uses the term “intervention” to describe activities that decrease the  
796 overall exposure from existing sources of radiation. The rehabilitation of an  
797 abandoned uranium tailings dam is an example of an “intervention”. The  
798 criteria on which it is decided that intervention is required are generally not  
799 the same as those applying to radiation protection in a “practice”. In  
800 particular, the dose limits for members of the public for exposure from  
801 practices may not be directly relevant in determining if intervention is  
802 required; in fact the ICRP recommends that intervention would not generally  
803 be justified unless the individual doses averted by the intervention were

804 significantly above the annual dose limit for a member of the public. As the  
805 Code is principally concerned with “practices” its requirements may not be  
806 directly applicable to “interventions”.

807

808 However, the requirements of the Code may be applicable to the operation of  
809 intervention, for example for controlling the radiation doses to the workers.

810

#### 811 **3.6.4 Exceptional and Special Circumstances**

812

813 Radiation Protection Series (RPS) Publication No. 1 (ARPANSA 2002/NOHSC  
814 2002) allowed the relevant regulatory authority, in exceptional circumstances,  
815 to grant a temporary relaxation of the occupational dose limitation  
816 requirements. However, the Radiation Health Committee has now advised  
817 that this relaxation is not recommended. Such a relaxation should not be  
818 required in properly managed operations to which the Code applies.

819

820 RPS Publication No. 1 (ARPANSA 2002/NOHSC 2002) also allows, in special  
821 circumstances, that the dose limit to members of the public could be relaxed,  
822 provided that the average over a five year period does not exceed 1 mSv per  
823 annum. Again, in a properly managed operation to which the Code applies,  
824 such a relaxation should not be required.

825

#### 826 **3.6.5 Critical Group**

827

828 The critical group is defined in the glossary. RPS Publication No.1  
829 (ARPANSA 2002/NOHSC 2002) also recommends that in evaluating  
830 compliance with the limit on effective dose to members of the public, the  
831 effective dose to the critical group should be assessed. The monitoring  
832 program should be designed to collect sufficient data to allow such an  
833 assessment to be made.

834

#### 835 **3.6.6 Radiological Protection of the Environment**

836

837 For the purposes of the Code it is assumed that by achieving adequate  
838 protection of human health, an acceptable level of protection will be afforded  
839 to the environment. However, this assumption may not be valid in all  
840 circumstances and specific additional control measures may be required.

841

#### 842 **3.6.7 Dose Constraints**

843

844 Dose constraints for particular categories of employee should be used when  
845 appropriate. For employees not directly involved in work with radiation, a  
846 dose constraint should be adopted which would normally be related to the  
847 public effective dose limit specified in Schedule 1.

848

849 Dose constraints applied to the critical group, through modelling of the  
850 exposure pathway, imply restrictions at the source (ie. discharge limits).

851

### 852 **3.7 APPROVALS AND AUTHORISATIONS**

853

854 The Code specifies that approval must be received from the relevant  
855 regulatory authority (see Annex A) for the Radiation Protection Plan and the  
856 Radioactive Waste Management Plan prior to the commencement of any stage  
857 of an operation to which the Code applies. Authorisation for the construction,  
858 and for operation, is also required. It is also likely that other legislative  
859 measures have requirements for approvals or authorisations.

860

861 The requirements and administrative procedures for obtaining approvals and  
862 authorisations will be determined by the relevant regulatory authority, and  
863 should be made clear to the operator in good time. Some aspects of an  
864 approval procedure that might be adopted are discussed below.

865

### 866 **3.7.1 Consultation**

867

868 In order to ensure that the plans developed by the operator are consistent with  
869 the requirements of the relevant regulatory authority, and to allow prompt  
870 and efficient evaluation of the plans, it is important that there be continuing  
871 consultation between the operator and the relevant regulatory authority(ies).  
872 It is unlikely that an optimum design for facilities will be achieved unless  
873 requirements for radiation protection and waste management are included in  
874 the initial specifications. Consultation will allow all parties to be clear on the  
875 requirements and constraints that should be considered.

876

### 877 **3.7.2 Authorisation to Construct**

878

879 At the completion of the engineering design phase of a project, it is in the  
880 interests of all parties that there be an understanding that the proposed  
881 facilities will be acceptable. The operator needs to have confidence that,  
882 provided facilities are built and function as designed and all other operational  
883 requirements are met, the regulatory authority will be able to grant  
884 authorisation to operate; while the regulator can have confidence that all  
885 relevant requirements have been addressed in the design.

886

887 This assurance is provided by the formal “authorisation to construct”, as  
888 required in Section 2.9 of the Code.

889

890 An application for authorisation to construct would be expected to contain the  
891 following information:

892

#### 893 **(a) Mining and Processing Facilities**

894

895 The application for construction approval should include the  
896 following:

897

(i) plans of the proposed mine or processing plant and an  
898 outline of the equipment to be constructed or installed and  
899 its function;

900

(ii) an outline of the operational procedures for the mine or  
901 processing plant; and

- 902 (iii) an outline of the Radiation Protection Plan for the operation  
903 of the proposed mine or processing plant, including details  
904 of the engineering controls that will be put in place.

905  
906 (b) **Waste Management Facilities**

907  
908 It would be expected that the RWMP for the operation should be  
909 approved prior to the commencement of construction of waste  
910 management facilities; however, some details, for example  
911 monitoring locations and frequencies, might not be finalised.

912  
913 In addition, other information may be required, such as:

- 914 • further engineering detail on the actual construction of  
915 facilities;  
916 • schedules and timetables for construction; and  
917 • quality assurance procedures in place during construction.

918  
919 **3.7.3 Authorisation to Operate**

920  
921 Authorisation is required for the commencement of operation of a mine, mill,  
922 or waste disposal facility. In seeking such authorisation, the operator would  
923 be expected to demonstrate that the facility has been constructed in  
924 accordance with authorisations, and that all plant, equipment and procedures  
925 required by the approved Radiation Protection Plan and Radioactive Waste  
926 Management Plan are in place and operational.

927  
928 Authorisation to Operate may be given in stages, with an initial  
929 commissioning phase where monitoring inspection etc. is relatively intensive.  
930 Once it has been determined that the operation has stabilised within design  
931 parameters, then the operator might request a reduction in monitoring and  
932 inspection to a level appropriate to routine operation. The results obtained  
933 during the commissioning phase would be used to determine ongoing  
934 monitoring and inspection requirements.

935  
936 **3.7.4 Cessation of Operations**

937  
938 Cessation of operations constitutes a “significant change” under Clause 2.9.5  
939 of the Code, and the relevant regulatory authority (see Annex A) should be  
940 notified. The operator should continue all relevant monitoring, inspection  
941 and rehabilitation programs until approval to discontinue is received from the  
942 relevant regulatory authority.

943  
944 (a) **Temporary Cessation**

945  
946 Changes to the RPP and RWMP may be required when operations  
947 cease. The relevant regulatory authority will need to be assured  
948 that appropriate care and maintenance procedures, monitoring  
949 and inspection (particularly of waste management facilities), and  
950 other requirements are in place to ensure that the site remains in

951 an acceptable condition, and that deterioration, which might  
952 prejudice reopening or final rehabilitation, does not occur.

953

954 (b) ***Permanent Closure***

955

956 Prior to permanent closure of an operation, plans for  
957 decommissioning and rehabilitation will need to be updated or  
958 prepared, and submitted for approval. Such plans will form part  
959 of the relevant RPP and RWMPs. Again, the relevant regulatory  
960 authority will require assurance that the site remains in an  
961 acceptable condition until rehabilitation is complete, and that  
962 deterioration which might prejudice final rehabilitation does not  
963 occur.

964

965 **3.7.5 Authorisation to Rehabilitate**

966

967 The waste management plan should contain proposals for rehabilitation of the  
968 project as a whole and for individual components (for example tailings dams  
969 reaching their capacity). On decommissioning, these plans will need to be  
970 updated and engineering detail finalised.

971

972 Inappropriate attempts at rehabilitation may prejudice the ability to attain an  
973 acceptable final state. For this reason, rehabilitation operations should not be  
974 attempted without authorisation.

