TECHNICAL PROGRAMME

1997-2022
25 YEARS OF FORO

FORO

Reference OFC-07.07

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Design and layout: Ángel Merlo
Legal deposit: M-14939-2022
Printed on 100% recycled paper,
with responsible forest management
certificate

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CSN CONSEJO DE SEGURIDAD NUCLEAR

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FORO

The work of the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies goes beyond the borders of the countries that comprise them. Every day, FORO works to ensure that 600 million Ibero-American citizens have higher and better levels of nuclear and radiological safety and security.

Its 25-year history has been, without a doubt, a collective success. A success achieved thanks to the many people who have done their part year after year.

There are many recognitions for this work. Therefore, it is no coincidence that at the 20th Ibero-American Summit, held in 2010 in Mar del Plata (Argentina), the Heads of State and Government decided to expressly welcome the work carried out by the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies. The International Atomic Energy Agency has also recognised the work of FORO in its resolutions in recent years, acknowledging the interest of its products for other regions. Both organisations have recognised the efforts of our association to generate a common Ibero-American working space, with the aim of consolidating nuclear and radiological safety and security in our region.

Today FORO is an unwavering reality. It is a strong identity that speaks with its own voice, in Spanish and Portuguese, to the whole world. A voice that needs to continue to be heard in the most intelligent and effective way possible: by investing in innovation, technology and knowledge. And, above all, by consolidating and extending our association with the aim of promoting radiological and nuclear safety and security at the highest level in the Ibero-American region.

Our association will always be, of course, at the service of people and of society. For this reason, today more than ever, we Ibero-American regulatory agencies must be especially rigorous and demanding of ourselves. Because our responsibility is great and our potential is enormous.

This technical programme that you have in your hands describes what FORO represents as a collective. There are the figures, there are the data, there are the facts that describe what we embody. It is the synthesis of a collective effort that represents this great Ibero-American family. A great family that, we are sure, has exciting years ahead of it, full of great challenges.

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FORO constitution meeting (1997, Veracruz, Mexico)

Introduction/Preface

The Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO) is an association of regulatory authorities, founded in Veracruz in July 1997, with the objective of achieving and maintaining high levels of radiological and nuclear safety and security in all practices involving the use of ionising radiation.

The current members of FORO are the regulatory authorities of Argentina (Autoridad Regulatoria Nuclear, ARN), Brazil (Comissão Nacional de Energia Nuclear, CNEN), Chile (Comisión Chilena de Energía Nuclear, CCHEN), Colombia (Ministerio de Minas y Energía, MINMINAS), Cuba (Dirección de Seguridad Nuclear, DSN), Spain (Consejo de Seguridad Nuclear, CSN), Mexico (Comisión Nacional de Seguridad Nuclear y Salvaguardias, CNSNS), Paraguay (Autoridad Reguladora Radiológica y Nuclear, ARRN), Peru (Instituto Peruano de Energía Nuclear, IPEN) and Uruguay (Autoridad Reguladora Nacional en Radioprotección, ARNR).

With Spanish as its working language and many other cultural ties, FORO has established a high level of trust among its members to work together and thus promote very high levels of safety and security among its members and, by extension, throughout the Ibero-American region. Hence the importance of its vision to be a fruitful forum for strengthening the region's regulatory institutions through the exchange of information, knowledge and experience.

FORO was created with the aim of promoting safety and security in all practices that use radioactive or nuclear facilities and materials in Ibero-America and to foster the exchange of information, knowledge and experience in radiation protection and nuclear safety and security in the region from a regulatory perspective

In 2003, interest arose in generating greater knowledge and harmonising practices among its members through the development of projects and activities of common interest within a Technical Programme, defined in the FORO Statute, and in close cooperation with the International Atomic Energy Agency (IAEA), the association's scientific/technical reference. Two new objectives were established: to detect, extract, analyse and share knowledge and experiences to improve radiological and nuclear safety and security in Ibero-America; and to establish relations with national, regional and international organisations whose policies and objectives are of interest for the achievement of FORO objectives.

