PROPOSED REGULATORY GUIDE

C-200 (E)

RADIATION SAFETY TRAINING FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION WORKERS

Consultative Document

Published by the
Atomic Energy Control Board
(October 15, 1998)

Atomic Energy Control Board | Commission de contrôle de l'énergie atomique

Canada

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Preface

The Atomic Energy Control Board (AECB) has approved the release of C-200 (E), a proposed regulatory guide, for trial use over a period of one year as part of its public consultation program. The consultation trial use period of one year is beneficial to the development of working experience by both the AECB and the licensees. The approach allows for a more generous consultation period.

The *NSC Act* and pursuant regulations will come into effect during the trial use period. The AECB will become Canadian Nuclear Safety Commission (CNSC). The language used in C-200 (E) reflects the philosophy of the *NSC Act* and the proposed new regulations.

A letter will be sent at the end of the trial use period during November 1999 to all licensees and public participants asking to provide comments. CNSC staff will provide input based on their experience.

You are invited to provide comments and suggestions during or immediately following the trial use period. Please direct comments to:

Operations Assistant
Corporate Documents Section
Atomic Energy Control Board
P.O. Box 1046, Station B
Ottawa ON K1P 5S9

or

e-mail: reg@atomcon.gc.ca

Notice

On March 20, 1997, Bill C-23, the *Nuclear Safety and Control Act*, received Royal Assent. When this Guide was published it was not yet in force. When the *NSC Act* and regulations come into force, this document will be revised. Proposed Regulatory Guide C-200 (E) references the existing *Atomic Energy Control Act* and its Regulations, which remain in force until further notice.

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Appendices

About this Regulatory Guide

The AECB provides instruction, assistance and information in *Regulatory Guidance Documents* (RGDs). These documents are intended to guide the conduct of anyone subject to regulatory requirements, such as AECB licensees, and others involved with the AECB's regulatory process.

This Regulatory Guide helps licensees develop and implement radiation safety training programs for workers and supervisors that are effective and are acceptable to the AECB.

The information[1] in this Guide is intended for current AECB licensees, licence applicants and radiation safety instructors. In addition to sections describing the general requirements for radiation safety training, specialized sections are provided for:

- radioisotope licensees using open source radioactive material, sealed sources and devices containing radioactive prescribed substances
- Medical accelerator licensees
- transportation and packaging operators
- radiation safety instructors

If you fit one of the above categories, you should read the appropriate sections of the Guide, and retain the Guide for reference. The following chart will assist you in determining which sections you should read.

[1] The training for a qualified operator (QO) or any other person who is helping with industrial radiography is not addressed in this guide. There is a separate AECB program for industrial radiography safety training.

How to use this Guide

If you are a...	*you should read Sections...*	*and Appendixes...*
Radioisotope licensee or applicant	1 to 9	1 to 9
Radioisotope safety training instructor	1 to 9, 12, 13, 14	1, 2, 3, 4, 6, 7, 8, 9
Medical accelerator licensee or applicant	1 to 8 plus 10	1, 2, 3, 4, 5, 7, 8,
Medical accelerator radiation safety instructor	1, 2, 4, 5, 6, 8, 10, 12, 13, 14	1, 2, 3, 4, 7, 8, 9
Transportation and packaging personnel	1 to 5, plus 8, 11, 12, 13, 14	1, 2, 3, 4, 5, 7, 8, 9

The AECB, Nuclear Legislation and Regulatory Process

The AECB is a federal regulatory agency with responsibilities for radiation safety. It ensures that nuclear facilities and the use of nuclear materials do not pose undue risk to health, safety, security, and the environment.

At present, the AECB operates under the authority of the *Atomic Energy Control (AEC) Act* and related regulations. A new Act, the *Nuclear Safety and Control (NSC) Act*, received Royal Assent on March 20, 1997, and will be implemented on a date to be fixed by order of the Governor in Council. The accompanying regulations are being developed in accordance with federal policies and process, which include consultations with industry and the public.

The *NSC Act* will replace the *AEC Act*. However, until the new Act and regulations are proclaimed, the existing legislation continues to apply. Accordingly, this Consultative Document pertains to activities conducted under the authority of the *AEC Act* and regulations.

The AECB will consider the comments received in response to this document for purposes of finalizing or revising this draft Guide.

Background

All radioisotope licences issued by the AECB include a condition requiring licensees to ensure that only persons properly trained and informed of the hazards are allowed to handle radioactive materials. This licence condition has been a requirement for many years. Moreover, the process of applying for many types of radioisotope licence requires that the applicant submit a description of the proposed radiation safety training program. AECB radioisotope licensing staff review these training program descriptions, provide feedback to licensees about their programs, and require that training be improved where necessary.

Similarly, particle accelerator operating licences require that licensees train every person who works in the facility in radiation safety.

AECB radioisotope licensing staff prepared a brief description of the standards for radiation safety training in Consultative Document C-121 "Requirements for a Radiation Safety Program for Consolidated Radioisotope Licensees" (August, 1992). C-121 was directed at institutions holding consolidated radioisotope licences, mainly universities. The document was later revised and the training standards were removed because they belonged in a stand-alone document which should apply to the radiation safety training of workers, including supervisors, for all activities licensed or regulated through MRD by the AECB. This Guide fulfills that need for a stand-alone document.

Further impetus for the development of a regulatory guide describing radiation safety training was provided by an article in the April, 1995, issue of the Canadian Radiation Protection Association (CRPA) Bulletin. The article described the results of a survey of radiation safety training programs at institutions holding consolidated radioisotope licences. It concluded that radiation safety training is varied and further highlighted the need for a comprehensive regulatory guide.

Seeking input from the regulated community, AECB staff consulted more than 70 radiation safety officers (RSOs) about specific radiation safety training requirements for workers. RSOs were consulted at a workshop held during the CRPA meeting in Victoria in May of 1997. Feedback from workshop participants has been incorporated into the training matrices in this Guide.

The guidelines are not mandatory. However, they do clearly indicate what the AECB expects to see in training programs required to fulfill licensing requirements, as well as the methods for administering and maintaining those programs. Conformance with the guidelines will expedite the licence assessment process.

In preparing a set of general guidelines it is simply not practical to prepare a separate guideline that addresses all the training necessary for each specific job. Accordingly, these guidelines are general in nature and should not be assumed to be comprehensive. The intent is to provide a foundation for developing a training program that is acceptable to the AECB.

Licensees should not regard the guidelines as a replacement for the proper identification of the specific training needs of their staff and the development of training programs in radiation safety that meet those needs. It remains the responsibility of the licensee to ensure that their training programs meet the particular needs of both the job and the individual worker.

Abbreviations used in this Guide

µSv	microsievert
AEC Act	*Atomic Energy Control Act*
AEC Regulations	*Atomic Energy Control Regulations*
AECB	Atomic Energy Control Board
ALARA	as low as reasonably achievable
CNSC	Canadian Nuclear Safety Commission
CGSB	Canadian General Standards Board
HVL	half-value layer
IAEA	International Atomic Energy Agency
LAO	Licence Assessment Officer
LET	linear energy transfer
MBq	megabecquerel
MRD	Materials Regulation Division (of the AECB)
MSDS	Material Safety Data Sheets (associated with WHMIS)
mSv	millisievert
NSC Act	*Nuclear Safety and Control Act*
PMT	photomultiplier tube
QA	quality assurance
QC	quality control
QO	qualified operator
RSDS	Radiation Safety Data Sheets (associated with WHMIS)
RSO	radiation safety officer
rem	roentgen equivalent man [unit of dose equivalent. SI: sievert (Sv)]
SAT	Systems (also Systematic) Approach to Training
TLD badge	thermoluminescent dosimeter badge
WHMIS	Workplace Hazardous Materials Information System
WLM	working level month

Radiation Safety Training

for Radioisotope, Medical Accelerator
and Transportation Workers

Proposed Regulatory Guide

Section 1: Introduction

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Introduction

1.1 This Regulatory Guide advocates a systems approach to radiation safety training and includes suggestions for integrating radiation safety into work practices.

1.2 The systems approach includes the development, implementation and evaluation of initial and continuing training programs as well as the development of training as a solution to operational problems associated with radiation safety. The focus is on the actual job requirements. This will result in improved radiation safety and protection, minimize future regulatory problems, and may have a significant positive impact on the licensee's business.

1.3 Site-specific factors that may have to be considered when developing a training program for a particular licensee should be discussed with staff of the AECB.

Application

1.4 This Guide applies to the radiation safety training of radioisotope, medical accelerator and transportation workers.

[A note to industrial radiography licensees: the training for a qualified operator (QO) or any other person who is helping with industrial radiography is not addressed in this guide. There is a separate AECB program to become a QO which includes the *Study Guide for the Qualified Operator Examination*, a written examination and registration. The persons responsible for industrial radiography radiation safety are the licensee and the operator (who must be either a QO, or a supervised trainee.)]

1.5 References made to licensees in this document also apply to non-licensed persons regulated by the AECB in the packaging and transportation of nuclear substances.

1.6 For the transportation of nuclear substances there are two types of workers:

- licensee staff, such as persons working at nuclear facilities
- non-licensed persons, regulated by the AECB, such as air carrier personnel and couriers.

Training is a regulatory requirement

1.7 The *Act* authorizes the making of regulations. The regulations authorize the issue of licences containing conditions. Standard licence condition 565 for radioisotope licences issued by the AECB, for example, requires the licensee to ensure that *only persons properly trained in work with radioactive prescribed substances, and informed of the hazards involved, are allowed to handle such substances.*
Failure to comply with the regulations is an offence under the *Act.*

1.8 Licences issued by the AECB may contain training conditions covering matters such as *instructions to be given to atomic radiation workers respecting the hazards of ionizing radiation and the procedures to be followed to limit exposure to ionizing radiation;*
the qualifications, training and experience of any person who is to use or supervise the use of the prescribed substance or any device or equipment to which the licence applies.

1.9 The AECB expects that applications for a radioisotope licence will include a description of the training and experience required of all personnel, including trainees, who work with, will be handling or are in the vicinity of radioactive material.

1.10 The scope and depth of radiation safety training will vary significantly with the job requirements and the responsibilities of the individual. These requirements and responsibilities are determined by the licensee and assessed by AECB licensing staff by reviewing the task analysis, training course outlines and training manual contents submitted as part of the licence application. If the training program is suitable, AECB staff recommends its acceptance to the designated officer of the AECB.

Developing a safety culture

1.11 Under the regulations and licences, the development and implementation of radiation safety training programs is the responsibility of the licensee. Licensees are encouraged to discuss their training programs and the recommendations contained in this Guide with AECB staff.

1.12 The ultimate goal of radiation safety training is the development of a safety culture. While the overall responsibility for the development of such a culture rests with management, the ultimate responsibility for the practice of safety rests with each individual.

1.13 AECB staff have observed that poor compliance with radiation safety practices is usually a direct result of workers not receiving appropriate information. Staff have also noted that time spent discussing safety issues with the licensee's staff during inspection visits has a positive impact on future compliance.

1.14 All licensees should allocate resources in proportion to the magnitude and scope of their work so that the basic recommendations of this Guide are addressed.

1.15 Licensees should meet the standards of the radiation safety training program described in Section 2 of this Guide, or through an equivalent program developed by the licensee and accepted by the AECB.

Program design

1.16 To be acceptable to the AECB, a radiation safety training program must follow the Systems Approach to Training (SAT). SAT is now internationally recognized, and is used by agencies and departments such as the U.S. Nuclear Regulatory Commission (USNRC), the International Atomic Energy Agency (IAEA) and the Public Service Commission of Canada. SAT is the standard by which the quality of a radiation safety training program will be judged and the procedures approved by the AECB.