975

976 An application for authorisation to rehabilitate should include the following  
977 information:

- 978 • the condition of the site to be rehabilitated, including the facilities  
979 and waste to be rehabilitated, levels of contamination, and  
980 quantities of waste;
- 981 • details of rehabilitation measures to be undertaken;
- 982 • management of waste generated during rehabilitation;
- 983 • the anticipated final state of the site after rehabilitation, including  
984 estimates of the levels of residual contamination;
- 985 • details on ongoing monitoring and surveillance that will be  
986 required after rehabilitation; and
- 987 • contingency plans, and plans for remediation of any defects in the  
988 rehabilitation that may become apparent.

989

990 At the conclusion of the rehabilitation, the operator may wish to relinquish  
991 responsibility for the site. Generally the requirements and conditions for this  
992 step will be set in legislation. However, in respect of matters covered by the  
993 Code, requirements and responsibilities for continuing monitoring and  
994 surveillance of the site, and of any remedial work that may become necessary,  
995 will need to be determined. Any land use restrictions that may be necessary,  
996 and the administrative mechanisms that will implement them will also need to  
997 be determined.

998

### 3.7.6 Variations

Variations to operational procedures, changes in equipment in the mine or processing plant, or to the scope or output of the project that may increase exposure of employees or members of the public, constitute “significant changes” which require notification to the relevant regulatory authority under Clause 2.9.5 of the Code.

## 3.8 RADIATION PROTECTION PLAN

The Code requires the development and implementation of a Radiation Protection Plan (RPP) by the operator, with periodic review, evaluation and modification as necessary to ensure continued adequacy of resources, and continued effectiveness and direction, thus ensuring continuous improvement.

The purpose of the Radiation Protection Plan is to control the exposure of employees and members of the public to radiation at or from the practice by the inclusion of measures that are relevant to the degree of risk.

To facilitate this process, it is essential that the Radiation Protection Plan provides for continuous feedback to management, workers and front-line supervisors as to the continued effectiveness of control systems, and that the data it generates are reviewed and responded to in the same manner as other management information.

Further guidance can be obtained by reference to Australian and international standards, in particular Australian Standards AS/NZS 4801:2001 (Standards Australia 2001a), AS/NZS 4804:2001 (Standards Australia 2001b) and AS/NZS ISO 9001:2000 (Standards Australia 2000).

### 3.8.1 Development of Plan

#### (a) Sources of Exposure

The RPP should contain sufficient information to allow all significant exposure sources and pathways to be identified. This should include plans of the mine or processing plant, descriptions of the equipment to be used and processes involved, and estimates of the radionuclide concentrations in process streams.

#### (b) Control Measures

The RPP needs to identify the measures that will be implemented to control radiation exposures. These may include provision of engineering controls such as ventilation, dust or fume control measures, and shielding. Other controls such as occupancy limitation (for example by use of Controlled and Supervised Areas), warning signs and labels, personal hygiene facilities and provision and use of personal protection where necessary should

1049 also be addressed. Measures to ensure that workers are  
1050 adequately supervised in their duties will be required.

1051  
1052 Control of doses to members of the public is achieved principally  
1053 by controlling discharges of waste, and this will be addressed in  
1054 the RWMP. These aspects of the two plans will need to be  
1055 developed in conjunction.

1056

1057 (c) ***Dose Estimates***

1058

1059 Estimates of the exposures or doses that will arise from the  
1060 operation will need to be provided in order to judge the adequacy  
1061 of the proposed control measures. These estimates may be made  
1062 from empirical data, from modelling or from experience in similar  
1063 operations.

1064

1065 (d) ***Monitoring***

1066

1067 Details of the plan to monitor radiation should be submitted.  
1068 There are three main aims for monitoring, which should be  
1069 addressed:

- 1070
- 1071 • demonstration of compliance with regulatory limits, etc;
  - 1072 • determination of doses received by individuals or groups; and
  - 1073 • provision of information on the effectiveness of engineering  
and procedural control measures.

1074

1075 Different monitoring techniques may be required to achieve these  
1076 aims.

1077

1078 The plan needs to provide information on the monitoring  
1079 techniques to be used, and schedules of monitoring frequencies.

1080

1081 The intensity of monitoring should be matched to the exposures  
1082 potentially received. It is common practice to “designate”  
1083 employees who are likely to receive significant doses (for example,  
1084 greater than 5 mSv per annum). Such designated employees are  
1085 then monitored more intensively (including, where appropriate,  
1086 personal monitoring), and their doses are assessed individually.  
1087 Non-designated employees will then be monitored less  
1088 intensively, and their doses assessed as an average of their  
1089 relevant workgroup(s).

1090

1091 The RPP will need to include methods for the calculation of doses  
1092 from the monitoring results, and these methods should be  
1093 acceptable to the relevant regulatory authority. These calculations  
1094 require the use of “dose conversion factors”, which are based on  
1095 the radionuclides involved, and their physical and chemical forms  
1096 (ie. particle size and solubility). Tables of these factors are

1097 provided in Tables II-III and II-IV of International Basic Safety  
1098 Standards (BSS), Safety Series No. 115 (IAEA 1996).

1099  
1100 Schedule 2 provides dose conversion factors that may be used as  
1101 default values for inhalation of the mixtures of radionuclides  
1102 commonly found in operations to which the Code applies. These  
1103 values are chosen so as to be unlikely to underestimate the doses  
1104 arising from monitored exposures. If more accurate dose  
1105 assessments are required, dose conversion factors appropriate to  
1106 the operation can be used. In such cases monitoring will be  
1107 required to determine the relevant parameters, and the plan  
1108 should provide for such monitoring.

1109  
1110 Non-radiological parameters, such as occupancy times, and the  
1111 use and effectiveness of personal protection may also need to be  
1112 monitored.

1113  
1114 Investigation levels which, if exceeded by monitoring results,  
1115 trigger investigations or actions may be set as part of the RPP.

1116  
1117 Monitoring plans need to be flexible enough to respond to  
1118 changing circumstances.

1119  
1120 Surface contamination monitoring is not useful for personal dose  
1121 calculations nor is it directly useful in assessment of the  
1122 effectiveness of engineering controls. However, it is the prime  
1123 method of assessing housekeeping standards (procedural control  
1124 issues), and is useful in checking of equipment prior to  
1125 maintenance. Surface contamination checks are also crucial for  
1126 control over release of potentially contaminated equipment from  
1127 site (gatehouse control). For these reasons, surface contamination  
1128 monitoring will usually be an integral component of the overall  
1129 monitoring plan.

1130

1131 (e) **Education and Training**

1132  
1133 Appropriate education and training in the radiation aspects of the  
1134 operation need to be provided to all workers. The training needs  
1135 to be directed towards understanding the measures that should be  
1136 taken to reduce radiation exposure, and needs to include job  
1137 specific training. Additional training for supervisors needs to be  
1138 supplied.

1139  
1140 Education and training needs to be continuing, and measures to  
1141 evaluate the effectiveness of the training should be included.

1142  
1143 Induction and training programs should be documented and  
1144 employee participation should be recorded.

1145  
1146 (f) **Reporting and Record Keeping**

1147  
1148 The RPP needs to include provisions for reporting the results of  
1149 the monitoring program, and related information. Reports will be  
1150 required for the relevant regulatory authority, management, and  
1151 for the workers, both as individuals and as a group, at least on a  
1152 twelve-monthly basis. Operational requirements may require  
1153 more frequent reporting and analysis to management.  
1154 Requirements for reporting operational matters such as incidents  
1155 or accidents should also be developed.

1156  
1157 Records of monitoring results, dose assessments including  
1158 calculation methods, and related information should be retained  
1159 in a form that will allow them to be retrieved. Such records  
1160 should normally be retained for a period of at least 30 years. They  
1161 should not be destroyed without consulting the relevant  
1162 regulatory authority (see Annex A), and appropriate measures for  
1163 their management should be put in place should the project close.

1164  
1165 **3.8.2 Implementation of Plan**

1166  
1167 (a) **Personnel and Resources**

1168  
1169 The RPP needs to include commitments to provide adequate staff,  
1170 with appropriate qualification and experience, and with sufficient  
1171 resources, to properly implement the requirements of the plan,  
1172 and other requirements of the Code. Radiation protection staff  
1173 need access to continuing training and professional development.

