Radiation Protection Authority

Zambia

SAFETY GUIDE

RPA SG 6

Occupational Exposure

2015

NOTICE OF APPROVAL

The Radiation Protection Authority Board (RPAB), has on the (day/month/2015), approved the safety guide on Occupational Exposure. This guide is approved for the purposes of providing practical guidance with respect to the Ionising Radiation Protection Act, No. 16 of 2005.

Dr. Esther Munalula Nkandu

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CHAIRPERSON

Radiation Protection Authority Board

Mr. Boster Dearson Siwila

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EXECUTIVE DIRECTOR

Radiation Protection Authority

FOREWORD

Over the last 50 years, the use of Ionising Radiation in Zambia has significantly increased. Institutions using Ionising Radiation include those in Health, Manufacturing, Mining, Agriculture, Research and Training sectors.

Less than half of the occupationally exposed workers are exposed to artificial radiation sources. The majority of occupationally exposed workers are exposed to elevated levels of natural radionuclides. The principal natural sources of radiation exposure being radon in building and cosmic rays at aircraft altitudes.

In 2005, the Zambian Government enacted the Ionising Radiation Protection Act to provide for the protection of the public, workers and the environment from the harmful effects arising from the use of devices or materials that produce ionising radiation. The Ionising Radiation Protection Act allowed for the establishment of the Radiation Protection Authority to spearhead the implementation of provisions of the Act. To fully implement the Act the Zambian Government has priotised strengthening national regulatory capacity.
Strengthening national regulatory capacity includes among other equally important elements, the development and implementation of Safety Guides for Practices using ionizing radiation.

The purpose of this Guide is to establish guidelines to ensure personal exposures to radiation are maintained as low as reasonably achievable (ALARA) and that they meet the Radiation Protection Authority goals. Workers are required to use appropriate ALARA principles (time, distance and shielding) to maintain individual exposures to ALARA levels. Annual dose limits for workers have been established.
This guidance requires that Licensees set up appropriate radiation protection programmes and that workers use the radiation protection equipment and monitoring devices provided to them.

It is my sincere hope that this guide will be a good basis for attaining sustainable radiation protection of the public, workers and the environment and compliance by Licensees with the provisions of the Law.

Hon Dr. Joseph Kasonde, MP

MINISTER OF HEALTH

LIST OF ACRONYMS

RPAB Radiation Protection Authority Board

RPA Radiation Protection Authority

RPO Radiation Protection Officer

RPMP Radiation Protection Management Plan

RPP Radiological Protection Program

PDR Personnel Dosimetry Records

SSDL Secondary Standard Dosimetry Laboratory

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1.0 INTRODUCTION

1.1 General

1.1.1 Occupational exposure to radiation can occur as a result of various human activities, including work associated with the different stages of mining, the use of radioactive sources and x-ray machines in medicine, scientific research, agriculture and industry, and occupations that involve the handling of materials containing enhanced concentrations of naturally occurring radionuclides.

1.1.2 This safety guide provides guidance on fulfilling the requirements of the national Ionising Radiation Act and General Regulations, and the International Basic Safety Standards, with respect to occupational exposure. It will be used by RPA to monitor all practices for compliance with the Act.

1.1.3 Nothing in this Occupational Radiation Exposure Guide shall be construed as relieving a Licensee from complying with other applicable national and international laws and regulations governing hazards in the workplace.

1.1.4 This safety guide addresses the technical and organisational aspects of the control of occupational exposures in situations of both normal and potential exposures. It covers the following categories of personnel:

1.1.4.1 Radiation workers;

1.1.4.2 Radiation protection officers; and

1.1.4.3 Radiation safety officers.

1.2 Objective

The objective of this safety guide is to provide guidance on the control of occupational exposure in practices that use devices and or sources that emit Ionising radiation.

Specifically, it is intended for use by:

1.2.1 Licensees and workers;

1.2.2 Radiation Protection Officers;

1.2.3 Health and Safety Committees concerned with radiation protection of workers; and

1.2.4 Managers, Staff and appointed persons of RPA.

2.0 RESPONSIBILITIES

2.1 Licensee - It is the responsibility of a Licensee to appoint a Radiation Protection Officer at their Practice. The appointed Radiation Protection Officer shall have to be recognised by the RPA prior to assuming their responsibilities.

2.2 RPO - The Radiation Protection Officer shall be responsible for managing the radiation protection and quality assurance programs of the Practice.

2.3 RPA - The RPA shall also be responsible for ensuring compliance with this Occupational Exposure Safety Guide.

3.0 DOSE LIMITATION SYSTEM

3.1 Dose limit

For all practices which could involve occupational exposure, dose limits shall be imposed on the doses that each worker may incur during the course of their work so that they are not

subjected to an unacceptable risk attributable to the radiation exposure. The limits are set to prevent the occurrence of both short and long term effects of ionising radiation.

3.2 Limits of exposure for radiation workers

3.2.1 Occupational exposure of workers and apprentices over the age of 18 years shall be subject to the following dose limits:

3.2.1.1 An effective dose of 20 mSv per year averaged over five consecutive years (100 mSv in 5years), and of 50 mSv in any single year;

3.2.1.2 An equivalent dose to the:

A. lens of the eye of 20 mSv per year averaged over 5 consecutive years (100 mSv in 5 years) and of 50 mSv in any single year; B. extremities (hands and feet) or the skin of 500 mSv in a year.

