Introduction

The Canadian Nuclear Safety Commission (CNSC) regulates all types of Class II Prescribed Equipment (PE), such as irradiators; teletherapy machines; particle accelerators and brachytherapy remote afterloaders, to ensure their safe operation and the safety of Canadians. These complex devices require competent workers to safely operate and maintain them. There is currently no formal regulatory requirement dictating the necessary knowledge, skills and abilities that a Class II PE service technician (hereinafter: service technician) must possess in order to safely maintain these devices. As stipulated in *General Nuclear Safety and Control Regulations Section* 12 (1) (a) and (b) respectively: a) Licensees shall ensure a presence of a sufficient number of qualified workers to carry out licensed activities safely in accordance with the *Act* and its associated regulations and the licence; b) train the workers to carry on the licensed activity in accordance with the *Act*, the regulations made under the *Act* and the licence.

CNSC Staff surveyed service technicians and commissioned a subject matter expert to provide a detailed report regarding the training, experience, safety hazards, relevant legislation, industry incidents and events and networking opportunities of service technicians.

CNSC staff employed the results of the study and report to establish a common set of service technician competencies (competency profile) which can be used by licensees to create assessments, selection techniques and tools, and to establish common practices and terminology for recruitment, performance management, workforce planning, training, and employee development. The competency profile will further support ongoing safe operation of Class II PE.

CNSC will review the profile periodically (on a 5-year basis).

Purpose

The service technician competency profile will be of value to an array of users within the CIIPE licensee community. Primarily, its purpose is to:

- Establish baseline criteria for assessing the competency of service technicians
- Provide a benchmark to ensure service technicians contribute to the overall safe and effective operation of Class II equipment
- Provide a reference for new and existing service technicians to benchmark and reflect on their professional development in the maintenance of CIIPE
- Promote knowledge, skill and safety-related attribute standardization, both within a licenced facility and throughout the Canadian CIIPE service technician community
- Provide a basis (learning outcomes) for curriculum development of CIIPE service technician training programs

Scope

The competency profile outlines objectives, focusing on the application of knowledge and tasks that a service technician will need to do or accomplish to safely maintain Class II PE. The profile is general to allow for consistency throughout the servicing community while respecting the unique and complex maintenance requirements of a wide array of Class II PE. The profile provides a starting point from which licensees can develop specific training plans to ensure service technicians have the knowledge, skills and abilities required to safely maintain each facilities Class II PE.

Document Overview

This guidance is divided into 4 sections:

- Key Terms

  Introduces definitions for key terms used throughout the document.

- Training and Training Records
  Training and competency assessment is most effective when it is flexible, performance oriented and systematically developed. This section provides information regarding suggested best practices to assist licensees in developing training programs for service technicians.

- Competency Profile and Framework

  The competency profile is subdivided into four areas: Technology, Regulatory, Safety and Behavioural. Technology competencies focus on the application of knowledge and skills to safely perform servicing activities on Class II PE. Regulatory competencies focus on understanding and applying the related legislation governing servicing activities of Class II PE. Safety competencies focus on the hazard identification and mitigation associated with servicing activities of Class II PE. Behavioural competencies outline personal attributes that will help a service technician adapt to the role, develop professionally, and achieve competency in the technology, regulatory and safety areas

- Appendices

  Appendices are included to support the competency profile and licensee training program development.

Key Terms

The glossary of terms is provided to clarify the meaning of key terms throughout this document. Terms and acronyms that are commonly understood are not defined here. Additional definitions can be found in the appropriate regulation or within the CNSC's REGDOC-3.6 Glossary of CNSC Terminology.