1174  
1175 (b) **Integration into Operation**

1176  
1177 The plan needs to demonstrate that it is integrated into other  
1178 Occupational Health and Safety (OH&S) management and the  
1179 management of the operation as a whole. This includes ensuring  
1180 that radiation issues will be considered in planning of any changes  
1181 or development of the operation, and that the results of

1182 monitoring are made available promptly to management, in  
1183 particular so that corrective measures are taken as required in a  
1184 timely fashion.

1185

### 1186 **3.8.3 Quality Assurance**

1187

1188 A quality assurance program, which is compliant with Australian Standard  
1189 AS/NZS ISO 9001:2000 (Standards Australia 2000), needs to be  
1190 implemented, including traceability of all radiation measurements to  
1191 Australian metrological standards.

1192

#### 1193 (a) **Calibration**

1194

1195 The RPP should include measures for calibration of equipment  
1196 used in monitoring, including where appropriate, traceability to  
1197 Australian standards. Schedules for calibration should be  
1198 included, which are appropriate to the type of equipment and the  
1199 conditions under which it is used.

1200

#### 1201 (b) **Auditing**

1202

1203 A system of auditing of the performance of the RPP should be  
1204 implemented. This may include both internal and external  
1205 auditing.

1206

### 1207 **3.8.4 Review and Assessment**

1208

1209 The continual review and assessment is essential in achieving continual  
1210 improvement of radiation protection, and should be addressed in the RPP.  
1211 This may include review of doses, including trends over time, for both the  
1212 operation as a whole and for smaller areas or workgroups, review of the  
1213 monitoring plan to ensure that monitoring frequencies and techniques remain  
1214 appropriate, and review of administrative procedures and work practices.

1215

### 1216 **3.8.5 Accidents and Incidents**

1217

1218 All radiological accidents should be reported without delay to the relevant  
1219 regulatory authority (see Annex A). The relevant regulatory authority should  
1220 be advised as soon as is practicable of the cause of the incident or accident, its  
1221 consequences and the steps taken to remedy the situation and to prevent a  
1222 recurrence.

1223

1224 In the event of an accident which causes or which may lead to significant  
1225 doses of radiation or significant contamination of persons with radioactive  
1226 materials, and following any immediate first aid and medical assistance  
1227 provided, the relevant regulatory authority should be consulted without delay  
1228 for advice on the medical management of those exposed. Appropriate  
1229 counselling should be provided to the persons affected.

1230

1231 Corrective measures should be taken, as necessary, to bring an accident under  
1232 control and to prevent a recurrence.

1233

1234 All radiological incidents should be recorded and reported as required by the  
1235 relevant regulatory authority. The relevant regulatory authority should be  
1236 advised of the cause of the incident, its consequences and the steps taken to  
1237 remedy the situation and to prevent a recurrence.

1238

### 1239 **3.9 RADIOACTIVE WASTE MANAGEMENT PLAN**

1240

1241 The Radioactive Waste Management Plan (RWMP) is an integral part of a  
1242 project and should be addressed from the inception of project planning. It  
1243 should be based on best practicable technology. The RWMP includes a  
1244 description of the facilities and resources, and the procedures such as  
1245 operating instructions, and monitoring program.

1246

1247 The RWMP should be developed in conjunction with the Radiation Protection  
1248 Plan.

1249

1250 The RWMP should be developed and updated as the project progresses  
1251 through the various stages of the operation (including temporary suspension  
1252 of operation, if applicable) and to be able to cope with any foreseeable  
1253 contingency. The RWMP should be revised if circumstances change  
1254 significantly or if indicated by the results of monitoring and surveillance  
1255 programs. All changes to the RWMP need to be approved by the relevant  
1256 regulatory authority.

1257

1258 The establishment of “baseline” conditions is an important part of the  
1259 development of a RWMP. A monitoring program designed to evaluate baseline  
1260 conditions should be developed in conjunction with the relevant regulatory  
1261 authority. It is important that it be commenced early enough to allow  
1262 seasonal variations in pre-existing conditions to be evaluated prior to  
1263 commencement of the project. These “baseline” conditions should be  
1264 established prior to any collection of significant amounts of radioactive  
1265 material through ground disturbance exercises. These conditions will  
1266 probably have to be established whilst the RWMP is being developed.

1267

1268 The RWMP should address such monitoring as is needed to verify the  
1269 effectiveness of engineering design, to validate models and predictions, and to  
1270 demonstrate compliance with discharge limits and operational discharge  
1271 procedures.

1272

1273 All relevant employees should be acquainted with the approved RWMP in  
1274 particular the reasoning behind the containment policy and the requirements  
1275 for allowing discharges to take place. Any fluctuations from normal operating  
1276 conditions should be assessed for their effect on the approved RWMP.

1277

#### 1278 **3.9.1 Development of Plan**

1279

1280 In order that a Plan which is acceptable to the relevant regulatory authority is  
1281 developed in a timely and efficient manner, it is important that the relevant  
1282 regulatory authority be made aware of all relevant information. Prior to  
1283 seeking approvals (or authorisation) for a RWMP, the operator should consult

1284 with the relevant regulatory authority with respect to the waste to be  
1285 generated, possible management strategies, and the potential effects of this  
1286 waste on members of the public (critical group assessment) and the  
1287 environment. As the project develops, consultation with the relevant  
1288 regulatory authority should continue. The operator should inform the  
1289 relevant regulatory authority of matters that it considers may significantly  
1290 affect the current or future management of the waste, or the potential for  
1291 appropriate rehabilitation.

1292

1293 The identification of potential, past, and future impacts on the environment  
1294 are aspects to be considered in devising the monitoring program for the  
1295 RWMP.

1296

1297 In developing the RWMP all relevant pathways for dispersion of radionuclides  
1298 and for radiation exposure should be considered. The assessment should  
1299 include the optimisation of handling, treatment, storage, and disposal of  
1300 radioactive waste. The following elements, although not exhaustive, are given  
1301 as a guide for information that may be relevant to some operations for  
1302 inclusion in the RWMP:

- 1303 • outline of the operation and the processes generating waste;
- 1304 • characterisation of waste including nature of material (chemical,  
1305 physical and radiological), contaminants, and quantities and rate of  
1306 production;
- 1307 • characterisation of the environment: climate, terrain  
1308 (geomorphology), soils and vegetation, and hydrology;
- 1309 • heritage (social and cultural), and land use (present, potential and  
1310 future);
- 1311 • waste management facilities and practices, waste conditioning, and  
1312 containment including siting, design and construction, and  
1313 operation;
- 1314 • discharges: form (liquid, solid, and gaseous), receiving  
1315 environment, discharge and release criteria;
- 1316 • contingency measures: natural events, incidents, equipment  
1317 failures, and operational failures;
- 1318 • initial impact (safety) assessment;
- 1319 • monitoring, surveillance and reporting: personnel and monitoring  
1320 equipment, and geotechnical monitoring;
- 1321 • assessment and review of integrity of the facility;
- 1322 • environmental monitoring: assessment of doses, environmental  
1323 impacts, reporting; and
- 1324 • post-operational practices: temporary suspension of operations,  
1325 decommissioning, closure, decontamination, rehabilitation,  
1326 monitoring, (long term) surveillance and reporting, records  
1327 management, and institutional control and land use.

1328

1329 Throughout the operational stage the plans for decommissioning should be  
1330 further developed in consultation with the relevant regulatory authority.

1331 Decommissioning proposals should be reviewed whenever there is a  
1332 significant change in the operation or of the waste management system, and at  
1333 other intervals determined by the relevant regulatory authority.

1334

1335 The operational plan should include contingency plans to cover the cases of  
1336 early shutdown or temporary suspension of operations. These contingency  
1337 plans should address the continuation of all measures required to safeguard  
1338 the integrity of the containment facility.

