



Canadian Nuclear
Safety Commission

Commission canadienne
de sûreté nucléaire

REGULATORY
GUIDE

Certification of Exposure Device Operators

G-229

MARCH 2004

TYPES OF REGULATORY DOCUMENTS

The legal framework within which the Canadian Nuclear Safety Commission (CNSC) operates includes the *Nuclear Safety and Control Act*, its Regulations and other legal instruments such as licences, certificates and orders. The legal framework is supported by regulatory documents issued by the CNSC, the main classes of which are:

Regulatory Policy (P): a document that describes the philosophy, principles or fundamental factors that underlie the CNSC's approach to its regulatory mission. It provides direction to CNSC staff and information to stakeholders.

Regulatory Standard (S): a document that describes CNSC requirements. It imposes obligations on the regulated party, once it is referenced in a licence or other legally enforceable instrument.

Regulatory Guide (G): a document that indicates acceptable ways of meeting CNSC requirements, as expressed in the Act, Regulations, regulatory standard or other legally-enforceable instrument. It provides guidance to licensees and other stakeholders.

Regulatory Notice (N): a document that provides licensees and other stakeholders with information about significant matters that warrant timely action.

Regulatory Guide

G-229

CERTIFICATION OF EXPOSURE DEVICE OPERATORS

Published by the
Canadian Nuclear Safety Commission
March 2004

Certification of Exposure Device Operators

Regulatory Guide G-229

Published by the Canadian Nuclear Safety Commission

© Minister of Public Works and Government Services Canada 2004

Extracts from this document may be reproduced for individual use without permission, provided the source is fully acknowledged. However, reproduction in whole or in part for purposes of resale or redistribution requires prior written permission from the Canadian Nuclear Safety Commission.

Catalogue number : CC173-3/2-229E

ISBN 0-662-36038-9

Également publié en français sous le titre

Accréditation des opérateurs d'appareil d'exposition.

Document availability

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

Communications and Information Management Directorate
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
280 Slater Street
Ottawa, Ontario, K1P 5S9

Telephone: (613) 995-5894 or 1-800-668-5284 (Canada only)

Facsimile: (613) 992-2915

E-mail: publications@cnsccsn.gc.ca

TABLE OF CONTENTS

1.0	PURPOSE	1
2.0	SCOPE	1
3.0	RELEVANT LEGISLATION	1
	3.1 Regulatory Framework.....	1
	3.2 Legislation.....	2
4.0	EDO CERTIFICATION PROCESS	2
5.0	QUALIFICATIONS	2
	5.1 Training.....	2
	5.2 Experience.....	3
6.0	TRAINING AND APPRENTICESHIP	3
	6.1 Vocational training program	3
	6.2 Apprenticeship program.....	4
7.0	EXAMINATIONS	4
	7.1 Written Examination.....	4
	7.2 Criteria for Passing the Written Examination	5
	7.3 Failure in the Written Examination	5
	7.4 Practical Examination	6
	7.5 Criteria for Passing the Practical Examination.....	6
	7.6 Failure in the practical examination.....	6
8.0	REGISTERING FOR THE WRITTEN EXAMINATION	7
	8.1 Availability.....	7
	8.2 Registration.....	7
	8.3 Notification of examination results.....	7
9.0	APPLICATION FOR CERTIFICATION BY THE CNSC	8
	9.1 Applying for certification	8
	9.2 Cost recovery fees.....	8
	9.3 Information to be submitted.....	8
	9.4 Certification.....	9
10.0	REFUSAL TO CERTIFY	9
11.0	DECERTIFICATION	9
	11.1 Reasons for decertification.....	9
	11.2 Applying for new certification	9
12.0	NOTIFICATIONS AND OPPORTUNITY TO BE HEARD	10
	12.1 Notification of a Proposed Decision to Refuse a Certification.....	10
	12.2 Notification of a proposed decision of decertification.....	10
	12.3 Content of notifications	10
	12.4 Opportunity to be heard	10

13.0 SURRENDER OF THE CERTIFICATE	10
GLOSSARY	11
APPENDIX A — SUGGESTED TRAINING TOPICS.....	13
A.1 Introduction.....	13
A.2 Fundamental Properties of Matter.....	13
A.3 Radiation and Radioactivity.....	13
A.4 Interaction of Radiation with Matter.....	14
A.5 Radiation Units	14
A.6 Radiation Detection and Measurement	14
A.7 Biological Effects of Radiation.....	15
A.8 Controlling Radiation Exposure.....	16
A.9 Gamma Radiography Exposure Devices – Principles of Operation	17
A.10 Normal Operating Procedures of Gamma Radiography Exposure Devices.....	17
A.11 Emergency Operating Procedures of Gamma Radiography Exposure Devices ..	18
A.12 Transportation Requirements.....	19
A.13 Nuclear Safety and Control Act and Regulations	19
APPENDIX B — EDUCATIONAL INSTITUTIONS PROVIDING THE VOCATIONAL PROGRAM AT TIME OF PUBLICATION	20
APPENDIX C — EXAMPLES OF QUESTIONS OF THE WRITTEN EXAMINATION..	21
C.1 Examples of Multiple-choice Questions.....	21
C.2 Example of an Essay Question	21
APPENDIX D — APPLICATION FOR CERTIFICATION AS AN EXPOSURE DEVICE OPERATOR.....	22