Term	Description
Competency	The combination of training, skills, experience, and knowledge that a person possesses and their ability to apply them to perform a task successfully and safely.
Corrective Maintenance (CM)	Activities performed to return prescribed equipment to its safe operating condition (Sometimes called extensive maintenance.)
Maintenance	The organized activities, both administrative and technical, to keep Class II prescribed equipment and radiation devices, as well as structures, systems and components, in good operating condition.
Manufacturer's Training	Training conducted by the manufacturer of the licensee's prescribed equipment. It is a formal course; usually attended at the manufacturer's facility.
Occupational Hazards	For the purpose of this document: the hazards that involve conventional health and safety: physical lifting objects; climbing ladders; crushing hazards; etc.
On the Job Training (OJT)	The training undertaken in the actual work environment to obtain required job-related knowledge and skills.
Prescribed Equipment (PE)	In this document: the certified equipment owned by a Class II licensee and regulated by the CNSC, A full definition for Class II PE can be found within Section 1 of the *Class II Nuclear Facilities and Prescribed Equipment Regulations*.
Preventive Maintenance (PM)	Actions that detect, preclude or mitigate degradation of a functional structure, system or component to sustain or extend its useful life by controlling degradation and failures to an acceptable level. Preventive maintenance may be routine, periodic, planned or predictive.
Safety Culture	Characteristics of the work environment, such as the values, rules, and common understandings that influence workers' perceptions and attitudes about the importance that the organization places on safety.
Safety-related attributes	Observable attributes of safety that reflect an organization's values and behaviors related to safety that each worker is expected to exhibit consistently on the job.
Servicing	Any maintenance of the equipment, including installation, repair or dismantling, other than routine operation procedures as indicated in the manufacturer's operating manual for the equipment, or as authorized in the licence issued for possession or use of the equipment. In order to perform servicing activities on PE in Canada, an individual must obtain the service licence from the CNSC.

Training

REGDOC-2.2.2, Personnel Training, Version 2, specifically Section 5 and Appendix A, provide guidance to licensees on the analysis, design, development, implementation, and evaluation of training programs for workers such that the training is preparation for performance on the job and is systematically developed leading from identification of a training requirement to the confirmation that the requirement has been satisfied.

Following the guidance in REGDOC-2.2.2, Personnel Training, Version 2, Section 5 and Appendix A, it is expected that resulting formal, documented, licensee initial and continuing training programs should address and include (but not be limited to) the acquisition and maintenance of the applicable competencies provided in the following service technician competency profile. The competencies are broadly grouped into four sections:

1) Technology Competencies
2) Regulatory Competencies
3) Safety Competencies
4) Safety-related Attributes

Training Records

As stipulated in the *Class II Nuclear Facilities and Prescribed Equipment Regulations, Section 21:*

(2) b, Every licensee who uses Class II prescribed equipment shall keep a record of the training received by each worker, including the date and subject of the training; and

(3), Every licensee shall retain a record of training referred to in paragraph (2) b for the period that the worker is employed by the licensee.

Competency Profile Framework

Service technicians are generally hired into the service technician role with pre-existing knowledge, skills, and abilities in conventional mechanical or electrical devices and their repairs. They have likely completed some relevant training through a college or university program or gained on-the-job experience in a previous work role. With diverse educational and experiential backgrounds, newly hired service technicians have a foundation for learning the specialized methods and procedures to safely repair and maintain Class II PE at their licensed facility.

Understanding that service technicians come to the role from a diversity of backgrounds, the CNSC has developed a general, high-level, competency profile which outlines the tasks a technician will be able to perform safely and independently when they have achieved competence in the maintenance of their specific Class II PE.

The profile is divided into those activities expected at the core competency level and at the advanced competency level. See table below for service technician role description by core and advanced competency level:

Service technician role descriptions by competency level	
Core	Advanced
Service technicians at this level are generally fully functioning specialists in routine maintenance of their specific prescribed equipment. Performs a variety of recurring and non-recurring work that involves related or varying processes and that are associated with moderately complex systems. Analyzes and determines various courses of action. Capable of preforming maintenance and repairs alone or as part of a team.	The advanced level may be achieved by performing maintenance and repairs at the core level on a regular basis for a prolonged time. The advanced service technician performs a number of widely varying and diverse assignments that require in-depth analysis and diagnostic work. Serves as a "technical expert" within the work unit and guides and coaches others. Demonstrates a thorough and extensive understanding of the most difficult and complex systems.