1339

1340 In accordance with best practicable technology, factors to consider in  
1341 developing the RWMP in order to minimise the environmental detriment  
1342 include:

1343       • the level of effluent control achieved and the extent to which  
1344 environmental pollution and degradation are prevented in similar  
1345 mining, milling and mineral processing operations anywhere in the  
1346 world;

1347       • the total cost of the application or adoption of that technology  
1348 relative to the environmental protection to be achieved by its  
1349 application or adoption;

1350       • evidence of detriment, or lack of detriment, to the environment  
1351 after the commencement of the project in question;

1352       • the physical location of the project in question; and

1353       • the age of equipment and facilities in use on the project in question  
1354 and their relative effectiveness in reducing environmental pollution  
1355 and degradation; and social factors including possible adverse  
1356 social effects of introducing new technology.

1357

### 1358 **3.9.2 Implementation of Plan**

1359

#### 1360 (a) **Commissioning**

1361

1362 The operator should be capable of demonstrating to the relevant  
1363 regulatory authority that the facility has been constructed in  
1364 accordance with the approved design, and that operational  
1365 procedures including monitoring are in place prior to  
1366 commissioning any waste management facility. The relevant  
1367 regulatory authority could approve operation for a restricted  
1368 period of commissioning. An approved monitoring and  
1369 surveillance program would be required in this commissioning  
1370 stage.

1371

#### 1372 (b) **Routine Operation**

1373

1374 Where the relevant regulatory authority is satisfied that the  
1375 RWMP can be operated within its design parameters, then  
1376 approval of routine operation may be issued. An approved  
1377 monitoring and surveillance program would be required for  
1378 routine operations.

1379

1380 (c) **Variations**

1381

1382 The operator would be expected to inform the relevant regulatory  
1383 authority of:

- 1384 • any changes to the operation which may alter the nature or  
1385 quantity of waste generated;
- 1386 • any proposal to change the waste containment system; and
- 1387 • any unanticipated circumstances that may lead to a variation in  
1388 the performance of the approved RWMP.

1389

1390 The relevant regulatory authority would determine whether these  
1391 changes require approval of modifications to the approved Waste  
1392 Management System. These changes would not normally be put  
1393 into effect until any required approval has been issued.

1394

1395 If it is necessary to temporarily suspend operations, the  
1396 contingency plans referred to previously should be brought into  
1397 effect. If the suspension continues for more than 12 months the  
1398 RWMP should be reviewed. During such reviews the  
1399 decommissioning plan would also be reviewed.

1400

1401 (d) **Decommissioning**

1402

1403 The operator should not commence operations for  
1404 decommissioning or rehabilitating any waste management facility  
1405 except in accordance with provisions of the approved waste  
1406 management system. The relevant regulatory authority would  
1407 determine when the decommissioning phase has been completed.

1408

1409 **3.9.3 Quality Assurance**

1410

1411 A quality assurance program should be included in the RWMP. It should  
1412 cover the civil engineering and geotechnical aspects of the containment  
1413 system; the operation of the system; the appropriateness, scope and frequency  
1414 of the monitoring programs; and the accuracy and traceability to Australian  
1415 Standards wherever appropriate of sample analyses arising from the  
1416 monitoring programs.

1417

1418 Further guidance can be obtained by reference to Australian standards, in  
1419 particular Australian Standard AS/NZS ISO 14001:1996 (Standards  
1420 Australia 1996).

1421

1422 **3.9.4 Reporting and Record Keeping**

1423

1424 An annual report on the performance of the RWMP should be prepared for  
1425 submission to the relevant regulatory authority. This report should analyse  
1426 and present the results of the monitoring program for the previous year,  
1427 including assessment of doses and environmental impacts.

1428

1429 **3.9.5 Review and Assessment**

1430

1431 During the operational phase the operator should continue to assess the  
1432 performance of the Radioactive Waste Management Plan in conjunction with  
1433 the relevant regulatory authority. The Plan should be reviewed at a frequency  
1434 determined by the relevant regulatory authority with a view to continuous  
1435 improvement, and the operator may formulate an improved monitoring  
1436 program based on the previous results and any foreshadowed changes.

1437

1438 **3.10 RESPONSIBILITIES**

1439

1440 **3.10.1 Operator**

1441

1442 In the event that an employee advises her employer that she is pregnant, the  
1443 employer should discuss with the employee the probable dose that the  
1444 employee will receive for the remainder of the pregnancy. If the dose to the  
1445 employee is estimated to not exceed 1 mSv for the rest of the pregnancy, then  
1446 no specific additional radiation protection measures are required (for  
1447 example, change of duties).

1448

1449 There is a requirement in the Code on the operator to notify the relevant  
1450 regulatory authority (see Annex A) of any changes which are likely to  
1451 significantly increase radiation exposures to workers or members of the  
1452 public, or requirements for the management of radioactive waste. In deciding  
1453 whether a change is significant, the operator will need to consider the  
1454 magnitude of expected dose increase, number of people exposed, and  
1455 duration. Examples include:

1456

- major change in plant process or components; and
- change of the order of 30% or more in production capacity.

1457

1458

1459 There may also be requirements to report such changes under other  
1460 legislation.

1461

1462 The operator has a general duty of care in regard to a whole range of  
1463 occupational health and safety issues, of which the radiation protection  
1464 aspects of the Code form part. Compliance with the Code should demonstrate  
1465 achievement of duty of care in radiation protection matters. In developing the  
1466 RPP and RWMP, the operator should consider all other OH&S requirements  
1467 and recognise the potential for conflicts in their control. Prioritization of  
1468 hazard control requirements will need to be made.

1469

1470 Similarly, the operator has a general duty to protect the environment in which  
1471 he operates. Control of radionuclides and management of radioactive waste  
1472 may constitute only one aspect of overall environmental protection  
1473 environments.

1474

1475 The operator has responsibility to appoint an appropriately qualified RSO.  
1476 The requirements will change depending on the scale of the operation and  
1477 concomitant risks of radiation exposure. Normally, an RSO is expected to

1478 have a degree in physical sciences or equivalent and some years of experience  
1479 in radiation protection, preferably in the mining industry.

1480

### 1481 **3.10.2 Relevant Regulatory Authority**

1482

1483 The relevant regulatory authority is responsible for ensuring that approved  
1484 Radiation Protection Plans and Radioactive Waste Management Plans are  
1485 adequate to meet the objectives of the Code. In carrying out this  
1486 responsibility, the relevant regulatory authority would be expected to:

- 1487 • inform potential applicants of all approvals and authorisations that  
1488 will be required at each stage of the project, and the administrative  
1489 requirements for applications;
- 1490 • provide the opportunity for operators or potential operators to  
1491 consult with the relevant regulatory authority on matters relating to  
1492 the Code;
- 1493 • consider all relevant applications and proposals, submitted at each  
1494 stage of the approval process;
- 1495 • advise applicants promptly of decisions on applications, including  
1496 reasons for the rejection of any applications;
- 1497 • advise applicants on requirements for reporting of project  
1498 activities, monitoring results, dose assessments, incidents and  
1499 accidents, and other matters that may be required; and
- 1500 • make arrangements for the long-term retention of records of  
1501 radiation exposure and related matters.

1502

1503 The relevant regulatory authority is also responsible for auditing compliance  
1504 with the objectives of the Code. This auditing may be carried out by the  
1505 relevant regulatory authority themselves or by contracting an external auditor.  
1506 In carrying out this function, the relevant regulatory authority would be  
1507 expected to:

- 1508 • communicate any concerns and requirements in relation to the  
1509 system to the proponent and may require modifications to plans,  
1510 criteria, standards and characteristics as deemed necessary; and
- 1511 • determine the means of indemnifying the relevant regulatory  
1512 authority against costs of surveillance, monitoring, premature  
1513 closure and any rectification work which may become necessary.

1514

1515 The relevant regulatory authority also has responsibility to ensure that upon  
1516 decommissioning of facilities to which the Code applies, appropriate  
1517 administrative and other procedures are in place to ensure the long-term  
1518 integrity of sites, particularly waste disposal sites.

