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Proposal for a professional qualification course in radiation protection to obtain the registration of Supervisor of Radiation Protection (SRP) to work at teaching and research institutions

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ABSTRACT

According to the CNEN Standard NN 6.01, aiming at professional registration for the preparation, use and handling of radioactive sources in teaching and research (T&R) activities, the candidate must submit to the National Nuclear Energy Commission (CNEN), in addition to the professional registration or diploma recognized by the Ministry of Education (MEC) and the application for registration, proof of radiation protection course, with a minimum load of forty (40) hours. In this sense, the present paper aims to present a proposal and an experience report of a training course. The course, developed in conjunction with the rectory of the State University of West Paraná (UNIOESTE) / Cascavel *campus*, was directed to 12 professionals (teachers and technicians of the Chemistry and Biology courses), and carried out at the Fine Equipment Laboratory, in 2020. After the training, individuals were registered for the preparation, use and handling of radioactive sources with all the documentation proposed in Standard NN6.01 to obtain the registration and title of Supervisor of Radiation Protection (SRP) at T&R institutions issued by CNEN . With this certification, the professional will have a record valid for 05 years in low-risk installations, classified according to Standard NN 6.02. It is understood that the professional qualification course, with the objective of being certified by CNEN, is of great importance for T&R institutions that use radioactive material, in view of the lack of qualified professionals, and can be applied in other T&R institutions.

Keywords: **professional qualification course, radiation protection, supervisor of radiation protection, teaching and research institutions, standard CNEN NN 6.01.**

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1. INTRODUCTION

The introduction of new technologies and the modernization of equipment have expanded the spectrum of importance of radiation protection in services that use nuclear technology in the application of ionizing radiation. Thus, safety is extremely relevant in the construction of knowledge in radiation protection, being fundamental in the teaching-learning process in the area [1].

In recent years, for example, the use of radionuclides by laboratories at teaching and research (T&R) institutions has grown considerably. The main radionuclides used in these laboratories are those with short half-lives and low energy, such as Na-24 (14.9 hours, β and γ emission), P-32 (14.3 days, β emission), S-35 (87.9 days, β emission), Ca-45 (163 days, β emission), Cr-51 (27.8 days, γ emission), I-125 (60.2 days, γ emission), I-131 (8 days, β and γ emission), Au-198 (2.7 days, β and γ emission) and Tl-207 (73.1 days, γ emission). The radionuclide most used in research is P-32. In addition to these, radionuclides H-3 (12.2 years, β emission) and C-14 (5,730 years, β emission) are widely used, despite having a long half-life [2; 3].

In Brazil, several types of research are developed that use open sources with different radioactive isotopes, where professionals and students involved (considered occupationally exposed individuals - OEIs) are subject to external exposure and internal contamination. Thus, T&R institutions that use sources are authorized by the National Nuclear Energy Commission (CNEN) and monitored to control external exposure to radiation [3].

As part of the licensing process, every facility must submit to CNEN a Radiation Protection Plan that will be evaluated based on normative criteria, so that the classification of areas and the need and type of individual monitoring will be determined by the detailing of the place of work, safety conditions and potential exposures, where the implementation of an individual monitoring program for internal contamination should be based on safety conditions, physical-chemical characteristics of the radionuclides involved and the activities handled annually [3].

Therefore, to ensure the proper functioning of the equipment and properly manage activities with ionizing radiation, training services for quality assurance and control must be offered.

For example, according to CNEN Standard NN 6.01, for the process of registering professionals with higher education qualified for the preparation, use and handling of radioactive sources in T&R, the candidate must submit to CNEN, in addition to the professional registration or diploma recognized by the Ministry of Education (MEC) and the application for registration, proof of successful completion in a Radiation Protection course in the area, with a minimum load of forty (40) hours.

In this sense, the present paper aims to present a proposal and an experience report of a training course in order to obtain the registration of individuals for the preparation, use and handling of radioactive sources and of Supervisor of Radiation Protection (SRP) to work at T&R institutions.

1.1. Number of T&R Institutions and Qualified Professionals

Today, 182 T&R institutions are registered, distributed regionally according to Table 1.

Table 1: Geographical distribution of T&R institutions.

Region	**Nr. of Institutions (182)**	**%**
Midwest	10 (Distrito Federal = 4; Goiás = 4; Mato Grosso = 1 ; Mato Grosso do Sul = 1)	5,5
Northeast	10 (Bahia = 2; Ceará = 4; Pernambuco = 3; Piauí = 1)	5,5
North	4 (Amazônia = 1; Pará = 3)	2,2
Southeast	136 (Espírito Santo = 2; Minas Gerais = 13; Rio de Janeioro = 35; São Paulo = 86)	74,8
South	22 (Paraná = 9; Rio Grande do Sul = 11; Santa Catarina = 2)	12,0

Source: [4].