1.17 SAT places emphasis on the provision and management of training for all employees by the licensee. It provides consistency, efficiency, management control and accountability in the training and qualification of workers. SAT can be integrated easily into any licensee's existing management system. In small operations with no full-time instructors, other functional specialists, with suitable training, can operate SAT in the area of specialization on a limited scale.

1.18 The model for SAT, which is illustrated in Appendix 1, has five phases: training analysis, evaluation design, training design, conduct and evaluation, and validation. The detailed standards for these phases are described in Section 7. Examples of evaluation and validation questionnaires are provided in Appendixes 2 and 3. More detailed descriptions of SAT can be found in documents such as the IAEA's Technical Report Series No.380, *Nuclear Power Plant Personnel Training and its Evaluation - A Guidebook* (International Atomic Energy Agency, Vienna), and the *Systems Approach to*

Training, revised edition, published by the Public Service Commission of Canada.

1.19 The first steps in designing a training program are to establish performance standards and to select the most appropriate training environment—classroom, laboratory, on-the-job, or self study, or a combination of these.

1.20 Training programs should include a series of activities intended to develop learning objectives, tests and other indicators of trainee performance. The design is based on job classification and task analysis, as well as feedback from on-the-job experiences. The design phase should also include the development of a training plan that guides the development phase of the training program.

1.21 The development phase starts with the learning objectives produced during the design phase and identifies the content that meets the trainees' needs. See Section 2 for information about how to determine the content of training programs, also Sections 9 through 13 for details of training modules for different types of licensed facilities.

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Section 2: Content and Format

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Program content

2.1 A radiation safety training program acceptable to the AECB includes the following elements:

- learning objectives
- topics to be covered, including tasks to be performed
- format to provide the information
- statements on performance, conditions and standards

Each of these elements is discussed in this section.

Licensee organizations should also state their policies and philosophy on training in their radiation safety programs.

Learning objectives

2.2 Licensees should develop learning objectives for the tasks selected for training. This ensures that training is linked directly to job performance and that the content of the training program is defined. Learning objectives describe what is to be learned in terms of measurable trainee performance. A learning objective consists of:

- a statement of the action that the trainee should perform
- the conditions under which the action should take place
- the standards of acceptable performance of the action.

See 2.10, *Statements on performance, conditions and standards*, for additional information.

Topics to be covered

2.3 The topics to be covered in radiation safety training can be grouped under three broad headings:

- Definitions and terms, including essential terminology, radiation protection and the effects of radiation
- Concepts, ranging from good work practices to the worker's responsibility for radiation safety
- Regulations and licensing, including current and proposed regulations governing training requirements, and the license issued for that particular facility

2.4 Appendix 5 contains a summary of recommended topics. Depending on the type of program, and the level of knowledge of the trainees, it may not be necessary to include all the recommended topics. Determine which are “nice to know” and which are “must know” topics. Keep in mind that in job-related training, topics such as radiation protection equipment are essential.

2.5 Prepare a timetable showing how much time will be allocated to each topic. Ensure that there is enough time to address the “must know” topics in detail.

2.6 On completing the training program workers should be able to understand why specific work practices and procedures are required, to perform these work practices and to know when and how to respond to upset conditions and emergency situations.

Worker classification and required training

2.7 Section 13 of this Guide includes matrix tables designed to aid in determining workers’ job classification. In each table, the column headed *Recommended Training Modules* specifies the subject areas in which training is required. Appendix 5 provides, in summary, specific suggestions for the content of each module.

Formats to provide the information

2.8 If the training is to be delivered in a traditional classroom or lecture setting, the use of audio-visuals such as overheads, films, slides, and videos, will improve comprehension. Group discussions and practical demonstrations are also effective.

2.9 Computer-based training can also be used for individual or group training, or for self-paced study. However, competent persons knowledgeable in radiation and related safety matters should always be available to assist and answer questions that may arise. Practical workshops and demonstrations are also recommended to complement computerized and self-paced training modules.

Statements on performance, conditions and standards

2.10 Before a training session begins the licensee should have a clear definition of what the trainee is expected to know by the end of that session. To this end, the training program should contain statements on performance, conditions and standards:

Performance statement: this should clearly state what is expected of the trainee on completion of the training session, and what results the instructor, supervisor and inspector can initially observe and evaluate. Specifically:
What the participant will be able to *do.* For example, to *identify* the radiological risks when cleaning up spills.
What the participant will be able to *demonstrate.* For example, to *select* the appropriate equipment for monitoring dose rates.

Conditions statement: describes the performance level expected of the trainee at the end of the training period and on commencement of work without supervision or consultation. This is the context of the action.

Standards statement: provides a definition of the minimum acceptable standard of performance and the recognition of success. Indicates how well the action must be performed.

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Section 3: Workplace Hazardous Materials Information System (WHMIS)

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR ANY LICENCE PREPARED BY THE AECB

About WHMIS

3.1 WHMIS (pronounced whim-iss) is a nationwide communication system that provides information to workers and employers on hazardous materials used in the workplace. WHMIS applies to all Canadian workplaces. It requires that all workers who work with or near a hazardous substance, as defined in the *Controlled Products Regulations*, are informed about potential hazards and recommended safe work practices.

3.2 As a result of the definition in the *AEC Act* for "prescribed substance" which includes any substances containing radioisotopes, hazardous materials containing radioisotopes are currently excluded from WHMIS. This will change when the *NSC Act* comes into force replacing the definition for "prescribed substances" by "nuclear substances".

3.3 Under the *NSC Act* a "nuclear substance" does not include the substances being used that carry radionuclides. This means that the non-radioactive carrier material, if a controlled substance within the meaning of the Hazardous Products Act, will be subject to the rules of WHMIS and will, therefore, require WHMIS labelling. There will be quantity exemptions for the non-radioactive component of mixtures based on a combination of volume or weight, and hazard.

3.4 WHMIS requires that information be provided in three ways:

- All controlled products used in the workplace must have a WHMIS label on the container.
- Material Safety Data Sheets (MSDS) and hazard information must be readily available in the workplace. An MSDS summarizes the health and safety information about the product.
- Workers must receive training to be able to recognize and work safely with the controlled products.

3.5 Trainees should be informed that the *HAZARD SYMBOL* is an important part of the WHMIS label.

3.6 The AECB is developing a program of "WHMIS-equivalence", where all workers who may be exposed to radioactive materials in the workplace will, regardless of risk, be afforded basic safety information and training. This basic program will be based on the requirements that will be specified in the new CNSC *Worker Safety Information Regulations*. The program will likely be based on the following being in place:

a. criteria for worker training, covering all workers in the industries regulated by the AECB who may come into contact with radioactive material or who may be exposed to radiation

b. a product labelling system equivalent to the WHMIS labelling system. (AECB's current labelling requirements are sufficient)

c. Radiation Safety Data Sheets (RSDS) similar to the WHMIS MSDS. [Unlike the MSDS, which are produced by the manufacturers of conventionally hazardous products, the RSDS may be produced and supplied by the AECB. Appendix 8 contains a draft sample RSDS]

d. the right of a worker representative or OSH Committee to participate in the development and review of WHMIS-equivalent training programs.

The AECB will advise its licensees when the program will come into effect. WHMIS-equivalence training will be necessary.

Guidance on basic WHMIS-equivalent training

3.7 Every worker encountering radioactive materials at the workplace should receive a level of training that is consistent with the risks associated with their proximity to and/or handling of the radiological hazard. Even workers subjected to only very low risk should receive at least a basic level of training.

3.8 Training programs should include instruction in:

a. the types, quantities and forms of radioactive material that may be encountered by the worker

b. the significance of labelling and signage for radioactive material that may be encountered by the worker

c. the contents of radioisotope safety data sheets relevant to the workplace and the significance of the information contained therein

d. procedures for those licensed activities that are relevant to the worker's duties or understanding the safety implications of the radioactive material

e. procedures to be followed when unplanned releases of radiation or radioactive material are present or suspected

f. procedures to be followed in case of emergency involving radioactive material.

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Section 4: Induction Training, Basic Training and Retraining

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Induction training

4.1 The induction or initial training program is important because it provides the basis of all training and work that follows. It presents to the new worker the licensee's safety philosophy and standards that should be stated in supporting documents to the licence application. It also makes the new worker aware of the regulatory requirements for training.

4.2 Induction training can be provided as a single training session. Alternatively, the instructor may prefer to divide the training into shorter periods or modules to make it easier for the trainees to absorb and retain the new knowledge.

4.3 Develop timetables to indicate how much time is to be spent on each topic. This helps to determine how much detail can be included. For suggestions on the timing for each topic, refer to the guidelines in Sections 9 through 12.

4.4 The major goals of induction training are to:

a. provide a brief introduction to radiation safety and the licensee's existing radiation safety program that will enable trainees to recognize and deal with situations that require precautions and explain to them their responsibility in reducing their own radiation exposure
b. provide new workers with the knowledge and skills to understand radiation safety and procedures to perform initial work assignments safely
c. confirm that the worker has the ability to understand radiation safety and procedures and is motivated to perform assignments in an acceptable manner
d. show that operations are monitored by licensees and regulatory agencies.

4.5 The AECB recommends that induction training include:

a. emphasis on the licensee's commitment to radiation safety by reviewing the licensee's existing policies, programs, radiation health and safety procedures, and awareness of the applicable legal provisions
b. explanation of the methods used and problems encountered in the licensee's operation, as well as the control mechanisms in place, such as radiation protection equipment, codes of practice, hygiene, ventilation and dosimetry
c. identifying the location of the posted local radiation safety rules and procedures

d. informing the new worker about the health effects of radiation exposure
e. providing the names of persons to be contacted on matters of health and safety emergencies
f. training on how to handle upset conditions, instruction for emergency procedures and evacuation plans.

4.6 Key topics for both the induction and subsequent training modules and programs must relate to practical on-the-job situations and conditions. Even at the induction level, these should include a basic understanding of:

- radiation theory
- radiation protection
- radiation units
- types of radiation exposure and doses
- risks associated with radiation exposure and doses
- understanding personal dose and exposure records.

4.7 Trainers should encourage participants to ask questions, but it is important to limit your answers to essentials. Too much detail can be confusing. Participants should be tested after completing their induction training. Supervisors should follow-up and make recommendations concerning additional instruction that may be required.

Basic training

4.8 Detailed basic training for site-specific working areas and conditions is provided only after successful completion of induction training. This type of training can take place both in a classroom and on the job.

4.9 Basic training should:

a. instruct workers in the procedures submitted by the licensee and accepted by the AECB to ensure regulatory compliance
b. inform workers of their responsibility to report promptly to the licensee any condition(s) that might violate the *AEC Regulations* or licence conditions
c. instruct personnel who do not work directly with prescribed radioactive substances but who may work in the vicinity of radioactive materials—such as janitorial, security, maintenance, nursing, and clerical staff—in how to recognize warning symbols, actions expected in case of radiation hazard, and who to contact about radiation safety issues
d. educate trainees about the radiation characteristics, radiation risks and hazard levels of the materials with which they will be working

e. describe the regulatory process and the measures taken by the licensee to protect workers

f. instruct supervisors about the persons who are to be constantly supervised while they remain in areas where a potential for radiation exposure exists, for example, persons less than 18 years of age

g. inform female workers that subsection 19.(4) of the *AEC Regulations* requires them to advise the licensee if they are pregnant, and that special reduced limits apply during the term of the pregnancy (also see subsection 11.(1) of the proposed *Radiation Protection Regulations*).