1519

## Schedule 1

### ARPANSA'S RECOMMENDATIONS FOR LIMITING EXPOSURE TO IONIZING RADIATION (2002) – DOSE LIMITS

Application	Dose Limits <sup>1</sup>	
	Occupational	Public
Effective dose	20 mSv per year, averaged over a period of 5 consecutive calendar years <sup>2</sup>	1 mSv in a year <sup>4</sup>
Annual equivalent dose in:		
the lens of the eye	150 mSv	15 mSv
the skin <sup>5</sup>	500 mSv	50 mSv
the hands and feet	500 mSv	–

1. The limits shall apply to the sum of the relevant doses from external exposure in the specified period and the 50-year committed dose (to age 70 years for children) from intakes in the same period.
2. With the further provision that the effective dose shall not exceed 50 mSv in any single year. In addition, when a pregnancy is declared by a female employee, the embryo or fetus should be afforded the same level of protection as required for members of the public.
3. (DELETED)
4. In special circumstances, a higher value of effective dose could be allowed in a single year, provided that the average over 5 years does not exceed 1 mSv per year.
5. The equivalent dose limit for the skin applies to the dose averaged over any 1 cm<sup>2</sup> area of skin, regardless of the total area exposed.

NOTE 1: The above dose limits table has been directly extracted from ARPANSA's *Recommendations for limiting exposure to ionizing radiation (1995)*, [republished as RPS 1 in 2002]. However, as the RHC now advises that the exceptional circumstances clause is not recommended for use in Australia, note 3 of the table in RPS 1 has been deleted from this Code.

NOTE 2: Exposure to radiation from natural sources is generally excluded from occupational or public exposure, except when the exposure is a direct consequence of a practice or is specifically identified by the appropriate authority as requiring control through the implementation of a program of radiation protection. Medical exposure includes doses received by patients undergoing medical diagnosis or therapy, doses received by volunteers in medical research, and doses received knowingly and willingly by persons other than health care workers as a consequence of their proximity to an exposed patient. Dose limits do not apply to exposures from natural sources, except as described above, or to medical exposures.

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## Schedule 2

### DOSE CONVERSION FACTORS FOR AIRBORNE RADIONUCLIDES<sup>1</sup>

#### Part A: For specified mixtures of radionuclides

Mixture	Factors for Inhalation <sup>2</sup> (mSv/ $\alpha$ dps)
<i>Uranium dusts</i> <sup>3</sup>	
Ore dust <sup>4</sup>	$7.2 \times 10^{-3}$
Product dust <sup>5</sup>	$7.9 \times 10^{-3}$
Tailings dust <sup>5</sup>	$6.7 \times 10^{-3}$
<i>Thorium dust</i>	
Th-232 series	$1.1 \times 10^{-2}$

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1567  
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1569  
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1576  
1577

- Notes:
1. The values tabulated are taken from IAEA Basic Safety Standard No. 115 (IAEA 1996) for the longest pulmonary retention class for an AMAD of 1  $\mu$ m. The values quoted are applicable to adults.
  2.  $\alpha$ dps means the expectation of the number of alpha-particle disintegrations per second of the mixture. It is assumed that no loss of radon occurs.
  3. It is assumed that 0.72% by mass of natural uranium is U-235.
  4. Secular equilibrium is assumed.
  5. Greater than 90% uranium extraction to product is assumed, with greater than 90% rejection of thorium, radium and daughters to tailings.

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1583  
1584

#### Part B: For radon daughters

Radionuclides	Factor (mSvJ)
Radon-222 daughters	$1.2 \times 10^3$
Radon-220 daughters	$3.9 \times 10^2$

1585  
1586

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## Glossary

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### Accident

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an unintended event which causes, or has the potential to cause, employees or members of the public to be exposed to radiation from which the individual doses or collective doses received do not lie within the range of variation which is acceptable for normal operation. An accident may result from human error, equipment failure or other mishap; it may require emergency action to save life or to safeguard health, property or the environment. An accident requires investigation of its causes and consequences and, possibly, corrective action within the program for control of radiation, and it may require remedial action to mitigate the consequences.

1681

### Action level

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1683

the level of *dose* rate or *activity* concentration above which *remedial* or *protective actions* should be carried out in chronic exposure or emergency exposure situation.

1684

### Activity

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1686

the measure of quantity of radioactive materials, except when used in the term "human activity".

1687

### Activity median aerodynamic diameter (AMAD)

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1689

the diameter of a unit density sphere with the same terminal velocity in air as that of an aerosol particle whose activity is the median for the entire aerosol.

1690

### ALARA

1691

an acronym for 'as low as reasonably achievable', used in the context of optimisation.

1692

### Annual limit on intake (ALI)

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1695

that quantity of a radionuclide which, taken into the body during one year, would lead to a committed effective dose equal to the occupational annual limit on effective dose.

1696

### Approval

1697

1698

an Australian/New Zealand Standard jointly published by Standards Australia and Standards New Zealand.

1699

### AS/NZS

1700

1701

a written agreement by the relevant regulatory authority that a plan or proposal meets the radiation protection requirements of the Code.

1702

### Authorisation

1703

1704

the granting by a regulatory body of written permission for an operator or class of operators to perform specified activities.

1705

### Best practicable technology (BPT)

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that technology, from time to time relevant to a specific project, which enables radioactive waste or exposure to radiation to be managed so as to minimise radiological risks and detriment to people and the environment, having regard to:

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- (a) the achievable levels of effluent control and the extent to which pollution and degradation of the environment is minimised or prevented in comparable mining operations elsewhere;
- (b) the cost of the application or adoption of that technology relative to the degree of radiological and environmental protection expected to be achieved by its application or adoption;
- (c) evidence of detriment or lack of detriment to the environment after the commencement of mining operations;
- (d) the location of the mine;

- 1718 (e) the age of the equipment and facilities in use for mining purposes and their  
1719 relative effectiveness in achieving radiological and environmental  
1720 protection; and  
1721 (f) the potential long term hazards from the wastes.

1722 **Clearance**

1723 the removal of radioactive materials or objects within authorized practices from any  
1724 further control by the relevant regulatory authority.

1725 **Constraint**

1726 either **dose constraint** in the case of exposures anticipated to be received, or **risk**  
1727 **constraint** in the case of potential exposures (see **dose constraint** and **risk**  
1728 **constraint**).

1729 **Controlled area**

1730 an area to which access is subject to control and in which employees are required to  
1731 follow specific procedures aimed at controlling exposure to radiation.

1732 **Critical group**

1733 a group of members of the public comprising individuals who are relatively  
1734 homogeneous with regard to age, diet and those behavioural characteristics that  
1735 affect the doses received and who receive the highest radiation doses from a  
1736 particular practice.

1737 **Detriment**

1738 a measure, or measures, of harm caused by exposure to radiation and usually taken  
1739 to mean health detriment; it has no single definition, but can be taken to be an  
1740 attribute or a collection of attributes which measure harm, such as attributable  
1741 probability of death and reduction of life expectancy.

1742 **Disposal**

1743 the emplacement of waste in an approved, specified facility without intention of  
1744 retrieval. Disposal may also include the approved direct discharge of effluent (eg.  
1745 liquid or gaseous waste) into the environment with subsequent dispersion.

1746 **Dose**

1747 a generic term which may mean absorbed dose, equivalent dose or effective dose  
1748 depending on context.

1749 **Dose constraint**

1750 a prospective restriction on anticipated dose, primarily intended to be used to discard  
1751 undesirable options in an optimization calculation.

1752 in occupational exposure, a dose constraint may be used to restrict the options  
1753 considered in the design of the working environment for a particular category of  
1754 employee.

1755 in medical exposure, a dose constraint for volunteers in medical research may be  
1756 used to restrict the options considered in the design of an experimental protocol.

1757 in public exposure, a dose constraint may be used to restrict the exposure of the  
1758 critical group from a particular source of radiation.

1759 **Effective dose**

1760 a measure of dose which takes into account both the type of radiation involved and  
1761 the radiological sensitivities of the organs and tissues irradiated.

1762 Effective dose, E, is the sum of weighted equivalent doses in all organs and tissues of  
1763 the body. It is given by the expression:

1764 
$$E = \sum_T w_T H_T$$

1765 where  $H_T$  is the equivalent dose in organ or tissue  $T$  and  
1766  $w_T$  is the weighting factor for that organ or tissue  $T$ .