Since the Technical Programme was launched, 21 projects or activities have been initiated, and 14 of them have been successfully concluded (the remaining 7 are currently in progress), with the participation of more than 100 experts from the region and a budget of more than one million euros. All products generated by FORO are public and are available on its webpage, La RED (www.foroiberam.org) for interested parties. Most of the results are also being published by the IAEA in the form of joint FORO-IAEA technical documents (TecDoc), and have been presented at the most important IAEA conferences of the international regulatory sector. Another contribution to global safety has been using the results of the FORO Technical Programme in the develop-

ment of IAEA safety guides, or incorporating them into the agenda for training courses and workshops and consolidating training for regulators and regulated parties. The international community has recognised the excellent quality and usefulness of the work carried out by FORO, which has been incorporated into the regulations and practices of regulators or regulated parties in many countries in the region and around the world.

FORO carries out its regulatory Technical Programme based on the principles of innovation, equity, effectiveness, efficiency, thoroughness, consistency and sustainability, and in line with FORO's strategic guidelines and action plan, approved by its Plenary (its governing body).

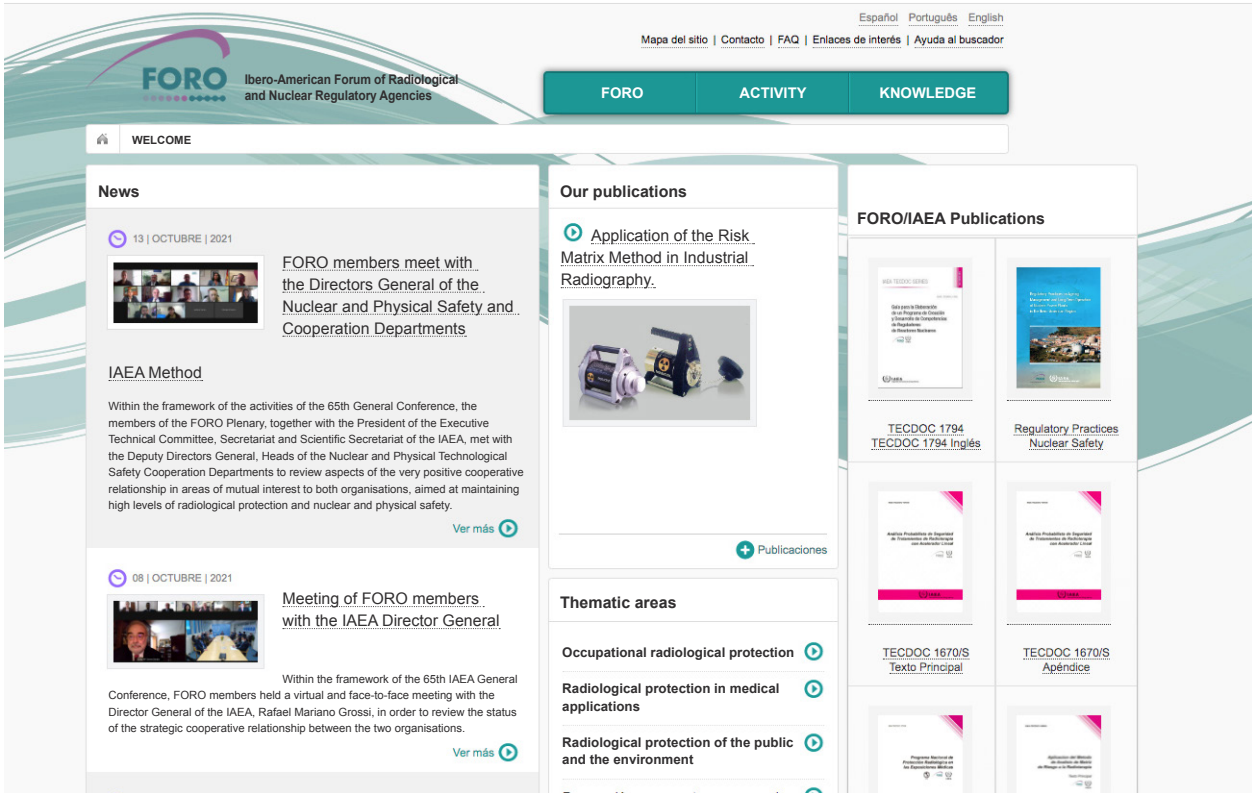
FORO's contribution to radiation protection and nuclear safety and security, as well as the value of its model and Technical Programme, have been recognised by the IAEA, the Ibero-American General Secretariat (SEGIB), the International Commission on Radiological Protection (ICRP), the International Radiological Protection Association (IRPA), the Pan American Health Organization (PAHO) and the World Health Organisation (WHO), as well as other international and regional organisations and associations. FORO's cooperation with these institutions of interest is a strategic objective that guides the work of the association. Through this cooperation, FORO verifies that its projects are innovative, gathers information to make its technical programme more efficient, and disseminates its results to other countries in the region and beyond. FORO aims to promote a beneficial exchange of experience and knowledge in key areas of radiological protection and nuclear safety and security in areas of interest, relevant and up-to-date topics.