CERTIFICATION OF EXPOSURE DEVICE OPERATORS

1.0 PURPOSE

This regulatory guide describes the minimum training and experience that the Canadian Nuclear Safety Commission (CNSC) considers appropriate for persons seeking certification as Exposure Device Operators (EDOs). For ease of reference and as an aid to these persons (referred to in this document as “EDO candidates”), the guide also describes the process that these persons should follow in order to apply for certification by the CNSC. This guide also discusses the power of the CNSC to decertify an individual and the possible grounds which may give rise to such action.

2.0 SCOPE

This guide has been prepared to assist:

1. EDO candidates;
2. Educational institutions and gamma radiography licensees that design or offer vocational training programs and apprenticeship programs for EDO candidates; and
3. The Non-destructive Testing (NDT) Certifying Agency, Natural Resources Canada, that administers the written examination to EDO candidates on behalf of the CNSC and, on request, also administers the practical examination.

This guide does not purport to address all the safety aspects associated with the use of material and the operation of equipment that are potentially hazardous. Anyone using potentially hazardous material or equipment is responsible for following appropriate health and safety practices.

3.0 RELEVANT LEGISLATION

3.1 Regulatory Framework

The CNSC is the federal agency that regulates the use of nuclear energy and materials to protect health, safety, security and the environment, and to respect Canada’s international commitments on the peaceful use of nuclear energy.

The *Nuclear Safety and Control Act (NSCA, or Act, or NSC Act)* requires persons or organizations to be licensed by the CNSC for carrying out the activities referred to in section 26 of the Act, unless otherwise exempted. The regulations made pursuant to the Act stipulate prerequisites for CNSC licensing, certification, and the obligations of licensees and workers.

3.2 Legislation

1. Sections 24 to 29 of the *Nuclear Substances and Radiation Devices Regulations* apply to the certification process for exposure device operators and the associated processes of refusal to certify and decertification.
2. Pursuant to Sections 21(e) and 22 of the *CNSC Cost Recovery Fees Regulations*, there is a fee for the CNSC's assessment of EDO applications.
3. While not specific to the certification process, EDO candidates should also be aware of other applicable regulations made pursuant to the Act in addition to the *Nuclear Substances and Radiation Devices Regulations*, namely, the *General Nuclear Safety and Control Regulations*, *Radiation Protection Regulations*, and *Packaging and Transport of Nuclear Substances Regulations*.

4.0 EDO CERTIFICATION PROCESS

Section 24 of the *Nuclear Substances and Radiation Devices Regulations*, made pursuant to the Act, prohibits any person, other than a certified exposure device operator or a trainee acting under the direct supervision and continuous observation of a certified exposure device operator, to operate an exposure device. Any person who wishes to become an exposure device operator must apply to the CNSC for certification.

The CNSC will assess each application on a case-by-case basis, and may consider alternative types of training and experience to those recommended in this guide as may be appropriate in the context of a particular application. However, alternatives to the expected training and experience described in this guide should be such as to give the CNSC reasonable assurance that EDO candidates have the knowledge and skills required to safely operate these devices.

5.0 QUALIFICATIONS

Exposure devices used in industrial gamma radiography contain relatively strong radiation sources; their improper operation can lead to serious radiation incidents. As a consequence, to operate these devices in a way that does not pose unreasonable risk to the health and safety of the public or the safety of the environment, EDOs should be thoroughly familiar with the principles of gamma radiography and the principles and practices of radiation protection and radiation safety. Furthermore, EDOs should be thoroughly familiar with the procedures for the safe operation of exposure devices. In addition, the medical condition of EDOs should in no way unreasonably impair their ability to operate exposure devices in a safe manner.

The CNSC believes that the knowledge and skills required to safely operate an exposure device can only be obtained by persons having an appropriate combination of training and experience. For these reasons, the CNSC expects EDO candidates to possess, at the time of their application for certification, the minimum qualifications outlined below.

5.1 Training

As a minimum, 40 hours of vocational training in radiation safety and in the theory and practice of gamma radiography, as specified in paragraph 6.1 of this guide.

5.2 Experience

As a minimum, 320 hours of apprenticeship as an EDO trainee, at a licensed gamma radiography facility, as specified in paragraph 6.2 of this guide.