Retraining

4.10 The AECB recommends retraining programs both to enhance and maintain employee competence. Workers should be retrained after receiving new assignments and when procedures change. The retraining must reflect the new working conditions and environment to which the worker will be exposed.

4.11 As a general rule the licensee should provide retraining annually or bi-annually. More detailed radiation retraining programs should be provided every three-to-five years. In addition, radiation safety topics should be discussed at informal safety meetings held for workers at least once a month.

4.12 The degree of retraining required depends on each worker's knowledge and experience, and will be reflected on their training record (see *Keeping records* in Section 5). Validation (refer to Section 7 dealing with program verification) provides a means of assessing the overall level of knowledge retained by workers, and identifying the areas where retraining is essential.

Training of supervisors

4.13 The radiation safety training program for supervisors and workers should be the same, with the exception that the supervisor is expected to provide on-the-job guidance to the workers and include instruction on the interpretation of regulations and licence conditions, and the necessity of compliance. In addition to radiation safety training, the AECB recommends instruction for effective supervision. Management should evaluate the effectiveness of the supervisor’s training.

4.14 It is important that supervisors are trained to set an example to the workers by following the rules and regulations, using protective equipment correctly, wearing their assigned dosimeters, and supporting the licensee’s radiation safety programs.

4.15 Supervisors should be trained to observe the attitudes and performance of workers who report to them, note any deficiencies and make recommendations concerning requirements for any additional training.

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Section 5: Administering Training Programs

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Keeping records

5.1 It is the licensee's responsibility to ensure that a complete record is maintained of the qualifications and training received by every worker (refer to Section 1 for a more detailed description of the licensee's responsibilities for training). These records should indicate if and when previous experience and training have been taken into consideration.

5.2 If there are site-specific factors that may have to be considered in developing, implementing and maintaining training records you can discuss them with AECB staff.

Training program records

5.3 The training program records maintained by the licensee should include:

- training plans
- training group procedures and lesson plans
- training materials
- test/examination blanks
- training schedules
- trainee participation (names and occupations of those attending each lecture)
- results of training examinations and course evaluations
- analysis results (job and task)
- changes to the program and when implemented (note that significant changes must be approved by the AECB before implementation.)
- data gathered to assess the program's effectiveness
- certification records

Certification

5.4 The licensee should provide every worker with a certificate indicating that the worker has successfully completed the radiation safety training program.

5.5 The certificate should reference the AECB requirement for certification, and should include the trainee's name, title of the course, modules completed, date of issue, and the names of the licensee and the person responsible for issuing the certificate.

Scheduling

5.6 Schedules for both new worker training and retraining for established workers are important. In preparing and maintaining schedules take into consideration the needs of the trainees and their supervisors, and the best conditions for learning.

5.7 For example, the program can be concentrated into a solid week of training, or spread out over a period of time. To minimize disruptions, set the schedule and communicate it well in advance to the participants and their supervisors.

5.8 In addition to dates, the schedules should indicate the location, type of training, the instructor's name, and the names and work classifications of the trainees.

5.9 Some sample schedules are shown in Appendix 4.

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Section 6: Selecting and Training Instructors

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Instructor qualifications

6.1 The AECB expects that instruction will be provided either by qualified staff of the licensee or by an outside training institution or consultant, using a training program acceptable to the AECB.

6.2 While the format and materials in a training program are approved by the AECB, the effectiveness of the training depends to a large extent on how well it is delivered. It is important, therefore, that the instructor selection profile include:

- subject matter expertise in the relevant tasks or environmental factors, gained through experience and training
- effective oral communication skills
- the successful completion of an instructional techniques course that includes rigorous evaluation.

See also Objective 2 in Section 7 of this Guide.

6.3 In addition, instructors selected for radiation safety training should have:

- adequate knowledge of the applicable regulations and licence conditions
- successfully completed studies in radiation safety
- adequate support staff
- all necessary materials, equipment and tools
- a reliable system of document control and records management

Instructor training

6.4 The licensee should establish, for AECB acceptance, the technical and instructional qualifications criteria, procedures and programs for selecting, training and authorizing qualified instructors.

6.5 Most instructors achieve the required instructional qualifications by completing a specific training program. Instructors are expected to continuously upgrade their training in order to maintain their technical knowledge and instructional skills.

Learning objectives

6.6 Learning objectives for training instructors include:

- role of the instructor
- understanding how adults learn
- using appropriate training techniques
- using lesson plans and other instructional materials and media
- conducting lectures, discussions and practical demonstrations
- establishing job performance measures to evaluate on-the-job training
- assisting trainees in solving learning problems
- assessing trainees
- maintaining and using individual trainee records and program records.

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Section 7: Program Verification

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Evaluation and validation

7.1 Evaluation and validation of training programs are essential in order to determine their effectiveness. Licensees should establish quality controls for radiation safety training programs and their delivery based on ongoing evaluation and validation. For continuing evaluation of their radiation safety training programs, licensees should review the five essential phases of SAT (see paragraph 1.18 of this Guide) to verify compliance. This section outlines the objectives for such a review

7.2 Evaluations of radiation safety training programs should be comprehensive and consistent over time. Acceptable measurable objectives and criteria for regulatory evaluations are included in this section. Appendix 2 contains sample evaluation forms.

7.3 Validation closes the loop, through linkage of all previous components or phases of a training program. It proves the soundness of the training program, and indicates if it is defensible and efficient. It is the process that identifies whether the abilities learned and evaluated are required on the job and are being used to produce acceptable performance.

7.4 The licensee should validate the training program within three months following the completion of the worker's training. In addition, AECB inspectors will periodically evaluate and validate training programs, including training materials and methods of instruction. Schedules and records will also be verified through inspections. (See Appendixes 4 and 7 in this Guide).

Objectives and criteria for evaluating training programs

7.5 The following are objectives and criteria for regulatory evaluations of radiation safety programs, where

- an *objective* specifies an end result of an effective, well-managed training program
- supporting *criteria* specify conditions or actions that satisfy the intent of the objectives.

Preparation of the radiation safety training program

7.6 This section covers the first three phases of SAT: analysis, evaluation design, and training design.

Objective 1 ***Training programs are effectively organized, directed and supported.***

Criterion 1.1 The goals of the training program are clearly defined and understood.

Criterion 1.2 The specific responsibilities of personnel who manage, supervise, develop, conduct and evaluate training are clearly stated and understood.

Criterion 1.3 Personnel in a licensed facility whose duties could have an impact on the environment, the public or on the safe and reliable operation of the facility, have clearly defined and documented qualification needs, and well documented initial and continuing training programs.

Criterion 1.4 A framework for establishing, conducting and maintaining training programs in accordance with the principles of SAT is documented in written policies and procedures.

Criterion 1.5 Personnel are aware of the training required for their respective positions and of the performance expected of them during and after training.

Criterion 1.6 Management ensures that all personnel receive the required training and that the records of the training process are maintained that are easily understood and readily accessible for review and inspection purposes.

Criterion 1.7 Instructional facilities such as workshops, classrooms and laboratories are adequately equipped to meet the specific objectives of the training program.

Criterion 1.8 Adequate funding and personnel are available to support effectively all the required training programs and activities.

Criterion 1.9 Training developed or implemented by contractors or outside organizations meets the same specifications as the AECB-accepted training provided by the licensee's training department.

Objective 2 ***Training personnel have the subject matter expertise, experience and instructional skills needed to discharge their assigned duties.***

Criterion 2.1 Subject matter expertise and instructional skills of training personnel meet documented training and qualification standards.

Criterion 2.2 Training personnel receive additional training periodically to maintain and improve their technical knowledge and instructional skills.

Criterion 2.3 Current revisions of radioactive materials handling procedures, technical references and radiation protection procedures are readily available to training personnel.

Criterion 2.4 Personnel who conduct on-the-job training and assessment receive adequate training on the policies, practices, methods and standards for delivering this training and for assessing trainee performance.

Criterion 2.5 Training personnel monitor training delivered by contractors, beginner instructors and personnel from outside the training department, and obtain feedback on their performance from the course participants.

Criterion 2.6 The performance of all training personnel is periodically monitored and assessed. The results are fed back to the instructors and used to improve their performance.

Objective 3 ***The job performance requirements are determined by an analysis of the duties, where such duties could have an impact on the environment, the workers, the public or on the safe and reliable operation of the licensed facility. This analysis serves as the basis for the development of learning objectives, training materials and job performance measures.***

Criterion 3.1 Qualified personnel occupying positions for which training is being developed participate in the analysis of the jobs that they perform to provide subject matter expertise.

Criterion 3.2 The analysis identifies the tasks requiring initial training and those requiring continuing training, with due consideration to tasks performed infrequently during non-routine and upset conditions.

Criterion 3.3 The analysis identifies the skills and knowledge needed for the tasks selected for training and is sufficiently detailed to enable the development of learning objectives, test items and job performance measures.

Criterion 3.4 Learning objectives are developed and kept current to establish the training content for task-related knowledge and skills, taking into consideration the initial knowledge, skills and experience of the trainees.

Criterion 3.5 Learning objectives state clearly the satisfactory standards of trainee performance and are linked to job performance requirements.

Criterion 3.6 Learning objectives are sequenced, grouped and organized appropriately according to the required progression of learning.

Criterion 3.7 Job performance measures and test items for written and oral examinations are developed to measure job-related knowledge and performance of trainees, including higher cognitive abilities such as analytical and diagnostic skills.

Objective 4 Training materials encompass the knowledge and skills required to meet the learning objectives.

Criterion 4.1 Necessary training materials, including lesson plans, laboratory guides, individualized study guides and on-the-job training guides, are developed to promote effective and consistent delivery of training.

Criterion 4.2 Training materials are accurate, support the learning objectives and test items, and are maintained so as to reflect current knowledge.

Implementing the training program

Objective 5 ***Training delivery employs principles of good instructional presentation and conveys accurate information consistently and clearly.***

Criterion 5.1 Classroom, on-the-job and skills training are implemented as outlined in the training materials approved by the licensee are conducted by individuals qualified to perform the job who possess adequate instructional and assessment skills.

Criterion 5.2 Lesson plans or equivalent training guides approved by the licensee are used in all instructional settings to ensure consistent training delivery directed towards specific learning objectives.

Criterion 5.3 Instructors are prepared adequately to deliver training effectively and consistently with access to the necessary instructional aids and equipment.

Criterion 5.4 Instructors use techniques appropriate to the learning objectives, lesson content and instructional setting.

Criterion 5.5 Individualized or self-paced instruction, if used, gives the trainees sufficient guidance and supporting material to master the learning objectives.

Criterion 5.6 When the task is simulated because it cannot be performed in the actual job setting, the differences between the simulated task and the actual must be reviewed with the trainees prior to training.

Criterion 5.7 The procedures used during training are those used during licensed activities.

Criterion 5.8 Training reinforces the expectations of management for the conduct of licensee activities by their personnel. The diagnostic and teamwork skills required for the operations, according to the expectations of the licensee's management, are developed.

Objective 6 Trainees are evaluated on their mastery of the learning objectives and receive prompt feedback on their performance.

Criterion 6.1 There is a clear link between the test items or job performance measures and the initial analysis of the job performance requirements.

Criterion 6.2 Trainees are evaluated regularly and receive prompt feedback on their strengths and weaknesses, and on the need for any remedial training.

Criterion 6.3 Trainees who fail to meet minimum performance standards receive remedial training and reassessment.

Criterion 6.4 The licensee's personnel successfully complete all training requirements for their position before being assigned to work independently. Exemptions from training are based on appropriate test results or other objective evidence that the subject training is not required.