1767 The unit of effective dose is the same as for equivalent dose, J kg<sup>-1</sup>, with the special  
1768 name sievert (Sv).

1769 **Employee**

1770 a person who works for an employer within an operation including a contractor  
1771 performing work on the project site on behalf of the owner/operator.

1772 **Employer**

1773 an operator who, or which, engages people to work within an operation; the term  
1774 employer includes a self-employed person.

1775 **Equivalent dose**

1776 a measure of dose in organs and tissues which takes into account the type of radiation  
1777 involved.

1778 Equivalent dose,  $H$ , is a weighted dose in an organ or tissue, with the radiation  
1779 weighting factor(s) determined by the type and energy of the radiation to which the  
1780 organ or tissue is exposed. The equivalent dose  $H_T$  in organ or tissue  $T$  is given by the  
1781 expression:

1782 
$$H_T = \sum_R w_R D_{T,R}$$

1783 where  $D_{T,R}$  is the absorbed dose averaged over the organ or tissue  $T$  due to radiation  
1784  $R$  and  
1785  $w_R$  is the radiation weighting factor for that radiation.

1786 The unit of equivalent dose is the same as for absorbed dose, J kg<sup>-1</sup>, with the special  
1787 name sievert (Sv).

1788 **Exclusion**

1789 in the context of assessing radiation exposure, the deliberate omission of a specified  
1790 component, or components, of total exposure to radiation.

1791 **Exemption**

1792 a designation, by the relevant regulatory authority, for sources of radiation that are  
1793 not subject to nuclear regulatory control because they present such a low radiological  
1794 hazard; the deliberate omission of a practice from regulatory control, or from some  
1795 aspects of regulatory control, by the relevant regulatory authority.

1796 **Exposure**

1797 either: the circumstance of being exposed to radiation,  
1798 or: a defined dosimetric quantity now no longer used for radiation protection  
1799 purposes.

1800 (The context in which the word is used should avoid ambiguity.)

1801 **IAEA**

1802 International Atomic Energy Agency, headquarters located in Vienna, Austria.

1803 **ICRP**

1804 the International Commission on Radiological Protection. It is an independent  
1805 organisation that provides general guidance on radiation protection. The  
1806 recommendations of the ICRP are not legally binding, but are generally followed by  
1807 countries framing national regulatory requirements.

**1808 Incident**

1809 an event which causes, or has the potential to cause, abnormal exposure of employees  
1810 or members of the public and which requires investigation of its causes and  
1811 consequences. Such an event may require corrective action within the program for  
1812 control of radiation, but is not of such scale as to be classified as an accident.

**1813 Intervention**

1814 an action intended to reduce or avert exposure or the likelihood of exposure to  
1815 sources which are not part of a controlled practice or which are out of control as a  
1816 consequence of an accident or other event.

**1817 Intervention level**

1818 a reference level of an environmental or dosimetric quantity, such as absorbed dose  
1819 rate; if measured values of that quantity are found to consistently exceed the  
1820 intervention level, remedial action should be considered.

**1821 Investigation level**

1822 a reference level of an environmental or dosimetric quantity, such as absorbed dose  
1823 rate; if measured values of that quantity are found to consistently exceed the  
1824 investigation level, the cause or implications of the situation should be investigated.

**1825 Institutional control**

1826 control of a waste site by an authority or institution designated under the law. This  
1827 control may be active (monitoring, surveillance, remedial work), or passive (land use  
1828 restrictions).

**1829 ISO**

1830 the International Organization for Standardization. It is a non-governmental  
1831 organisation with a Central Secretariat in Geneva, Switzerland that coordinates a  
1832 network of national standards institutes.

**1833 Justification**

1834 the notion that human activities which lead to exposure to radiation should be  
1835 justified, before they are permitted to take place, by showing that they are likely to do  
1836 more good than harm.

**1837 Licence**

1838 a written approval issued to an operator, which allows the operator to carry out an  
1839 operation legally.

**1840 Limitation**

1841 the requirement that radiation doses and risks should not exceed a value regarded as  
1842 unacceptable.

**1843 Mining and mineral processing**

1844 Mining is all activities associated with the extraction, from a mine, of ore containing  
1845 uranium- or thorium-series radionuclides either in sufficient quantities or  
1846 concentrations to warrant exploitation for the respective elements or present in  
1847 conjunction with other substances being mined, in quantities or concentrations  
1848 which require radiation protection measures to be taken, as determined by the  
1849 relevant regulatory authority.

1850 Mineral processing is the activities associated with the processing of ores as defined  
1851 above to produce a physical or chemical concentrate.

**1852 NOHSC**

1853 the National Occupational Health and Safety Commission established by section 6 of  
1854 the *National Occupational Health and Safety Commission Act 1985*.

- 1855 **Occupational exposure**  
1856 exposure of a person to radiation which occurs in the course of that person's work  
1857 and which is not excluded exposure.
- 1858 **OH&S**  
1859 Occupational Health and Safety.
- 1860 **Operation**  
1861 an instance of a practice; a particular human activity which may result in exposure to  
1862 ionizing radiation and to which a program of radiation protection applies.
- 1863 **Operator**  
1864 any person or entity responsible for a mining or mineral processing operation which  
1865 may lead to exposure to ionizing radiation.
- 1866 **Optimization**  
1867 the process of maximising the net benefit arising from human activities which lead to  
1868 exposure to radiation.
- 1869 **Practice**  
1870 any human activity that introduces additional sources of exposure or exposure  
1871 pathways or extends exposure to additional people or modifies the network of  
1872 exposure pathways from existing sources, so as to increase the *exposure* or the  
1873 likelihood of exposure of people or the number of people exposed.
- 1874 **Public exposure**  
1875 exposure incurred by members of the public from radiation sources, excluding any  
1876 *occupational* or *medical exposure* and the normal local natural background radiation  
1877 but including exposure from authorized *sources* and practices and from *intervention*  
1878 situations.
- 1879 **Radiation**  
1880 electromagnetic waves or quanta, and atomic or sub-atomic particles, propagated  
1881 through space or through a material medium.
- 1882 **Radiation Safety Officer (RSO)**  
1883 an individual technically competent in radiation protection matters relevant for a  
1884 given type of practice who is designated by the operator or employer to oversee the  
1885 application of the requirements of the Code.
- 1886 **Radioactive waste**  
1887 radioactive waste means material that contains or is contaminated with radionuclides  
1888 at concentrations or activities greater than clearance levels as established by the  
1889 relevant regulatory authority, and for which no use is foreseen.
- 1890 **Relevant regulatory authority**  
1891 the radiation protection authority or authorities designated, or otherwise recognized,  
1892 for regulatory purposes in connection with protection and safety relating to the use of  
1893 radiotherapy equipment. A list of regulatory authorities in Australia is included as  
1894 Annex A.
- 1895 **Risk constraint**  
1896 a restriction applied to potential exposure (see dose constraint).
- 1897 **Specific activity**  
1898 the activity of a radionuclide per unit mass of the element, or the activity of a  
1899 radioactive material per unit mass of that material.
- 1900 **Stochastic effect**

1901 an effect known to occur sometimes as a consequence of exposure to radiation, but  
1902 which may or may not be expressed in a particular exposed person, the likelihood of  
1903 the effect occurring being a function of the dose received.

1904 **Supervised area**

1905 an area in which working conditions are kept under review but in which special  
1906 procedures to control exposure to radiation are not normally necessary.

1907 **System of radiation protection**

1908 a generic process of radiation risk management designed to limit the health risks  
1909 arising from exposure to radiation to acceptable levels in a manner which takes  
1910 economic and social considerations into account.

1911 **Waste management system**

1912 includes all the facilities and procedures involved in the handling, treatment, storage  
1913 and disposal of radioactive wastes.

1914 **Working level month (WLM)**

1915 a unit of exposure to radon progeny or thoron progeny.