Regarding certified professionals, there are currently 420 working at T&R institutions, distributed regionally according to Table 2.

Table 2: Geographical distribution of professionals with higher education qualified for the preparation, use and handling of radioactive sources in T&R institutions.

Region	Nr. of Professionals (420)	%
Midwest	17 (Distrito Federal = 6; Goiás = 6; Mato Grosso = 1 ; Mato Grosso do Sul = 4)	4,0
Northeast	32 (Bahia = 14; Ceará = 8; Pernambuco = 8; Rio Grande do Norte = 1; Sergipe = 1)	7,6
North	4 (Amazônia =1; Pará = 3)	1,0
Southeast	294 (Espiríto Santo = 2; Minas Gerais = 35; Rio de Janeiro = 68; São Paulo = 189)	70,0
South	73 (Paraná = 38; Rio Grande do Sul = 31; Santa Catarina = 4)	17,4

Source: [4].

It is observed that most T&R institutions, as well as qualified professionals, are located in the Southeast region, with greater concentration in the states of Rio de Janeiro and São Paulo.

1.2. Standard CNENNN 6.01 - requirements for the registration of individuals for the preparation, use and handling of radioactive sources

The objective of this Standard is to regulate the process of registering qualified professionals with a higher education level for the preparation, use and handling of radioactive sources, in radioactive installations, in industry, agriculture, teaching and research [5].

The higher-level professional must be previously registered to work in the following areas [5]:

a) Medical applications for the use, preparation and handling of unsealed radioactive sources;

b) Medical applications for the use and handling of sealed radioactive sources;

c) Industrial applications;

d) Applications in Agriculture;

e) Medical-veterinary applications;

f) Services; and

g) Applications in teaching and research, which includes the scope of this research, involving the areas of nuclear physics; nuclear chemistry; biology; hydrology, including tracers; oceanography; ecology; dentistry; pharmacology; physical education; nutrition; radiopharmacy; radiobiology.

The candidate for registration as an individual, who qualifies him/her for the preparation, use or handling of radioactive sources, must submit the following documents to CNEN [5]:

a) professional registration with the corresponding councils, in the biomedical, scientific or technological areas, as applicable; in the absence of a class council, a diploma recognized by the Ministry of Education;

b) application for registration with the CNEN, according to the CNEN model; and

c) successful completion of a Radiation Protection course for the Preparation, Use and Handling of Radioactive Sources, with a minimum load of forty (40) hours, in an Institution accredited by the MEC.

The registration will be provided for the area of activity established therein and will be valid for 5 (five) years, being revalidated for an equal period of time, provided that the professional proves to have carried out activities in his/her area of activity during, at least, the half of the validity period of his/her registration [5].

1.3. Standard CNEN 7.01 - certification of qualification of supervisor of radiation protection (SRP)

According to Standard 7.01, which aims to establish the necessary requirements for the certification of qualification of SRPs, professionals qualified to work at T&R institutions are also qualified to act as SRP, since that acting at a facility may also be responsible for radiation protection actions in the transport of radioactive materials in the following low-risk facilities [6]:

I - facilities of group 4;

II - installations of subgroups 3A and 7A that use analytical techniques;

III - group 5 research laboratories that exclusively use reference sources for measuring or calibrating equipment; and

IV - facilities of group 2A.

Therefore, according to Standard 7.01, the SRP can also work at T&R institutions.

2. MATERIALS AND METHODS

The course, developed in conjunction with the Rectory of the State University of West Paraná (UNIOESTE) / Cascavel *campus*, in view of the lack of qualified professionals, was directed to 12 professionals (teachers and technicians of the Chemistry and Biology courses), and carried out at UNIOESTE's Fine Equipment Laboratory, in 2020.

After the training, individuals were registered for the preparation, use and handling of radioactive sources with all the documentation proposed in Standard NN6.01 to obtain the title issued by the CNEN.

3. RESULTS AND DISCUSSION

The Laboratory of Fine Equipment from (UNIOESTE) / Cascavel *campus* uses a gas chromatograph equipped with a flame ionization detector and an electron capture detector. This type of detector has inside a sealed source that houses the radioactive material Ni-63 (Figure 1).

