Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

REGULATORY
GUIDE

Radiation Safety Training Programs for Workers Involved in Licensed Activities with Nuclear Substances and Radiation Devices, and with Class II Nuclear Facilities and Prescribed Equipment

G-313

July 2006

Canada

TYPES OF REGULATORY DOCUMENTS

Regulatory documents support the Canadian Nuclear Safety Commission (CNSC) regulatory framework. By expanding on expectations set out in general terms in the *Nuclear Safety and Control Act* and associated regulations, regulatory documents provide one of the core management tools upon which the CNSC relies to fulfill its legislated obligations.

The regulatory documents most commonly published by the CNSC are *regulatory policies*, *regulatory standards*, and *regulatory guides*. At the highest level, regulatory policies provide the direction for regulatory standards and guides, which serve as the policy "instruments." A fourth type of regulatory document, the *regulatory notice*, is issued when warranted. Because the information in a *regulatory notice* must be conveyed with relative urgency, the development process is faster than that applied to the other documents.

Regulatory Policy (P): The regulatory policy describes the philosophy, principles or fundamental factors on which the regulatory activities associated with a particular topic or area of concern are based. It describes why a regulatory activity is warranted, and therefore promotes consistency in the interpretation of regulatory requirements.

Regulatory Standard (S): The regulatory standard clarifies CNSC expectations of what the licensee should do, and becomes a legal requirement when it is referenced in a licence or other legally enforceable instrument. The regulatory standard provides detailed explanation of the outcomes the CNSC expects the licensee to achieve.

Regulatory Guide (G): The regulatory guide informs licensees about how they can meet CNSC expectations and requirements. It provides licensees with a recommended approach for meeting particular aspects of the requirements and expectations associated with their respective licensed activities.

Regulatory Notice (N): The regulatory notice notifies licensees and other stakeholders about significant matters that warrant timely action.

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RADIATION SAFETY TRAINING PROGRAMS FOR WORKERS INVOLVED IN LICENSED ACTIVITIES WITH NUCLEAR SUBSTANCES AND RADIATION DEVICES, AND WITH CLASS II NUCLEAR FACILITIES AND PRESCRIBED EQUIPMENT

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Document availability

The document can be viewed on the CNSC web site at www.nuclearsafety.gc.ca. Copies may be ordered in English or French using the contact information below:

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RADIATION SAFETY TRAINING PROGRAMS FOR WORKERS INVOLVED IN LICENSED ACTIVITIES WITH NUCLEAR SUBSTANCES AND RADIATION DEVICES, AND WITH CLASS II NUCLEAR FACILITIES AND PRESCRIBED EQUIPMENT

1.0 PURPOSE

This regulatory guide is intended to assist licensees of and applicants for licences for nuclear substances and radiation devices, and Class II nuclear facilities and prescribed equipment, to develop radiation safety training programs for workers in accordance with the *General Nuclear Safety and Control Regulations* and *Nuclear Substances and Radiation Devices Regulations*, the *Class II Nuclear Facilities and Prescribed Equipment Regulations*, and the *Radiation Protection Regulations*, and for the purpose of the *Nuclear Safety and Control Act* (NSCA).

This guide is *not* intended to serve or be interpreted as an established training program, but rather as an approach that will assist individual licensees in determining and meeting the specific radiation safety training needs of their workers.

2.0 SCOPE

This document describes a method for developing a typical program for training in radiation safety for workers involved in activities licensed pursuant to the *Nuclear Substances and Radiation Devices Regulations* and the *Class II Nuclear Facilities and Prescribed Equipment Regulations*.

This guide deals only with radiation safety training; however, CNSC staff recommends that such training be part of a comprehensive occupational health and safety program.

This document is not intended for licensees subject to *Class I Nuclear Facilities Regulations* or *Uranium Mines and Mills Regulations*. Training for Exposure Device Operators, and for Consignees, Consignors, and Carriers of radioactive equipment, is addressed in regulatory guides G-229, *Certification of Exposure Device Operators* and G-314, *Implementation of Radiation Protection Programs by Consignors, Carriers, and Consignees of Radioactive Material*.

While the systematic approach to training (SAT) provides the foundation for the training program development method presented in this guide, the SAT approach has been expanded to include Continuous Improvement and Continued Training as an integral component of a radiation safety training program. This modification promotes efforts to ensure that both the radiation safety training program itself, and individual worker awareness, are kept up to date.

3.0 RELEVANT LEGISLATION

The Canadian Nuclear Safety Commission (CNSC) is the federal agency that regulates the development and use of nuclear energy and the production, possession, and use of nuclear substances, prescribed equipment, and prescribed information to prevent unreasonable risk to the health, safety, and security of persons and the environment, and to respect Canada's international commitments on the peaceful use of nuclear energy.

Persons or organizations are required to be licensed by the CNSC to carry out the activities referred to in Section 26 of the NSCA, subject to the regulations. The associated regulations stipulate prerequisites for CNSC licensing, and the obligations of licensees and workers.

Requirements associated with worker training and training programs can be found in several portions of the NSCA and the regulations made pursuant to it. These include, but are not limited to, the following:

1. Paragraph 12(1)*(b)* of the *General Nuclear Safety and Control Regulations* stipulates that, "every licensee shall train the workers to carry on the licensed activity in accordance with the *Act*, the regulations made under the *Act* and the licence;"
2. Paragraph 3(1)*(f)* of the *Nuclear Substances and Radiation Devices Regulations* stipulates that an application for a licence in respect of a nuclear substance or a radiation device, other than a licence to service a radiation device, shall contain, in addition to other information, "the proposed training program for workers;"
3. Paragraph 4*(d)* of the *Nuclear Substances and Radiation Devices Regulations* stipulates that an application for a licence to service a radiation device shall contain, in addition to other information, "the proposed qualification requirements and training program for workers;"
4. Paragraph 3*(q)* of the *Class II Nuclear Facilities and Prescribed Equipment Regulations* stipulates that an application for a licence to construct a Class II nuclear facility shall contain, in addition to other information, "the proposed responsibilities of and qualification requirements and training program for workers during the operation of the nuclear facility;"
5. Paragraph 4*(s)* of the *Class II Nuclear Facilities and Prescribed Equipment Regulations* stipulates that an application for a licence to operate a Class II nuclear facility shall contain, in addition to other information, "the proposed responsibilities of and qualification requirements and training program for workers;"
6. Paragraph 5*(j)* of the *Class II Nuclear Facilities and Prescribed Equipment Regulations* stipulates that an application for a licence to decommission a Class II nuclear facility shall contain, in addition to other information, "the proposed responsibilities of and qualification requirements for workers;"

7. Paragraph 7*(d)* of the *Class II Nuclear Facilities and Prescribed Equipment Regulations* stipulates that an application for a licence to service Class II prescribed equipment shall contain, in addition to other information, “the proposed qualification requirements and training program for workers;”
8. Paragraph 4*(a)* of the *Radiation Protection Regulations* requires, as a part of the radiation protection program, that every licensee, “keep the amount of exposure to radon progeny and the effective dose and equivalent dose received by and committed to persons as low as is reasonably achievable, social and economic factors being taken into account, through the implementation of:
   a) management control over work practices;
   b) personnel qualification and training;
   c) control of occupational and public exposure to radiation; and
   d) planning for unusual situations.”
9. Paragraph 3(1)*(e)* of the *Nuclear Substances and Radiation Devices Regulations* requires an application for a licence in respect of a nuclear substance or a radiation device, other than a licence to service a radiation device, to contain, in addition to other information, information on “the roles, responsibilities, duties, qualifications and experience of workers;” and
10. Section 27 of the *General Nuclear Safety and Control Regulations* states that, “every licensee shall keep a record of all information relating to the licence that is submitted by the licensee to the Commission.”