Criterion 6.5 There is a formal procedure for verifying that contractors, temporary personnel, or other non-plant personnel have been appropriately trained for the work to which they are assigned.

Criterion 6.6 Tests and assessments are prepared and administered in a consistent manner. All answers expected during written or oral tests are specified in advance in appropriate marking guides that are consistent with accepted working practices.

Criterion 6.7 Adequate precautions are taken to ensure confidentiality of examinations, tests and making guides.

Evaluating the training program

Objective 7 ***Training programs are systematically evaluated and, if necessary, revised so that on-the-job competence is attained and maintained.***

Criterion 7.1 Training programs are evaluated on a basis determined by the AECB with all the individual evaluation activities integrated into a comprehensive evaluation system.

Criterion 7.2 Training program improvements and changes are proposed, initiated, tracked and incorporated into the program in a timely manner.

Criterion 7.3 Feedback on training activities is solicited regularly from both trainees and instructors during training program evaluations.

Criterion 7.4 For validation purposes, former trainees are asked for feedback on the strengths and weaknesses of the training program and its individual courses, approximately three months after the end of the program.

Criterion 7.5 Supervisors and managers are interviewed regularly to obtain feedback on job performance problems, training priorities, and the effectiveness of recent training in enabling the licensee's personnel to do their jobs.

Criterion 7.6 Training programs are revised, where necessary, to reflect procedural and equipment changes, changes in job descriptions, industry-wide significant events, as well as other aspects of operating experience.

Criterion 7.7 Inspections and evaluations of training programs performed by groups external to the training department, for quality assurance, are factored into the training program evaluation process.

Criterion 7.8 Job analyses, learning objectives, test items, job performance measures, lesson plans and training material are revised to reflect the findings of training program evaluations.

Criterion 7.9 Training delivery in the workshop, classroom, laboratory field and on-the-job is evaluated regularly and evaluation results are communicated to instructors.

Criterion 7.10 Test results and other indicators of trainee performance are analysed to identify areas where the training program can be improved.

Criterion 7.11 Training provided by contractors or outside organizations is evaluated to ensure that it meets the job needs and that its quality is consistent with accepted training standards.

Criterion 7.12 Records are maintained of evaluations, and decisions resulting from evaluations, that are easily understood and readily accessible for review and inspection.

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Section 8: AECB assessment of radiation safety training programs

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AECB assessment of radiation safety training programs

8.1 The AECB requires applicants to include a description of their radiation safety training programs as part of the submission for a licence.

8.2 Radiation safety training program descriptions are assessed by AECB staff using the standards and criteria in this Guide.

8.3 Radiation safety training programs that conform to this Guide expedite the licence assessment process.

8.4 Other radiation safety training programs should conform with the intent of this Guide or be revised to conform. AECB licensing staff inform applicants in writing of deficiencies in their radiation safety training programs.

8.5 Following acceptance, the applicant's radiation safety training program description is referenced in a condition of the licence. Any substantial change to the radiation safety training program requires the prior written acceptance of the Board.

8.6 AECB staff monitor compliance with accepted and referenced licensee radiation safety training programs during site visits.

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Section 9: Radioisotopes

THIS SECTION APPLIES TO RADIOISOTOPE LICENSEES AND APPLICANTS FOR ANY RADIOISOTOPE LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Radioisotope licensees

9.1 All radioisotope licences issued by the AECB pursuant to section 7 of the *AEC Regulations* include a licence condition requiring the licensee to ensure that only persons properly trained in work with radioactive prescribed substances and informed of the hazards involved are allowed to handle such substances. As a licensee it is your responsibility to ensure that every person working in the facility:

a. is competent to work safely
b. is adequately trained in radiation safety
c. has actual notice of and complies with the conditions of the licence

The philosophy behind these regulatory requirements has not changed for the proposed *Nuclear Substances and Devices Regulations* to be implemented under the *NSC Act*.

9.2 You also have a responsibility to provide training to their workers before they start to work with radioisotopes, except when on-the-job training is carried out under the direct supervision of a person with a level of training and expertise that is acceptable to the AECB. The scope and depth of the radiation safety training for radioisotope workers should reflect the actual radioisotope operations and radiation risks associated with their work.

9.3 Some groups of workers, such as nuclear medicine technologists and medical physicists, whose work routinely requires the manipulation of radioisotopes and exposure to radiation, receive extensive radiation safety training as part of their specialized education or certification. These workers should also comply with the radiation safety training recommended in this Guide, but may demonstrate the required level of training through their academic background and professional certification.

Safety training modules for those dealing with radioisotopes

9.4 Refer to section 12 for a description of the suggested module content and also to section 13, table 13-1: Radioisotope worker training matrix.

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Section 10: Medical particle accelerators

THIS SECTION APPLIES TO MEDICAL ACCELERATOR LICENSEES, APPLICANTS FOR ANY PARTICLE ACCELERATOR LICENCE PREPARED BY THE AECB AND TO RADIATION SAFETY INSTRUCTORS

Particle accelerator licensees

10.1 All particle accelerator licences issued pursuant to sections 7 and 9 of the *AEC Regulations* include a licence condition requiring the licensee to ensure that every person working in the facility:

a. is competent to work safely
b. is adequately trained in radiation safety
c. has actual notice of and complies with the conditions of the licence

10.2 You also have a responsibility to provide training to your workers before they start to work with the accelerator, except when on-the-job training is carried out under the direct supervision of a person with a level of training and expertise that is acceptable to the AECB. The scope and depth of the radiation safety training for particle accelerator workers should reflect the actual operations and radiation risks associated with their work. Modules should include:

- accelerator operation
- radiation production (direct radiation and radiation from activation)
- shielding (see 10.4)
- personnel safety interlocks and warning displays (see 10.5)
- personnel dosimetry special to the facility (neutrons, for example)
- operating practices to avoid personnel exposure to radiation

10.3 Some groups of accelerator employees have received extensive radiation safety training as part of their specialized education or certification. Such employees are expected to comply with the radiation safety training recommended in this Guide, but may demonstrate the required degree of competence through their academic background and/or professional certification.

10.4 *Time, distance* and *shielding* are all important factors in controlling the risks associated with radiation. However, the training program should also be sure to remind participants that accelerators have a fourth control: they can simply be turned off.

10.5 Paragraph 4.(5)(b) of this Guide states that worker protection, including personal protective equipment and clothing, and the importance of personal hygiene in the prevention of spreading and ingesting contaminants, should be included in radiation safety training. Note that the interlock system is also part of radiation safety in accelerators.

Safety training modules for particle accelerator licensees

10.6 The topics in the modules should reflect what is required to be delivered according to the analysis phase of SAT (see Appendix 1).The instructor can vary the length and content of each module depending on the understanding, qualifications and experience of the participants. Refer to section 12 of this guide for a description of the suggested module content and also to section 13, Table 13-2: Medical Accelerator Training Matrix.

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Section 11: Transportation of radioactive nuclear substances

THIS SECTION APPLIES TO THOSE DEALING WITH THE PACKAGING AND TRANSPORTATION OF RADIOACTIVE NUCLEAR SUBSTANCES/MATERIALS AND TO RADIATION SAFETY INSTRUCTORS

Transportation of radioactive materials

11.1 Section 3.(1) of the *Transport Packaging of Radioactive Materials Regulations [TPRM Regulations]* references the *Transportation of Dangerous Goods Regulations [TDG Regulations]*. As a result the requirements set out in the *TDG Regulations* are mandatory.

11.2 Basic training should include:

a. fundamental requirements of the regulations mentioned in 11.1 above, governing the transport of radioactive material
b. preparing packages
    i. classification, packaging, contamination levels and qualification of workers
    ii. consignor responsibilities, checks before transportation, including measuring surface dose rates, and determining the transport index [meaning the number for a package or transport container derived in accordance with the procedures described in Schedule XI of the *TPRM Regulations*]
c. labelling of transportation containers
d. describing nuclear substances (radioactive materials) on shipping papers
e. emergency response.

11.3 Module content should include the procedures necessary for paragraphs a. to e., plus:

f. reporting requirements
g. receipt of nuclear substances (radioactive materials), including survey requirements and receipt records
h. shipment of nuclear substances (radioactive materials), including preparing the nuclear substances for shipment, completing shipping documentation and surveying the packages
i. transportation of nuclear substances (radioactive materials), including the packaging of nuclear substances, the labelling of transport containers and completing the shipping documents
j. placarding of a transport vehicle.

Safety training modules for those dealing with packaging and transportation of radioactive nuclear substances/materials

11.4 Refer to section 12 for a description of the suggested module content and also section 13, Table 13-3:Transportation Training Matrix.

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Section 12: Radiation Safety Training Modules

THIS SECTION APPLIES TO RADIOISOTOPE AND MEDICAL ACCELERATOR LICENSEES AND APPLICANTS FOR ANY RADIOISOTOPE OR PARTICLE ACCELERATOR LICENCE PREPARED BY THE AECB, TO THOSE DEALING WITH THE PACKAGING AND TRANSPORTATION OF RADIOACTIVE NUCLEAR SUBSTANCES/MATERIALS, AND TO RADIATION SAFETY INSTRUCTORS.

The topics in the modules should reflect what is required to be delivered according to the analysis phase of SAT (see Appendix 1). The instructor can vary the length and content of each module depending on the understanding, qualifications and experience of the participants.

Module 1: *Radiation Orientation Lecture (Radioisotopes, Accelerators and Transportation)*

OBJECTIVE**:**

1. To provide a brief introduction to the radiation safety training program and radiation safety practices.

MODULE CONTENT:

1. General (non-technical) summary of radiation and radiation effects. Technical terms should be carefully selected and worded to avoid misunderstanding. The aim is to give a general idea of the whole problem of radiological protection or of some particular field of it.

2.(a) ***(Radioisotopes*)** Basic training to enable employees and others to recognize and deal with situations that require precautions. These trainees may include technical staff, personnel in shipping/receiving, janitorial or housekeeping, secretarial or clerical, management, contractors, maintenance staff, security, emergency services, students and visitors.

2.(b) ***(Accelerators and transportation)*** Basic training to enable employees and others to recognize and deal with situations that require precautions.

3.(a) ***(Radioisotopes*)** Problem recognition and superficial risk analysis, including whom to contact in the event of problems and what simple steps to take to protect themselves and others until radiation safety personnel arrive. For example, a member of the cleaning staff should be able to recognize a radiation warning symbol and be familiar with the organization's radioactive waste handling procedures. A shipping/receiving clerk should know what steps to take if a radioactive package is damaged and whom to call for assistance.

3.(b) ***(Accelerators and transportation)*** Problem recognition and superficial risk analysis, including whom to contact in the event of problems and what simple steps to take to protect themselves and others until radiation safety personnel arrive.

Module 2: *Regulatory Requirements (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To inform trainees of the regulatory requirements, including the responsibilities of licensees to provide the training prescribed in standard licence conditions.
2. To acquaint the trainees with precautionary practices and procedures and with records, reports and notification procedures.
3. To inform trainees of the qualifications and skills their job requires.
4. To inform trainees on worker responsibilities under the regulations, including the procedure for reporting unusual occurrences.

MODULE CONTENT:

A. *Atomic Energy Control Act* and *Regulations/Nuclear Safety and Control Act* and highlights of the proposed new regulations.

B. AECB licence conditions

C. Notices, regulatory documents and AECB instructions

D. Other federal, provincial or local regulatory agency requirements that affect radioisotope workers.

Module 3: *Operating and Emergency Procedures (Radioisotopes, Accelerators and Transportation)*

Note: This module should be tailored to complement the licensee's own needs and procedures.