6.0 TRAINING AND APPRENTICESHIP

The CNSC expects EDO candidates to complete a vocational training program and an apprenticeship program which address the knowledge and skills that an EDO should have to safely operate an exposure device. To be acceptable to the CNSC, these programs should be based on a systematic approach to training (SAT).

6.1 Vocational training program

The vocational training program should cover the following subjects:

1. The principles of gamma radiography;
2. All applicable aspects of radiation protection and radiation safety principles;
3. The principles of operation of industrial exposure devices and their normal operating and emergency procedures; and
4. The relevant sections of the *NSC Act* and of the applicable regulations made pursuant to the *NSC Act* (see paragraph 3.2 of this guide).

Refer to Appendix A to this guide for a detailed list of topics that should be covered in the vocational training program.

The CNSC recommends that EDO candidates complete the vocational training program at a recognized educational institution or at a licensed gamma radiography facility where that licensee has the resources to properly manage the program. Alternatively, this training program may be completed by correspondence with a recognized educational institution. Refer to Appendix B of this guide for educational institutions offering the vocational training program for EDO candidates at the time of publication of this guide. Although it is recommended that vocational training be completed prior to the start of apprenticeship training, it may also be completed during the first few weeks of employment.

Since the vocational training program provides EDO candidates with knowledge of the principles of gamma radiography, and radiation protection, and of the regulatory requirements, the CNSC expects EDO candidates to complete this program before entering the apprenticeship program referred to in paragraph 6.2.

6.2 Apprenticeship program

The apprenticeship program should cover the following topics:

1. Principles of operation of specific exposure devices and associated equipment;
2. Supervised operation of specific exposure devices and associated equipment;
3. Use of remote handling tools;
4. Personal dosimetry;
5. Use of survey meters;
6. Specific emergency procedures including practical exercises; and
7. Human factors considerations resulting from the working environment, substance abuse, fatigue and stress.

The CNSC expects EDO candidates to complete their apprenticeship program at a licensed gamma radiography facility under the direct supervision of an experienced certified EDO appointed by the licensee. This period of apprenticeship should be with the same licensee and completed within six months.

Furthermore, the CNSC expects EDO candidates to commence their apprenticeship program no later than three months after completing the written examination described in paragraph 7.1 of this guide, since it is a well-known fact that the knowledge acquired during training gradually deteriorates if not regularly used in the actual performance of the job.

7.0 EXAMINATIONS

7.1 Written Examination

To obtain a certification by the CNSC, EDO candidates must successfully complete a written examination administered on behalf of the CNSC by the NDT Certifying Agency. The CNSC expects EDO candidates to pass this written examination at the completion of the vocational training program referred to in paragraph 6.1 of this guide. The purpose of the written examination is to determine whether EDO candidates have the knowledge required to operate an exposure device in a safe manner, and in accordance with the applicable regulations made pursuant to the *NSC Act*.

The written examination consists of:

1. 60 multiple-choice questions each worth 1 point; and
2. A number of essay questions with a total worth of 40 points. These questions are selected from a bank of questions that has been approved by CNSC staff at the time of the examination.

The written examination will contain a representative sample of questions, covering the subjects listed in Appendix A of this guide, to assess the knowledge of EDO candidates in the following areas:

1. Fundamental properties of matter;
2. Radiation and radioactivity;
3. Radiation units;
4. Radiation detection and measurement;
5. Biological effects of radiation;
6. Radiation exposure control;
7. Exposure devices:
 - a) principles of operation,
 - b) normal operating procedures,
 - c) emergency procedures, and
 - d) transportation requirements; and
8. *NSC Act* and applicable regulations made pursuant to the *Act*

Refer to Appendix C of this guide for examples of questions that may be asked in the examination.

7.2 Criteria for Passing the Written Examination

Since the examination is a limited sampling of the knowledge the CNSC considers essential to the safe operation of an exposure device, the pass mark of the examination is 75 percent overall, with a minimum of 20 points on the essay questions.

7.3 Failure in the Written Examination

The CNSC expects EDO candidates who fail the written examinations to wait at least 30 days before reapplying for the examination. This time should be used by EDO candidates to review the vocational training program

In addition, in the opinion of the CNSC, EDO candidates who fail the written examination on two consecutive attempts have not mastered the knowledge of the principles of gamma radiography, radiation protection, and of the regulatory requirements needed to safely operate exposure devices. As a consequence, the CNSC expects those candidates to repeat the entire vocational training program before reapplying for the examination.

7.4 Practical Examination

The CNSC also expects EDO candidates to pass a practical examination at the completion of the apprenticeship program referred to in paragraph 6.2 of this guide. The purpose of the examination is to determine whether EDO candidates have acquired the skills and attitudes required to operate an exposure device in a safe manner.

The practical examination should be conducted under the supervision of an experienced certified EDO at the licensed facility where the EDO candidate has completed the apprenticeship program. Alternatively, EDO candidates may apply to the NDT Certifying Agency to complete the practical examination at one of its test centres.