1916  $1 \text{ WLM} = 170 \text{ WL.h}$

1917 One working level month is equivalent to  $3.54 \text{ mJ.h.m}^{-3}$

1918

1919 **Annex A**

1920

1921 **RADIATION PROTECTION AND REGULATORY AUTHORITIES**

1922

1923 **Table A1: Radiation Protection Authorities**

1924

1925 Where advice or assistance is required from the relevant radiation protection  
1926 authority, it may be obtained from the following officers:

COMMONWEALTH, STATE / TERRITORY	CONTACT
Commonwealth	Director, Regulatory Branch ARPANSA PO Box 655 Miranda NSW 1490 Email: <a href="mailto:info@arpansa.gov.au">info@arpansa.gov.au</a> Tel: (02) 9541 8333 Fax: (02) 9541 8348
Australian Capital Territory	Manager Radiation Safety Radiation Safety Section ACT Health Locked Bag 5 Weston Creek ACT 2611 Email: <a href="mailto:radiation.safety@act.gov.au">radiation.safety@act.gov.au</a> Tel: (02) 6207 6946 Fax: (02) 6207 6966
New South Wales	Director Radiation Control Department of Environment and Conservation PO Box A290 Sydney South NSW 1232 Email: <a href="mailto:radiation@epa.nsw.gov.au">radiation@epa.nsw.gov.au</a> Tel: (02) 9995 5000 Fax: (02) 9995 6603
Northern Territory	Manager – Radiation Health Radiation Health Section Department of Health and Community Services GPO Box 40596 Casuarina NT 0811 Email: <a href="mailto:envirohealth@nt.gov.au">envirohealth@nt.gov.au</a> Tel: (08) 8922 7489 Fax: (08) 8922 7334
Queensland	Director, Radiation Health Department of Health 450 Gregory Terrace Fortitude Valley QLD 4006 Email: <a href="mailto:radiation_health@health.qld.gov.au">radiation_health@health.qld.gov.au</a> Tel: (07) 3406 8000 Fax: (07) 3406 8030
South Australia	Director, Radiation Protection Division Environment Protection Authority PO Box 721 Kent Town SA 5071 Email: <a href="mailto:radiationprotection.branch@state.sa.gov.au">radiationprotection.branch@state.sa.gov.au</a> Tel: (08) 8130 0700 Fax: (08) 8130 0777
Tasmania	Senior Health Physicist Health Physics Branch Department of Health and Human Services GPO Box 125B Hobart TAS 7001 Email: <a href="mailto:health.physics@dhhs.tas.gov.au">health.physics@dhhs.tas.gov.au</a> Tel: (03) 6222 7256 Fax: (03) 6222 7257
Victoria	Manager, Radiation Safety Program Department of Human Services GPO Box 4057 Melbourne VIC 3001 Email: <a href="mailto:radiation.safety@dhs.vic.gov.au">radiation.safety@dhs.vic.gov.au</a> Tel: (03) 9637 4167 Fax: (03) 9637 4508
Western Australia	Secretary, Radiological Council Locked Bag 2006 Nedlands WA 6009 Email: <a href="mailto:radiation.health@health.wa.gov.au">radiation.health@health.wa.gov.au</a> Tel: (08) 9346 2260 Fax: (08) 9381 1423

1927

1928 **Table A2: Regulatory Authorities**

1929

1930 The following organisations regulate various aspects of mining and mineral  
1931 processing:

COMMONWEALTH, STATE / TERRITORY	CONTACT
Commonwealth	Director, Regulatory Branch ARPANSA PO Box 655 Miranda NSW 1490 Email: info@arpansa.gov.au Tel: (02) 9541 8333 Fax: (02) 9541 8348
Australian Capital Territory	Manager Radiation Safety Radiation Safety Section ACT Health Locked Bag 5 Weston Creek ACT 2611 Email: radiation.safety@act.gov.au Tel: (02) 6207 6946 Fax: (02) 6207 6966
New South Wales	Deputy Director-General, Mineral Resources NSW Department of Primary Industries PO Box 344 Hunter Region Mail Centre NSW 2310 Email: webcoord@minerals.nsw.gov.au Tel: (02) 4931 6666 Toll-free: 1300 763 122 Fax: (02) 4931 6790
Northern Territory	Chief Executive Officer Department of Business, Industry and Resource Development GPO Box 3000 Darwin NT 0801 Email: mineral.info@nt.gov.au Tel: (08) 8999 5204 Fax: (08) 8941 1284
Queensland	Director, Radiation Health Department of Health 450 Gregory Terrace Fortitude Valley QLD 4006 Email: radiation_health@health.qld.gov.au Tel: (07) 3406 8000 Fax: (07) 3406 8030
South Australia	Director, Radiation Protection Division Environment Protection Authority PO Box 721 Kent Town SA 5071 Email: radiationprotection@state.sa.gov.au Tel: (08) 8130 0700 Fax: (08) 8130 0777
Tasmania	Mineral Resources Tasmania Department of Infrastructure, Energy and Resources GPO Box 56 Rosny Park TAS 7018 Email: info@mrt.tas.gov.au Tel: (03) 6233 8377 Fax: (03) 6233 8338
Victoria	Manager, Radiation Safety Program Department of Human Services GPO Box 4057 Melbourne VIC 3001 Email: radiation.safety@dhs.vic.gov.au Tel: (03) 9637 4167 Fax: (03) 9637 4508
Western Australia	Secretary, Radiological Council Locked Bag 2006 Nedlands WA 6009 Email: radiation.health@health.wa.gov.au Tel: (08) 9346 2260 Fax: (08) 9381 1423

1932 **Please note:** Tables A1 and A2 were correct at the time of printing but is subject to  
1933 change from time to time. For the most up-to-date list, the reader is advised to  
1934 consult the ARPANSA web site ([www.arpansa.gov.au](http://www.arpansa.gov.au)). For after hours emergencies  
1935 only, the police will provide the appropriate emergency contact number.

**Annex B****HEALTH EFFECTS OF IONIZING RADIATION AND STANDARDS FOR CONTROL OF EXPOSURE**

It is well known that high doses of ionizing radiation can cause harm, but there is continuing scientific uncertainty about effects at low doses. At levels of dose routinely encountered by members of the public and most present-day radiation workers, there is little or no epidemiological evidence of health effects. Radiation protection standards recognize that it is not possible to eliminate all radiation exposure, but they do provide for a system of control to avoid unnecessary exposure and to keep doses in the low dose range.

Extreme doses of radiation to the whole body (around 10 sievert\* and above), received in a short period, cause so much damage to internal organs and tissues of the body that vital systems cease to function and death may result within days or weeks. Very high doses (between about 1 sievert and 10 sievert), received in a short period, kill large numbers of cells, which can impair the function of vital organs and systems. Acute health effects, such as nausea, vomiting, skin and deep tissue burns, and impairment of the body's ability to fight infection may result within hours, days or weeks. The extent of the damage increases with dose. However, 'deterministic' effects such as these are not observed at doses below certain thresholds. By limiting doses to levels below the thresholds, deterministic effects can be prevented entirely.

Doses below the thresholds for deterministic effects may cause cellular damage, but this does not necessarily lead to harm to the individual: the effects are probabilistic or 'stochastic' in nature. It is known that doses above about 100 millisievert, received in a short period, lead to an increased risk of developing cancer later in life. There is good epidemiological evidence – especially from studies of the survivors of the atomic bombings - that, for several types of cancer, the risk increases roughly linearly with dose, and that the risk factor averaged over all ages and cancer types is about 1 in 100 for every 100 millisievert of dose (i.e. 1 in 10,000 per millisievert).

At doses below about 100 millisievert, the evidence of harm is not clear-cut. While some studies indicate evidence of radiation-induced effects, epidemiological research has been unable to establish unequivocally that there are effects of statistical significance at doses below a few tens of millisieverts. Nevertheless, given that no threshold for stochastic effects has been demonstrated, and in order to be cautious in establishing health standards, the proportionality between risk and dose observed at higher doses is presumed to continue through all lower levels of dose to zero. This is called the linear, no-threshold (LNT) hypothesis and it is made for radiation protection purposes only.

There is evidence that a dose accumulated over a long period carries less risk than the same dose received over a short period. Except for accidents and medical exposures, doses are not normally received over short periods, so that it is appropriate in determining standards for the control of exposure to use a risk factor that takes this into account. While not well quantified, a reduction of the high-dose risk factor by a factor of two has been adopted internationally, so that for radiation protection purposes the risk of radiation-induced fatal cancer (the risk factor) is taken to be about 1 in 20,000 per millisievert of dose for the population as a whole.