3.2.2 For occupational exposure of apprentices under the age of 18 years who are being trained for employment involving radiation and for exposure of students under the age of 18 years who use sources in the course of their studies, the dose limits are:

3.2.2.1 An effective dose of 6 mSv in a year;

3.2.2.2 An equivalent dose to the lens of the eye of 20 mSv in a year;

3.2.2.3 An equivalent dose to the extremities (hands and feet) or the skin of 150 mSv in a year.

3.2.3 For purposes of RPA occupational exposure monitoring, personnel dosimetry will be carried out every two months with reference to the dose limits prescribed in section 3.2.1 and 3.2.2. Table 3.1 below indicates the RPA dose limits.

Table 3.1 RPA Occupational Dose Limits

	Effective Dose Limits		**Monthly Converted Limits**	
3.1.1	20 mSv per year averaged over 5 years		1.6 mSv per month averaged over 5 years	
3.1.2	50 mSv in any 12 month period		4.1 mSv per month	
	Equivalent Dose Limits			
3.1.3	Lens of the eye	150 mSv per year	Lens of the eye	12.5 mSv per month
3.1.4	Skin	500 mSv per year	Skin	41.7 mSv per mouth

4.0 OPTIMIZATION OF RADIATION PROTECTION FOR PRACTICES

Occupational exposure shall be optimised in order to ensure that the magnitude of individual doses, the number of people exposed and the likelihood of incurring exposure shall be kept as low as reasonably achievable, taking into account the benefits and risks of the exposure (including social and economic factors).

4.1 Optimization factors

The radiological protection factors needed to meet the Radiation Protection optimisation are the:

4.1.1 nature and magnitude of potential exposures and the likelihood of their occurrence;

4.1.2 limits and technical conditions for operation of the source;

4.1.3 ways in which:

A. structures, systems, components and procedures related to radiation protection or safety might fail, singly or in combination, or otherwise lead to potential exposures, and the consequences of such failures;

B. changes in the environment could affect protection or safety;

C. operating procedures related to protection or safety might be erroneous, and the consequences of such errors;

4.1.4 protection and safety implications of any proposed modifications.

4.2 Optimization of radiation protection and safety

4.2.1 The Practice shall ensure that:

4.2.1.1 a written policy that indicates commitment to the optimization of the protection within the organization by appropriate radiation protection programmes, commensurate with the level and the nature of the radiological risk presented by the practice, is in place;

4.2.1.2 workers are:

A. involved as much as possible in the development of the optimization program. In addition, there shall be established, mechanisms that provide

an opportunity for feedback on the effectiveness of the radiation protection measures;

B. sufficiently trained to enable them to effectively participate in the optimization of protection and safety

4.2.1.3 the RPO is sufficiently trained to be able to verify the application of the optimization program at the workplace.

4.3 The Optimization program

A structured optimization program will include the following steps:

4.3.1 Identifying :

A. all practicable protection options that might potentially reduce the occupational exposure;

B. economic, social and radiological factors relevant to the particular practice.

4.3.2 comparing all available options and selecting the best option(s);

4.3.3 quantifying, where possible, the relevant factors for each protection option, and

4.3.4 where uncertainties exist, performing a sensitivity analysis by testing different values for the key parameters of the selected option.

4.4 Application of dose constraints

Dose constraints are used prospectively in the planning of protection. They may be applied to the dose a worker is exposed to from a specified task or operation or from an entire job. They may also be applied to the designing of facilities or equipment. They should therefore, be set

on a case by case basis according to the specific characteristics of a particular exposure situation.

4.4.1 RPA shall:

4.4.1.1 set the dose constraints in consultation with the licensee;

4.4.1.2 exercise regulatory oversight over the application or use of the dose constraints.

4.5 Application of investigation levels

4.5.1 An investigation level is the value of a quantity such as effective dose, intake, or contamination per unit area or volume at or above which an investigation is triggered.

4.5.2 The Licensee shall conduct an investigation when the conditions in 4.5.1 are encountered.

4.5.3 The Licensee shall ensure that RPA receives notification within 24hours of the incident/accident.

4.6 Investigation procedures

4.6.1 Licensees shall include in the local rules and procedures the values of any relevant investigation level or authorized level, and procedure to be followed in the event that such value is exceeded.

4.6.2 The Licensee shall conduct formal investigations, as required by the Regulations, whenever:

4.6.2.1 an individual effective dose exceeds an investigation level;

4.6.2.2 any of the operational parameters related to protection or safety are out of the normal range established for the specific operational conditions;

4.6.2.3 any equipment failure, severe accident or error takes place, which cause , or has the potential to cause, a dose in excess of stipulated dose limits, and;

4.6.2.4 any other event or unusual circumstance that causes or has the potential to cause, a dose in excess of the stipulated dose limit or the operational restrictions imposed on the installation(e.g., the significant change in workload or operating conditions of radiology equipment) have been breached.