4.0 HOW TO USE THIS GUIDE

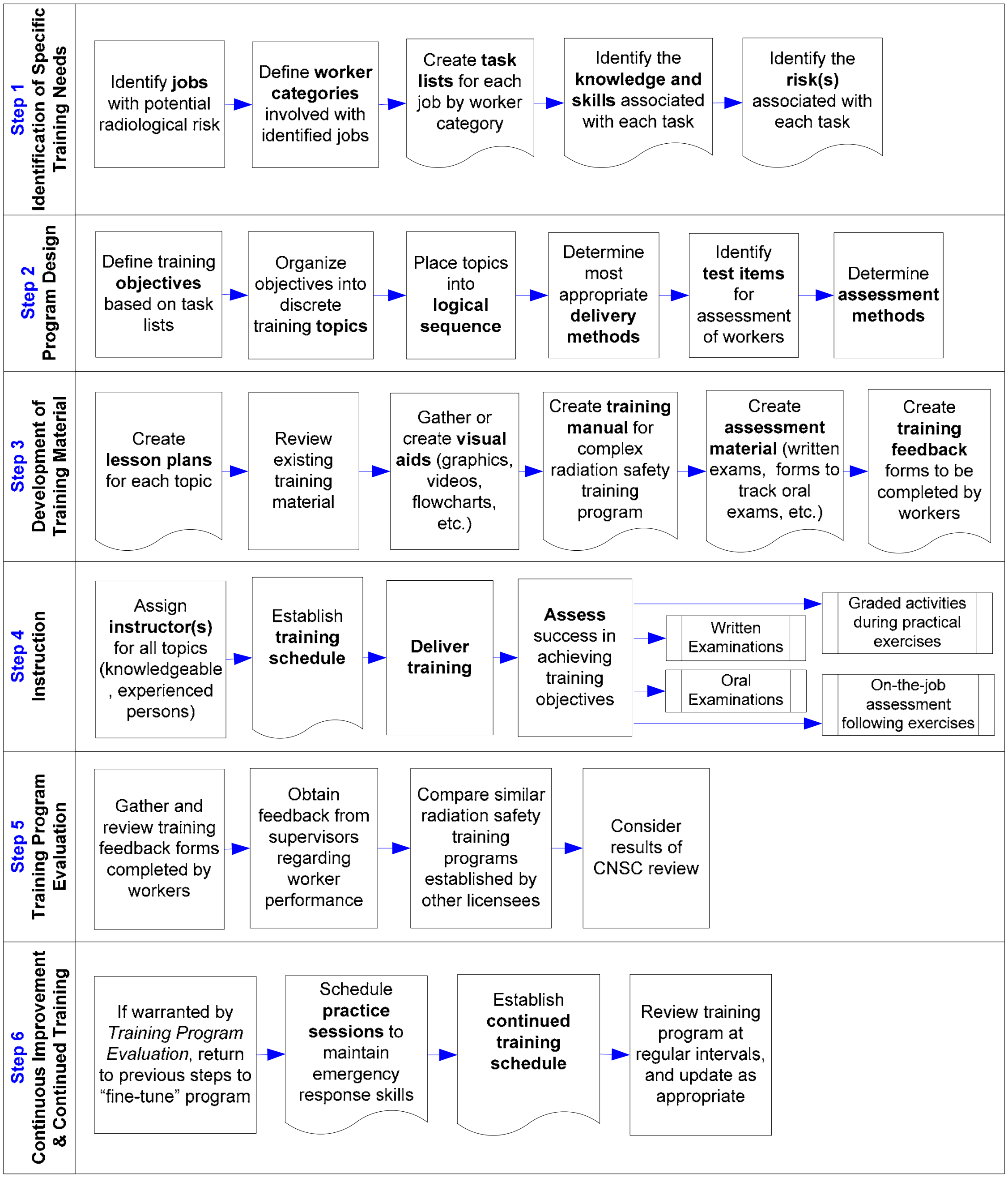
An effective radiation safety training program is essential to protecting health, safety, security, and the environment, and is considered part of a comprehensive occupational health and safety program.

Responsibilities of the licensee with respect to training are highlighted in Section 5.0 of this document, and Section 6.0 addresses the responsibilities of workers.

The high level process diagram presented on the following page presents the six main phases for developing a radiation safety training program that identifies and responds to activity-specific training needs. This process is discussed in further detail in Section 7.0, and the SAT approach on which it is based in presented in Appendix B.

Licensees considering relatively few worker categories performing relatively few or straightforward tasks may determine that a simplified training program is adequate to meet the needs of their workers. CNSC staff recommends that each of the six process steps be included to the appropriate degree in developing even the simplest radiation safety training program.

Process for Developing a Radiation Safety Training Program



The topics to be covered, and the depth to which they should be addressed, will depend on the complexity of the licensed activity, the specific duties of workers, the radiological risk associated with those duties, and previous training and experience.

4.1 Other Resources

Some other documents that may be useful in developing a radiation safety training program are provided in the *Associated Documents* section of this guide. For example, CNSC regulatory guide G-229, *Certification of Exposure Device Operators*, includes training information specific to the operation of exposure devices, and G-314 addresses *Implementation of Radiation Protection Programs by Consignors, Carriers, and Consignees of Radioactive Material*. Another helpful resource can be found in *Building Competence in Radiation Protection and the Safe Use of Radiation Sources*, published by the International Atomic Energy Agency (IAEA) (RS-G-1.4).

The appendices at the end of this document provide information about:

1. Categorizing workers into groups in order to perform job and task analysis (Appendix A);
2. The systematic approach to training on which this guide is largely based (Appendix B); and
3. Sample topics for radiation safety training, including suggestions for how each topic might be presented to best facilitate learning (Appendix C).

5.0 RESPONSIBILITIES OF THE LICENSEE

Licensees are responsible for informing their workers of the risks of exposure to radiation that may be associated with their duties. This is achieved in part by developing and implementing an effective radiation safety training program.

Licensees may outsource any part of the radiation safety training program; however, the licensee remains directly responsible for ensuring that workers receive appropriate training as it relates to their specific jobs. Within this responsibility, the licensee is expected to:

1. Promote a safety culture;
2. Determine the level of training required by workers;
3. Ensure the continuous improvement of worker skills and of the overall training program;
4. Invest the resources required to maintain an effective radiation safety training program that is appropriate for the licensed activities; and
5. Maintain appropriate records.

5.1 Promoting a Safety Culture

Effective training is vital in developing and promoting a safety culture. This culture evolves from knowledge of appropriate safety practices and the skills to implement those practices, and an overall respect for safety. Awareness of the risks associated with a job and the ability to use appropriate safety equipment or proper work control methods to mitigate those risks are practical elements of a safety culture. A strong safety culture relies on the mutual commitment of both the licensee and the workers, and requires unqualified support of and commitment from all levels of management within the organization.

5.2 Determining the Level of Training Required

The level of training required is based on the level of risk, which is determined by a thorough analysis of each worker's role within the licensed activity. The licensee should conduct this analysis as a first step in developing a radiation safety training program. The topics and detail provided in radiation safety training should reflect the radiological hazards present, the nature of the potential exposure, and the duties and responsibilities of the individual workers, with primary consideration being given to the difficulty, importance, and frequency (DIF) of the tasks associated with radiation safety.

5.3 Continuous Improvement and Continued Training

The safety culture established through effective training will be further strengthened by the licensee's commitment to maintain and continuously improve worker competency. To this end, an iterative radiation safety training program includes periodic reviews and evaluations to ensure that worker knowledge and skills are appropriate and up to date, and to maintain the currency and appropriateness of the training program by providing continued training, also referred to as "refresher" training.

5.4 Training Investment

A comprehensive radiation safety training program requires an investment of resources by the licensee. These resources may include adequate funding and training facilities, competent training personnel, and allocation of sufficient time for training. The level of investment will vary depending on the risk associated with the licensed activity, and the training needs identified by the job and task analysis.

5.5 Maintaining Records

The licensee is required to maintain records associated with training programs. These records should include the process that was used to develop their training approach, along with appropriate records of training.

6.0 RESPONSIBILITIES OF WORKERS

The following responsibilities are stated in the *General Nuclear Safety and Control Regulations*, Section 17, "Obligations of Workers:"

"17. Every worker shall

(a) use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive nuclear substances, in a responsible and reasonable manner and in accordance with the Act, the regulations made under the Act and the licence;

(b) comply with the measures established by the licensee to protect the environment and the health and safety of persons, maintain security, control the levels and doses of radiation, and control releases of radioactive nuclear substances and hazardous substances into the environment;

(c) promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be

(i) a significant increase in the risk to the environment or the health and safety of persons,

(ii) a threat to the maintenance of security or an incident with respect to security,

(iii) a failure to comply with the Act, the regulations made under the Act, or the licence,

(iv) an act of sabotage, theft, loss or illegal use or possession of a nuclear substance, prescribed equipment or prescribed information, or

(v) a release into the environment of a quantity of a radioactive nuclear substance or hazardous substance that has not been authorized by the licensee;

(d) observe and obey all notices and warning signs posted by the licensee in accordance with the *Radiation Protection Regulations*; and

(e) take all reasonable precautions to ensure the worker's own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public, and the maintenance of security."

In addition, workers are responsible for applying the training, knowledge, and skills they have learned to perform their jobs in a safe manner.

7.0 SUGGESTED PROCESS FOR TRAINING PROGRAM DEVELOPMENT

SAT provides the basis of an effective method for meeting the training needs of workers, and ensuring that the right people receive the right training at the right time. In order to achieve ongoing currency of training programs and constant preparedness of workers to respond to emergency situations, this guide expands on the five-step SAT approach by adding a sixth step referred to as *Continuous Improvement and Continued Training*.

As introduced in the process diagram in Section 4.0 of this document, the six iterative steps recommended for developing a radiation safety training program are:

1. Identification of Specific Training Needs;
2. Training Program Design;
3. Development of Training Materials;
4. Instruction (including trainee assessment);
5. Training Program Evaluation; and
6. Continuous Improvement and Continued Training.