7.5 Criteria for Passing the Practical Examination

During the practical examination, the EDO candidate should demonstrate, to the satisfaction of the certified EDO supervising the examination, competence in performing each of the following tasks:

1. Determine safe surface dose rates on the exposure device;
2. Take an exposure device from storage and attach all necessary equipment in preparation for use;
3. Prepare for exposure by establishing working areas and erecting safe exposure barriers to prevent unauthorized entry;
4. Cycle the source assembly to the exposed position and return it to the fully shielded position;
5. Use the appropriate survey meters to verify that the source assembly has returned to the fully shielded position;
6. Lock the exposure device, detach all associated equipment and return the locked exposure device to its storage location; and
7. Prepare an exposure device for transportation as specified in the *Packaging and Transport of Nuclear Substances Regulations*.

7.6 Failure in the practical examination

The CNSC expects EDO candidates who fail to perform competently one or two of the tasks listed in paragraph 7.5 to receive remedial practical instruction on these tasks before retaking the corresponding part of the examination.

In addition, EDO candidates who fail to perform competently more than two tasks listed in paragraph 7.5 do not have, in the opinion of the CNSC, the skills and attitudes required to safely operate exposure devices. As a consequence, the CNSC expects those candidates to repeat the entire apprenticeship program before retaking the entire examination.

8.0 REGISTERING FOR THE WRITTEN EXAMINATION

8.1 Availability

The written examination for EDO candidates is available on request. This examination may be completed either at the NDT Certifying Agency's headquarters in Ottawa or at one of its Approved Test Centres or Special Test Centres across Canada. Applicants should anticipate a delay of approximately two weeks between receipt of the exam registration application by the NDT Certifying Agency and being notified of the status of their application.

8.2 Registration

To register for the examination, the EDO candidates should complete the Exposure Device Operator Examination form (form EDOE-1). This application form and instructions are available from:

NDT Certifying Agency
Natural Resources Canada
Minerals and Metals Sector
568 Booth Street
Ottawa, Ontario
K1A 0G1
Phone: (613) 992-3914 or 992-7956
Facsimile: (613) 943-8297

Along with the application to register for the examination, EDO candidates should include evidence of their completion of the vocational training program referred to in paragraph 6.1 of this guide.

8.3 Notification of examination results

The NDT Certifying Agency will notify EDO candidates, by mail, of the result of the written examination.

9.0 APPLICATION FOR CERTIFICATION BY THE CNSC

9.1 Applying for certification

An “Application for Certification as an Exposure Device Operator” is attached as Appendix D of this guide. Completed applications, along with payment of the required fee, should be submitted to:

Accounting Operations Section
Finance and Administration Directorate
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, Ontario
K1P 5S9
For information, toll-free: 1-800-668-5284

9.2 Cost recovery fees

It is federal government policy to implement user charges for services that provide recipients with direct benefits beyond those received by the general public. As indicated in the application form in Appendix D, an “Application for Certification as an Exposure Device Operator” must be accompanied by the appropriate cost recovery fee referred to in paragraph 3.2 of this guide. All cheques and money orders must be made payable to the Receiver General for Canada.

9.3 Information to be submitted

As indicated in the application form in Appendix D, the following information should be submitted with the application for EDO certification:

1. The candidate’s name in full;
2. The address of the candidate’s business;
3. Evidence of completion of the vocational training program referred to in paragraph 6.1 of this guide;
4. Evidence of completion of the apprenticeship program referred to in paragraph 6.2 of this guide;
5. Evidence of the successful completion of the written examination referred to in paragraph 7.1 of this guide;
6. Evidence of the successful completion of the practical examination referred to in paragraph 7.4 of this guide; and
7. A declaration signed by the candidate indicating that, to the best of the candidate’s knowledge, no medical condition or other impairment exists that would unreasonably affect the candidate’s ability to operate the exposure device in a safe manner.

9.4 Certification

The CNSC may certify a person as an EDO if the following conditions are met:

1. The candidate's combination of training and experience meets the CNSC qualifications referred to in section 5 of this guide;
2. The candidate has successfully completed the written examination referred to in paragraph 7.1 of this guide;
3. The candidate has successfully completed the practical examination referred to in paragraph 7.4 of this guide;
4. No other known condition exists that would render the candidate unsuitable for the EDO position; and
5. The candidate has submitted, with the application, the required fee for certification as an EDO.

10.0 REFUSAL TO CERTIFY

The CNSC may, in the public interest, refuse to certify persons as EDOs if, in the CNSC's judgement, these persons fail to demonstrate that they meet the expectations outlined in this guide.