This publication is one of the ways FORO decided to celebrate its 25th anniversary, by sharing experiences and regulatory knowledge and, especially, the results of its Technical Programme, one of FORO's fundamental pillars for the achievement of its objectives.

La RED

Though its collaborative platform, La RED (www.foroiberam.org), FORO shares all the results of its Technical Programme and the most relevant information of the association, such as news, milestones, basic documentation and links of interest. It also has a publicly accesible documentary repository that includes the most relevant regulatory standards from the member organisations, and a search engine to identify texts on specific topics of interest to help regulators in the region when drafting their own standards or using existing knowledge for the development or improvement of each country's regulations.

Information on each of the thematic areas adopted by FORO can be found in La RED: occupational radiological protection; radiological protection in medical applications; radiological protection of the public and the environment; emergency preparedness and response; investigation and follow-up of accidents and incidents; source control; decommissioning and closure of facilities; waste management; nuclear safety; transport of radioactive material; legal issues; human and organisational factors; nuclear security. In addition to this information, La RED of-



La RED home page

fers tools for collaboration between experts in the Ibero-American region, providing access to working groups and optimising communications and interactions through the use of social media technologies. About a hundred regulatory specialists from various technical fields interact through the network, sharing their experience, good practices and lessons learned, addressing problems through technical projects and other activities, and making the results available to others.

FORO Plenary Meeting (Chile, 2019)

Probabilistic Safety Analysis of Linear Accelerator Radiotherapy Treatments (PSA Project)

Objective

The overall objective of this project was to begin introducing proactive safety assessment methods in radiotherapy as a complement to traditional reactive methods, by applying a Probability Safety Analysis (PSA) of the radiotherapy treatment process with a medical linear accelerator (LINAC) to investigate the main causes and sequences of events that can lead to accidental exposure to ionising radiation, and to explore the applicability of this type of analysis. The specific objectives consisted of carrying out a pilot study to identify possible accident initiating events, accident sequences, potential accidental exposure scenarios and the main risk contributors based on the importance of human errors and equipment failures considered in the study, in order to improve the safety and regulatory control of radiotherapy using a LINAC.

Scope

The PSA study was applied to the external beam radiotherapy treatment process of a hypothetical radiotherapy service, based on existing practices in the FORO member countries that participated in this project, as well as on experiences reported in the literature, which was denoted as a reference model. This process begins when it is clinically prescribed and concludes at the end of the prescribed treatment sessions.

As for the equipment being studied, only the linear accelerator was analysed in detail, while other equipment, such as the treatment planning system, the computerised tomography simulator and the real-time dosimeter, were included as macro components. The study does not go into detail about the parts that make up the equipment, and it considers human errors related to its operation, but not equipment failures. With respect to the software, only the failure modes related to data input and output (failure during software operation) were considered, without analysing in detail its programming (source code).

All human actions of the different professionals involved in the treatment process were considered, excluding from the analysis those that constitute a medical decision. It was therefore assumed that the physician's actions were in accordance with clinical intent, such as prescribing the treatment dose, for example. However, the errors were taken into consideration by recording their intention in writing and communicating the decision.

Only radiological risks were studied, excluding the risks of falls, collisions, electric shocks, fire and explosion. In terms of exposed persons, the study was applied to patients, occupationally exposed persons and the public, although the study was mostly focused on patients.