7.1 Identification of Specific Training Needs

The appropriate content and depth of radiation safety training is determined by identifying the knowledge and skills workers must have to perform their jobs in a safe manner. This is accomplished by performing a job and task analysis for all applicable worker categories, and building a training program that is tailored to the training needs identified for those categories.

7.1.1 Influencing Factors

Radiation safety training programs vary significantly between licensees. Factors influencing training depth and content may include:

1. Type, complexity, and risk level of the licensed activity;
2. Categories of workers (as described in Appendix A);
3. Level and type of radiological risk associated with individual jobs and tasks;
4. Task difficulty, importance, and frequency;
5. Other radiological hazards that may be present;
6. Degree of worker supervision;
7. Workers previous operational experience, education, and training;
8. Applicable regulatory requirements and licence conditions;
9. Available resources; and
10. Geographical area of the licensed activity.

7.1.2 Job and Task Analysis

The job and task analysis should first produce a list of all jobs associated with the licensed activity, and then identify the tasks within those jobs and the associated radiological risk(s), and the difficulty, importance, and frequency of each task. The tasks are then analyzed to determine the knowledge and skills that are required to perform them in a safe manner.

The job and task analysis should define the risks directly associated with the occupational exposure of each job and task, as well as the potential risk presented by any general hazards in the facility, such as the presence of flammable material or corrosive agents that could affect the integrity of radiation sources.

Both normal operation and emergency situations should be taken into account, including the actions workers should take to protect themselves, other workers, the public, and the environment during emergencies such as fire and accidental spills and releases.

For complex jobs, such as the operation of a medical accelerator, the analysis may be quite lengthy because of the number and complexity of the tasks associated with the job. For simpler jobs, such as the operation of a nuclear gauge, the analysis may indicate training that is quite straightforward.

The job and task analysis provides the basis for producing the detailed training objectives during the program design phase.

7.2 Program Design

During the program design phase, the results of the job and task analysis are used to determine clear training objectives, enabling establishment of specific topics to be covered in the training program (refer Appendix C of this guide for some sample topics). The topics are then arranged in a logical sequence of training lessons to establish the course structure.

Program design should include consideration of the delivery method(s) that will be used to teach the various topics, such as classroom instruction, on-the-job training, self-study, or combinations of these or other appropriate delivery methods, as discussed in Section 7.4, “Instruction,” and Appendix B, subsection B.5.1, “Methods of Training Delivery.”

In addition, this phase includes determining the methods and test items that will be used to assess (or test) workers at appropriate intervals during training, and at the end of the entire training program.

If applicable, a training program entry test should also be developed during this phase for use in determining the level of competence of new workers.

7.3 Development of Training Material

The complexity of the training objectives identified in the program design phase will determine the level of effort the licensee will need to apply in developing appropriate training material. This effort might include:

1. Developing lesson plans;
2. Gathering or developing training manuals and supporting tools (i.e., graphics, videos, etc.);
3. Determining appropriate delivery methods and, if applicable, assigning instructors;
4. Determining assessment methods and establishing test items; and
5. Establishing training schedules.

7.3.1 Lesson Plans

Lesson plans are the controlling documents that guide training and ensure consistency of instruction between trainee groups, and from instructor to instructor. The lesson plan guides the instructor, providing a checklist of lesson objectives, the training material and training aids that may be used, other reference material if applicable, and an estimate of the time to be dedicated to each objective within the lesson.

7.3.2 Training Manuals

If the training objectives are complex and extensive, it may be appropriate to develop a training manual to support some or all of the lessons to be delivered. This step may be unnecessary for simpler training needs.

Since developing new training material can be costly and time consuming, existing material may be considered before committing resources to the preparation of new material. Existing material may be available from either inside the licensed facility (from previous or other training programs), or from external sources, and should be reviewed to determine whether it meets the needs of the training program, is appropriate to the background of the workers, and is compatible with the training objectives.

7.4 Instruction

Licensees may establish a dedicated group within their organization to deliver radiation safety training. When there is no such group, experienced staff or external sources may be assigned this task. Where training needs are minimal, delivery may be simple enough to be assigned to a knowledgeable individual, or assumed directly by the owner/operator, as in the case of a single portable gauge licensee.

Training can be effectively delivered in a number of ways. For example, while the classroom environment is most appropriate for theoretical training, a lab setting may be the best scenario for practical application of theory. Supervised and guided on-the-job instruction provides an opportunity for the worker to obtain experience that cannot be acquired otherwise. Some other methods of instruction to consider, especially in cases where the number of workers to be trained is minimal, include self-study, computer-based training (CBT), or distance learning through an educational institution. The various delivery methods are discussed further in Appendix B, subsection B.5.1, “Methods of Training Delivery.”

Learning is most easily accomplished when the worker can clearly relate what is being taught to the job they have to perform. For this reason, it is a recommended practice to include, where it can be accomplished safely, periods of supervised on-the-job training to complement other training methods.

7.4.1 Instructors

If competent instructors are unavailable internally, then licensees may outsource training to external service providers. Some licensees elect to use the learning services of educational institutions that have developed radiation safety training programs. In all cases, the licensee is responsible for selecting competent instructors, or ensuring that the programs available from educational institutions or training providers are appropriate to achieving the established training objectives. As mentioned above, if training needs are straightforward, instruction might be assigned to a knowledgeable individual, or assumed directly by the owner/operator.

7.4.2 Assessment

Assessment is necessary to verify whether workers have mastered the training objectives and acquired the competence needed to perform their jobs safely. Progress should be assessed at regular intervals, such as after each lesson or exercise, and again at the completion of the entire radiation safety training program. Written or oral examinations to measure knowledge, and observation of performance during an exercise to measure skill, are the common tools for these assessments. Testing should be based on the training objectives using the test items prepared in the program design phase of training program development.

A number of testing methods may be effectively used to assess the knowledge and skills gained in training, including:

1. Written examinations;
2. Oral examinations;
3. Practical examinations (included in practical exercises); and/or
4. Assessment of on-the-job training.

These methods are discussed further in Appendix B, subsection B.5.2, “Assessment.”

7.4.3 Scheduling

Scheduling of individual training will depend on each worker's experience and previous training. For example, if a worker is new to a position and requires extensive initial training and practical experience, then training should be scheduled for completion before initial work commences.

Some new workers may have already received appropriate training, and some refresher training may be sufficient. However, the licensee should *not* assume that any radiation safety certification, experience, or training that has been previously obtained by the worker will be adequate for the licensed activity and the related jobs and tasks. Training program entry tests can be used to determine training needs prior to commencement of work.

Some factors that may influence scheduling include availability of training resources and the number of participants who will require similar instruction.

7.5 Training Program Evaluation

Program evaluation enables licensees to measure the effectiveness of their radiation safety training programs and make adjustments as necessary. The combined results of internal and external evaluations can be used to validate the effectiveness of the radiation safety program, and to determine whether the program should be modified or otherwise improved.

7.5.1 Internal Evaluation

A good indicator of training effectiveness is overall licensee performance, since it is closely related to the performance of the workers. For example, frequent emergencies, equipment failures, unplanned events, and abnormal radiation doses to workers, are some possible indicators of an ineffective training program.

Other very useful sources of internal evaluation include internal audits or inspections, feedback from workers and their supervisors, and feedback from the instructors themselves. Worker feedback can provide insight into the problem areas, as well as acknowledgement of effective training processes, and supervisors can identify training related problems in worker performance that could be improved through more or different training. In addition, instructors can identify lessons with which a significant number of workers experienced difficulty, or topics that generated an abundance of questions, indicating a lack of clarity in the information being delivered.

7.5.2 External Evaluations

Independent evaluations by external groups or organizations give licensees the opportunity to compare the success of their radiation safety training programs against similar programs. The perspective provided by external evaluations supplements the results of internal evaluations, ensuring that all aspects of the program are considered.

Other examples of external evaluations are the assessments and audits conducted by CNSC staff of licence applications or renewals, or as part of the CNSC compliance program. The level of detail in the CNSC reviews will reflect the level of risk associated with the licensed activity.

7.6 Continuous Improvement

The radiation safety training program should be dynamic, incorporating a "feedback mechanism" that facilitates response to the results of program evaluations and to operational experience, leading to continuous improvement of the program. If the original program meets all current requirements of the workers, then improvement activities will be restricted to "fine-tuning" rather than repeated application of the entire program development process.

With the goal of maintaining competence, continuous improvement should also include periodic reviews to ensure that worker knowledge and skills are appropriate and up to date. In particular, review should include emergency response refresher training since practice is needed to ensure that workers are always prepared to respond immediately and effectively to emergencies.