Consider the following principles when using the competency profile:

- The competency profile is not exhaustive, there may be additional tasks not listed here that are critical to the safe maintenance and repair of Class II PE. Licensees are encouraged to develop additional specific competencies in support of service technician training.
- Each competency may not be applicable to all licensed PE or facilities, it is up to the licensee to determine applicability of competencies.
- The competencies in the profile are interdependent and not intended to be applied in isolation.
- The service technician performs appropriate competencies in a manner consistent with the situation at hand, while complying with organizational directives. The competencies are not intended to be applied in the sequence listed, nor should they be considered a protocol.
- Performance of a competency requires the application of learning, which may involve the cognitive domain (knowledge and critical thinking skills), the affective domain (attitudes and values) and the psychomotor domain (manual skills).
- The competency profile defines the key learning outcomes that should be the product of the licensee training programs. They do not constitute a complete educational curriculum, nor do they define a learning process; these should be developed by appropriately qualified licensee personnel.

Competency Profile

1.0 Technology based competencies

Technology competencies focus on the application of knowledge and skills to safely perform servicing activities on Class II PE and their related ancillary systems.

Key Competency	Core	Advanced
Maintains PE following licensee's preventative maintenance (PM) schedule, policies or procedures.	• Performs routine or repetitious PM tasks completely and accurately • Recognizes and obtains required equipment, materials, and tools that are needed to do the job • Uses appropriate record keeping method • Ensures all PM work meets and/or exceeds applicable codes and standards	• Schedules PM and ensures availability of appropriate resources to perform it • Analyzes the PM procedures and implements changes or improvements when applicable • Performs equipment control software updates • Checks and re-checks PM work of others considering accuracy with respect to standards and codes
Performs corrective maintenance (CM) as required on PE, auxiliary and safety systems to return to safe operating state. (*See Appendix C for List of Primary and Associated Components pertaining to Class II PE)*	• Operates PE and associated systems while adhering to facilities operating procedures • Works effectively as a team member when performing major repairs requiring more than one individual • Takes advantage of available resources (personnel, processes, departments, and tools) to complete work efficiently. • Adheres to the facility servicing policies and procedures • Conducts trouble-shooting procedures during CM • Selects appropriate tools to perform required CM • Operates PE Software to move safely into maintenance mode and return safely to operation mode • Applies appropriate maintenance triage	• Analyzes the CM procedures and implements changes or improvements when applicable • Gathers and analyzes/interprets information to better understand the nature of the problem. • Conducts calibrations when applicable • Schedules CM and ensures availability of appropriate resources to perform it • Assists with the procurement of external services where required • Assists with the physical assembly and/or dismantling of the PE during Facility commissioning and/or decommissioning • Checks and re-checks CM work of others considering accuracy with respect to standards and codes
Adhere to Facility's Maintenance Management System	• Describe the facility's maintenance management system • Generates the appropriate record for each maintenance task	• Analyzes data from the facility's maintenance management system to identify recurring issues • Proactively develops procedures to alleviate recurring issues

Key Competency	Core	Advanced
Ensures availability and accuracy of required parts for scheduled and corrective maintenance activities.	• Adheres to facility's shipping and receiving procedures • Orders required replacement parts • Verifies correct part number before ordering and after receipt	• Manages spare parts inventory • Analyzes spare parts requirements and justify the appropriate amount of inventory • Contributes to the cost tracking and budgeting of spare parts
Performs applicable safety and operational checks (quality assurance -QA) according to license documents.	• Adheres to the facility's QA policies or procedures • Performs facility's QA activities when required	• Analyzes data from the facility's QA procedures to identify possible issues • Analyzes facility's QA procedures to ensure they are providing the appropriate results • Proactively develops improvements to facility procedures and policies to mitigate possible issues and improve outcomes
Adheres to facilities waste disposal procedure, policies or standards.	• Complies with facility's waste procedures • Performs the appropriate waste activity when required • Adheres to safe waste practices • Uses appropriate protective devices, equipment and apparel for waste disposal	• Analyzes the facility's waste procedures to ensure they conform to all related legislations and regulations • Provides improvements to the facility's waste procedures when appropriate • Create WHMIS information if necessary
Adheres to facilities securities procedures, policies or standards.	• Complies with the facility's Class II PE security procedures or requirements where applicable.	• Analyze the facility's security procedures to ensure they conform to all related legislations and regulations • Provide improvements to the facility's security procedures where appropriate

2.0 Regulatory

Regulatory competencies focus on understanding and applying the variety of related legislation governing servicing activities of Class II PE.