OBJECTIVES:

1. To acquaint the trainee with the operating and emergency procedures.
2. To provide information about the organization of operating and emergency procedures.
3. To show the trainee an example of procedure implementation.

MODULE CONTENT:

A Operating procedures

1. Radiation safety program personnel (duties and responsibilities)
   a. Radiation safety officer
   b. Radiation safety instructor
   c. Area supervisor
   d. Assistant supervisory personnel
2. Facility requirements
   a. Use areas
   b. Storage areas
3. Radiation Safety Program
   a. Personnel monitoring
      - film/TLD badges
      - pocket dosimeters
      - ring badges (for example, finger dosimeters) ***(radioisotopes)***
      - internal dosimetry (urine analysis, whole body counting) ***(radioisotopes)***
   b. Radiation detection instruments
      - preparation for use
      - daily check
      - use of
   c. Use of security
      - posting warning signs
      - calculating boundary of restricted area
   d. Surveys
      - area surveys
      - vehicle survey (if applicable)
      - wipe survey
      - other as applicable
   e. Transportation of radioactive materials
   f. Receipt and disposal of radioactive material
   g. Leak testing of radioactive sources
   h. Inventory, inspection and maintenance of equipment
      - requirements
      - records
   i. Records management

B Emergency procedures

1. Contamination
2. Other

3. Emergency response training

C Hands-on exercises (where applicable)

1. Procedures for receiving and opening packages of radioactive material
2. Locking and securing sources
3. Use of open source radioactive material
   a. Handling equipment
   b. Protective clothing
   c. Prevention of contamination
   d. Decontamination procedures
   e. Ventilation
4. Use of sealed radioactive sources

Module 4: *Structure of Matter (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To acquaint the trainee with the basic concepts on the structure of matter.
2. To provide information about the relationship of the particles to matter as they relate to radioactive isotopes specific to the task.

MODULE CONTENT:

Start the module with matter on a macroscopic scale, relate to molecules and then to atoms.

A. Structure of the atom
   1. The nucleus
      a. Proton - characteristics
      b. Neutron - characteristics
   2. Electrons
      a. Characteristics
      b. Orbits
      c. Orbit jumping and escape

B. Atomic number - determination

C. Atomic weight - determination

D. Isotopes
   1. Definition

2. Radioactive vs stable
3. Types used by the trainee, or those isotopes with which the trainee has a possibility of coming in contact.

Module 5: *Radiation and Radioactivity (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To acquaint the trainee with the basic concepts of radiation.
2. To provide information about the types of radioactive decay.
3. To introduce the units of radioactive decay including the International Standard Units (SI)
4. To introduce the concepts of radiation interaction with matter.
5. To provide information about the hazards of various types of radiation.

MODULE CONTENT:

Start the module with a definition of radiation.

A. Discussion of the types of radiation
   1. Alpha and beta -- type, hazard and shielding
   2. Gamma and X-ray -- type, hazard and shielding
   3. Neutrons --- type, hazards and shielding
   4. Electron capture and positron emission (Optional)
B. Electron Volt - unit of radiation energy
   1. Definition
   2. Energy spectrum
C. Mechanism of decay -- decay to stable form
D. Activation of matter
E. Units of radioactivity
   1. Becquerel/Curie
   2. Half-life concept
      a. Decay charts
      b. Calculation of half-life

F. Interaction of radiation with matter

1. Ionization - effect on electrical stability
   A basic definition of ionization and a simple description of the production of electron - ion pairs in matter should suffice.
   a. Particle ionization
   b. Electromagnetic ionization
      - photoelectric effect
      - Compton effect
      - pair production
2. Effects: energy lost by radiation to the material through which it is passing
   a. Range in tissue (linkage with biological effects in Module 8)
   b. Range in air
   c. Linear energy transfer (LET)

Module 6: *Radiation Units (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To acquaint the trainee with the units used to measure radiation.
2. To provide information concerning the correct usage of the units as they apply to different types of radiation.
3. To provide information concerning the conversion of the old units to the new units (SI).

MODULE CONTENT:

A. The coulomb (Roentgen) — X-ray and gamma ray exposure to air. May mention that the coulomb is the historical unit for measuring exposure to air by X- and gamma rays
B. The Gray (Gy) [RAD (R)]— Absorbed dose
   1. Definition and discussion
C. The sievert (Sv) [REM (rem) — Unit of dose equivalent

   ICRP 60 introduced new units: “equivalent dose” and “effective dose”. (The latter is a combined radiation and biological unit.)

   1. Definition
   2. Qualify factor (QF) (for the new units QF has been replaced with “w_R - radiation weighting factor”)
   3. Conversion from and to Si units
D. Submultiples, for example, changing mSv to Sv [mR to R]

E. Relationship between units
   1. Difference between units
   2. Changing from one unit to next

Module 7: *Radiation Detection and Measurement (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To develop a basic understanding of radiation detection and measurement.
2. To learn the basic concepts of radiation measuring instruments.
3. To acquaint trainees with the more commonly used radiation measuring instruments required for the operation/environment in which they will be employed.
4. To learn how to differentiate between a survey meter (dose rate meter) and a contamination meter.
5. To provide information concerning interpretation of radiation protection instrument readings.

MODULE CONTENT:

A. Dose vs. dose rate devices
   1. Dosimeters - total dose device
   2. Survey instruments - dose rate devices

B. Survey instruments

1. Ion chamber instruments:

   a). Typical examples of commercially available instruments

   b). Specifications of radiation protection importance

   c). Use, including the interpretation of radiation instruments measurements, recognizing problem areas and recording the results of instrument readings

   d). Advantages and disadvantages

2. Geiger Müller (GM) instruments:

   - as for B. 1.

3. Proportional counter instruments:

   - as for B. 1.

4 Solid state instruments:

- as for B. 1.

C. Contamination instruments:

- as for B. 1.

D. 1. Personal dosimeters

a) Typical examples of commercially available dosimeters

b) Specifications of radiation protection importance

c) Energy response

d) Procedures use, wearing and storing personal pocket dosimeters

e) Advantages and disadvantages

f) Interpretation of results

2. Thermoluminescent dosimeter (TLD) badges

a). Film badge design, basic operation and use

b). Use of control badges

c). Procedures for wearing badges

d). TLD badge vs. film badge

3. Pocket dosimeters

a) Typical examples of commercially available dosimeters

b) Specifications of radiation protection importance

c) Energy response

d) Procedures use, wearing and storing personal pocket dosimeters

e) Advantages and disadvantages

f) Interpretation of results

4. Electronic dosimeters

a) Typical examples of commercially available dosimeters

b) Specifications of radiation protection importance

c) Energy response

d) Procedures use, wearing and storing personal pocket dosimeters

e) Advantages and disadvantages

f) Interpretation of results

E. Solid state detectors

1. Energy bonds, holes, electron traps
2. Scintillation detectors
   a) Basic operation
   b) Components - crystal, PMT tube
3. Advantages and disadvantages

F. Maintenance of equipment and the calibration of radiation measurement devices
   1. Regulatory requirements
   2. Inspection frequency for equipment
   3. Specify the following:
      a. Practical instrument appearance check
      b. Battery check
      c. Calibration certificate check
      d. Check source response check

Module 8: *Biological Effects (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To inform trainees of the relative sensitivity of various cells of the body to radiation.
2. To develop an understanding of the types of biological effects of radiation on the various organs and tissues of the body.
3. To acquaint the trainee with the stochastic and deterministic effects of radiation on living matter.
4. To acquaint trainees with the genetic effects of radiation.

MODULE CONTENT:

A. Types of effects
   1. Stochastic and non-stochastic
   2. Somatic
      a) short term vs long term
      b) early radiation effects
      c) late radiation effects
   3. Genetic

B. Radiosensitivity

C. Dose-effect relationship
   1. Classification of doses
   2. Effects of acute radiation
   3. Chronic doses and late effects

D. Sources of radiation exposure
   1. Hazards from external radiation
   2. Hazards from internal radiation

E. Clinical effects on Humans
   1. Factors that determine what effect a given dose will have
      a) Part of body exposed
      b) Rate of exposure
      c) Extent of body part that receives exposure
      d) Age of the individual
      e) Biological variations among individuals

F. Radiation hazard in proper perspective
   1. The philosophy of radiation benefits and risks
   2. Personal exposure
      a) man-made sources
      b) background
   3. Radiation risks to trainees from their specific job task(s)
   4. Maximum permissible doses for workers

Module 9: *Effects of Radiation on the Foetus (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To provide workers with knowledge of radiation effects on an unborn child.
2. To enable workers to make better judgements regarding radiation risks while pregnant.
3. To explain the declaration of pregnancy procedure (see also Module 2, Regulatory Requirements).

MODULE CONTENT:

A. Genetic effects:

1. Definition: abnormality observed in offspring due to previous irradiation of a parent's reproductive system
2. Increase in risk with any exposure

B. Teratogenic Effects:
   1. Abnormality observed in offspring due to irradiation *in utero*
   2. Increase in risk above threshold value

C. Explanation of the risks to the foetus from internal and external doses:
   1. Review of specific risks associated with specific tasks

D. Protective measures

E. Specify activities that are not acceptable/personal choice.

F. Declaration of pregnancy [*AEC Regulations* 19(4)]

G. Dose limits while pregnant and the relative risks involved.

Module 10: *Controlling Radiation Exposure (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To relate time, distance and shielding as methods of reducing radiation exposure.
2. To impress on the trainees the importance of the ALARA principle — keeping exposures as low as reasonably achievable, taking into account economic and social factors.
3. To develop an understanding of the hazard from contamination when handling loose radioactive material, and contamination control practices.

MODULE CONTENT:

A. Control of external radiation exposure
   1. Time — Dose = Dose Rate x Time
   2. Distance
      a. Definition of inverse square law
         - explain that not all fields diminish at a rate proportional to the square of the distance from the source since many decrease at much slower rates, depending on the geometry of the conditions of exposure
      b. Example problems
   3. Shielding
      a. Definition of half-value layer (HVL)

b. HVL for various shielding materials
c. Example problems

4. Use of time, distance and shielding in actual radioisotope work
5. Contamination control

B. Control of internal radiation exposure

1. Modes of entry into body
   a. Inhalation
   b. Ingestion
   c. Absorption through skin
2. Leak testing of sealed sources
   a. Requirement
   b. Procedures
3. Contamination control
   a. Monitoring procedures
      - instrument survey
      - wipe survey
      - regulatory limits
   b. Contamination prevention
      - handling equipment
      - personnel protective equipment
   c. Decontamination techniques
4. Bioassay
   a. Requirements
   b. Method and frequency
   c. Body counting vs urinalysis
   d. Contamination control

Module 11: *Transportation Requirements (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To acquaint the trainee with the basic requirements of regulations governing the transport of radioactive material.
2. To provide information necessary to properly label transportation containers.
3. To provide information necessary to properly describe radioactive material on shipping documents.