Figure 1: *Facilities and equipments used in the course.*
Source: the authors

This equipment is used to analyze and quantify liquid samples in organic solvents of various compounds. It is currently used in teaching and research in several areas of knowledge, serving undergraduate courses in Environmental Engineering, Chemical Engineering and Food Engineering.

It also serves the *Lato Sensu* and *Stricto Sensu* Postgraduate Courses in Food Science and Technology and Environmental Engineering, in addition to meeting the demands of other UNIOESTE / Cascavel *campus* and other Universities in the Region in different lines of research.

The Course was normally developed in the facilities of UNIOESTE / Cascavel *campus*, during 40 hours (Table 3).

Table 3: The structure of the 40 hour course (each Module lasting 5 hours/class)

Module	**Contents**
1- Radiation	1.1. Composition of matter and atomic theory 1.2. Structure of matter 1.3. Origin of radiation 1.4. Radioactivity 1.5. Nuclear radiation 1.6. Radiation produced by the interaction of radiation with matter
2 - Natural and Artificial Sources of Ionizing Radiation	2.1. Natural sources 2.2. Artificial sources
3 - Interaction of Radiation with Matter	3.1. Ionization, excitation, activation and Bremsstrahlung 3.2. Directly and indirectly ionizing radiation 3.3. Interaction of electromagnetic radiation with matter 3.5. Interaction of directly ionizing radiation with matter 3.6. Interactions of electrons with matter
4 - Biological effects of radiation	4.1. Cell structure and metabolism 4.2. Interaction of radiation with biological tissue 4.3. Stages of production of the biological effect by radiation 4.4. Tissue radiosensitivity 4.5. Classification of biological effects
5 - Radiological quantities	5.1. Conceptual evolution of magnitudes 5.2. Procedures for defining radiological quantities 5.3. Quantities 5.4. Relationship between the quantities 5.5. New operational quantities
6 - Radiation detectors	6.1. Operating principles 6.2. Detectors using photographic emulsions 6.3. Thermoluminescent detectors
7 - Notions of Radiation Protection	7.1. Radiation protection principles 7.2. The radiation protection plan 7.3. Radiation protection service activities 7.4. Practical rules for radiation protection
8 - CNEN Standards	8.1 Standard NN 6.01 8.2 Standard NN 7.01 8.3 Standard NN 6.02

Source: the authors

The material was made available to students in media and printed form (Figure 2).

Figure 2: c*ourse dynamics.*
Source: the authors

At the end, an evaluation of the proposed content was carried out. For Researcher A., the course was important to learn the necessary requirements for handling radioactive material: "*With this course, I believe that now we can develop a working protocol for the use of radioactive material, in order to increase the issue of radiological protection and the correct disposal of the material.*". After passing the course, UNIOESTE / Cascavel *campus* issued a certificate (Figure 3).

UNIVERSIDADE ESTADUAL DO OESTE DO PARANÁ / CAMPUS DE CASCAVEL
CENTRO DE CIÊNCIAS EXATAS E TECNOLÓGICAS
PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA AGRÍCOLA
SISTEMAS BIOLÓGICOS E AGROINDUSTRIAIS / RECURSOS HÍDRICOS E SANEAMENTO AMBIENTAL

CERTIFICADO

Certificamos que **JORGE HIPOLITO PEREIRA DO NASCIMENTO** ministrou o curso **"Radioproteção para o preparo, uso e manuseio de fontes radioativas"** realizado nas instalações da UNIOESTE CAMPUS CASCAVEL, no período de 01 a 05 de fevereiro de 2021, com carga horária de 40 horas.

Sendo que o presente é verdadeiro, firmamos,

Cascavel, 05 de fevereiro de 2021.

Prof. Dr. Divair Christ
Coordenador do projeto Extensão
Cursos e palestras PGEAGRI

Profª. Dra. Mônica Sarolli Silva de Medonça Costa
Coordenadora do Programa de Pós-Graduação
Stricto Sensu em Engenharia Agrícola - PGEAGRI

Prof. Físico Jorge HF Nascimento

unioeste

Radiônica Assessoria em Radioproteção Ltda.