11.0 DECERTIFICATION

11.1 Reasons for decertification

The CNSC may decertify an EDO where the Commission has reasonable grounds to believe that the person is no longer qualified or capable of operating exposure devices in a safe manner, or where the EDO's conduct has been such as to give rise to a reasonable concern that the EDO is not acting responsibly when operating those devices.

Without restricting the general principle above, examples of circumstances that the CNSC may take into account in making this determination include:

1. Any medical condition or other impairment that affects the EDO's ability to operate an exposure device in a safe manner;
2. Contravention of the *NSCA Act* or of the relevant regulations made pursuant to the *Act*; and
3. Failure to work on a regular basis as an EDO or as a supervisor of EDO trainees for more than two years, unless the EDO can provide evidence, acceptable to the CNSC, of having maintained the knowledge and skills required to operate an exposure device in a safe manner.

11.2 Applying for new certification

An EDO who has been decertified may apply for a new certification by submitting an application to the CNSC. The application must include evidence that the concerns that led to the decertification have been addressed and that the person still has the knowledge and skills expected of an EDO, as described in this guide.

12.0 NOTIFICATIONS AND OPPORTUNITY TO BE HEARD

12.1 Notification of a Proposed Decision to Refuse a Certification

The CNSC will notify a person who has applied for certification of a proposed decision to refuse the certification at least 30 days before refusing to certify the person.

12.2 Notification of a proposed decision of decertification

The CNSC will notify a person of a proposed decision of decertification at least 30 days before decertifying the person.

12.3 Content of notifications

The notifications referred to in paragraphs 12.1 and 12.2 will include the reasons for the proposed decision and will inform the persons of their right to be heard on the matter as required by section 26 and section 27 of the *Nuclear Substances and Radiation Devices Regulations*.

12.4 Opportunity to be heard

A person who has been notified of the proposed decisions referred to in paragraphs 12.1 and 12.2 may, within 30 days of receiving the notification, request an opportunity to be heard either orally or in writing. Information on the process such a person should follow in order to be heard may be obtained by writing to:

The Director
Personnel Certification Division
Directorate of Assessment and Analysis
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, Ontario
K1P 5S9
Facsimile: (613) 995-5086

If the person requests an opportunity to be heard, that person will be provided with the opportunity under section 28 of the *Nuclear Substances and Radiation Devices Regulations*, and will be notified at the completion of the hearing of the decision and the reasons for it. If a person does not request an opportunity to be heard within the prescribed time, the person will be notified of the decision and the reasons for it.

13.0 SURRENDER OF THE CERTIFICATE

Pursuant to section 29 of the *Nuclear Substances and Radiation Devices Regulations*, an EDO, on being notified of a decision of decertification, must immediately surrender to the CNSC the EDO's certificate.

GLOSSARY

certification

an attestation by the CNSC that the named individual has the qualifications expected of an exposure device operator (accréditation)

certified

certified by the CNSC under paragraph 21(1)(i) of the *NSC Act* or by a designated officer authorized under paragraph 37(2)(b) of the *NSC Act* (accrédité)

certified Exposure Device Operator (EDO)

a person who has the qualifications to safely operate industrial gamma radiography exposure devices anywhere in Canada and who is certified as such by the CNSC (opérateur d'appareil d'exposition (OAE) accrédité)

NDT Certifying Agency

the division of Natural Resources Canada that administers, on behalf of the CNSC, the written examination for candidates for the position of exposure device operator (organisme de certification en END)

dosimeter

any device for measuring a dose of radiation that is worn or carried by an individual (dosimètre)

evidence

original document or notarized copy of a document used in support of an application for examination or certification (attestation de réussite)

exposure device

a radiation device that is designed for carrying out gamma radiography, and includes any accessory to the device such as a sealed source assembly, a drive mechanism, a sealed source assembly guide tube and an exposure head (appareil d'exposition)

licensee

a person who is licensed to carry on an activity described in any of paragraphs 26(a) to (c) of the *NSC Act* in relation to a nuclear substance or a radiation device (titulaire de permis)

operate

(in respect of an exposure device): coupling the drive mechanism to the exposure device, uncoupling the drive mechanism from the exposure device, locking or unlocking the exposure device, and all activities involving the device that take place while the sealed source assembly is not locked inside the device in the fully shielded position (faire fonctionner)

qualifications

the combination of training and experience expected of an exposure device operator (qualifications)

recognized educational institution

an institution having a federal or provincial charter that provides the vocational training program to persons seeking certification as exposure device operators (établissement d'enseignement reconnu)

sealed source assembly

a sealed source that is designed to be used in an exposure device, and includes the components that are permanently attached to the sealed source (assemblage de source scellée)

systematic approach to training (SAT) (Approche systématique à la formation)

a structured approach to training comprised of the following phases:

1. **analysis**
the identification of training needs and of the knowledge, skills and attributes required to perform a particular job (analyse)
2. **design**
the conversion of the knowledge, skill and attribute requirements identified in the analysis into training objectives and the production of a training plan (conception)
3. **development**
the preparation of the training materials to meet the training objectives (élaboration)
4. **implementation**
the conduct of training using the training materials developed (mise en oeuvre)
5. **evaluation**
the determination of the effectiveness of training in producing competent workers. Evaluation feedback is used as input to the other phases of SAT to ensure continued training effectiveness (évaluation)

APPENDIX A

Suggested Training Topics

A.1 Introduction

1. History and discovery of radioactivity
2. Definition of industrial radiography
3. Review of mathematics used in industrial radiography

A.2 Fundamental Properties of Matter

1. Structure of the atom and of the nucleus
2. Atomic number and atomic weight – definition
3. Isotopes:
 - a) Definition
 - b) Radioactive and stable isotopes
 - c) Isotopes used in industrial gamma radiography

A.3 Radiation and Radioactivity

1. Definition of radiation
2. Decay mechanisms of radioactive isotopes
 - a) Alpha decay: characteristics of alpha particles, hazard and shielding
 - b) Beta decay: characteristics of beta particles, hazard and shielding
 - c) Gamma decay: characteristics of gamma rays, hazard and shielding
 - d) Neutron emission: hazards and shielding
3. Energy spectrum of electromagnetic radiation
4. Decay charts
5. Activity
 - a) Unit of activity – Becquerel or Curie
 - b) Half-life
 - c) Half-life plots

A.4 Interaction of Radiation with Matter

1. Energy loss by alpha, beta, gamma and neutron radiation
 - a) Range in air
 - b) Range in selected materials (Al, Fe, steel, U)
 - c) Range in tissue
2. Ionization
 - a) Particle ionization
 - b) Gamma ray ionization
 - (i) Photoelectric effect
 - (ii) Compton effect
 - (iii) Pair production

A.5 Radiation Units

1. Exposure: Coulomb/Kg and the Roentgen (R): Definition and meaning
2. Absorbed dose: Gray (Gy) and rad (rad): Definition and meaning
3. Dose equivalent: Sievert (Sv) and rem (rem): Definition and meaning
4. Multiples and submultiples of radiation units
5. Conversion from and to SI units

A.6 Radiation Detection and Measurement

1. Dose and dose rate devices
2. Personal dosimeters
 - a) Thermoluminescent dosimeter (TLD)
 - (i) Principles of operation
 - (ii) Importance in radiation protection
 - (iii) Sensitivity and limitations
 - (iv) Extremity TLDs
 - (v) Procedures for use, wearing and storing TLDs
 - b) Direct reading dosimeter (DRD)
 - (i) Principles of operation
 - (ii) Low range and high range DRDs
 - (iii) Importance in radiation protection
 - (iv) Sensitivity and limitations
 - (v) Procedures for use, wearing and storing DRDs

- c) Personal alarming dosimeters (PAD)
 - (i) Principles of operation
 - (ii) Importance in radiation protection
 - (iii) Sensitivity and limitations
 - (iv) Procedures for using, wearing and storing PADs
3. Interpretation and recording of personal dosimeter readings
4. Typical examples of commercially available personal dosimeters
5. Survey instruments
 - a) Ion chamber instruments
 - (i) Principles of operation
 - (ii) Importance in radiation protection
 - (iii) Sensitivity and limitations
 - (iv) Instrument failures
 - (v) Procedure for using and storing ion chamber instruments
 - b) Geiger Müller (GM) counters:
 - (i) Principles of operation
 - (ii) Importance in radiation protection
 - (iii) Sensitivity and limitations
 - (iv) Instrument failures
 - (v) Procedure for using and storing GM counters
6. Interpretation and recording of survey instrument readings
7. Typical examples of commercially available survey instruments
8. Maintenance and calibration of radiation measurement devices
 - a) Regulatory requirements
 - b) Inspection of equipment including frequency
 - c) Instrument checks

A.7 Biological Effects of Radiation

1. Sources of radiation exposure: Hazards from external radiation
2. Types of effects
 - a) Stochastic and non-stochastic effects
 - b) Somatic effects
 - (i) Early radiation effects
 - (ii) Delayed radiation effects
 - c) Genetic effects

3. Clinical effects on humans
 - a) Radiosensitivity of organs
 - b) Classification of doses
 - (i) Effects of acute radiation doses
 - (ii) Chronic doses and delayed effects
 - c) Factors determining the effect of a given dose
 - (i) Part of body exposed
 - (ii) Rate of exposure
 - (iii) Extent of body part that receives exposure
 - (iv) Age of the individual
 - (v) Biological variations among individuals
4. Radiation hazards in proper perspective
 - a) Radiation benefits and risks
 - b) Personal exposures
 - (i) From man-made sources
 - (ii) From background radiation
5. Radiation risks to gamma radiography exposure device operators
6. Maximum permissible doses for nuclear energy workers