4.6.3 The Licensee shall initiate investigations as soon as possible following discovery of the event.

4.6.4 The general investigation levels of individual doses for control of exposure purposes adopted by RPA are shown in **Table 4.6.4.1.**

Table 4.6.4.1: General Investigation levels

Radiation Quantity Monitored	**Period**	**Investigation level**
A. Personal dose equivalent Hp(10)	Two weeks	0.5 mSv
	One month	1 mSv
B. Personal dose equivalent Hp(0.07)	Two weeks	6 mSv
	One month	25 mSv

C. Area dose rate	Instantaneous	0.0075 mSv/h

Adopted from IAEA Safety Standards

4.6.5 A written report of the investigation shall be prepared. It shall include the cause, determination or verification of any dose received, corrective actions, and instructions or recommendations to avoid reoccurrence.

4.6.6 The Licensee shall submit a written report to the RPA and other concerned bodies as may be required as soon as possible after the investigation but not exceeding 10 working days.

5.0 RADIATION PROTECTON PROGRAMME FOR PRACTICES

The general objective of a Radiation Protection Program for a practice is to ensure that all management structures, policies, procedures and organisational arrangements that facilitate adequate protection and safety are in place. The programme may include protection of the worker, environment and the general public as appropriate. It should include measures to prevent or reduce potential exposures and the mitigation of the consequences of an accident should it occur.

5.1 Establishment of the Radiation Protection Management Programme

5.1.1 Licensees shall perform radiological evaluation and safety assessment prior to establishing a Radiation Protection Management Programme (RPMP). The prior evaluation and safety assessment shall determine what satisfactory working conditions can be achieved at the facility design stage.

5.1.1.1 The prior radiological evaluation and safety assessment to be performed by Licensees shall include, as appropriate, a systematic critical review

of:

A. the identified areas of routine and reasonably foreseeable potential exposures, and

B. estimated relevant doses and probabilities.

5.1.1.2 Furthermore, this prior radiological evaluation should indicate the essential features that need to be incorporated within the RPMP, the degree of planning being commensurate with the nature and magnitude of the risk and the feasibility of mitigating the consequences should an accident or emergency occur.

5.1.2 When developing the RPMP consideration must be given to the provision of containment, ventilation, interlocks and where applicable, shielding. These considerations should aim at minimising the need for relying on administrative controls and personal protective equipment for protection and safety during normal operations.

5.1.3 If the measures stipulated in 5.1.2 are not adequate to restrict exposure of workers to radiation, consideration shall be given to the use of special tools, personal protective equipment and specific task-related training.

5.2 Radiological Protection Programme (RPP)

The licensee shall establish/adopt a radiation protection programme to cover the following elements:

5.2.1 The assignment of responsibilities for occupational radiation protection and safety to different management levels, including corresponding organizational arrangements and, if

applicable, the allocation of the respective responsibilities between the Licensee's and employees include:

5.2.1.1 designation of controlled or supervised areas;

5.2.1.2 local rules for workers to follow ;

5.2.1.3 arrangements for monitoring workers and the workplace; 5.2.1.4 acquisition and maintenance of radiation protection instruments; 5.2.2 a system for recording and reporting all the relevant information related to the:

5.2.2.1 control of exposures;

5.2.2.2 decisions regarding measures for occupational radiation protection and safety, and;

5.2.2.3 monitoring of individuals.

5.2.3 the education and training programme on the nature of the hazards, protection and safety;

5.2.4 the methods for periodically reviewing and auditing the performance of the RPP;

5.2.5 the plans to be implemented in case of radiological accident/incident;

5.2.6 a health surveillance programme ; and

5.2.7 a quality management system for the occupational radiation protection programme.

5.3 Responsibilities pertaining to a Radiological Protection Programme

The Licensee shall be responsible for;

5.3.1 the protection of workers from occupational exposure; and

5.3.2 compliance with any other relevant requirements of the Regulations.

5.3.3 applying the requirements of the Regulations to any occupational exposure, from man-made or natural sources, which are not excluded from the Regulations;

5.3.4 ensuring that for all workers engaged in activities that involve or could involve occupational exposure are monitored;

5.3.5 decisions regarding measures for occupational protection and safety are recorded and made available to the relevant parties, through their representatives where appropriate, as specified by the RPA;

5.3.6 establishing and implementing policies, procedures and organizational arrangements for protection and safety, with priority given to design and technical measures for controlling occupational exposures;

5.3.7 providing suitable and adequate facilities, equipment and services for protection and safety. The nature and extent of the safety measures being commensurate with the expected magnitude and likelihood of the occupational exposure;

5.3.8 provision of the necessary health surveillance and health services;

5.3.9 provision of appropriate protective devices and monitoring equipment and ensuring that the workers are able to use them properly

5.3.10 having suitable and appropriately trained human resources as well as periodic retraining and updating as required in order to ensure the necessary level of competence;

5.3.11 maintenance of adequate records as required by the Regulations;

5.3.12 arrangements to facilitate consultation and co-operation with workers with respect to protection and safety, to achieve the effective implementation of the Regulations;

5.3.13 providing necessary conditions to promote a safety culture;

5.3.14 ensuring that workers exposed to radiation from sources within a practice that are not required by or directly related to their work have the same level of protection against such exposure as members of the public.