TREINAMENTO DE RADIOPROTEÇÃO

Carga horária: 40 horas/aulas
Instrutores: Jorge Hipolito F. Nascimento – Físico – Pós Graduado em Segurança de Fontes Radioativas IRD/AIEA - CNEN AP 1448
Gustavo Oliveira da Conceição – Tecnólogo em Radiologia - Mestrando em Radioproteção IEN/CNEN- CNEN AP 1718

1 - Radiações
1.1. Composição da matéria e teoria atômica
1.2. Estrutura da matéria
1.3. Origem da Radiação
1.4. Radioatividade
1.5. Radiações nucleares
1.6. Radiação produzida pela interação de radiação com a matéria

2 - Fontes naturais e artificiais de radiação ionizante
2.1. Fontes naturais
2.2. Fontes artificiais

3 - Interação da radiação com a matéria
3.1. Ionização, excitação, ativação e radiação de freamento
3.2. Radiações diretamente e indiretamente ionizantes
3.3. Interação da radiação eletromagnética com a matéria
3.5. Interação das radiações diretamente ionizantes com a matéria
3.6. Interações de elétrons com a matéria

4 - Efeitos biológicos da radiação
4.1. Estrutura e metabolismo da célula
4.2. Interação da radiação com o tecido biológico
4.3. Etapas da produção do efeito biológico pela radiação
4.4. Radiossensibilidade dos tecidos
4.5. Classificação dos efeitos biológicos

5 - Grandezas radiológicas
5.1. Evolução conceitual das grandezas
5.2. Procedimentos de definição das grandezas radiológicas
5.3. Grandezas radiológicas
5.4. Relação entre as grandezas
5.5. Novas grandezas operacionais

6 - Detectores de radiação
6.1. Princípios de operação
6.2. Detectores utilizando emulsões fotográficas
6.3. Detectores termo luminescentes

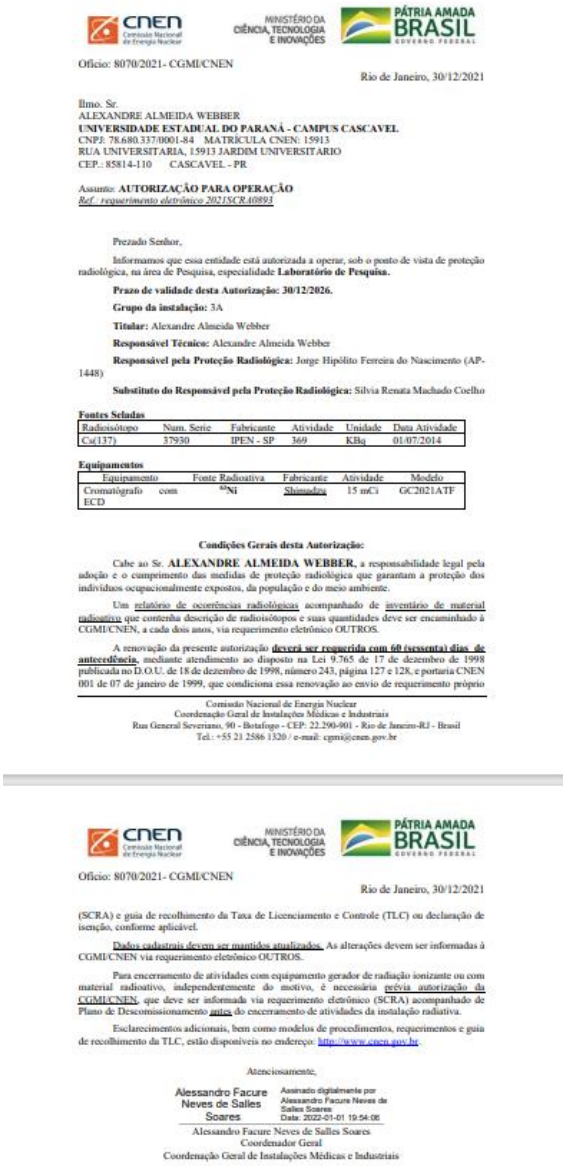
7 - Noções de Radioproteção
7.1. Princípios de radioproteção
7.2. O plano de radioproteção
7.3. Atividades do serviço de Radioproteção
7.4. Regras práticas de proteção radiológica

Figure 3: *Course Certificate issued by UNIOESTE / Cascavel campus***.**

Source: the authors

After the training, individuals were registered for the preparation, use and handling of radioactive sources with all the documentation proposed in Standard NN6.01 to obtain the title

issued by CNEN. With this certification, the professional will have a registration valid for 05 years in low-risk facilities (Figure 4).