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\* The sievert (Sv) is a unit of measurement of radiation dose (see ARPANSA's *Recommendations for limiting exposure to ionizing radiation (2002)*).

1988 If the LNT hypothesis is correct, any dose carries some risk. Therefore, measures for  
 1989 control of exposure for stochastic effects seek to avoid all reasonably avoidable risk.  
 1990 This is called optimizing protection. However, risk in this sense may often be  
 1991 assessed in terms of risk to a population, and may not ensure sufficient protection of  
 1992 the individual. Consequently, the optimization approach is underpinned by applying  
 1993 dose limits that restrict the risk to individuals to an acceptable level. The  
 1994 fundamental regulatory philosophy is expressed in three principles, based on the  
 1995 recommendations of the International Commission on Radiological Protection  
 1996 (ICRP), which may be summarized as follows:

1997  
 1998 *Justification:* human activities that cause exposure to radiation may be  
 1999 permitted only if they do more good than harm;

2000 *Optimization of protection:* exposure to radiation from justified activities should  
 2001 be kept as low as reasonably achievable, social and economic factors being taken  
 2002 into account; and

2003 *Limitation of individual dose:* doses must not exceed the prescribed dose limits.  
 2004

2005 Determining what is an acceptable risk for regulatory purposes is a complex value  
 2006 judgement. The ICRP reviewed a number of factors in developing its  
 2007 recommendations, which have in general been internationally endorsed, including by  
 2008 the World Health Organization, the International Labour Organisation and the  
 2009 International Atomic Energy Agency. Australia's Radiation Health Committee, now  
 2010 established under the ARPANSA Act<sup>†</sup>, has recommended that the international  
 2011 standards be adopted in Australia. The recommended dose limits are summarized as  
 2012 follows:

<b>Limit on effective dose*</b>		
	For occupational exposure	For members of the public
To limit individual risk	20 mSv per year, averaged over 5 years*	1 mSv in a year*

2021 \*for details, see ARPANSA's *Recommendations for limiting exposure to ionizing radiation*  
 2022 (2002)

2023  
 2024 In most situations, the requirements for limiting individual risk ensure that doses are  
 2025 below deterministic thresholds, but for cases where this does not apply, the  
 2026 recommended limits are as follows:

<b>Annual limit on equivalent dose*</b>		
	For occupational exposure	For members of the public
To prevent deterministic effects		
in the lens of the eye	150 mSv	15 mSv
in the skin	500 mSv	50 mSv
in the hands and feet	500 mSv	—

2037 \*For details, see ARPANSA's *Recommendations for limiting exposure to ionizing radiation*  
 2038 (2002)

2039

<sup>†</sup> The *Australian Radiation Protection and Nuclear Safety Act (1998)*

2040 In the case of occupational exposure during pregnancy, the general principle is that  
2041 the embryo or fetus should be afforded the same level of protection as is required for  
2042 a member of the public. For medical workers, the ICRP recommends that there  
2043 should be a reasonable assurance that fetal dose can be kept below 1 mGy<sup>‡</sup> during the  
2044 course of the pregnancy. This guidance may be generalised to cover all  
2045 occupationally exposed pregnant workers by keeping the fetal dose below 1 mSv. A  
2046 full explanation of radiation protection principles and of the recommended standards  
2047 for Australia is given in ARPANSA/NOHSC Radiation Protection Series No. 1:  
2048 *Recommendations for limiting exposure to ionizing radiation (1995)* and *National*  
2049 *standard for limiting occupational exposure to ionizing radiation* (both republished  
2050 in 2002).  
2051

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<sup>‡</sup> The gray (Gy) is a unit of radiation dose. For X-rays and gamma radiation, it is essentially equivalent to the sievert.

## Annex C

### ARPANSA RADIATION PROTECTION SERIES PUBLICATIONS

ARPANSA has taken over responsibility for the administration of the former NHMRC Radiation Health Series of publications and for the codes developed under the *Environment Protection (Nuclear Codes) Act 1978*. The publications are being progressively reviewed and republished as part of the *Radiation Protection Series*. All publications listed below are available in electronic format, and can be downloaded free of charge by visiting ARPANSA's website at [www.arpansa.gov.au/codes.htm](http://www.arpansa.gov.au/codes.htm).

Radiation Protection Series publications are available for purchase directly from ARPANSA. Further information can be obtained by telephoning ARPANSA on 1800 022 333 (freecall within Australia) or (03) 9433 2211.

#### RADIATION PROTECTION SERIES

- RPS 1. Recommendations for Limiting Exposure to Ionizing Radiation (1995) and National Standard for Limiting Occupational Exposure to Ionizing Radiation (republished 2002)
- RPS 2. Code of Practice for the Safe Transport of Radioactive Material (2001)
- RPS 3. Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (2002)
- RPS 4. Recommendations on the Discharge of Patients undergoing Treatment with Radioactive Substances (2002)
- RPS 5. Code of Practice and Safety Guide for Portable Density/Moisture Gauges Containing Radioactive Sources (2004).
- RPS 6. National Directory for Radiation Protection, Edition 1.0 (2004)

Current publications from the NHMRC Radiation Health Series and the Environment Protection (Nuclear Codes) Act Series are available free of charge by contacting ARPANSA on (03) 9433 2211 or email [info@arpansa.gov.au](mailto:info@arpansa.gov.au). Publications that are still current are:

#### RADIATION HEALTH SERIES

- RHS 2. Code of practice for the design of laboratories using radioactive substances for medical purposes (1980)
- RHS 3. Code of practice for the safe use of ionizing radiation in veterinary radiology: Parts 1 and 2 (1982)
- RHS 4. Code of practice for the safe use of radiation gauges (1982)
- RHS 8. Code of nursing practice for staff exposed to ionizing radiation (1984)
- RHS 9. Code of practice for protection against ionizing radiation emitted from X-ray analysis equipment (1984)
- RHS 10. Code of practice for safe use of ionizing radiation in veterinary radiology: part 3-radiotherapy (1984)

- 2098 RHS 12. Administration of ionizing radiation to human subjects in medical research  
2099 (1984)
- 2100 RHS 13. Code of practice for the disposal of radioactive wastes by the user (1985)
- 2101 RHS 14. Recommendations for minimising radiological hazards to patients (1985)
- 2102 RHS 15. Code of practice for the safe use of microwave diathermy units (1985)
- 2103 RHS 16. Code of practice for the safe use of short wave (radiofrequency) diathermy  
2104 units (1985)
- 2105 RHS 18. Code of practice for the safe handling of corpses containing radioactive  
2106 materials (1986)
- 2107 RHS 19. Code of practice for the safe use of ionizing radiation in secondary schools  
2108 (1986)
- 2109 RHS 20. Code of practice for radiation protection in dentistry (1987)
- 2110 RHS 21. Revised statement on cabinet X-ray equipment for examination of letters,  
2111 packages, baggage, freight and other articles for security, quality control  
2112 and other purposes (1987)
- 2113 RHS 22. Statement on enclosed X-ray equipment for special applications (1987)
- 2114 RHS 23. Code of practice for the control and safe handling of radioactive sources  
2115 used for therapeutic purposes (1988)
- 2116 RHS 24. Code of practice for the design and safe operation of non-medical  
2117 irradiation facilities (1988)
- 2118 RHS 25. Recommendations for ionization chamber smoke detectors for commercial  
2119 and industrial fire protection systems (1988)
- 2120 RHS 26. Policy on stable iodine prophylaxis following nuclear reactor accidents  
2121 (1989)
- 2122 RHS 28. Code of practice for the safe use of sealed radioactive sources in borehole  
2123 logging (1989)
- 2124 RHS 29. Occupational standard for exposure to ultraviolet radiation (1989)
- 2125 RHS 30. Interim guidelines on limits of exposure to 50/60Hz electric and magnetic  
2126 fields (1989)
- 2127 RHS 31. Code of practice for the safe use of industrial radiography equipment  
2128 (1989)
- 2129 RHS 32. Intervention in emergency situations involving radiation exposure (1990)
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