Tasks outside of treatment, such as installation, acceptance tests, commissioning, maintenance and repairs, were excluded from the study. The same applies to evaluation of shielding and dismantling and decommissioning of the facility.

Results

The project was the first international application of the PSA methodology outside the field of nucle-

HUMAN ERROR VS. EQUIPMENT FAILURE							
Patient Exposure							
Individual Episodic (Z3A)		Collective Episodic (Z3D)		Programmatic (Z3B)		Systematic (Z3C)	
Human Error	Equipment Failure	Human Error	Equipment Failure	Human Error	Equipment Failure	Human Error	Equipment Failure
87.46%	-	0.02%	0.04%	15.46%	-	0.28%	0.03%
87.46%		0.06%		15.46%		0.31%	
100% of programmatic accidental exposures are due to human error							
10% of systematic accidental exposures are due to equipment failure (LINAC; TPS; TAC)							
Systematic accidental exposures due to equipment failure are 500 times less likely than programmatic exposures due to human error							

Some of results of a probabilistic safety analysis

ar power plants, adjusting and using it to assess the safety of radiotherapy treatments using a linear accelerator (LINAC).

Its results constituted significant contributions in terms of understanding the risks and internal safety aspects of LINAC radiotherapy, defining a group of 118 accident-initiating events for an analysis of 434 potential accident sequences and the consideration of 120 safety barriers, determining the impacts and risk significance of the different groups analysed: patients, occupationally exposed workers and the public.

The project formulated 48 important recommendations on strategies to be followed, possible technical or organisational solutions and initiatives that can help prevent or reduce the probability of occurrence of accidental exposures in LINAC radiotherapy, linked to exposed personnel, processes, treatment premises and stages, work equipment and materials, and the organisations linked to the practice, among many other factors.

Impacts of the project

The project provided a decisive source of information and data to further develop the Risk Matrices project for safety assessment in medical practice.

The most useful aspect of this project, aside from demonstrating the applicability of the methodology to this type of practice and increasing understand-

ing of the risks involved and the advantages of proactive safety assessment methods, lies in the fact that it was a decisive project for the subsequent development of the project related to risk matrices.

Publications

- 2012: *Análisis Probabilista de Seguridad de Tratamientos de Radioterapia con Acelerador Lineal*, joint FORO-IAEA publication, TecDoc 1670/S.
- 2011: *Los métodos de análisis de riesgo en radioterapia: Análisis probabilístico de seguridad*, ALFA Journal no. 15 of the Spanish Nuclear Safety Council.
- 2015: *Análisis Probabilista de Seguridad (APS) del proceso de tratamiento de radioterapia con un Acelerador Lineal de usos médicos*, Proceedings of the 12th Congress of the International Radiation Protection Association (IRPA 12).

Conference presentations

- 2008: *Seguridad y Control Regulador de las Instalaciones Radiactivas de Radioterapia mediante la aplicación de Técnicas de Análisis e Identificación de Riesgos*, Nuclear Safety Council R & D Workshop (CSN, Madrid, Spain).

Participants

Juan José Vilaragut Llanes, project leader (CBSN, Cuba); Susana B. Papadopulos (ARN, Argentina); Pedro Paulo Pereira Jr. (National Cancer Institute, Brazil); Rubén Ferro Fernández (CNSN, Cuba); Manuel Rodríguez Martí (CSN, Spain); Ma- ría Luisa Ramírez (CSN, Spain); Arturo Pérez Mulas (CSN, Spain); Marta Barrientos Montero (CSN, Spain); Fernando Somoano (ELEKTA, Spain); José Miguel Delgado Rodríguez (Madrid Oncology Institute, Spain); Ramón López Morones (CNSNS, Mexico); Pedro Ortiz López (IAEA).

FORO would also like to thank Eduardo Larrinaga Cortina, Lourdes Pérez Guevara, Jorge Alemañy Álvarez, José de Jesús Rivero Oliva, Fernando García Yip, Ileana Silvestre Patallo, Andrés de la Fuente Puch, Cruz Duménigo González, Carmen Álvarez, Ana Blanes Tabernero, Anel Hernández Garcés, Verónica Godínez, Adrián López, Daniel García, Ramón del Castillo Bahi, Rodolfo Alfonso Laguardia, Ileana Silvestre Patallo, Ivón Morales.