Ofício: 8070/2021- CGMI/CNEN

Rio de Janeiro, 30/12/2021

Ilmo. Sr.
ALEXANDRE ALMEIDA WEBBER
UNIVERSIDADE ESTADUAL DO PARANÁ - CAMPUS CASCAVEL
CNPJ: 78.680.337/0001-84 MATRÍCULA CNEN: 15913
RUA UNIVERSITARIA, 15913 JARDIM UNIVERSITARIO
CEP.: 85814-110 CASCAVEL - PR

Assunto: **AUTORIZAÇÃO PARA OPERAÇÃO**
Ref.: requerimento eletrônico 2021SCRA0893

Prezado Senhor,

Informamos que essa entidade está autorizada a operar, sob o ponto de vista de proteção radiológica, na área de Pesquisa, especialidade **Laboratório de Pesquisa.**

Prazo de validade desta Autorização: 30/12/2026.

Grupo da instalação: 3A

Titular: Alexandre Almeida Webber

Responsável Técnico: Alexandre Almeida Webber

Responsável pela Proteção Radiológica: Jorge Hipólito Ferreira do Nascimento (AP-1448)

Substituto do Responsável pela Proteção Radiológica: Silvia Renata Machado Coelho

Fontes Seladas

Radioisótopo	Num. Serie	Fabricante	Atividade	Unidade	Data Atividade
Cs(137)	37930	IPEN - SP	369	KBq	01/07/2014

Equipamentos

Equipamento	Fonte Radioativa	Fabricante	Atividade	Modelo
Cromatógrafo com ECD	^{63}Ni	Shimadzu	15 mCi	GC2021ATF

Condições Gerais desta Autorização:

Cabe ao Sr. **ALEXANDRE ALMEIDA WEBBER,** a responsabilidade legal pela adoção e o cumprimento das medidas de proteção radiológica que garantam a proteção dos indivíduos ocupacionalmente expostos, da população e do meio ambiente.

Um relatório de ocorrências radiológicas acompanhado de inventário de material radioativo que contenha descrição de radioisótopos e suas quantidades deve ser encaminhado à CGMI/CNEN, a cada dois anos, via requerimento eletrônico OUTROS.

A renovação da presente autorização **deverá ser requerida com 60 (sessenta) dias de antecedência,** mediante atendimento ao disposto na Lei 9.765 de 17 de dezembro de 1998 publicada no D.O.U. de 18 de dezembro de 1998, número 243, página 127 e 128, e portaria CNEN 001 de 07 de janeiro de 1999, que condiciona essa renovação ao envio de requerimento próprio

Comissão Nacional de Energia Nuclear
Coordenação Geral de Instalações Médicas e Industriais
Rua General Severiano, 90 - Botafogo - CEP: 22.290-901 - Rio de Janeiro-RJ - Brasil
Tel.: +55 21 2586 1320 / e-mail: cgmi@cnen.gov.br

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(SCRA) e guia de recolhimento da Taxa de Licenciamento e Controle (TLC) ou declaração de isenção, conforme aplicável.

Dados cadastrais devem ser mantidos atualizados. As alterações devem ser informadas à CGMI/CNEN via requerimento eletrônico OUTROS.

Para encerramento de atividades com equipamento gerador de radiação ionizante ou com material radioativo, independentemente do motivo, é necessária prévia autorização da CGMI/CNEN, que deve ser informada via requerimento eletrônico (SCRA) acompanhado de Plano de Descomissionamento antes do encerramento de atividades da instalação radiativa.

Esclarecimentos adicionais, bem como modelos de procedimentos, requerimentos e guia de recolhimento da TLC, estão disponíveis no endereço: http://www.cnen.gov.br.

Atenciosamente,

Alessandro Facure Neves de Salles Soares
Assinado digitalmente por Alessandro Facure Neves de Salles Soares
Data: 2022-01-01 19:54:08

Alessandro Facure Neves de Salles Soares
Coordenador Geral
Coordenação Geral de Instalações Médicas e Industriais

Figure 4: *Registration of the Course participant as Technical Responsible and SRP by CNEN.*

Source: the authors

4. CONCLUSION

It is understood that the professional qualification course aimed at CNEN certification is of great importance for T&R institutions that use radioactive material, and can be applied in other T&R institutions in Brazil, considering that the vast majority of qualified professionals are located in the Southeast.

The relevance of this work is to train professionals in radiation protection, not only to occupy the space in companies focused on this area, as collaborators, but also, to become multipliers.

Due to the scarcity of professional training courses focused on radiation protection, such professionals are unable to register with the CNEN, so it is necessary to understand the needs in the area of radiation protection that the market is signaling, both in terms of professional training to become SRP, as well as for those who somehow wish to become multipliers of such knowledge working in the T&R area.

This research aims to contribute with new knowledge about radiation protection and thus improve safety in spaces where the use of radiation can be used, benefiting a greater number of people, both professionals and users of instruments that contain any radioactive source.

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