A.8 Controlling Radiation Exposure

1. ALARA (as low as reasonably achievable) principle
2. Action levels
3. Control of external radiation exposure
 - a) Time
 - b) Distance
 - (i) Example problems
 - c) Shielding
 - (i) Definition of half-value (HVL) and of tenth-value (TVL) layers
 - (ii) HVL and TVL for various shielding materials
 - (iii) Example problems
 - d) Use of time, distance and shielding in industrial radiography work
4. Control of internal radiation exposure: Modes of entry into body
 - a) Inhalation
 - b) Ingestion
 - c) Absorption through skin

5. Contamination control
 - a) Contamination prevention
 - b) Detection of contamination

A.9 Gamma Radiography Exposure Devices – Principles of Operation

1. Physical and chemical characteristics of sources
 - a) Radiation hazards
 - b) Contamination hazards
2. Cable operated exposure devices
 - a) Components
 - b) Principles of operation
 - c) Maintenance
 - d) Emergency equipment
3. Pneumatically operated exposure devices
 - a) Components
 - b) Principles of operation
 - c) Maintenance
 - d) Emergency equipment

A.10 Normal Operating Procedures of Gamma Radiography Exposure Devices

1. Specific safe operating procedures for:
 - a) Fabrication shop operations
 - b) Pipeline operations
2. Daily operating procedures
 - a) Equipment preparation
 - b) Transport of equipment to job site
3. Radiographic safe work practices
 - a) Job site control
 - (i) Establishment of restricted areas
 - (ii) Posting of signs and surveillance of restricted areas
 - (iii) Regulatory requirements for surveys, posting of signs, and surveillance of high radiation areas
 - (iv) Deployment of emergency equipment
 - b) Record keeping

A.11 Emergency Operating Procedures of Gamma Radiography Exposure Devices

1. Recognizing emergency situations
2. Use of emergency equipment
3. General emergency procedure
 - a) Source pre-retrieval procedure
 - (i) STAR (Stop, Think, Act, Review) principle
 - (ii) Plan retrieval
 - (iii) Radiation surveys
 - (iv) Locating source and verification of its condition
 - (v) Dosimetry requirements
 - b) Source retrieval procedure
 - c) Source post-retrieval procedure
 - (i) Secure source
 - (ii) Determination of the cause of the emergency
 - (iii) Taking source out of service
 - d) Reporting requirements
4. Specific emergency situations
 - a) Loss or theft of source
 - b) Fire
 - c) Source leakage
 - d) Transport accidents
 - e) Cable operated exposure device emergencies
 - (i) Source disconnect, misconnect
 - (ii) Source jammed in guide tube
 - (iii) Source jammed in collimator
 - (iv) Source not fully retracted
 - (v) Source outside the exposure device
 - f) Pneumatically operated exposure device emergencies
 - (i) Source jammed in guide tube nozzle
 - (ii) Source jammed in the guide tube
 - (iii) Source not fully retracted
 - (iv) Source outside the exposure device

A.12 Transportation Requirements

1. Receipt of radioactive sources
 - a) Radiation survey requirement
 - b) Receipt records
2. Shipment of radioactive sources
 - a) Preparing and packaging radioactive sources for shipment
 - b) Completing shipping documents
 - c) Radiation survey of package
3. Transportation of radioactive sources
 - a) Package certificate and special arrangement requirements
 - b) Licensing requirements for carriers
 - c) Transport safety
 - d) Labelling transport container
 - e) Completing shipping document
 - f) Placarding of transport vehicle

A.13 Nuclear Safety and Control Act and Regulations

1. Relevant sections of the *NSC Act*
2. Relevant sections of the regulations made pursuant to the *Act*:
 - a) *General Nuclear Safety and Control Regulations*
 - b) *Radiation Protection Regulations*
 - c) *Nuclear Substances and Radiation Devices Regulations*
 - d) *Packaging and Transport of Nuclear Substances Regulations*
 - e) *CNSC Cost Recovery Fees Regulations*