Continued training should be incorporated into the program to ensure that the benefits of initial training are maintained, and that new or updated information, such as "best practices" or legislative, regulatory, or licensing changes, are shared with workers in a timely fashion. In most cases, continued training should be preceded by new job and task analyses for individual worker(s).

Refresher training should be scheduled for all workers at regular intervals throughout the lifecycle of the licence, and reflected in the licensee's radiation safety training program documentation. Refresher training should also be scheduled in at least the following instances:

1. Prior to assuming any change in tasks;
2. When changes are made to the licensee's procedures or equipment;
3. In response to changes in legislation, regulations, or licence conditions; and
4. Upon notification of new scientific or technological innovations.

8.0 DOCUMENTING THE PROCESS

Licensees are responsible for maintaining records of their radiation safety training programs, including records of the training received by each worker. Training records allow licensees to monitor training effectiveness and to establish an inventory of their workers' skills. These records may be requested by CNSC staff when evaluating a licensee's radiation safety training program.

Records of the radiation safety training program can include such items as:

1. The results of job and task analyses;
2. Training objectives, test items, and examinations;
3. Lesson plans and course schedules;
4. Training manuals and other instructional tools and materials;
5. Instructions for practical exercises and on the job training checklists;
6. Course descriptions, dates when courses were offered, worker attendance, and examination results; and
7. Results of training program evaluations.

For each worker, records of radiation safety training should include at least the following:

1. Summary of relevant education, training, and experience at the time of hiring;
2. Summary of current and previous positions with the licensee;
3. Results of training program entry tests, if applicable; and
4. Initial and continuing training completed, including course titles, attendance dates, and examination results.

GLOSSARY

ALARA
The guiding principle in implementing a radiation safety training program is to, "…keep the amount of exposure to radon progeny and the effective dose and equivalent dose received by and committed to persons as low as reasonably achievable (ALARA), social and economic factors being taken into account. (Refer to *Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable" (ALARA)*, Regulatory Guide, G-129, Rev. 1/2004.)

Licensed Activity
An activity described in any of paragraphs 26 *(a)* to *(f)* of the NSCA that a licence authorizes the licensee to carry on.

Systematic Approach to Training

An iterative approach that provides a logical progression from the identification of the competencies required to perform a job to the development and implementation of training to achieve these competencies, through subsequent evaluation of training, and back to fine-tuning the program as necessary.

Task
A task is defined as a work sequence within a job, with identifiable start and end points. For example, the job of calibrating a radiation detector includes a sequence of several tasks.

Worker
For the purpose of this document, "worker" refers to any individual who may be exposed to radiological hazards associated with the licensed activity.

ASSOCIATED DOCUMENTS

Additional information about legislation, regulations, and other publications associated with radiation safety training can be found in the following documents:

1. *Certification of Exposure Device Operators*, Regulatory Guide, G-229/2004;

2. *Class II Nuclear Facilities and Prescribed Equipment Regulations*, SOR/2000–205;

3. *General Nuclear Safety and Control Regulations*, SOR/2000–202;

4. *Implementation of Radiation Protection Programs by Consignors, Carriers, and Consignees of Radioactive Material*, Draft Regulatory Guide, G-314/2004;

5. *International Atomic Energy Agency (IAEA) Safety Standard Series—Building Competence in Radiation Protection and the Safe Use of Radiation Sources*, RS-G-1.4;

6. *Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable" (ALARA)*, Regulatory Guide, G-129 Rev. 1/2004;

7. *Nuclear Safety and Control Act*, S.C. 1997, c.9;

8. *Nuclear Substances and Radiation Devices Regulations*, SOR/2000-207;

9. *Packaging and Transport of Nuclear Substances Regulations*, SOR/2000-208;

10. *Radiation Protection Regulations*, SOR/2000-203;

11. *Regulatory Fundamentals*, Regulatory Policy, P-299;

12. *Transportation of Dangerous Goods Act*, 1992, S.C. 1992, c.34;

13. *Transportation of Dangerous Goods Regulations*, SOR/2001-286; and

14. *Working Safely with Nuclear Gauges*, A.E.C.B, 1997.

APPENDIX A
CATEGORIES OF WORKERS TO BE CONSIDERED

This appendix is intended to assist licensees in grouping their workers when performing the job and task analysis discussed in subsection 7.1.2. While some general recommendations are made regarding the radiation safety training that may be appropriate for each sample category, it remains the responsibility of the licensees to determine the actual worker categories that apply to their licensed activities, and to identify the unique training needs for those categories.

A.1 Management

Licensees or their managers (in larger organizations) have the ultimate responsibility for ensuring worker safety. They should therefore have a good understanding of the NSCA and of any other legislation and regulations relevant to their licensed activities. They should also know the principles of radiation safety and safety culture, and understand their responsibility for managing radiation risks by implementing the ALARA principle.

A.2 Radiation Safety Personnel

The Radiation Safety Officer (RSO) is responsible for ensuring the radiation safety of workers, and may be assisted by technical personnel responsible for performing specific tasks. Smaller licensees that may not have full time RSOs will still have someone responsible for radiation safety, licensing, and compliance matters. These individuals should understand the NSCA, the applicable regulations made pursuant to the NSCA, and the conditions of the licence under which their activities are being carried out. RSOs and assisting technical personnel should also be well informed about the current radiation protection principles, methods, and practices related to the licensed activity.

Training for RSOs and other radiation safety personnel should cover at least all topics associated with radiation safety at the level of detail required by their responsibility in ensuring the day-to-day safety of workers and of the public. Radiation safety personnel should also be trained on methods and techniques for controlling, using, handling, storing, and disposing of nuclear substances, and for controlling, using, or operating the applicable radiation devices and prescribed equipment. Training should cover the methods and techniques for monitoring radioactive contamination and supervising decontamination work, and for monitoring and controlling the radiation fields and radiation exposure of all workers.

A.3 Nuclear Energy Workers

Under the NSCA, a Nuclear Energy Worker (NEW) is a person who is required to perform duties in such circumstances that there is a reasonable probability of receiving a dose of radiation greater than the prescribed limit for the general public (1 mSv/year). In practical terms, NEWs are individuals who routinely use nuclear substances or operate radiation devices or prescribed equipment. As such, they are occupationally exposed to radiation and are closely monitored for the radiation dose they may receive.

Examples of NEWs include operators of accelerators, irradiation facilities, or diagnostic or therapeutic radiology equipment; medical physicists or other medical personnel performing diagnostic or therapeutic procedures that rely on radiation sources; and nurses assisting patients undergoing such procedures. In addition, given that a worker who is likely to receive more 1 mSv/year is designated a NEW, a receptionist in a nuclear medicine department may be classified as a NEW even though the role does not include direct use of nuclear substances.

NEWs generally require more extensive and specialized radiation safety training than workers who may only occasionally be exposed to radiation. The training objectives for these workers and the level of detail with which each topic should be covered depend on the licensed activity, the radiation hazards to which they may be exposed, the nature of their jobs and the associated tasks and responsibilities, and the difficulty, importance, and frequency of those tasks. For example, workers operating an irradiation facility or involved in radiation therapy, whose duties involve the continuous use of radiation sources, would likely need more extensive training than workers operating nuclear gauges or gas chromatographs.

Where appropriate and safe, training for NEWs should include practical exercises and on-the-job-training. In some cases, NEWs should work under supervision for a period of time after training is completed, until they have acquired sufficient experience and self confidence to perform their jobs safely and competently.

A.4 General Employees

This group includes workers whose duties do not typically involve the direct use of radioactive material or other radiation sources, but who may occasionally go into areas where they could be exposed to radiation. Whether a worker can be classified as a general employee or not depends on several factors, including the frequency with which they may be required to enter areas where radiation hazards exist, the duration of their stay in those areas, the potential magnitude of exposure, and the level of supervision.

This group typically includes cleaning and maintenance staff, storage, shipping and receiving personnel, and administrative staff, and may include some categories of nurses, visitors, and students. These workers should be provided with *radiation awareness training* that addresses radiation hazards present in the workplace, the level of exposure they may receive, basic protective measures against radiation, how to monitor their own exposure, and how to recognize radiation warning signs or symbols.

A.5 Female Workers

In addition to the technical training appropriate to their specific duties at the facility, radiation safety training for female workers should include detailed information on the risks posed to an embryo or foetus by exposure to radiation. They should also be advised that Paragraph 11 of the *Radiation Protection Regulations* requires a NEW who becomes aware that she is pregnant to inform the licensee of the pregnancy in writing so that measures are taken to limit the effective dose she may receive to 4 mSv for the balance of the pregnancy.

A.6 Engineering and Technical Personnel

Some licensees may employ engineers and technicians responsible for the maintenance, repair, or modification of equipment or workspace, and for developing plans for decommissioning equipment. Radiation safety training for engineering and technical personnel will depend on their duties and on the particular jobs and tasks to be performed. In most cases, training on radiation and its effects, the specific radiological hazards present, and the protective measures to be taken, may be sufficient to minimize exposure.