Application of the Risk Matrix Method to Radiotherapy (Project MATRIXES)

Objective
The objective of this project is to apply the risk matrix methodology to the self-assessment of radiotherapy services. The aim was to adapt this methodology to the external beam radiotherapy treatment process of a hypothetical radiotherapy service (reference facility), based on the existing best practices in FORO member countries and the experiences reported in the literature, and thus obtain a series of recommendations to reinforce the quality and safety programmes of radiotherapy departments.

Scope
The study considered the situations in the linear accelerator radiotherapy process that could give rise to accidental exposures, both for patients, employees or the public, from the installation of the equipment to the end of the treatment. Although the medical procedure itself is not included in the scope of this project, all aspects leading to an undesired deviation from the prescription given by the physician were considered. The analysis of accidents with exposure to orphan sources or during the transport of radioactive sources was excluded.

The adaptation and implementation took into account operational experience (lessons learned from accidental exposures) and the results of the probabilistic safety analysis studies (PSA Project).

One of the advantages of the risk matrix method is that it allows the different parameter values to be grouped together (occurrence frequency of an initiating event, probability of barrier failure, accident consequences and risk level of the initiating event) into discrete levels that are more manageable for decision making than numerical values.

Results
The application of the risk matrix method to the generic radiotherapy service revealed that, in that service, events with catastrophic consequences in external beam therapy have a medium or low risk, except for one event related only to radiotherapy, with 60Co in cases of manual treatment planning, with a much higher associated risk.

In the application of the accelerator risk matrix, 142 possible initiating events that could lead to accidental exposures were generated. Of these events, 93.7% would have consequences for the patient, 3.5% for occupational staff and 2.8% for members of the public. In addition, 100 direct barriers were analysed, 37 elements that contribute to reducing the frequency of accident-initiating events (frequency mitigators) and 26 that could reduce the severity of potential consequences (consequence mitigators). It was demonstrated that there were no very high risk consequences.

In terms of applying the methodology to radiotherapy with external beams of 60Co, 132 initiating events were generated. Of these events, 92% would have consequences for the patient, 5% for occupational workers and 3% for members of the public. Also analysed were 91 direct safety barri-

Consequence of the Initiating Event						
	MHC	HR	HR	MHR	MHR	
		HR	HR	HR	MHR	
		MR	MR	HR	HR	
		MR	MR	MR	HR	
	HC	HR	HR	HR	MHR	
		MR	HR	HR	HR	
		MR	MR	HR	HR	
		LR	LR	MR	MR	
	MC	MR	MR	HR	HR	
		MR	MR	MR	HR	
		MR	MR	MR	MR	
		LR	LR	MR	MR	
	LC	MR	MR	MR	MR	
		LR	LR	MR	MR	
		LR	LR	LR	LR	
		LR	LR	LR	LR	
		MLF	LF	MF	HF	Frequency of Initiating Event

Level of consequences vs. frequency based on the Risk Matrix

ers, 41 frequency mitigators and 50 consequence mitigators.

When applying the method to high-dose-rate radiotherapy treatments, 113 initiating events were generated. Of these, 81% would have consequences for the patient, 13% for occupational workers and 5% for members of the public. In this case, 74 direct safety barriers, 62 frequency mitigators and 26 consequence mitigators were analysed.

Finally, 80 events were generated when applying the methodology to low-dose-rate (LDR) brachytherapy and permanent implant treatments. Of these events, 76% would have consequences for the patient, 13% for occupational workers and 11% for members of the public. Here, 70 direct safety barriers, 41 frequency mitigators and 21 consequence mitigators were analysed.

The initiating events identified can occur at any stage of the treatment process, as well as during the installation and commissioning phases.