5.3.15 obtaining previous occupational history and other information as may be necessary to provide protection and safety in compliance with the Regulations for any individual they may engage permanently or temporarily.

5.3.16 providing appropriate information demonstrating protection in accordance with the Regulations to an employer of workers that may use a source under the control of the Licensee; and

5.3.17 taking such administrative actions as are necessary to ensure that workers are informed that ensuring protection and safety is an integral part of a general occupational health and safety programme in which they have specific obligations and responsibilities for their own protection and the protection of others against radiation exposure and for the safety of sources.

5.3.18 facilitating compliance by workers with the requirements of the Regulations. The compliance by the workers shall include:

5.3.18.1 following any applicable rules and procedures for protection and safety specified by the employer, or licensee;

5.3.18.2 proper use of monitoring devices and protective equipment;

5.3.18.3 co-operating with the Licensee with respect to protection and safety and the operation of radiological health surveillance and dose assessment programmes;

5.3.18.4 providing to the Licensee such information on their past and current work as is relevant to ensure effective and comprehensive protection and safety for themselves and others;

5.3.18.5 abstaining from any wilful action that could put themselves or others in situations that contravene the requirements of the regulations; and

5.3.18.6 accepting such information, instruction and training concerning protection and safety as will enable them to conduct their work in accordance with the requirements of the Regulations.

5.3.19 reporting to the Licensee as soon as possible any circumstances they identify that could adversely affect protection and safety.

5.3.20 recording any report received from a worker that identifies circumstances that could affect compliance with the requirements of this Safety guide and regulations, and taking appropriate action.

5.3.21 establishing local rules and procedures in writing as will be necessary to ensure adequate levels of protection and safety for workers and other persons.

5.3.21.1 the local rules shall be:

A. known by employees and any other persons to whom they may apply; and

B. observed by all concerned, including procedures for wearing, handling, storage of personal dosimeters, and any other actions or procedures to minimize radiation exposure.

5.4 Conditions of service within the scope of a Radiological Protection Programme

5.4.1 Special compensatory arrangements or preferential treatment with respect to salary or special insurance coverage, working hours, length of vacation, additional holidays or retirement benefits shall not be used as substitutes for the provision of proper protection and safety measures.

5.4.2 Pregnant workers

5.4.2.1 A female worker shall, on becoming aware that she is pregnant, notify the Licensee in order that her working conditions may be modified if necessary.

5.4.2.2 A Licensee who has been notified of a pregnancy by a female worker shall adapt the working conditions in respect of occupational exposure so as to ensure that the embryo or foetus is afforded the same broad level of protection as required for members of the public.

5.4.2.3 Pregnancy shall not be considered a reason to exclude oneself or to exclude a worker from work.

5.4.3 Alternative duties for workers

The Licensee shall make every reasonable effort to provide workers with suitable alternative duties in circumstances where it has been determined, either by the RPA or in the framework of the health surveillance programme required by the Regulations, that a worker, for health reasons, may no longer continue in employment involving occupational exposure.

5.4.4 Radiation exposure restrictions for young persons

5.4.4.1 No person under the age of 16 years shall be subjected to occupational exposure.

5.4.4.2 No person under the age of 18 years shall be allowed to work in a controlled area unless supervised and only for the purpose of training.

5.5 Classification of working areas

5.5.1 Controlled areas

Licensees shall designate as a controlled area, any area in which specific protective measures or safety provisions are or could be required for:

5.5.1.1 controlling normal exposures or preventing the spread of contamination during normal working conditions; and

5.5.1.2 preventing or limiting the extent of potential exposures.

5.5.2 Supervised areas

A supervised area is an area for which occupational exposure conditions are kept under review even though specific protection measures and safety provisions are not normally required.

5.6 Protective equipment and tools

The Licensee shall ensure that workers are provided with suitable and adequate personal protective equipment in line with the regulations.

5.6.1 Personal protective equipment include but are not limited to:

5.6.1.1 lead aprons,

5.6.1.2 thyroid protectors,

5.6.1.3 protective eyewear (lead goggles) and

5.6.1.4 gloves.

5.6.2 Additional protective devices should be available in fluoroscopy and interventional radiology rooms, which may include:

5.6.2.1 ceiling suspended protective screens;

5.6.2.2 protective lead curtains mounted on the patient table;

5.6.2.3 protective lead curtains for the operator if the x ray tube is placed in an over couch geometry and if the radiologist or relative of the patient must stand near the patient; and

5.6.2.4 mobile lead lined screens.

5.7 Individual monitoring and exposure assessment

It is mandatory that individual exposure is monitored. Individual external doses shall be determined by using individual monitoring devices approved by the RPA, such as dosimeters, film badges or other detecting devices.

5.7.1 Individual dose monitoring shall be undertaken for workers who are normally exposed to radiation in controlled areas.

5.7.2 The monitoring device shall be worn on the front of the upper torso of the body, between the shoulders and the waist.