A.7 Purchasing, Shipping, and Receiving Workers

Workers involved in purchasing nuclear substances should be familiar with the possession limits and the security and inventory controls required by regulations.

In addition to radiation safety training, workers in this category should receive training on the packaging and transport of nuclear substances, as discussed in regulatory guide G-314, *Implementation of Radiation Protection Programs by Consignors, Carriers, and Consignees of Radioactive Material*. This training is an essential element required by the *Packaging and Transport of Nuclear Substances Regulations* and the *Transport of Dangerous Goods Regulations*.

A.8 Contractor Personnel

Some licensees outsource specific work out to an outside contractor. Contractor personnel may include general labourers, technicians, consultants, and maintenance and security personnel. In all cases, radiation safety training for contractor personnel should be similar to that required by full time personnel performing identical tasks, and should be commensurate with the radiation hazards to which they may be exposed. Previous training can be identified from contractors' documented experience, and assessed through training program entry testing. If previous training is inadequate, the licensee should ensure that contractor personnel receive additional training appropriate to their duties, or should arrange for them to be directly supervised by suitably trained workers.

A.9 Visitors

Individuals entering a licensed facility for brief periods of time, such as members of a visiting group, personnel of a delivery firm, or messengers, are usually accompanied by an escort and normally should not need any radiation safety training. They should, however, be informed of the radiation hazards in the facility and of the risk of accidental radiation exposures.

Individuals visiting a facility for an extended period of time who have not received radiation safety training, such as scientists and students, should undergo appropriate training.

A.10 Emergency Response Personnel

Emergency situations may occur at any facility, and the potential radiation risk to workers, the public, and the environment in emergency situations is directly proportional to the nature of the radiological hazards that are present.

During an emergency, there may be a need for the intervention of specialized personnel other than licensee workers, such as fire fighters, police, and medical personnel, and it is recognized that, in some situations, emergency response personnel from outside organizations may not have received sufficient radiation safety training.

To ensure adequate preparedness of all parties, CNSC staff recommends that the licensee liaise with emergency response personnel to coordinate response capability and to provide information pertaining to the provincial and federal health and safety regulations associated with the facility or the activities carried out therein. Emergency response personnel should at least be informed about the hazards they may encounter, and in the event of an emergency, should be accompanied and closely supervised by the licensee's radiation safety personnel while carrying out their response duties.

APPENDIX B
THE SAT FRAMEWORK

SAT provides the basis of an effective method for developing and maintaining radiation safety training for persons working at a nuclear facility, or at any other place where nuclear substances or prescribed equipment are produced, used, possessed, packaged, transported, or disposed of. Section 7.0, “Suggested Training Approach,” built on the SAT framework to present a high level approach to developing a radiation safety training program that included continuous improvement and continued training. This appendix provides a more detailed discussion of the basic SAT framework.

B.1 Introduction

Implementation of the SAT framework begins with the clear identification of training requirements. In the case of radiation safety training, this ensures that training requirements for all jobs related to a licensed activity can be established and met. Contrary to curricula-driven training, SAT leads to training programs tailored to the needs of each category of workers for a licensed activity, ensuring that all required knowledge and skill sets are included, and that the time and cost investment is proportional to the actual training needs identified by the licensee.

Typically, SAT consists of five sequential phases:

1. *Analysis*: identifying the jobs and the tasks associated with each job, and determining the radiation safety related knowledge and skills required to safely perform those tasks;
2. *Design*: defining the training objectives and the methods by which training will be delivered, and designing test items and testing methods to establish whether training objectives have been met;
3. *Development*: establishing the sequence in which the training topics will be presented, developing lesson plans, developing or assembling training manuals, gathering all required training materials, and assigning instructors;
4. *Instruction*: instructor preparation, training delivery, and assessment (testing) of the workers; and
5. *Program Evaluation*: measuring the effectiveness of the training program through internal and external evaluation to validate the program and promote identification of areas where improvement might be indicated.

The basic SAT approach is cyclic, in that the program evaluation step can lead back to any of the preceding steps, resulting in an iterative radiation safety training program that is open to continuous improvement. In order to take full advantage of this feature, the CNSC has incorporated the sixth step, *Continuous Improvement and Continued Training*, into the recommended radiation safety training program development process, as described in subsections 5.3 and 7.6.

The effort required to develop a SAT-based radiation safety training program depends on the complexity and the radiological risk of the licensed activity. When the licensed activity is a simple one and the potential for radiation exposure to workers is low, a simplified approach to training may be appropriate. In those situations it may be justified to combine closely related steps, such as design and development, or even analysis, design, and development, to appropriately allocate time, cost, and resources. Where the licensed activity is complex and diversified, the potential for radiation exposure is high, and workers' duties are difficult to perform, a more in-depth application of each development phase may be warranted.

B.2 Analysis

Job and task analysis should result in a list of tasks for each job carried out. The tasks are then analyzed to determine the radiation safety related knowledge and skills required to perform them safely. This exercise defines the training each worker should receive in order to perform the tasks in a safe manner, providing the basis for establishing training objectives during the design phase.

Task analysis can be done by observing the tasks performed for the job, by interviewing job incumbents, or by extracting data from licensee documents (such as facility design documentation or system and equipment operating and maintenance procedures). For more complex jobs, a more suitable approach may be a "table top" analysis, where a group of experts identifies all the required knowledge and skills.

For complex jobs such as the operation of a medical accelerator, determination of the required knowledge and skills may be quite lengthy because of the number and complexity of the tasks associated with the job. For simpler jobs such as the operation of a nuclear gauge, analysis may be quite straightforward and may require minimal effort by a single, knowledgeable individual.

B.3 Design

During the design phase the results of the analysis are converted into training objectives, and the specific topics that should be covered in the training program are established (refer to Appendix C for some sample topics). The topics are then arranged in a logical sequence in training lessons to establish the course structure, delivery methods are determined, and the assessment items and testing methods are established. The design of the training program should take worker education and experience into account.

The design phase should also include consideration of whether entry level testing will be needed, and design of appropriate material to address that need.

Some radiation safety training programs may have entry level requirements that specify the technical knowledge and skills workers must have before they may enter the program. When the workers' background is not accurately known, it may be desirable and cost effective to administer an entry test to identify individual training needs. The entry test may identify gaps in prerequisite knowledge or skills that may need to be addressed before a worker can meet the entry level requirements, or it may indicate that training is unnecessary on some or all topics.

B.3.1 Training Objectives

Training objectives are statements of the knowledge and skills workers should be able to demonstrate at the completion of each training lesson. Training objectives should be measurable, and should include an action to be performed, the conditions under which the action takes place, and the standards for satisfactory performance.

Typical standards of performance might include recognition of radiological hazards, identification of equipment status, ability to use equipment, degree of accuracy, timely completion of tasks, and any other applicable metrics.

In order to determine whether training objectives have been met, they must be measurable. For example, a measurable objective addressing recognition of radiological hazards would be to state that the student will be able to recognize 80% of the radiological hazards presented in a list of ten.

B.3.2 Test Items and Testing Methods

Testing is the most direct way to determine whether workers have mastered the training objectives of each lesson. Consequently, test items must be consistent with the action statement, conditions, and standards of performance defined in the training objectives. The action verbs in the objectives drive the selection of the test items, and help to define whether the results will indicate knowledge-based or skills-based learning. Actions verbs such as *identify*, *list*, or *explain* suggest a knowledge-based test item, while others such as *select*, *calibrate*, and *detect* imply a skill-based test item.

Testing methods vary based on the types of test items selected, and the kind of learning being tested. For example, oral or written examinations are used to demonstrate the knowledge acquired by workers and their ability to generalize that knowledge to practical application, while practical tests allow the worker to demonstrate performance skills for specific tasks.

B.4 Development

Training materials are prepared in the development step. This material supports the training objectives and should emphasize job-related situations and conditions. Depending of the complexity of the radiation safety training program, training material may include:

1. Lesson plans;
2. A training manual or course notes;
3. Testing material that incorporates the established test items;
4. Models, transparencies, audiovisual aids, etc.;
5. Access to systems, equipment, and procedures for practical and on-the-job exercises; and
6. Other reference material such as applicable textbooks.

B.4.1 Lesson Plans

Lesson plans are the controlling documents that guide training and ensure consistency of instruction between groups of workers and from instructor to instructor. The lesson plan guides the instructor, providing a checklist of lesson objectives, the training material and training aids to be used, other applicable reference material, and the amount of time to be dedicated to each objective within the lesson.

B.4.2 Training Manuals

Since developing new training material can be costly and time consuming, licensees may choose to consider existing material before committing resources to the preparation of new material. Existing material should be reviewed to determine whether it meets the needs of the training program as is, or whether it can be modified to do so. All training material should be appropriate to the background of the workers and compatible with the training objectives.