Key Competency	Core	Advanced
Adheres to applicable legal and regulatory requirements *(See Appendix A for list of Canadian Regulations Governing Class II PE)*	• Identifies all legal and regulatory requirements pertaining to maintenance of the facility's PE • Complies with all applicable Federal, Provincial and Municipal legislation and regulations	• Analyzes workplace policies to ensure compliance within Federal, Provincial and Municipal legislation and regulations. • Revises workplace polices to ensure compliance within Federal, Provincial and Municipal legislation and regulations where necessary

3.0 Safety

Safety competencies focus on the hazard identification and mitigation associated with servicing activities of Class II PE.

Key Competency	Core	Advanced
Integrates safe work principles and practices into work to ensure a safe environment *(See Appendix B for list of Safety Hazards pertaining to Class II PE)*	• Identifies workplace hazards pertaining to the facility's PE • Understands WHMIS data pertaining to the Facility's PE • Uses appropriate protective devices, equipment and apparel • Uses appropriate radiation detection devices • Adapts safety practices according to the Facility's PE • Applies ALARA principles	• Analyzes the workplace to identify any unsafe conditions that could be minimized or eliminated • Regularly assesses safety conditions; identifies, communicates, and implements accident prevention and corrective measures in work related activities • Minimizes or eliminates any potential hazards or unsafe conditions
Recognizes and responds to safety hazards	• Recognize and respond to facility emergencies • Use the Facility's incident reporting process • Understands and practices emergency procedures • Recognizes safe and unsafe conditions • Takes appropriate precautions when encountering any new hazard	• Analyzes accidents or near-misses involving the maintenance of the Facility's PE • Develops procedures/practices to avoid future accidents/near-misses • Develops emergency procedures that could result from encountering the hazards associated with the facility's PE • Enforces appropriate emergency procedures.

4.0 Safety-Related Attributes

In addition to technical, regulatory and safety competencies, the CNSC's review of service technician qualifications identified safety-related attributes which contribute to a technician's ability to perform safe work and develop skills across the three preceding competency areas. While safety-related attributes can seem difficult to measure they are included here to provide a basis for licensees to consider these attributes when hiring and training service technicians.

Ensuring technicians demonstrate safety-related attributes can help to foster a licensees healthy safety culture. A healthy safety culture is a key factor in reducing the likelihood of safety-related events and mitigating their potential impact, and in continually improving safety performance. All workers, from senior managers downwards, have a shared responsibility to ensure that a healthy safety culture is a priority.

Attribute	**Definition**
Attention to Detail	Accomplishes tasks and processes accurately and completely.
Client and Customer Service	Develops and maintains strong relationships with clients (those who buy goods and services and for whom formal professional services are rendered) or customers (those who consume goods and services) by listening to the client/customer and understanding and responding to identified needs.
Communication	Communicates information to individuals or groups; delivers presentations suited to the characteristics and needs of the audience. Clearly and concisely conveys written information orally or in writing to individuals or groups to ensure that they understand the information and the message. Listens and responds appropriately to others.
Flexibility	Is open to change and new information and adapts behavior or work methods in response to new information, changing conditions, or unexpected obstacles. Effectively deals with ambiguity.
Influencing and Negotiating	Calmly and respectfully persuades others to accept recommendations, cooperate, or change their behavior; works with others towards an agreement; negotiates to find mutually acceptable solutions.
Interpersonal Skills	Shows understanding, friendliness, courtesy, tact, empathy, concern, and politeness to others. Develops and maintains effective relationships with others; may include effectively dealing with individuals who are difficult, hostile, or distressed; relates well to people from varied backgrounds and different situations; is sensitive to cultural diversity, race, gender, disabilities, and other individual differences.
Leadership (Teaching Others)	Takes initiative in completing tasks. Helps others learn through formal or informal methods. Identifies training needs and provides constructive feedback. Coaches others on how to perform tasks; acts as a mentor.
Problem Solving	Identifies problems, determines possible solutions, and actively works to resolve the issues
Safety and Health Compliance	Demonstrates an understanding of applicable policies and procedures, and maintains conditions that ensure a healthy and safe working environment.