5.7.3 The monitoring device shall be read every month.

5.7.4 In the event that regular monthly monitoring is impractical, the period between two monitoring events shall not exceed two months.

5.7.5 Dosimetry providers shall ensure that Personnel Dosimetry Records (PDR) are submitted to the Licensee and the RPA every month or as may be determined by the RPA from time to time.

5.7.6 The radiation monitoring devices shall be calibrated annually and the calibration shall be traceable to a Secondary Standard Dosimetry Laboratory (SSDL).

5.7.7 If an individual's dosimeter is lost, the RPO shall perform a dose assessment and record this evaluation of the dose and add it to the individual's records.

5.8 Monitoring the work place

5.8.1 All survey meters used for workplace monitoring shall be calibrated annually and this calibration shall be traceable to a SSDL.

5.8.2 Initial monitoring shall be conducted immediately after the installation of new equipment and shall include measurement of radiation leakage from equipment, and area monitoring.

5.8.3 The operability of all radiation monitors/survey meters and their warning devices shall be checked on each day of use.

5.9 Health Surveillance

5.9.1 The Licensee shall ensure that health surveillance for workers is conducted annually or as may be specified by the RPA. The primary purpose of the health surveillance is to assess the initial and continuing fitness of employees for their intended tasks.

5.9.2 Counseling should be provided for all women of child bearing age prior to the health surveillance. An in-house arrangement for such services is recommended.

5.10 Monitoring and health surveillance records

5.10.1 The Licensee shall submit all records of exposure and medical surveillance for each worker to the RPA.

5.10.2 In addition, the Licensee shall maintain copies of the exposure and medical surveillance records for each worker and the records shall be kept according to the requirements of RPA.

5.10.3 Strict confidentiality and privacy of personal health records shall be maintained at all times.

5.11 Retention Period for Records

5.11.1 The following are the periods for record retention:

	Type of record	**Suggested retention period**
5.11.1.1	Workplace monitoring	5 years
5.11.1.2	calibration of survey instrument	5 years
5.11.1.3	Occupational exposure of worker	Until the worker is or would be 75years
		of age and 30 years after cessation of work

5.11.1.4	Record of calibration of personal monitoring device	30 years after cessation of work

5.11.2 The individual occupational exposure record should be uniquely linked to the worker and should enable the appropriate summation of external and internal doses. For each year, the record should comprise of:

5.11.2.1 unique identification of the individual;

5.11.2.2 the exposure for the year to date and, where necessary, for the appropriate five-year period;

5.11.2.3 measurements of external dose, and method of assessment obtained as:

A. personal dose equivalent,Hp(10); and

B. if appropriate (e.g. in the case of significant exposure to low energy photon or beta radiation), personal dose equivalent,Hp(0.07);

5.11.2.4 measurements of internal dose obtained as:

A. committed effective dose,E(50); or

B. if appropriate (e.g. in the case of overexposure), committed equivalent dose,H(50);

5.11.2.5 evaluations of anomalous dose results, such as unexpectedly high or low doses;

5.11.2.6 the allocated dose for lost or damaged dosimeters or samples;

5.11.2.7 any other information on previous exposure as will be needed to demonstrate compliance with the requirements established by the relevant regulatory authority;

5.11.2.8 Information about the material and radionuclides involved in any previously known or suspected significant exposures, including;

A. any special dose limits imposed on the worker;

B. records of formal declarations of pregnancy, any revocations of such declarations, and notifications of the conclusion of a pregnancy;

C. lifetime dose to date.

5.11.3 The Licensee shall:

5.11.3.1 provide for access by a:

A. worker to their own exposure records; and

B. supervisor of the Health Surveillance Programme, the RPA and the employer to the exposure records of a worker.

5.11.3.2 facilitate the provision of copies of workers' exposure records when duly requested by new employers when workers change employment; and

5.11.3.3 in complying with the above, give due care and attention to the maintenance of appropriate confidentiality of records.

6.0 INTERVENTIONS IN EMERGENCIES

Refer to the Zambian National Emergency Preparedness and Response Plan

DEFINITIONS

Clearance level:

A value established by *RPA* and expressed in terms of *activity concentration or* total activity, at or below which sources of radiation may be released from *regulatory control.*

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Dose:

1. A measure of the energy deposited by *radiation* in a target.

2. *Absorbed dose*,

The quantity *E*, defined as a summation of all the tissue *equivalent doses*, each multiplied by the appropriate *tissue weighting factor*:

committed effective dose,

The quantity $E(\tau)$, defined as:

$$E(\tau) = \sum_{T} w_T \cdot H_T(\tau)$$

where $H_T(\tau)$ is the *committed equivalent dose* to tissue T over the integration time τ and w_T is the *tissue weighting factor* for tissue T. When τ is not specified, it will be taken to be 50 years for adults and the time to age 70 years for *intakes* by children.

Committed equivalent dose,

The quantity $H_T(\tau)$, defined as:

$$H_T(\tau) = \int_{t_0}^{t_0+\tau} \dot{H}_T(t)\mathrm{d}t$$

where t_0 is the time of *intake*, $H_T(t)$ is the *equivalent dose rate* at time t in organ or tissue T and τ is the time elapsed after an intake of *radioactive material*. When τ is not specified, it will be taken to be 50 years for adults and the time to age 70 years for *intakes* by children.