APPENDIX B

Educational Institutions

Providing the Vocational Program at time of Publication

British Columbia Institute of Technology

3700 Willingdon Ave.
Burnaby, BC
V5G 3H2

College d'Enseignement Général et Professionnel

3500 rue De Courval
Trois-Rivières, QC
G9A 5E6

College of the North Atlantic

1 Grand Bay Road
Port aux Basques, NF
A0M 1C0

INTEG, International NDT Training & Education Group

1409 Wallace Road
Oakville, ON
L6L 2Y1

CINDE, Canadian Institute for Non-Destructive Examination

c/o Mohawk College
135 Fennel Avenue West
Hamilton, ON
L8N 3T2

Northern Alberta Institute of Technology

11762 - 106 St
Edmonton, AB
T5G 2R1

Southern Alberta Institute of Technology

1301 - 16 Ave. NW
Calgary, AB
T2M 0LA

APPENDIX C

Examples of Questions of the Written Examination

C.1 Examples of Multiple-choice Questions

1. 1 Becquerel is equal to:
 - a) 3.7×10^{10} disintegrations per second
 - b) 1 disintegration per second
 - c) 3.7 disintegrations per second
 - d) 1 disintegration per minute
2. What is the dose rate at 2 metres from an unshielded 370 GBq (10 Ci) Cobalt-60 source?
 - a) 34 mSv/h (3.4 rem/h)
 - b) 68 mSv/h (6.8 rem/h)
 - c) 340 mSv/h (34 rem/h)
 - d) 680 mSv/h (68 rem/h)
3. An exposure device shall not be operated if a radiation measurement from any part of the surface of the device exceeds:
 - a) 10 mSv/h (1 rem/h)
 - b) 20 mSv/h (2 rem/h)
 - c) 200 Bq/h
 - d) 2 mSv/h (200 rem/h)

C.2 Example of an Essay Question

1. You are a certified exposure device operator of a cable drive radiographic exposure device. Upon completion of a collimated radiographic exposure the source capsule assembly becomes disconnected from the drive cable and remains in the collimator when you attempt to retract it to the fully shielded position in the radiographic device.
 - a) How would you react to this situation? *2 points*
 - b) Describe as many procedures as you can that could be used to return the source capsule assembly to the fully shielded position in the radiographic exposure device with as little exposure to radiation as possible. (Refer to Answer Tips below.)

Answer Tips

Your answer for 1.b) should consist of the following parts:

1. Preparations for Retrieval *8 points*
2. Retrieval Procedures *26 points*
3. Post Retrieval (steps to be taken after the retrieval) *4 points*

APPENDIX D

Application for Certification as an Exposure Device Operator

Additional copies of the above application form may be obtained from:

Director, Personnel Certification Division
Directorate of Assessment and Analysis
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, ON K1P 5S9
Phone: 1-800-668-5284

www.nuclearsafety.gc.ca



Application for Certification as an Exposure Device Operator

Mr. Mrs. Ms.

Name: _____ / _____ / _____
 (Please Print) Surname Given Name Middle Name

Address: _____
 (Please Print) _____
 _____ / _____ / _____
 City Province Postal Code

Telephone: (____) _____ - _____ Ext ____ **NRCan Registration No.:** _____

For CNSC Use Only

NRCan Registration No. _____

Received _____ / _____ / _____
 Month Day Year

Attached

Cost Recovery Fee

Evidence of vocational training

Written examination results

Evidence of apprenticeship

Practical examination results

Other

Certification

Issued _____ / _____ / _____
 Month Day Year

Refused _____ / _____ / _____
 Month Day Year

Employer: _____
 (Please Print)

Address: _____
 (Please Print) _____
 _____ / _____ / _____
 City Province Postal Code

Telephone: (____) _____ - _____ Ext ____ **Fax:** (____) _____ - _____

With your application you should submit:

- the required fee for certification (made out to the Receiver General for Canada)
- a statement of completion of the vocational training program from a recognized institution
- a statement of successful completion of the written examination from Natural Resources Canada (NRCan)
- a statement of completion of an apprenticeship program from a licensee
- a statement of successful completion of the practical examination from a licensee or a recognized institution
- alternatives to the training and experience above

Declaration of Medical Fitness and Consent to Keep Personal Information

I hereby certify that, to the best of my knowledge, I have no known medical conditions that could unreasonably impair my ability to operate an exposure device safely.

Furthermore, I hereby give my consent to the Canadian Nuclear Safety Commission (CNSC) to keep and share with the Non-destructive Testing (NDT) Certifying Agency of NRCan, and with my employers, information on my qualifications or other information on which a decision on my certification or decertification as an Exposure Device Operator may be made. I understand that personal information kept by the CNSC is protected under the *Privacy Act*, is retained in the Personal Information Bank CNS PPU 060, and cannot be disclosed to other parties without my written consent. I also understand that Sections 24 to 29 of the *Nuclear Substances and Radiation Devices Regulations* and Sections 21(e) and 22 of the *CNSC Cost Recovery Fees Regulations* apply to the certification process for exposure device operators.

Signature: _____ **Date:** _____ / _____ / _____
 Month Day Year

Submit this application and the required fee to:

Accounting Operations Section
 Finance and Administration Directorate
 Canadian Nuclear Safety Commission
 P.O. Box 1046, Station B
 Ottawa, ON K1P 5S9
 Tel: 1-800-668-5284, Fax: (613) 995-5086

For information on EDO certification, contact:

Director, Personnel Certification Division
 Directorate of Assessment and Analysis
 Canadian Nuclear Safety Commission
 P.O. Box 1046, Station B
 Ottawa, ON K1P 5S9
 Tel: 1-800-668-5284