References

1. Handbook of Occupational Hazards and Controls for Personnel in Diagnostic Imaging and Nuclear Medicine, Government of Alberta, 2011
2. Bloom's Taxonomy
3. CAMRT – ACTRM National Competency Profile for Entry-Level MRTS in Canada, 2020-03
4. *Engineering Technician Competency Model*, US Department of Interior, 2020-11

Appendices

A. List of Canadian Regulations governing CIIPE
B. List of Safety Hazards pertaining to CIIPE
C. List of Primary and Associated Components pertaining to CIIPE
D. Examples of Training Objectives

Appendix A:

List of Regulations governing Class II PE maintenance and operation:

Service technician work is governed by a variety of Federal, Provincial and Territorial bodies, including the CNSC. Licensees are encouraged to determine the Federal and Provincial Acts, Standards, and Regulations that pertain to their facility's PE. The Acts, Standards and Regulations listed here may refer to other official documents, such as bulletins that Licensees may be required to abide by. The list provided below is not exhaustive.

It should be noted when reading a title below if there is a "-" between the province name and the title of the document, the title excludes the province's name.

Canadian Environment Protection Act
Canada Occupational Health and Safety Regulations (SOR/86-304)
Canadian Nuclear Safety Commission Regulations

- General Nuclear Safety and Control
- Class II Nuclear Facilities and Prescribed Equipment
- Radiation Protection
- Nuclear Substances and Radiation Devices
- Packaging and Transport of Nuclear Substances
- Security

Canadian Electrical Code Safety Standards
Canadian – Radiation Emitting Devices Regulations
British Columbia Safety Standards Act and Regulations
British Columbia Electrical Safety Regulation
British Columbia Occupational Health and Safety Regulation
Power Engineers, Boiler, Pressure and Vessels Safety Regulations
Alberta Safety Codes Act
Alberta Electrical Code Regulation
Alberta Occupational Health and Safety Regulation
Alberta Pressure Equipment Safety Regulation
Saskatchewan – The Electrical Licencing Act
Saskatchewan - The Occupational Health and Safety Regulation
Saskatchewan – The Boiler and Pressure Vessel Regulation
Manitoba Electrical Code Regulation
Manitoba – Workplace Safety and Health Act
Manitoba Steam and Pressure Plants Regulation
Ontario Electrical Safety Code Regulation
Ontario Regulation – Boilers and Pressure Vessels
Ontario Regulation – Compressed Gas
Ontario Regulation – X-ray Safety
Ontario - The Occupational Health and Safety Act
Quebec – Regulation Respecting Occupational Health and Safety

Quebec - Regulation Respecting Pressure Installations
New Brunswick – Electrical Installation and Inspection General Regulation
New Brunswick General Regulation
New Brunswick – Boiler and Pressure Vessel Code, Regulation
New Brunswick – Code of Practice for Working Alone Regulation
Nova Scotia – Electrical Code Regulation
Nova Scotia Technical Safety Act
Nova Scotia Boiler and Pressure Equipment Regulations
Nova Scotia Occupational Health and Safety General Regulations
Prince Edward Island Electrical Inspection and Code Regulations
Prince Edward Island Boiler and Pressure Vessels Act Regulations
Prince Edward Island Occupational Health and Safety Act General Regulations
Newfoundland and Labrador – Electrical Regulations
Newfoundland and Labrador – Boiler, Pressure Vessel and Compressed Gas Regulations
Newfoundland and Labrador – Occupational Health and Safety Regulations
Health Canada Safety Codes:

- Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range 3kHz to 300 GHz – Safety Code 6
- Guidelines on Exposure to Electromagnetic Fields from Magnetic Resonance clinical Systems – Safety Code 26
- Safety Requirements and Guidance for Analytical X-ray Equipment – Safety Code 32
- Safety Procedures for the Installation, Use and Control of X-ray Equipment in Large Medical Radiological Facilities- Safety Code 35

Appendix B

List of Hazards Associated with CIIPE

Service technicians may encounter a variety of conventional and radiological hazards in the course of their repair and maintenance work with Class II PE. The following list of hazards associated with CIIPE includes most of the dangers presented by this equipment. However, it is not exhaustive. Licensees should review the manufacturer's maintenance instruction to ensure all hazards are identified.