Effective dose

The quantity E, defined as a summation of all the tissue *equivalent doses*, each multiplied by the appropriate *tissue weighting factor*:

$$E = \sum_T w_T \cdot H_T$$

where H_T is the *equivalent dose* in tissue Tand w_T is the *tissue weighting factor* for tissue T.

From the definition of *equivalent dose*, it follows that:

$$E = \sum_T w_T \cdot \sum_R w_R \cdot D_{T,R}$$

where w_R is the *radiation weighting factor* for *radiation R* and $D_{T,R}$ is the average *absorbed dose* in the tissue or organ T.

Θ The unit of *effective dose* is joule per kilogram (J/kg), given the name *sievert* (Sv).An explanation of the quantity is given in Annex B of ICRP 103 [1].

Θ *Effective dose* is a measure of *dose* designed to reflect the amount of *radiation detriment* likely to result from the *dose*.

Θ *Effective dose* cannot be used to quantify higher *doses* or to make decisions on the need for any medical treatment relating to *deterministic effects*.

Θ Values of *effective dose* from any type(s) of *radiation* and mode(s) of *exposure* can be compared directly.

equivalent dose or

equivalent dose, H_T. The quantity $H_{T,R}$, defined as:

$$H_{T,R} = w_R \cdot D_{T,R}$$

where $D_{T,R}$ is the *absorbed dose* delivered by *radiation* type R averaged over a tissue or organ T and w_R is the *radiation weighting factor* for *radiation* type R. When the *radiation* field is composed of different *radiation* types with different values of w_R the *equivalent dose* is:

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

organ dose.

Dose constraint:

A prospective and *source* related value of individual dose (*dose constraint*) or risk (*risk constraint*) that is used in planned exposure situations as a parameter for the optimization of protection and safety for the source, and that serves as a boundary in defining the range of options in optimization.

- For occupational exposure, a constraint on individual dose to workers established and used by registrants and licensees to set the range of options in optimizing protection and safety for the source.

- For public exposure, the dose constraint is a source related value established or approved by the government or the regulatory body, with account taken of the doses from planned operations of all sources under control. The dose constraint for each particular source is intended, among other things, to ensure that the sum of doses from planned operations for all sources under control remains within the dose limit.

Effective dose:

The quantity *E*, defined as a summation of all the tissue *equivalent doses*, each multiplied by the appropriate *tissue weighting factor*:

$$E = \sum_{\mathrm{T}} w_{\mathrm{T}} \cdot H_{\mathrm{T}}$$

where H_{T} is the *equivalent dose* in tissue T and w_{T} is the *tissue weighting factor* for tissue T.

From the definition of *equivalent dose*, it follows that:

$$E = \sum_{\mathrm{T}} w_{\mathrm{T}} \cdot \sum_{\mathrm{R}} w_{\mathrm{R}} \cdot D_{\mathrm{T,R}}$$

where w_{R} is the *radiation weighting factor* for *radiation* R and $D_{\mathrm{T,R}}$ is the average *absorbed dose* in the tissue or organ T.

Emergency plan:

A description of the objectives, policy and concept of *operations* for the response to an *emergency* and of the *structure*, authorities and responsibilities for a systematic, coordinated and effective response. The *emergency plan* serves as the basis for the development of other plans, *procedures* and checklists.

Employer:

A person or organization with recognized responsibilities, commitments and duties towards a *worker* in the employment of the person or organization by virtue of a mutually agreed relationship. (A self-employed person is regarded as being both an *employer* and a *worker*.) **Exemption:**

The determination by a *regulatory body* that a *source* or *practice* need not be subject to some or all aspects of *regulatory control* on the basis that the *exposure* and the *potential exposure* due to the *source* or *practice* are too small to warrant the application of those aspects or that this is the optimum option for *protection* irrespective of the actual level of the *doses* or *risks*.

Health professional:

An individual who has been formally recognized through appropriate national *procedures* to practice a profession related to health (e.g. medicine, dentistry, chiropractic, podiatry, nursing, medical physics, medical radiation technology, radiopharmacy, occupational health).

Inspection imaging device:

An imaging device designed specifically for imaging persons or cargo conveyances for the purpose of detecting concealed objects on or within the human body or within cargo or a vehicle.

Licence:

A legal document issued by the *regulatory body* granting *authorization* to perform specified *activities* relating to a *facility or activity*.

Licensee:

The holder of a current *licence*.

Medical exposure:

Exposure incurred by patients for the purposes of medical or dental diagnosis or treatment; by *carers and comforters*; and by volunteers subject to *exposure* as part of a programme of biomedical research.

Member of the public:

For *protection and safety* purposes, in a general sense, any individual in the population except when subject to *occupational exposure* or *medical exposure*. For the purpose of verifying compliance with the *annual dose limit* for *public exposure*, this is the *representative person*.