The training manual should be complete enough to reduce the distraction of having to take extensive notes. It should present topics in the logical sequence in which they will be presented. Each topic should be introduced with its objectives, including the rationale for its inclusion in the training program. Information should be presented in the context of the job, including a description of the work environment, how the information presented will be applied on the job, and the reasons why it is important.

Especially for more complex lessons, a comprehensive training manual can provide ongoing benefit as a reference tool for workers after training is complete.

B.4.3 Other Training Material

The use of training aids is often helpful in maintaining attention and interest, thereby improving training effectiveness. Various mediums can be employed, including slide presentations, films, video clips, graphics, flowcharts, etc.

A slide presentation can be helpful as a guide to organize the lesson, clarify or add to the lesson material, and illustrate the equipment under discussion.

Films and video clips can be used to supplement classroom presentations or to enhance self study or distance learning. They provide examples of real operations or short, selected work sequences, and can be very effective in enhancing learning if they are used to supplement rather than replace an actual lecture.

Graphic presentations might include such items as line graphs, histograms, pie charts, and diagrams. They can be used to help workers visualize equipment parameters or how data may trend in a given situation, or to facilitate understanding of concepts and phenomena.

Flow charts can effectively demonstrate the relationships of process steps, while block diagrams are effective in illustrating organizational structures.

B.4.3.1 Modifying Existing Material

Modifications to existing material might include adding or expanding information to support the training objectives, or updating references to ensure that current facility equipment, systems, or procedures, and current legislation, regulations, and licence conditions are reflected. In addition, the depth and breadth of the material may need to be altered to match the experience levels of the workers.

B.4.3.2 Creating New Material

New training material should adequately cover training objectives and ensure that the workers progress through training in an effective way. Material should be easy to use, and, where jargon or technical terms are necessary, they should be defined in the first instance of their use to ensure that the material will accommodate new workers.

B.5 Instruction

B.5.1 Methods of Training Delivery

There are a number of ways in which training can be delivered, including:

1. Classroom Instruction;
2. Self-study;
3. Computer-Based Training;
4. Distance Learning;
5. Practical Training; and
6. On-the-job Training

No matter which method or combination of methods is employed, a well planned program should alternate training in radiation fundamentals with practical exercises or on-the-job training sessions to ensure that both the theoretical and practical aspects of radiation safety are covered. Practical demonstrations and hands-on experience are valuable, and often essential, in radiation safety training.

B.5.1.1 Classroom Instruction

Fundamental lessons on radiation safety are normally delivered in a classroom setting. Workers are provided with the appropriate training material before the lesson begins, and the instructor states the training objectives at the beginning of each lesson and summarizes them when the lesson is complete. Clear identification of what has to be learned, and presentation of the material in an organized, concise, and factual manner, can motivate participants and make learning more effective. Other ways to maintain interest in the lesson include encouraging discussion, connecting the subject of the lesson to the jobs and tasks performed by the participants, and making use of relevant practical examples. Training lessons should not be too long, and should allow ample time between lessons for self study and review of previous lesson materials.

Instructor Preparation

Prior to delivering a lesson, the instructor should take the time to review the training objectives, the supporting training material, and the availability of the tools recommended for training presentation (i.e., training materials, computer equipment, slide presentations, etc.) to make efficient use of the time allocated to the lesson.

During preparation, the instructor should identify those parts of the lesson requiring more attention or more detailed explanation. Where the lesson consists of practical exercises or an on-the-job training exercise, the instructor should verify that technical or other reference material is at hand for use by the workers, and that the equipment to be used during the exercise is available.

B.5.1.2 Self-Study

Individual or "self-study" is also a very effective method by which workers can acquire the knowledge they need to understand the principles of radiation safety, and is particularly well suited to small facilities where classroom training is impractical because the number of workers is limited, or instructors are not readily available. Nevertheless, workers participating in self-study still require access to knowledgeable persons, such as RSOs or experienced, trained workers, who can monitor progress, answer questions, clarify difficult concepts, or assist in finding additional sources of information such as textbooks or other reference material. The worker will still need to be assessed (tested) at regular intervals, and again at the completion of the entire course.

B.5.1.3 Computer-Based Training

Another method for instructing workers on radiation safety fundamentals that is becoming more and more common is computer based training (CBT). CBT packages are available on the market from training providers, or can be downloaded from the Internet. This method of instruction is particularly useful for less complex facilities where training resources may be limited, but it is also gaining popularity for radiation safety training in facilities with complex and diversified activities as a convenient, cost effective, and flexible alternative to traditional classroom instruction. CBT still requires the presence of an instructor, RSO, or other knowledgeable person to guide worker progress, and to answer any questions.

CBT consists of interactive training modules with question and answer sections, and may use diagrams, pictures, simulations, and video sequences. While mastering each lesson's training objectives remains an essential feature in this form of training, the objectives may be part of the CBT lesson package and may not be presented in written format. CBT instruction may drastically reduce the need for printed manuals; however, some printed material and study guides, such as a CBT user's guide, are still required.

CBT software usually incorporates test items for interim and final assessment, and may also offer the possibility of pre-testing workers to identify those training objectives for which training would be redundant.

B.5.1.4 Distance Learning

Several educational institutions have developed training programs in radiation safety fundamentals that workers can use at home or in the workplace. Workers may study material supplied by the institution, or follow televised lessons. The institution delivering the course normally makes an instructor available to monitor progress. Tests must be completed and submitted to the institution at regular intervals during the course to obtain a certificate of successful course completion.

B.5.1.5 Practical Training

As with all other training delivery methods, training objectives for practical training should clearly identify the knowledge and skills workers should have mastered at the end of each exercise, including the standards for their assessment. Examples of practical exercises include, but are not limited to, glove box operation, use of personal dosimeters and interpretation of their readings, measurements of radionuclides in a sample, identification of unknown radionuclides in a sample, decontamination of a surface, and use of protective clothing.

Since practical exercises conducted at the end of a training session demonstrate how the lesson material can be applied in practice, a practical exercise that follows the lesson plan is most effective.

Participant safety is paramount during all training exercises. Practical exercises should be undertaken only when the relevant radiation safety training lessons have been successfully completed, and the instructor should closely monitor all aspects of the exercises. For more difficult lessons, it is often important for the instructor to first demonstrate how the exercise should be performed.

While practical exercises are usually more effective when performed individually by workers, availability of equipment and instructor time are two factors that may necessitate group work. The size of each group should be manageable, allowing adequate demonstration and close supervision by the instructor, giving each worker in the group the opportunity for hands-on practice, and ensuring time for questions. At the end of a practical exercise, the instructor should review all important aspects to ensure that they are well understood, and should discuss problems encountered during the exercise and ways in which they could be resolved. Finally, the instructor should point out mistakes workers may have made during the exercise and how they could have been avoided.

B.5.1.6 On-The-Job Training

In cases where the duties and responsibilities of a job are highly complex, training lessons and practical exercises may be insufficient to cover all safety aspects as thoroughly as necessary. For such jobs, structured on-the-job training may be essential to develop the knowledge and skills workers need in the actual work environment. As with practical training, worker safety remains the primary consideration in on-the-job training, which should be implemented only after the worker has successfully completed the relevant radiation safety lessons and exercises.

On-the-job training is an extended form of practical training that provides an opportunity to learn how to perform complex and difficult tasks or to operate complex equipment under supervision. Content and length of on-the-job training may vary significantly depending on the particular licensed activity and job requirements; workers typically progress from shadowing job incumbents performing a particular task and observing how a task should be performed, to performing the task under supervision, before carrying out the task unsupervised.

Prior to participating in on-the-job training, workers should have completed the radiation safety training associated with the relevant task(s). They should be familiar with the applicable reference material and training objectives, and should be monitored by individuals who are knowledgeable of on-the-job training and assessment methods, the tasks being taught, and any equipment being used. Before beginning an on-the-job exercise, the instructor should review the following items with the worker:

1. The purpose of the exercise;
2. The appropriate safety checks and actions to be performed prior to, during, and after operation of the equipment; and
3. The consequences of performing actions out of sequence.

Depending on the nature and difficulty of the lesson, it may be appropriate for the worker to first observe while the instructor performs the tasks before performing the exercise first hand.

B.5.2 Assessment

Assessment is necessary to verify whether workers have mastered the training objectives and acquired the competence needed to perform their jobs safely. Progress should be assessed after each lesson or exercise, and again at the completion of the entire set of applicable lessons. Examinations to measure knowledge, and observation of performance during hands-on exercises to measure skill, are the common tools for these assessments. Testing should be based on the training objectives and test items prepared in the design phase of training program development.

Testing results should be communicated to the workers as soon as possible after the assessment, and they should be informed of any results that indicate a requirement for additional training. Participants who fail a lesson examination during the program, or whose performance during an exercise is poor, should correct the problem area(s) before progressing in their training.