MODULE CONTENT:

A. Receipt of radioactive material
   1. Survey requirement
   2. Receipt record

B. Shipment of radioactive material
   1. Preparing material for shipment
   2. Completing shipping document
   3. Surveying package

C. Transportation of radioactive material
   1. Packaging radioactive material
   2. Package certificate/special form material certificate/special arrangement certificate requirements
   3. User licensing requirements
   4. Transport security
   5. In-transit transport licence
   6. Labelling transport container
   7. Completing shipping document
   8. Quality Assurance program

D. Placarding of transport vehicle

Module 12: *Practical Exercises [dependent on job tasks] (Radioisotopes, Accelerators and Transportation)*

OBJECTIVES:

1. To provide the trainee with the practical examples of the application of time, distance and shielding.
2. To demonstrate correct handling practices and precautions for nuclear substances.
3. To demonstrate the method for performing a wipe and survey and how to evaluate the wipe.
4. To demonstrate the correct method of leak testing sealed sources. ***(radioisotopes)***

MODULE CONTENT:

Recommended practical exercises

A. Time, distance and shielding calculations
B. Radiation detection instrument verification (instrument's accuracy, precision and reproducibility under conditions of intended use)
C. Radiation scattering
D. Contamination surveying and analysis
E. Leak testing of sealed sources
F. Surface decontamination methods
G. Contamination control
H. Personnel contamination and decontamination:
    1. radioactive spills
    2. damage to sealed sources
    3. device malfunctions
I. Radiation emergency procedures
J. Hands-on exercises (simulations, role playing)

Module 13: *Accelerator (accelerators)*

OBJECTIVES:

1. To acquaint the trainee with the sources of radiation at the accelerator, including activation of components.
2. To acquaint the trainee with the safety interlock system at the accelerator facility.
3. To inform the trainee of the safety procedures at the accelerator facility.

MODULE CONTENT:

A. Sources and potential sources of radiation from the accelerator.
B. Shielding principles used at the accelerator.
C. Description of the interlock system and of the radiation warning system.
D. Procedures to use the interlock system.
E. Other procedures including entry to the accelerator areas and handling of activated parts.
F. Use of radiation instrumentation.

The topics in the modules should reflect what is required to be delivered according to the analysis phase of SAT (see Appendix 1). The instructor can vary the length and content of each module depending on the understanding, qualifications and experience of the participants.

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Section 13: Recommended matrix tables for worker training programs:

THIS SECTION APPLIES TO RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENSEES AND APPLICANTS FOR ANY RADIOISOTOPE, MEDICAL ACCELERATOR OR TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Table 13-1: Radioisotope Worker Training Matrix

Module 1: Radiation Orientation Lecture;
Module 2: Regulatory Requirements;
Module 3: Operating and Emergency Procedures;
Module 4: Structure of Matter;
Module 5: Radiation and Radioactivity;
Module 6: Radiation Units;
Module 7: Radiation detection and Measurement;
Module 8: Biological Effects;
Module 9: Effects of Radiation on the Foetus
Module 10: Control of Radiation Exposure;
Module 11: Transportation Requirements;
Module 12: Practical Exercises

[1]Recommended Training Modules

Job Task/Use Description D - means detailed course I - means introductory course P - means professional qualification * - indicates female worker and supervisor of female workers	**1** ORIENTATION	**2** REGULATORY	**3** PROCEDURES	**4** MATTER	**5** RADIATION	**6** UNITS	**7** DETECTION	**8** BIO EFFECTS	**9** * FOETUS	**10** CONTROL	**11** TRANSPORT	**12** PRACTICAL
Sealed Sources												
Sealed source manufacturers	D	D	D	D	D	D	D	D	I	D	I	D
Radioactive device maintenance, installation.	P	D	D	I	D	D	D	I	I	D	D	D
Radioactive device service, dismantling	P	D	D	I	D	D	D	I	I	D	D	D
Radioactive device calibration	P	D	D	I	D	D	D	I	I	D	D	D
Handles check source <50 MBq	I	D	D		I	I	I			I		
Handles check source >50 MBq	D	D	D	I	D	D	D	I	*I	D	I	D
Electron capture detector/ Gas Chromatography /X-ray Fluorescence	I	I	D			I		I	*	I		
Bone analyser	D	I	D	I	I		I	I	D	I		
Table 13-1 continued												
Irradiators/calibrators	D	D	D	I	P	P	D	P	I	D		I
Self-shielded irradiators (e.g. Gammacell)	D	D	D	I	P	P	P	I	*	D	I	
Brachytherapy	D	D	D	P	P	P	P	D	D	D	I	D
Teletherapy	D	D	D	P	P	P	P	D	D	D		D
Static eliminators	I	D	D					I		I	I	
External radiation fields < 25 µSv/h	I	I	I		I	I	I	I	*	I		I

[1] Refer to pages 12.1 to 12.15 for a description of training module content

Job Task/Use Description D - means detailed course I - means introductory course P - means professional qualification * - indicates female worker and supervisor of female workers	**1** ORIENTATION	**2** REGULATORY	**3** PROCEDURES	**4** MATTER	**5** RADIATION	**6** UNITS	**7** DETECTION	**8** BIO EFFECTS	**9** * FOETUS	**10** CONTROL	**11** TRANSPORT	**12** PRACTICAL
External radiation fields > 25 µSv/h	D	D	D	I	D	D	D	D	D	D	I	D
Tower scanning (licensed as *portable gauge*)	D	I	D	I	I	D	I	I	I	I	D	I
Unsealed Sources												
Laboratory / benchwork < 10 MBq	I	I	D		I	I	D	I	*	I		D
Laboratory / benchwork > 10 MBq	D	D	D	I	D	D	D	D	D	D		D
Nuclear medicine pharmacy	D	D	D	D	D	D	D	D	D	D	D	D
Radioisotope processor/supplier < 10 GBq	P	D	D	P	P	P	D	D	I	D	D	D
Radioisotope processor/supplier > 10 GBq	P	D	D	P	P	P	D	D	D	D	D	D
Diagnostic human studies	P	D	D	P	P	P	P	D	D	D	I	D
Therapeutic human studies	P	D	D	P	P	P	P	D	D	D	I	D
Caring of radioactive patients	D	I	D		I	I	I	I	D	I		D
Table 13-1 continued												
Veterinary studies	D	D	D	D	D	I	D	I	D	D	D	D
Tracer field studies	D	D	D	P	D	P	D	D	D	D	D	D
Subsurface tracer studies	D	D	D	I	D	I	D	D	D	D	D	D
Industrial or Academic												
Instrument technician	I	I	D		I	I	I	I	I	I	I	
Isotope technician	D	D	D		D	D	D	D	I	D	I	I
Laboratory technician	D	I	D	I	D	D	D	D	D	D		D
Research students	I	I	D	D	D	D	D	D	D	D		I
Scientists/Engineers [field]	P	D			I			I	*	I		
Scientists/Engineers [lab]	P	D	I		I		I	I	*	I		

Job Task/Use Description D - means detailed course I - means introductory course P - means professional qualification * - indicates female worker and supervisor of female workers	**1** ORIENTATION	**2** REGULATORY	**3** PROCEDURES	**4** MATTER	**5** RADIATION	**6** UNITS	**7** DETECTION	**8** BIO EFFECTS	**9** * FOETUS	**10** CONTROL	**11** TRANSPORT	**12** PRACTICAL
Well logger	D	D	D	I	I	D	D	D	I	D	D	D
Gauge user [fixed]	D	D	D		D	D	D	I	I	I	I	D
Gauge user [portable]	I	D	D		I			I	*	I	D	I
Radiation Safety Officer (portable gauges)	I	D	D		D	I	I	I	I	I	D	I
Animal caretakers	I	I	D		I	I	I	I	I	D	I	I
Tracer technicians [unsealed sources]	D	D	D	P	D	P	D	D	D	D	D	D
Table 13-1 continued												
Irradiator operator	D	D	D	I	I	D	D	D	D	D	D	D
Calibration technician	D	D	D	I	I	D	P	D	D	D	I	I
Radiation Safety Officer (Industrial, general)	P	D	D	P	P	P	D	D	D	D	D	D
Medical												
Nuclear medicine physician [therapeutic]	P	P	D	P	P	P	P	P	P	P		I
Nuclear medicine physician [diagnostic]	P	P	D	P	P	P	P	P	P	P		D
Medical technologist [diagnostic nuclear medicine]	P	P	D	P	P	P	P	P	P	P		D
Medical technologist [therapeutic nuclear medicine]	P	P	D	P	P	P	P	P	P	P		D
Medical technologist [radiotherapy nuclear medicine]	P	P	D	P	P	P	P	P	P	P		D
Laboratory technician	D	D	D	I	D	D	D	I	D	D		D
Medical physicist	P	P	D	P	P	P	P	P	P	P	I	D
Radio pharmacist	P	P	D	P	P	P	P	P	P	P	D	D
Radio pharmacy technician	D	D	D	D	D	D	D	D	D	D	D	D
Radiation Safety Officer	D	D	D	D	D	D	D	D	D	D	D	D
Nurse [diagnostic]	D	D	D		I	I	I	I	I	I		
Nurse [therapeutic]	D	D	D		D	D	D	D	D	D		I
Nurse [radiotherapy]	D	D	D		I	D	D	D	D	D		I

Job Task/Use Description D - means detailed course I - means introductory course P - means professional qualification * - indicates female worker and supervisor of female workers	**1** ORIENTATION	**2** REGULATORY	**3** PROCEDURES	**4** MATTER	**5** RADIATION	**6** UNITS	**7** DETECTION	**8** BIO EFFECTS	**9** * FOETUS	**10** CONTROL	**11** TRANSPORT	**12** PRACTICAL
Table 13-1 continued												
Ward aid/orderly	I		D					I	I	I		
Support staff												
Security personnel	I		D				I	I		I	D	
Housekeeping/janitorial	I		D					I		I		
Shipping, receiving and distributing	I		D			I	I	I	I	D	D	I
Waste disposal	I		D	I		D	D	I	D	D	D	D
Service/maintenance	I		D					I		I		
Administrative												
Administrators	I		I					I	I	I		
Reception staff	I		I					I	I	I		
Safety officer	D	I	I					D	D	I		
Other												

Note: If the job task for the radioisotope worker does not appear in Table 13-1, contact the AECB Licence Assessment Officer (LAO) responsible for the licensee. In such cases a determination of job classification is made on the basis of the worker's task list supplied to the LAO.

Table 13-2: Medical Accelerator Training Matrix

Module 1: Radiation Orientation Lecture;
Module 2: Regulatory Requirements;
Module 3: Operating and Emergency Procedures;
Module 4: Structure of Matter;
Module 5: Radiation and Radioactivity;
Module 6: Radiation Units;
Module 7: Radiation detection and Measurement;
Module 8: Biological Effects;
Module 9: Effects of Radiation on the Foetus
Module 10: Control of Radiation Exposure;
Module 11: Transportation Requirements;
Module 12: Practical Exercises
Module 13: Medical Accelerator module(s)

[2]Recommended Training Modules

Job Task/Use Description	**1** ORIENTATION	**2** REGULATORY	**3** PROCEDURES	**4** MATTER	**5** RADIATION	**6** UNITS	**7** DETECTION	**8** BIO EFFECTS	**9** *FOETUS	**10** CONTROL	**11** TRANSPORT	**12** PRACTICAL	**13** ACCELERATOR
D - means detailed course I - means introductory course P - means that this training should be part of the person's professional qualification * - required for female workers and all supervisors													
Medical particle accelerator													
Radiation-oncologists	P	I	P	P	P	P	P	P	P	P		P	
Medical physicists	D	P D	D	P	P	P	P	P	P	P	I D	P	P
Radiotherapy technologists	D	I	P	P	P	P	P	P	P	P		P	I
Support technologists (dosimetry, electronics)	D	I	D	D	D	D	D	D	I	D		D	D
Administration/office workers	D							I	I				
Table 13-2 continued													
Service/maintenance (building workers)	D							I					
RSO	D	D	D	D	D	D	D	D	D	D	D	D	D
Head of the safety group	D	D	D	D	D	D	D	D	D	D	D	D	D
Non-technical support staff	D							I					

Note: If the job task for the accelerator worker does not appear in Table 13-2, contact the AECB Licence Assessment Officer (LAO) responsible for the licensee. In such cases a determination of job classification is made on the basis of the worker's task list supplied to the LAO.