Natural source:

A naturally occurring *source* of *radiation*, such as the sun and stars (*sources* of cosmic *radiation*) and rocks and soil (terrestrial *sources* of *radiation*), or any other material whose *radioactivity* is for all intents and purposes due only to radionuclides of natural origin, such as products or residues from the processing of minerals; but excluding radioactive material for use in a nuclear installation and radioactive waste generated in such an installation.

Notification:

A document submitted to the *regulatory body* by a person or organization to notify an intention to carry out a *practice* or other use of a *source*.

Occupational exposure:

Exposure of *workers* incurred in the course of their work.

Potential exposure:

Prospective *exposure* that is not expected to be delivered with certainty but that may result from an *anticipated operational occurrence*, *accident* at a *source* or owing to an *event* or sequence of *events* of a probabilistic nature, including equipment *failures* and operating errors.

Practice:

Any human activity that introduces additional *sources* of *exposure* or additional *exposure pathways*, or modifies the network of *exposure pathways* from existing *sources*, so as to increase the *exposure* or the likelihood of *exposure* of people or the number of people exposed.

Protection and safety:

The *protection* of people against *exposure* to *ionizing radiation* or due to *radioactive material* and the *safety* of *sources*, including the means for achieving this, and the means for preventing *accidents* and for mitigating the consequences of *accidents* if they do occur.

Protective action:

An action for the purposes of avoiding or reducing *doses* that might otherwise be received in an *emergency exposure situation* or an *existing exposure situation*.

Longer term protective action:

A *protective action* that is not an *urgent protective action*.

- Such protective actions are likely to be prolonged over weeks, months or years.
- These include measures such as relocation, agricultural countermeasures and remedial actions.

Mitigatory action. Immediate action by the *operator* or other party:

(1) To reduce the potential for conditions to develop that would result in *exposure* or a release of *radioactive material* requiring *emergency actions* on or off the site; or

(2) To mitigate *source* conditions that may result in *exposure* or a release of *radioactive material* requiring *emergency actions* on or off the site.

Precautionary urgent protective action. *A protective action* in the event of a *nuclear or radiation emergency* which must be taken before or shortly after a release of *radioactive material*, or before an *exposure*, on the basis of the prevailing conditions to prevent or to reduce the *risk* of *severe deterministic effects.*

Urgent protective action. A *protective action* in the event of an *emergency* which must be taken promptly (usually within hours) in order to be effective, and the effectiveness of which will be markedly reduced if it is delayed.

Public exposure

Exposure incurred by *members of the public* due to *sources* in *planned exposure situations*, *emergency exposure situations* and *existing exposure situations*, excluding any *occupational exposure* or *medical exposure*.

Registration

A form of *authorization* for *practices* of low or moderate *risks* whereby the person ororganization responsible for the *practice* has, as appropriate, prepared and submitted a *safety assessment* of the *facilities* and equipment to the *regulatory body*. The *practice* or use is authorized with conditions or limitations as appropriate.

Registrant

The holder of a current *registration*

Regulatory body

An authority or a system of authorities designated by the government of a State as having legalauthority for conducting the regulatory *process*, including issuing *authorizations*, and therebyregulating *nuclear, radiation, radioactive waste* and *transport safety*.

Risk

A multi attribute quantity expressing hazard, danger or chance of harmful or injurious consequences associated with exposures or *potential exposures*. It relates to quantities such as the probability that specific deleterious consequences may arise and the magnitude and character of such consequences.

Safety assessment

Assessment of all aspects of a *practice* that are relevant to *protection and safety*; for an *authorized facility*, this includes *siting, design* and *operation* of the *facility*.

Safety culture

The assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, *protection and safety* issues receive the attention warranted by their significance.

Source

1. Anything that may cause *radiation exposure* — such as by emitting *ionizing radiation* or by releasing *radioactive material* — and can be treated as a single entity for *protection and safety* purposes.

Θ For example, materials emitting *radon* are *sources* in the environment; a sterilization gamma irradiation unit is a *source* for the *practice* of *radiation* preservation of food and sterilization of other products; an X ray unit may be a *source* for the *practice* of radiodiagnosis; a nuclear power plant is part of the *practice* of generating electricity by nuclear fission, and may be regarded as a *source* (e.g. with respect to *discharges* to the environment) or as a collection of *sources* (e.g. for occupational *radiation protection* purposes). A complex or multiple installation situated at one location or site may, as appropriate, be considered a single *source* for the purposes of application of international *safety standards*.

***Natural source*.** A naturally occurring *source* of *radiation*, such as the sun and stars (*sources* of cosmic *radiation*) and rocks and soil (terrestrial *sources* of *radiation*), or any other material whose *radioactivity* is for all intents and purposes due only to radionuclides of natural origin, such as products or residues from the processing of minerals; but excluding radioactive material for use in a nuclear installation and radioactive waste generated in such an

installation.

***Radiation generator*.** A device capable of generating *ionizing radiation*, such as X rays, neutrons, electrons or other charged particles, that may be used for scientific, industrial or medical purposes.

2. *Radioactive material* used as a *source* of *radiation*.

- Such as those sources used for medical applications or in industrial instruments. These are, of course, *sources* as defined in (1), but this usage is less general.