B.5.2.1 Assessing Knowledge-Based Learning

Written and oral examinations are normally used to evaluate the radiation safety knowledge workers have acquired.

Written Examinations

Written examinations are particularly useful when testing large groups of workers. They should be designed to test generalized understanding of radiation safety concepts and their application rather than to simply elicit recall of specific examples provided in lessons. Written examinations therefore usually combine multiple choice questions with short answer and essay style questions. These examinations provide a direct written record of each worker’s success in achieving the knowledge-based training objectives.

Oral Examinations

Oral examinations are more time consuming than written examinations, because workers are assessed individually. Questions must be prepared in advance, and must be formulated in such a way that the responses will accurately reflect what the worker has learned. The key elements of acceptable answers should be determined prior to the examination.

Oral examinations should be well documented to maintain suitable records of responses. Examiners should prepare an assessment form for each worker that lists the knowledge areas or training objectives covered by each question, including the key answer elements expected. The score and the examiner's remarks should be added to the assessment form at the completion of the examination.

B.5.2.2 Assessing Skills-Based Learning

Assessment of practical exercises and on-the-job-training is the most direct way to determine whether workers have effectively learned the skills required to perform their jobs safely.

Assessment of Practical Exercises

The assessment of a practical exercise determines the worker's ability to perform a task or set of tasks by applying the appropriate knowledge and skills. The goal of the assessment is to confirm that the worker will be able to complete the tasks associated with the practical exercise without supervision.

Practical exercise assessment is normally conducted during the exercise itself. For this reason, the instructor should clearly identify those observations, remarks, and questions that are meant to assist the workers in mastering the training objectives of the exercise, and those that are intended as part of the graded assessment.

Assessment of On-the-Job Training

Unlike practical exercises, assessment of on-the-job training is conducted after completion of the exercise. Before assessment of each activity, the worker receives all the information that would normally be available when performing that activity in real life. Then, during the assessment, the worker demonstrates competence in performing the activity using all the relevant procedures, tools, and equipment.

The assessor should be a person with the experience and qualifications needed to perform and assess the activity being learned. Since the assessment is a measure of ability, the assessor should use a checklist of the skills workers should demonstrate and the actions and safety checks they should perform in safely completing the exercise.

B.6 Program Evaluation

Evaluations enable measurement of training program effectiveness, revealing areas that may require adjustment. The combined results of internal and external evaluations can be used to determine whether the program should be modified or otherwise improved.

B.6.1 Internal Evaluations

Since overall licensee performance is closely related to the performance of the workers, it provides a good indication of training effectiveness. The frequency of emergencies, equipment failures, unplanned events, and abnormal radiation doses to workers, are some possible measures of training program effectiveness.

Feedback from workers and their supervisors, and from the instructors themselves, provides useful feedback. Workers can provide insight into the problem areas and acknowledgement of effective training processes, and supervisors can identify problems in worker performance that could be improved through more or different training. In addition, instructors can identify lessons with which a significant number of workers experienced difficulty, or topics that generated an abundance of questions, indicating a lack of clarity or suggesting that a different approach should be considered.

Operational experience of other licensees can be valuable in evaluating radiation safety training programs, since a licensee can learn from the experiences of others. Information obtained from events that occurred elsewhere may point to a need for modifications or additions to a radiation safety training program.

B.6.2 External Evaluations

Independent evaluations by external groups or organizations give licensees the opportunity to compare the success of their radiation safety training programs against similar programs. The perspective provided by external evaluations supplements the results of internal evaluations, ensuring that all aspects of the radiation safety training program are considered.

Other examples of external evaluations are the assessments conducted by CNSC staff of licence applications or renewals, or as part of the CNSC compliance program.

A typical CNSC evaluation will look at how well workers perform their jobs, and at the overall quality of the radiation safety training program. This review may consider the job and task analysis, the development of training objectives, the quality of the training material, the qualifications of instructors, and the results obtained by workers. For any weakness detected in workers performance, CNSC staff will focus their attention on the related training material and determine whether the poor performance observed can be linked to a training deficiency or to other factors.

The detail of the CNSC review will reflect the level of risk associated with the licensed activity.

APPENDIX C
SAMPLE TOPICS FOR RADIATION SAFETY TRAINING

This appendix gives examples of some topics that might be included in a radiation safety training program, including suggested presentation sequences that should facilitate learning. The topics presented here do not represent an exhaustive list, as the decision about which topics to include or exclude will depend on the outcome of the job and task analysis, the results of entry-level testing and previous qualification, or special circumstances. Also, a radiation safety training program might need to include additional topics beyond those presented here in order to appropriately cover the specific training needs for a given program.

1. Radiation Orientation Lecture;
2. Regulations Pertaining to Radiation Safety;
3. Fundamentals of Radiation Safety;
4. Job-Specific Issues;
5. Structure of Matter;
6. Radioactivity and Radiation;
7. Radiation Detection and Measurement;
8. Radiation Units;
9. Biological Effects of Radiation;
10. Effects of Radiation on the Foetus;
11. Controlling Radiation Exposures;
12. Transportation Requirements;
13. Facility Documents, and Operating & Emergency Procedures; and
14. Security.

The topics to be covered and the depth to which they should be addressed will depend on the complexity of the licensed activity, the specific duties of workers, the radiological risk associated with those duties, and previous training and operational experience.

C.1 Radiation Orientation Lecture

To explain the principles of radiation, the radiation hazards present for the licensed activity, and basic radiation safety practices, including:

1. Principles of radiation, its properties and effects;
2. Radiation hazards associated with the licensed activity; and
3. Integration into the Workplace Hazardous Materials Information System (WHMIS).

C.2 Regulations Pertaining to Radiation Safety

All licensees and their respective workers should be familiar with the NSCA, and with the regulations and licence conditions that are pertinent to their activities and individual tasks. By including this information in a radiation safety training program, the licensee can ensure that all affected workers are aware of those issues that have been regulated, and this awareness can help minimize items of non-compliance.

In addition to the NSCA, some of the regulations and other instruments that are recommended for coverage include:

1. *Radiation Protection Regulations (RP)* (SOR/2000-203);
2. Relevant *General Nuclear Safety and Control Regulations (GN)* (SOR/2000–202);
3. *Nuclear Substances and Radiation Devices Regulations (NSRD)* (SOR/2000-207) that are directly relevant to radiation safety;
4. The *Packaging and Transport of Nuclear Substances Regulations (PTNS)* (SOR/2000-208) and *Transportation of Dangerous Goods (TDG)Regulations* (SOR/2001-286) are applicable to all licensees involved in the packaging and/or transportation of radioactive material;
5. *Class II Nuclear Facilities Regulations* (SOR/2000-205);
6. CNSC licence conditions;
7. Applicable CNSC regulatory policies, standards, guides, and notices; and
8. Other applicable federal, provincial, or local requirements.

C.3 Fundamentals of Radiation Safety

To acquaint all persons working where radiation hazards are present with the fundamentals of radiation safety, including:

1. Radioactivity and radioactive decay;
2. Types and characteristics of radiation;
3. Internal and external modes of exposure;
4. Radioactive sources and their relative importance as radiation hazards;
5. Information on background radiation;
6. Effective dose limits and application of the ALARA principle;
7. Radiation monitoring programs and procedures;
8. Radiation survey instruments, their use and limitations;
9. Time, distance, and shielding measures of protection;
10. Biological effects of exposure to radiation;
11. Risks associated with occupational exposures;
12. Exposure of minors and women of reproductive age;
13. Effective dose determination;
14. Contamination control, protective clothing, and safety equipment;
15. Decontamination procedures, including personal decontamination;
16. Emergency procedures;
17. Alarms, warning signs, and posting requirements;
18. Handling and transportation of radioactive material;
19. Radioactive waste policy of the licensee;
20. Responsibilities of workers, of supervisors, and of the licensee; and
21. Responsibilities of and interaction between workers and radiation safety staff.

C.4 Job-Specific Issues

To inform workers of radiation safety practices specific to their assigned jobs and associated tasks, such as:

1. Operating procedures specific to a person’s work area;
2. Job-specific issues such as use of particular equipment or techniques;
3. Risks associated with performing a task;
4. Use of proper work control methods; and
5. Specific procedures for maintaining radiation exposure ALARA.