[2]Refer to pages 12.1 to 12.15 for a description of the training module content

Table 13-3: Transportation Training Matrix

Module 1: Radiation Orientation Lecture;
Module 2: Regulatory Requirements;
Module 3: Operating and Emergency Procedures;
Module 4: Structure of Matter;
Module 5: Radiation and Radioactivity;
Module 6: Radiation Units;
Module 7: Radiation detection and Measurement;
Module 8: Biological Effects;
Module 9: Effects of Radiation on the Foetus
Module 10: Control of Radiation Exposure;
Module 11: Transportation Requirements;
Module 12: Practical Exercises

[3]Recommended Training Modules

Job Task/Use Description	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
D - means detailed course I - means introductory course P - means that this training should be part of the person's professional qualification * - required for female workers and all supervisors	ORIENTATION	REGULATORY	PROCEDURES	MATTER	RADIATION	UNITS	DETECTION	BIO EFFECTS	* FOETUS	CONTROL	TRANSPORT	PRACTICAL
Transport packaging of prescribed nuclear substances (and licences)												
RSO	D	D	D	P	P	P	P	P	P	P	D	D
Technical staff	D	D	D	P D	P D	P D	P D	P D	P D	P D	D	D
Conveyance operator	I	I	D	I	I	I	I	I	I	I	D	D
Table 13-3 continued												
Shippers/Receivers	D	D	D	I	D	D	D	D	D I	D	D	D
Stores personnel	I	D	D	I	I	I	I	I	I	I	D	D
Package design approval certificate; and, endorsement of a foreign design approval certificate												
Designer	I	D	D	D	D	D	D			D	D	D
Fabrication personnel	I	D	D									
Quality Assurance Inspector	I	D	D									

[3]Refer to pages 12.1 to 12.15 for a description of the training module content

Job Task/Use Description	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
D - means detailed course I - means introductory course P - means that this training should be part of the person's professional qualification * - required for female workers and all supervisors	ORIENTATION	REGULATORY	PROCEDURES	MATTER	RADIATION	UNITS	DETECTION	BIO EFFECTS	* FOETUS	CONTROL	TRANSPORT	PRACTICAL
Maintenance and inspection personnel	I	D	D	I	D	D	D	D	D	D	D	D
Special form (radioactive material) nuclear substances certificate												
Designer	D	D	D	D	D	D	D			D	I	D
Fabrication technicians	D	D	D	D	D	D	D	D	D	D	I	D
Quality control technicians	D	D	D	D	I	D	D	I	I	D	I	D
Authorization to transport nuclear substances in non-conforming packages												
Consignor	D	D	D	D	D	D	D	D	D	D	D	D
Conveyance operator	D	I	D	I	I	I	I	I	I	I	D	D
Table 13-3 continued												
Receiver	D	D	D	D	D	D	D	D	D	D	D	D
Surveyor or escort	D	D	D	P	P	P	P	P	D	D	D	D
Emergency response team	D	D	D	D	D	D	D	D	D	D	D	D
Documentation												
Shipping and receiving	I	I	I		I	I	I				I	I
Surveyor	I	I	I		I	I	P				I	I
Labelling and placarding												
RSO	D	D	D	P	P	P	D	P	I D	P	D	D
Shipping and receiving clerk	I	D	D	I	I	I	D	I	D I	I	D	I
Surveyor	P	D	D	I	I	P	P	D	D I	D	D	I
Conveyance operator	I	I	D		I	I	I	I	I	I	I	I

Job Task/Use Description	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
D - means detailed course I - means introductory course P - means that this training should be part of the person's professional qualification * - required for female workers and all supervisors	ORIENTATION	REGULATORY	PROCEDURES	MATTER	RADIATION	UNITS	DETECTION	BIO EFFECTS	* FOETUS	CONTROL	TRANSPORT	PRACTICAL
Stores personnel	I	D	D		I	I	I	I	I	I	I	I
Surveying and determining transport index												
RSO	D	D	D	P	P	P	D	P	D	P	D	D
Radiation surveyor	D	D	D	D	P	P	P	P	D I	D	D	D

Note: If the job task for the transportation worker does not appear in Table 13-3, contact the AECB. In such cases a determination of job classification is made on the basis of the worker's task list supplied to the Licence Assessment Officer.

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Section 14: Review objectives

THIS SECTION APPLIES TO LICENSEES AND APPLICANTS FOR RADIOISOTOPE, MEDICAL ACCELERATOR AND TRANSPORTATION LICENCE PREPARED BY THE AECB, AND TO RADIATION SAFETY INSTRUCTORS

Review objectives

This section provides an opportunity to review the objectives for your radiation safety program outlined in this Guide. You can use this section like a check list to verify that your training program meets the recommendations of the AECB. If you find areas where your training program does not meet a specific objective, review the appropriate sections of the Guide or consult with AECB staff for assistance.

1. Objectives for Systematic Analysis of Jobs to be Performed

Verify that:

1.1 A systematic method is used for identifying and selecting tasks for training to prepare individuals to do their jobs.

1.2 Tasks for continuing and initial training are differentiated.

1.3 The analysis is adequate for development of learning objectives.

1.4 The analysis is kept current as job performance requirements change.

2. Objectives for the Development of Learning Objectives

Verify that:

2.1 There are learning objectives related to knowledge, skills and abilities for each task.

2.2 Learning objectives contain actions, conditions and standards needed for job performance.

2.3 There are procedures to modify learning objectives as job performance requirements change.

3. Objectives for Design Implementation

Verify that:

3.1 The goals, objectives, responsibilities and authority of the training organization and staff are clearly stated.

3.2 Qualifications and training requirements for the training staff address both the acceptable subject matter and instructional skills.

3.3 Training is acceptably organized and sequenced and instructional setting are appropriate to tasks.

3.4 Lesson plans provide for consistent training delivery.

3.5 Existing instructional materials have been evaluated based on training requirements.

3.6 Training is conducted in an acceptable manner and records are maintained.

4. Objectives for Training Evaluation

Verify that:

4.1 Exemptions from training are objectively determined.

4.2 Trainee performance is regularly evaluated using job performance measures and objectives.

4.3 Trainees who perform below minimum standards during initial and re-qualification training receive remedial training and are retested.

4.4 Precautions are in place to prevent test compromise.

5. Objectives for Program Evaluation

Verify that:

5.1 Methods are in place to systematically evaluate the effectiveness of training programs and that training programs are updated.

5.2 Feedback from trainee tests, on-the-job experiences, and supervisors are used in program evaluation.

5.3 Instructor and trainee critiques are used in program evaluation.

5.4 Both internal and external program inspections are used to evaluate the program.

5.5 Training staff are routinely and objectively evaluated.

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Appendixes

Appendix 1
Systems Approach to Training (SAT)

A chart illustrating the phases of SAT is shown on the next page. The schematic outlines the process used in developing an effective training program. The main principles of SAT are summarized as follows:

- *Training meets actual job needs:* the job performance needs are determined by analysis of the duties where such duties could have an impact on the environment, the public or on the safe and reliable operation by the licensee. Such an analysis also serves as a basis for the development of learning objectives, training materials and job performance measures.
- *The training program is systematic*: training programs are effectively organized, directed and supported in a systematic way.
- *The training is documented*: training material defines the knowledge and skills required to meet the learning objectives. Training delivery employs the principles of good instructional presentation and conveys accurate information consistently and clearly.
- *Training is conducted by qualified staff*: training staff possess the necessary subject matter expertise, experience and instructional skills to discharge their assigned duties.
- Training is evaluated for effectiveness: the training program is evaluated, and revised as necessary, so that on-the-job competence is attained and maintained. Trainees are evaluated on their mastery of the learning objectives and receive prompt feedback on their performance.

Analysis research activity	**Evaluation Design** for effectiveness and efficiency	**Training Design** for development and initial implementation	**Conduct** implementation	**Validation monitors** effectiveness after 90 days	
Conduct needs and task analyses Identify training needs Develop: Performance objectives Training objectives Supporting specifications	Establish performance standards Determine trainee entry level Develop learning objectives Assess effectiveness by: Predicting on-the-job performance Diagnosing participant shortfalls Identifying incidents of over-training Efficiency: maximum number of trainees meeting the training objectives in the shortest time	Preliminary research, Prepare training plan, Develop training package, Develop admin package Organize learning objectives Specify learning objectives Produce training package Select and train instructors	Implement training plan Conduct training Evaluate trainee performance during and following training Document the training	Serves a percentage of course graduates through validation surveys and observation of workers' performance Assesses accuracy of original analysis and effectiveness of the design and conduct phases Determines effectiveness and removes impediments to the application of learning	***** F E E D B A C K

***** Denotes that feedback applies to all phases and components of SAT

Appendix 2
Training Evaluation

READ APPENDIXES 2 AND 3 IF YOU ARE A RADIOISOTOPE LICENSEE, A MEDICAL ACCELERATOR LICENSEE, AN INSTRUCTOR OR A TRAINING EVALUATOR

The following is an example of one style of reporting form for the evaluation of AECB licensees' radiation safety training programs

File:
Date:

Licensee:

Instructor(s) name(s)

Title(s)

Evaluator(s):

For each of the statements below, circle the number that comes closest to expressing the inspector's opinion.

Scoring guidance:
- 1 is unacceptable
- 2 is conditionally acceptable
- 3 is acceptable

A score of
- 21 to 41 indicates an unacceptable training program. Complete review required.
- 42 to 62 indicates a conditionally acceptable training program. Improvement needed.
- 63 indicates an acceptable training program. No action is required.

Instructor	**Remarks**
1) Organization and preparation 1 2 3 Unacceptable Acceptable	

Other questions in this section evaluating the instructor could include:

- Knowledge and mastery of subject
- Organization and preparedness
- Confidence and voice projection
- Enthusiasm
- Clear and understandable presentation of course content
- Ability to involve trainees
- Ability to respond to questions
- Overall assessment

Additional sections of the evaluation report form may include, but are not necessarily limited to:

Preparation

- Was the trainer present before the lesson?
- Were the course notes distributed in advance?
- Were the classroom and equipment ready?

Classroom presentation

- Did the class start on time?
- Did the instructor encourage trainees to participate?
- Were trainees' responses handled well?
- Were AV materials used effectively?
- Was there a good working atmosphere?
- Did the instructional methods maintain interest?
- How suitable was the amount of lecturing?
- How suitable was the amount of discussion?
- How useful were the discussions?
- How was the speed of presentation?
- Did participants have enough practice with new skills?

Training Content

- Were the lesson objectives clearly stated at the outset?
- Were the stated training objectives met?
- Was the course content as outlined?
- Was the course content relevant to the workplace?
- Was the course content appropriate for the level of trainees?
- Was the length of time taken for this course appropriate?
- Was all the course material covered in the time available?
- Was there time for a question-and-answer period?

- How thoroughly were the subjects covered?
- What was the overall value of this course?
- Were the results achieved on this course acceptable?

Quality of training facilities

- Was the classroom appropriate for the size of class and type of course?
- Was the room well lit and ventilated?
- Was the room properly equipped?

The evaluation form should also provide space for:

Notes on any changes and new materials used in the program

- Was the program presented as accepted by the AECB?
  - List any new materials used:
  - List any changes made to the accepted program:

Comments and suggestions

- Information of most value was:
- Information of least value was:
- Suggestions to improve the course:
- Specific concerns the inspector would like to see addressed:
- Additional comments:

Another style of evaluation form acceptable to the AECB is shown on the following page.