Dangerous source. A *source* that could, if not under *control,* give rise to *exposure* sufficient to cause *severe deterministic effects*. This categorization is used for determining the need for *emergency response arrangements* and is not to be confused with categorizations of *sources* for other purposes.

***Radioactive source*.** A *source* containing *radioactive material* that is used as a source of radiation.

***Sealed source*.** Is a *radioactive source* in which the *radioactive material* is (a) permanently sealed in a capsule or (b) closely bonded and in a solid form.

***Unsealed source*.** A *radioactive source* in which the *radioactive material* is either (a) permanently sealed in a capsule or (b) closely bonded and in a solid form.

Standards dosimetry laboratory

A laboratory designated by the relevant national authority that possesses certification or accreditation necessary for the purpose of developing, maintaining or improving primary or secondary standards for radiation dosimetry.

Supplier (of a source)

Any person or organization to whom a registrant or licensee delegates duties, totally or partially, in relation to the design, manufacture, production or construction of a source.

Worker

Any person who works, whether full time, part time or temporarily, for an *employer* and who has recognized rights and duties in relation to occupational *radiation protection*.

 A self-employed person is regarded as having the duties of both an *employer* and a *worker*.

Workers' health surveillance

Medical supervision intended to ensure the initial and continuing fitness of *workers* for their intended tasks.

ANNEX: CHECKLIST

Checklist for Safety Guide 6

OCCUPATIONAL EXPOSURE

(I) OPTIMIZATION OF RADIATION PROTECTION AND SAFETY

YES NO

☐ ☐ Availability of a written policy indicating commitment to the optimisation of

Protection within the organization

YES NO

☐ ☐ Involvement of workers in the development of the optimisation program

YES NO

☐ ☐ Sufficiently trained workers able to participate in the optimisation of protection and

safety

YES NO

☐ ☐ Sufficiently trained RPO able to verify application of the optimisation programme at

the workplace

OPTIMIZATION PROGRAMME

YES NO

☐ ☐ Availability of the steps of a structured optimisation programme

YES NO

☐ ☐ Availability of investigation report

B. RADIATION PROTECTION PROGRAMME

(II) ESTABLISHMENT OF THE RADIATION PROTECTION MANAGEMENT PROGRAMME (RPMP)

YES NO

☐ ☐ Availability of the Radiation Protection Management Plan (RPMP)

(III) RADIOLOGICAL PROTECTION PROGRAMME

YES NO

☐ ☐ Availability of the Radiological Protection Programme

YES NO

☐ ☐ Education and training programme on the nature of hazards, protection and safety provided

YES NO

☐ ☐ Availability of plans to be implemented in case of radiological accident/incident

YES NO

☐ ☐ Availability of health surveillance programme

YES NO

☐ ☐ Quality management system for the occupational radiation protection programme

(IV) RESPONSIBILITIES PERTAINING TO A RADIOLOGICAL PROTECTION PROGRAMME

YES NO

☐ ☐ All occupationally exposed workers monitored

YES NO

☐ ☐ Decisions regarding measures for occupational protection and safety recorded

YES NO

☐ ☐ Established and implemented policies, procedures and organisational arrangement

for protection and safety

YES NO

☐ ☐ Suitable and adequate facilities, equipment and services for protection provided

YES NO

☐ ☐ Necessary health surveillance and health services provided

YES NO

☐ ☐ Appropriate protective devices and monitoring equipment provided

YES NO

☐ ☐ Adequate records maintained

YES NO

☐ ☐ Necessary conditions to promote a safety culture provided

YES NO

☐ ☐ Appropriate information provided to Licensee from workers

YES NO

☐ ☐ Workers report to the licensee on circumstances identified to adversely affect

protection and safety

YES NO

☐ ☐ Local rules established in written

(V) PROTECTIVE EQUIPMENT AND TOOLS

YES NO

☐ ☐Availability of suitable and adequate personal protective equipment

INDIVIDUAL MONITORING AND EXPOSURE ASSESSMENT

YES NO

☐ ☐ Occupationally exposed workers in controlled areas monitored

YES NO

☐ ☐ Monitoring device regularly monitored

YES NO

☐ ☐ Dosimetry providers submit Personnel Dosimetry Records (PDR) to the Licensee and

RPA every month or as determined by RPA from time to time

YES NO

☐ ☐ Performance of a dose assessment and record evaluation done by RPO

(VI) MONITORING THE WORK PLACE

YES NO

☐ ☐ Survey meters used for work place monitoring calibrated annually in a SSDL

YES NO

☐ ☐ Initial monitoring conducted immediately after the installation of new equipment including measurement of radiation leakage from equipment and area monitoring

YES NO

☐ ☐ Operability of all radiation monitors/ survey meters and their warning devices checked on a daily basis

(VII) MONITORING AND HEALTH SURVEILLANCE RECORDS

YES NO

☐ ☐ All records of exposure and medical surveillance for each worker submitted to RPA

YES NO

☐ ☐ Copies of the exposures and medical surveillance records for each worker maintained

YES NO

☐ ☐ Strict confidentiality and privacy of personal health records maintained at all times

(VIII) INTERVENTIONS IN EMERGENCIES

YES NO

☐ ☐ Availability of the Emergency Preparedness and Response Plan