Impacts of the project

The risk matrix method is a systematic and simplified methodology derived from probabilistic safety analysis (PSA) techniques. It is a useful tool to obtain a global vision of the whole process, and to propose improvements to aspects that contribute to reducing

the risk level. While this method does not quantify the level of risk with the accuracy of a PSA, it does represent a structured way to prioritise risk reduction.

Publications

- 2012: *Aplicación del Método de la Matriz del Riesgo a la Radioterapia*, TecDoc 1685/S.
- 2013: *Prevention of Accidental Exposure in Radiotherapy: The Risk Matrix Approach*, article in the Health Physics journal, Volume 104; Issue 2; Pages 139 to 150.
- 2016: *Application of the Risk Matrix Method to Radiotherapy*, joint FORO-IAEA publication, Tec- Doc 1685.

Conference presentations

- 2012: *Application of the risk matrix approach in radiation therapy: an Ibero-American experience*, IAEA International Conference on Radiation Protection in Medicine (Bonn, Germany).
- 2015: *Radiation safety assessment of cobalt 60 exter- nal beam radiotherapy using the risk-matrix method*, IRPA 12, 12th Congress of the International Radiation Protection Association (Buenos Aires, Argentina).
- 2015: *Risk analysis methods: their importance for the safety assessment of practices using radiation*, IRPA 12, 12th Congress of the International Radiation Protection Association (Buenos Aires, Argentina).

Participants

Ramón López Morones, project leader (CNSNS, Mexico); Susana Papadopulos (ARN, Argentina); José McDonnell (National University of Rosario, Argentina); Marcelo Gonçalves (CNEN, Brazil); Pedro Paulo Pereira Jr. (National Cancer Institute, Brazil); Cruz Duménigo (CNSN, Cuba); Alba Guillén (CNSN, Cuba); Juan José Vilaragut (CNSN, Cuba); Rubén Ferro (CNSN, Cuba); Carmen Álvarez (CSN, Spain); María Luisa Ramírez (CSN, Spain); Manuel Rodríguez (CSN, Spain); Arturo Pérez Mulas (CSN, Spain); José Miguel Delgado (Madrid Institute of Oncology, Spain); Carlos Sánchez Cayuela (Madrid Institute of Oncology, Spain); Verónica Godínez Sánchez (CNSNS, Mexico); Adrián López García (CNSNS, Mexico); Ángel Bernardo Paz García (CNSNS, Mexico); Ricardo Rodríguez (National Cancer Institute, Mexico); Jorge Morales (National Institute of Oncology and Radiobiology, Cuba); Pedro Ortiz López (IAEA).

Development of a Tool for Applying the Risk Matrix Approach to Radiotherapy (SEVRRA Project)

Objective
Given the complexity of using the Risk Matrices Project, the National Nuclear Safety and Safeguards Commission from Mexico developed the System for Risk Assessment in Radiotherapy (SEVRRA) to apply the risk matrix methodology in a systematic and user-friendly manner. SEVRRA was provided to FORO for further development and use in the risk analyses of member agencies and hospitals operating such facilities.

Scope
SEVRRA includes risk models for using the 3DC linear accelerator, high and low-dose-rate brachytherapy, and cobalt therapy.

To this end, these models were used in more than a dozen services in the region, verifying their applicability in the field, identifying both strengths and weaknesses, obtaining risk profiles, and determining the main safety elements with the greatest impact on improving the safety of radiotherapy services, such as barriers and mitigators.