Training Delivery Evaluation Form

Trainer	.....	Course	.....	Level	.....
AECB Evaluator	.....	Class Size	.....	Date	.....
Training Centre	.....	Supervisor	.....	Time	.....

Code: S: satisfactory **I:** some improvement needed **U:** unsatisfactory

#	ITEM	S	I	U	COMMENTS
	PREPARATION				
	Trainer present before lesson				
	Course notes distributed before teaching started				
	Audio/visual aids ready				
	Class room ready				
	FACILITIES				
	Appropriate for teaching—well lit, ventilated, appropriate temperature				
	Quiet, free of distractions				
	Room layout appropriate for: Class size Type of course Use of AVs Demonstrations				
	TRAINING MATERIAL CONTENT				
	Relevant to the workplace				
	Relevant to trainees' jobs				
	Current and technically correct				
	"Nice to Know" material is clearly identified				

Appendix 3
Validation of Radiation Training

Validation (refer to Section 7 dealing with program verification) provides a means of assessing the overall level of knowledge retained by workers It identifies the areas where retraining is essential. This appendix contains sample forms and topics for trainee testing designed to assess the effectiveness of radiation training after 90 days.

Licensee: **File No**

Date:

1. **Employee's Background**

1.1 **Department** _____

1.2 **Position** _____

1.3 **How long employed by this licensee?**
_____

1.4 **When last did you receive radiation training or re-training by this company?**
_____

1.5 **Have you received any previous training in radiation before joining this company?** (If yes, give details)
_____

1.6 **When?** _____

1.7 **Where?** _____

(Note: responses to this page do not count towards the total marks)

Questionnaire

The test should take the form of a questionnaire. A number of approaches can be used to determine the effectiveness of the training.

For example, multiple choice questions, where the participants check or circle the correct answer:

The types of radiation usually associated with licensee's activities are mainly:

a) ionizing radiation
b) non-ionizing radiation.

Are you more likely to get lung cancer:

a) from working with radioactive materials
b) from smoking

Multiple choice questions can also ask participants to explain their choices:

Are the radiation exposure levels and doses received by workers in this type of licensed facility today, as compared to those received by workers 20 years ago, on the average, likely to be:

a) lower
b) higher
c) the same

Briefly explain your choice

_____

_____

Alternatively, participants can be required to complete statements that demonstrate their knowledge of the subject:

*Identify, and **write** in the space below, the type of radiation being described.*

a) - Relatively heavy particles, each consists of two protons and two neutrons
- Very low penetrating power. A sheet of paper will easily stop them
- Most important for their possible effects in the lungs.

This form of ionizing radiation is known as _____ radiation.

b) - Consists of electromagnetic radiation
- Will penetrate most materials including wood, concrete, and steel to various depths
- Generally affects all organs of the body from an *external* source.

This form of ionizing radiation is called _____ radiation.

Another approach is to use the true/false or yes/no testing technique:

		TRUE	FALSE
	Time, distance and shielding are important factors in radiation protection.		
a	TIME: To reduce exposure, workers may have to be rotated by working for shorter periods in high-radiation areas		
b	DISTANCE: You can reduce your exposure by keeping as far from the source of radiation as practicable.		
c	SHIELDING: You can reduce exposure from density of level gauges by placing heavy materials, such as lead, between the radiation source and the work area.		

Participants can also be asked simply to respond to direct questions about radiation:

a) To reduce exposure, spills of radioactive material must be cleaned up quickly. What methods are used for cleaning up spills in your workplace?

_____

_____

Testing topics

Whichever method, or combination of methods is used, the following topics should be covered in sufficient detail to reflect the material covered in the training course that is being validated:

- Terms, concepts and types of radiation
- Radiation
- Protective measures
- Regulations
- Dosimetry
- Worker responsibility

Refer to Appendix 5 for a detailed list of the topics covered under these headings.

Appendix 4
Training Schedules

The following is an example of a training schedule. It formalizes a licensee's program schedule and also helps AECB Inspectors plan for evaluation and validation exercises.

1999 SCHEDULE: RADIATION SAFETY TRAINING FOR WORKERS

Initial___ Basic___ Retraining___

Module:_____

Date (YMD)	**ID Number**	**Trainee Name**	**Init.**	**Classification**	**Location**	**Instructor**
99-1-20	12345	Doe	J.H.	Operator	Training Centre	Thomas D.

Alternatively time posters can be used to display monthly, quarterly or yearly training schedules.

Appendix 5
Radiation Safety Training Program Validation:
Summary of recommended topics (referred to in Appendix 3).

Note: the following list does not replace the information shown in the modules described in section 12, but outlines topics that may be considered for developing validation exercises, depending on specific needs:

1 **Definitions, terms and concepts**

1.1 *Definitions and terms:*

alpha (α), beta (β) and gamma (γ)
Atomic Radiation Worker (ARW)
atoms
decay chain
electrical charge
electrons, protons and neutrons
elements
half-life
ionization, and ionizing radiation
isotopes
maximum permissible concentration
maximum permissible exposure and dose
radioactivity
radon progeny
units [sievert (Sv), gray (Gy), becquerel (Bq), WL, WLh, WLM, joules]
uranium

1.2 *Radiation safety:*

function and use of radiation safety manual(s)
detection of radiation
radiation in the licensed facility (alpha, beta and gamma)
absorption of radiation
kinds of radiation exposure
control of external radiation exposure
control of internal radiation exposure
units for measuring radiation exposure
contamination and decontamination
restricted areas
warning signs

protective devices and clothing
dosimetry — types (e.g. TLD badge and how to comply)
occupational dose
whole body exposure
bioassay
radiological surveys
direct and indirect measurement of radioactive contamination
work place monitoring (air quality and quantity, dose rates, dust control, wipe samples)
controls for spills and unusual occurrences and procedures for clean-up
operating methods
managing waste materials
actions to be taken for personal contamination, including if a medical injury is involved
actions to be taken in case of fire and other emergencies
conditions which require bioassay
prenatal exposure limits and duties of a pregnant employee

1.3 *Effects of radiation:*
how radiation affects the human body
genetic and somatic effects of radiation
background and low level radiation
evidence of radiation effects
risk from radiation exposure
pregnant workers

2 **Concepts:**

2.1 *Explain the following concepts:*
Radiation safety in the work place
Good work practices
As low as reasonably achievable (ALARA principle)
Codes of practice
Time-Distance-Shielding, as it relates to dose reduction
No eating, drinking, smoking, chewing or application of cosmetics in a "radioactive " work area
Worker responsibilities in radiation safety (to self, co-workers and public)
Ventilation controls
The licensee’s operations cycle
Waste disposal methods

Actions required for a lost, late return or damaged personal dosimeter
Importance of informing supervision of any radiological incident
Common problems found during radiation safety reviews and inspections

3 Regulations and licensing

3.1 *Regulations*

The *Atomic Energy Control Act (AEC Act)*
Atomic Energy Control Regulations (AEC Regulations)
Transport Packaging of Radioactive Materials Regulations (TPRMR)
NSC Act and pursuant regulations
WHMIS

3.2 *Licensing*

The type of licence authorized by the AECB for this licensee.
Supporting documents, such as procedures manuals.

Appendix 6
Radiation Safety Information Sheets

Devices, licensed activities, types and quantities of radioisotopes and source sizes for which *Radiation Safety Information Sheets* are used, include:

- Electron capture/gas chromatography detectors
- Liquid scintillation counters
- Dewpointers
- Smoke detectors
- Surge voltage detectors
- Static detectors
- Static eliminators
- Bacterial growth incubators such as Bactec
- Tritium exit signs (aircraft and buildings)
- Tritium watches and gun sights
- All radioactive prescribed substances, sources and devices for which no licence is required
- Small radioisotope mini-generators
- Sealed sources <50 MBq scheduled quantities

Appendix 7
Training record

The following is a sample training record form that is acceptable to the AECB. The detail of the topics will vary. Test scores should be recorded. What was taught will be monitored by AECB staff.

Employee name: _____
Job classification: _____
Licensee: _____

Topic	Training Coordinator's Name	Pass (p) Fail (f)	Date
Module 1: Orientation lecture			
Module 2: Structure of matter			
Module 3: Radiation and radioactivity			
Module 4: Radiation units			
Module 5: radiation detection and measurement			
Module 6: Control of radiation exposure			
Module 7: Biological effects			
Module 8: Regulatory requirements			
Module 9: Operating and emergency procedures			
Module 10: Transportation requirements			
Module 11: Laboratory exercises (dependent on job tasks)			
Other training (specify)			

Appendix 8
Radiation Safety Data Sheet (RSDS)

Canadian Nuclear Safety Commission

P.O. Box 1046, Station B
Ottawa, Canada
K1P 5S9

Tel: (613) 995-5894 Fax: (613) 995-5086
24 Hour Emergency Hotline: (613) 995-0479

Radiation Safety Data Sheet

This data sheet presents information on radioisotopes only.
For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.
Detailed information is available on the CNSC Radioisotope Fact Sheet

Part 1 - Radioactive Material Identification

Chemical Symbol_____ Common Names_____
Atomic Weight _____ Atomic Number_____

Part 2 - Radiation Characteristics

Physical Half-Life_____

Principle Emissions	^{E}Max (MeV)	^{E}eff (MeV)	Dose Rate at Distance (mSv/h.GBq)	Shielding Required
Neutrons			(@ 1m)	TVL Paraffin_____cm
Gamma (γ) / X-Rays			(@ 1m)	TVL Lead_____
Beta* (β)			(@ 1m)	Range in Plexiglass_____cm
Alpha (α)			(not applicable)	(not applicable)

* Where Beta radiation is present, Bremsstrahlung radiation will be produced. Shielding may be required.

Progeny_____

Part 3 - Detection and Measurement

Methods of detection (in order of preference)

1.
2.
3.
4

Dosimetry

Whole Body ☐	Skin ☐	Extremity ☐	Neutron ☐
Internal:		Critical Organ(s):	

Part 4 - Preventive Measures

Always use the principles of time, distance and shielding to minimize dose

Engineering Controls:

Personal Protective Equipment (*for normal handling, unsealed sources only. Always use gloves and glass and other personal protective equipment and clothing as appropriate to the material handled)*

Special Storage Requirements

Part 5 - Control Levels

F (fast)		M (moderate)		S (slow)	
Ingestion	Inhalation	Ingestion	Inhalation	Ingestion	Inhalation

Maximum Release Concentration

Exemption Quantity (EQ)

Part 6 - Non-Radiological Hazards

Elemental Toxicity (LD_{50})

Emergency Procedures

*The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life threatening injury has resulted, **first** treat the injury, **second** deal with personal decontamination.*

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do Not abrade skin, only blot dry
- decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Emergency Protective Equipment, Minimum Requirements

- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing
- Suitable respirator selected

Appendix 9
References

The *AEC Regulations*

Nuclear Safety and Control Act

Proposed Regulations

AECB Compliance Policy

AECB Radiation Protection Training Policy

Public Service Commission of Canada, Systems Approach to Training, revised edition, April 1984.

Treasury Board Manual: Training Guide

OCD Objectives and Criteria for Regulatory Evaluations of NGS Training Programs, as revised May, 1995

Ontario Hydro, Nuclear Generation Division, Objectives and Criteria for Effective Training Programs, dated October 1989

IAEA-TecDoc-525, Guidebook on Training, etc. dated 1989.

US Nuclear Regulatory Commission, NUREG-1220, Training Review Criteria and Procedures

Evaluating Training Programs, The Four Levels, by Donald L. Kirkpatrick, 1994
Guideline for the Training of Workers at Uranium and Thorium Mining Facilities, First draft, Prepared by SDS, July 26, 1996.