C.5 Structure of Matter

To explain the basic concepts on the structure of matter and introduce the concepts of stable and radioactive isotopes, including:

1. Structure of the atom and the nucleus
    a) The nucleus
        (i) Proton: physical characteristics
        (ii) Neutron: physical characteristics
        (iii) Electrons: physical characteristics, orbits
2. Atomic number and atomic weight: definition and meaning
3. Isotopes
    a) Definition
    b) Nuclear stability
    c) Stable and radioactive isotopes
    d) Isotopes used in the facility

C.6 Radioactivity and Radiation

To explain the basic concepts of radiation, the types of radioactive decay, the interaction of radiation with matter, and the hazards associated with the types of radioactive decay, including:

1. Production of radioactive isotopes
2. Properties of radioactive isotopes
    a) Half-lives
    b) Decay to stable form
    c) Decay charts
3. Decay mechanisms of radioactive isotopes
    a) Alpha decay: characteristics, hazards, and shielding
    b) Beta-minus decay: characteristics, hazards, and shielding
    c) Beta-plus decay: characteristics, hazards, and shielding
    d) Electron capture
    e) Gamma decay: characteristics, hazards, and shielding
    f) X-ray emission: characteristics, hazards, and shielding
4. Energy spectrum of electromagnetic radiation
5. Neutron Radiation: production, characteristics, hazards, and shielding

6. Interaction of radiation with matter
   a) Charged Particles
      (i) Coulomb interaction
      (ii) Range in various materials
      (iii) Linear energy transfer (LET)
   b) Neutrons
      (i) Collisions with nuclei
      (ii) Range in various materials
      (iii) LET
   c) Gamma and X radiation
      (i) Photoelectric effect
      (ii) Compton effect
      (iii) Pair production
      (iv) LET
      (v) Range in various material
7. Energy loss of radiation in matter
   a) Range in tissue
   b) Range in air
   c) Range in selected material (Al, Fe, steel, U)
   d) LET

C.7 Radiation Detection and Measurement

To explain the principles of radiation detection and measurement and the principles of radiation measuring instrument operation, to acquaint workers with the personal dosimeters and radiation measuring instruments used at the workplace, and to explain how to interpret their readings.

Radiation detection and measurement training should include instruction in at least the following subtopics, as appropriate to the defined training needs:

1. Personal dosimeters;
2. Dose rate and contamination instruments; and
3. Licensed dosimetry services.

Personal Dosimeters

1. Types of Personal Dosimeters
   a) Personal Dosimeters of record
      (i) Thermoluminescent dosimeters (TLDs) for X, gamma, and beta radiation
      (ii) CR-39 for neutron radiation
   b) Personal Dosimeters for dose control
      (i) Direct Reading Dosimeters (DRDs)
      (ii) Personal Alarming Dosimeters (PADs)
      (iii) Electronic Personal Dosimeters (EPDs
2. Topics to be addressed for each type of Personal Dosimeter:
   a) Principles of operation
   b) Sensitivity and limitations
   c) Procedures for wearing, reading, and storing, as appropriate
   d) Interpretation of readings
   e) Importance in radiation protection

Dose rate and contamination instruments

1. Types of instruments
   a) Ionization chambers
   b) Proportional counters
   c) Geiger-Müeller (GM) counters
   d) Scintillation counters
   e) Neutron rem meters
2. Topics to be addressed for each type of instrument
   a) Principles of operation
   b) Sensitivities and limitations
   c) Maintenance and calibration
   d) Instrument failures
   e) Procedure for using and storing ion chamber instruments
   f) Interpretation of readings
   g) Importance in radiation safety

Licensed Dosimetry Services

1. Licensee-specific information

C.8 Radiation Units

To explain the units used to measure radiation, including:

1. Definition and meaning of exposure and its units (Coulomb/Kg and Roentgen (R));
2. Definition and meaning of absorbed dose and its units (Gray (Gy) and rad (rad));
3. Definition and meaning of equivalent dose and its units (Sievert (Sv) and rem (rem));
4. Definition and meaning of effective dose and its units (Sievert (Sv) and rem (rem));
5. Definition and meaning of organ or tissue weighting factors;
6. Definition and meaning of radiation weighting factors;
7. Definition and meaning of activity and its units (Becquerel/Curie);
8. Definition and meaning of electron volt (eV);
9. Multiples and submultiples of radiation units; and
10. Conversion from and to International System (S.I.) units.

C.9 Biological Effects of Radiation

To explain the relative sensitivity of various cells of the body to radiation, the types of biological effects of radiation on the various organs and tissues of the body, and the genetic effects of radiation, including:

1. Sources of Radiation Exposure
    a) External radiation
    b) Internal radiation
2. Types of effects
    a) Stochastic and non-stochastic effects
    b) Somatic effects
    c) Early radiation effects
    d) Delayed radiation effects
    e) Genetic effects
3. Clinical effects on humans
    a) Radiosensitivity of organs
    b) Dose-effect relationship
        (i) Effects of acute radiation doses
        (ii) Chronic doses and late effects

4. Factors determining the effects of a given dose
    a) Organ or tissue exposed
    b) Radiosensitivity of organs
    c) Rate of exposure
    d) Extent of body exposed
    e) Age of the individual
    f) Biological variations among individuals
5. Radiation hazard in perspective
    a) Radiation benefits and risks
    b) Personal exposure
        (i) From background radiation
        (ii) From man-made sources
6. Maximum permissible doses for workers
7. Occupational radiation risk to facility workers

C.10 Effects of Radiation on the Foetus

To explain the effects of radiation on an unborn child, including:

1. Effects on the foetus from internal or external exposures
    a) Genetic effects
        (i) Abnormalities observed in offspring due to previous irradiation of a parent's reproductive system
        (ii) Increase in risk of abnormalities with any exposure
    b) Teratogenic effects
        (i) Abnormality observed in offspring due to irradiation in utero
        (ii) Increase in risk of abnormalities above a threshold value
2. Protective measures
    a) Activities that are not recommended during pregnancy
    b) Obligation of the worker to inform the licensee of her pregnancy
    c) Dose limit for the balance of the pregnancy

C.11 Controlling Radiation Exposures

To explain the use of time, distance, and shielding to reduce radiation exposures, to explain contamination control practices, and to reinforce the concept of the ALARA principle:

1. Control of external radiation exposures
    a) Time (time x dose rate = dose)
    b) Distance
        (i) Inverse square law
        (ii) Effects of the source geometry on the inverse square law
    c) Shielding
        (i) Definition of half-value layer (HVL) and of tenth value layer (TVL)
        (ii) HVL and TVL of various shielding materials
    d) Use of time, distance, and shielding in the work environment
2. Control of internal radiation exposures
    a) Modes of entry of radioactive material into the body
        (i) Inhalation
        (ii) Ingestion
        (iii) Absorption through skin
3. Contamination prevention
    a) Handling equipment
    b) Personnel protective equipment
    c) Leak testing of sealed sources
        (i) Regulatory requirements (performing a leak test after a device has been in an incident, and maintaining records)
        (ii) Leak testing procedures
4. Contamination control
    a) Monitoring
    b) Instrument survey
    c) Swipe survey
    d) Regulatory requirements
5. Decontamination techniques

6. Bioassay
    a) Regulatory Requirements
    b) Method and frequency
        (i) Body counting vs. urinalysis
        (ii) Frequency requirements stipulated by the licence conditions

C.12 Transportation Requirements

To explain the regulatory requirements for receiving, handling, packaging, and transporting radioactive material.

1. Receiving radioactive material;
2. Handling of the material;
3. Records and Survey requirements, including shipment/transportation of radioactive material;
4. Preparing material for shipment;
5. Package certificate requirements;
6. Special arrangement requirements;
7. Licensing requirements for carriers;
8. Transport safety and security;
9. Labelling transport containers;
10. Completing shipping document;
11. Quality Assurance program;
12. In-transit transport licence; and
13. Placarding of transport vehicles.

C.13 Facility Documents, and Operating & Emergency Procedures

To provide information about facility documents and the organization of operating and emergency procedures, including:

1. Duties and responsibilities of radiation safety program personnel
    a) Radiation safety officer
    b) Radiation safety personnel
2. Radiation safety program procedures
3. Personnel monitoring
4. Use of radiation detection instruments
5. Performing radiation surveys

6. Calculating boundary of restricted area
7. Posting of warning signs
    a) Operating procedures
8. Inventory, inspection, and maintenance of equipment
    a) Requirements
    b) Records
9. Transportation of radioactive materials
10. Receipt and disposal of radioactive material
11. Leak testing of radioactive sources
12. Receiving and opening packages of radioactive material
13. Locking and securing sources
14. Operation and use of interlock systems (Class II)
15. Use of open sources
    a) Handling equipment
    b) Protective clothing
    c) Prevention of contamination
    d) Decontamination and decommissioning procedures
    e) Ventilation
16. Use of sealed radioactive sources
17. Emergency procedures
    a) Recognizing emergency situations
    b) Use of emergency equipment
    c) Contamination (applies to non-licensees)
    d) Fire
    e) Source leakage
    f) Transport accidents
    g) Emergency response
18. Reporting and notification requirements and procedures

C.14 Security

To provide information about security requirements for the facility, including:

1. Physical security
   a) On site
   b) In transit
   c) During field operations
2. Inventory control
   a) Reporting loss or theft