Hazard	**Type** **(Example or where most likely to encounter or what might be affected)**
Radiation	Beam Exposure
	Source Exposure
	Activated Components - (Targets, Collimator)
	Contamination (Fixed & Loose) (Corrosion /Material Damage)
Electrical	Shock -(High Voltage)
	Fire
	Burns - (Microwave)
Chemical	Toxic - (Beryllium, DU, Lead)
	Non-toxic – /Corrosion - (Lubricating Oils)
	By-Products
Gases	SF6 - (Microwave)
	Welding - (Hydrogen/ Argon)
	By-Products
	Pressurized/ Explosion -(Tank Valves)
	Implosion/Vacuum
Area	Confined/Restricted - (Pressure vessels, Service Pits)
	Asphyxiation - (Ozone, SF6)
Occupational/Mechanical	Falling - (Components, ladder)
	Crushing/Collision – (Gantry, Patient bed)
Surfaces	Hot – Burns
	Cold – Cryogenic – (Liquid Nitrogen, Dry Ice)
Biohazards	Patient excretions – (Body Fluids)
Laser	Beam – (Eye)
Magnetic	Projectile – (Maintenance Tools)
	Health – (Pacemaker)
Radio Frequency (RF)	Health – (Pacemaker)

Appendix C

List of CIIPE Major Components

Service technicians may contribute to the repair and maintenance of all major components of a licensee's prescribed equipment. This list is provided to illustrate the variety of components PE might have. Licensee's should take into account all components a service technician might encounter when developing specific training programs. This list is not exhaustive and will depend upon the specific Licensee's PE.

Power Supply
Cooling System
Safety System
Pneumatic/Hydraulic Components
Gantry
Collimator
Vacuum
OBI
Electron Gun
Control System
RF & Microwave systems
External Safety Systems
Cryogenic
Laser
Magnetism
Targets
Pressure Containers

Appendix D

Examples of Training Objectives

In support of Licensee development of service technician training programs, CNSC has included here examples of training objectives. The training objective examples below each item are not exhaustive. Licensees are to ensure all appropriate learning objectives are covered.

Bunker Radiation Safety Systems (as per the facility's design and procedures)

- Identify each component and understand the functionality of the major safety systems (LPO/Cameras/ /ESBs/Radiation status indicators/IR sensors/ motion sensors/Area Monitors, Programmable Logic Controller, Prescribed Equipment switch, etc)
- Effectively reads the system's wiring or logic diagrams
- Knows the QA testing frequency for each system
- Performs the QA testing for each system component
- Prepares the repair/replacement site appropriately
- Performs the repair/replacement for each system component
- Performs the repairs/replacements using the appropriate tools
- Performs the repairs/replacements using the appropriate PPE
- Orders the replacement component appropriately
- Performs the appropriate actions to return the system (have a second technician verify work/de-tag component/ notify staff/etc) to operation
- Disposes the faulty component(s) appropriately
- Records the appropriate information within the facility's maintenance management system

High Voltage

- Identifies all Facility's policies and procedures related to High Voltage safety including emergency procedures
- Identifies the need to work with one or more other personnel
- Identifies and wears the PPE required to work on High Voltage PE
- Identifies and performs lockout procedures
- Identifies and performs de-energizing procedures
- Identifies and grounds the PE prior to working
- Identifies and employs the appropriate tools/equipment for working on High voltage PE
- Identifies and establishes signs and barriers where lock out is not possible
- Identifies where the working alone policy and procedure may apply
- Identifies the equipment and location of the First Aid equipment if an accident should occur

Class II Nuclear Facilities and Prescribed Equipment Radiation Protection

- Knows what constitutes a CIIPE
- Knows the general requirements for a CII Facility
- Knows the requirements for radiation survey meters
- Knows the requirements for leak testing (if applicable)
- Knows the requirements for record keeping and retention specifically in relation to servicing

SF_6 Handling {Note – these training objectives could be adapted for any hazard by changing out SF6 for the hazard in question}

- Identifies the hazard and its by-products that may be produced by the PE
- Identifies all Facility's policies and procedures related to SF_6 safety including emergency procedures
- Identifies all of the SF_6 regulations
- Identifies and wears the PPE required to work with SF_6
- Identifies and employs the appropriate tools/equipment for working with SF_6
- Identifies and performs all the required actions for refilling SF_6 containers
- Identifies and performs all the required disposal actions of SF_6 and possible by-products