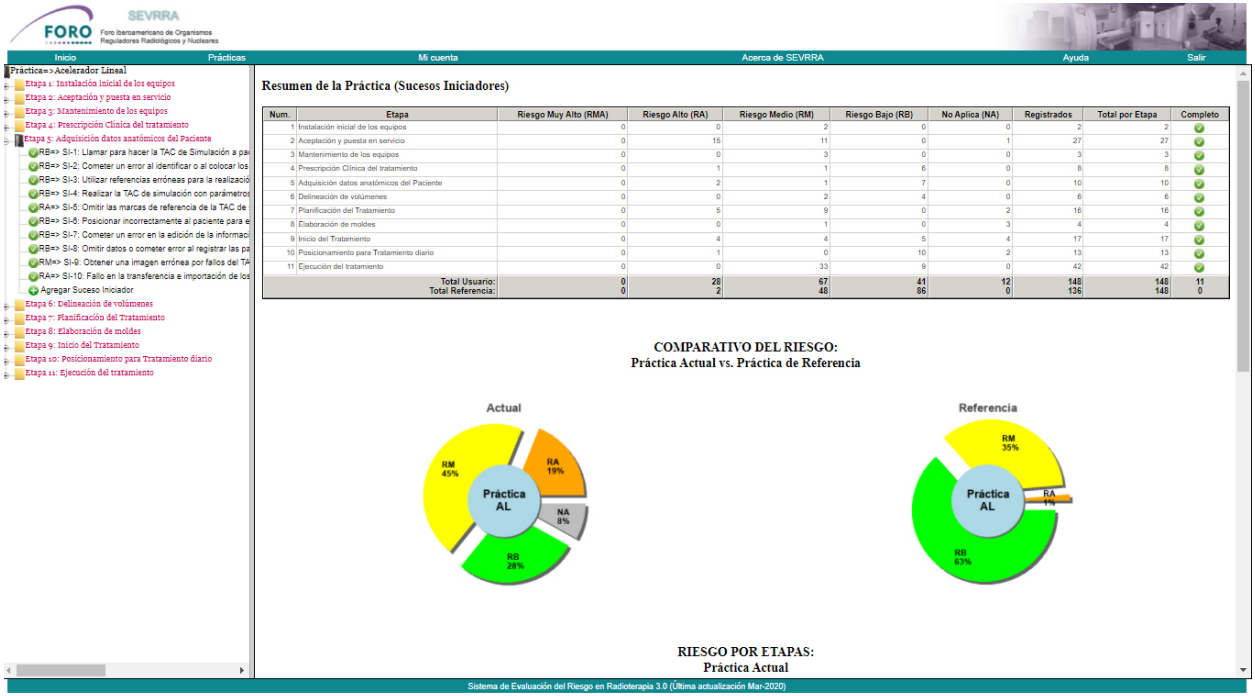
The risk calculation has a dual function in SEVRRA: 1. to inform the user of the current level of risk for the installation, and 2. to show the user the barriers that can be implemented in their practice to reduce the risk level of each initiating event. It shows the strengths and weaknesses of a practice in detail, so they can be improved upon.

The system is developed to accommodate all practices that are analysed using the risk matrix method. The results of the risk analysis presented by SEVRRA make it possible to identify the initiating events that are classed as high risk and/or very high risk, as well as the barriers and frequency mitigators that need to be implemented in the facility to achieve risk optimisation.

Results
The results of the project highlight the benefits of performing this type of prospective analysis for radiological protection and human health, and have been recognised by various international organisations and associations, such as the Pan American Health Organization (PAHO) and the International Atomic Energy Agency (IAEA), and its use is expected to become increasingly widespread and standard in the future practice of radiotherapy.

SEVRRA presents the user with the accident initiating events that have been identified for radiotherapy practices, as well as the barriers, frequency and consequence mitigators that exist in practice, also in order to recommend the good practices that should be followed. Consequently, it facilitates evaluation of the risk level of radiotherapy services and makes it possible to standardise the regulatory activities for evaluating the radiological safety of this medical practice, promoting good practices with risk information.

In addition, SEVRRA and its basic methodology allows identifying both strengths and weaknesses of radiotherapy services, which makes it possible to focus efforts on the implementation of safety measures, barriers and mitigators to prevent and reduce



Example of the use of SEVRRA online: Initiating events and associated risks

the occurrence of accidents, as well as to limit their consequences. The tool can be used according to the specific needs of each country, so regions other than Ibero-America can also benefit from it.

The system was originally operated offline, but it was later extended to run online and was incorporated into the FORO webpage (La RED). As such, the tool can be used according to the specific needs of each country, either by downloading it by running it online, so regions other than Ibero-America can also benefit from it.

Impacts of the project

Applying SEVRRA on a larger scale makes it possible to register a group of potential initiating events not considered in the services used as a reference. This is very significant because it could enrich the collective

experience and thus strengthen the proactive approach to the prevention of accidents in radiotherapy.

The risk matrix methodology and SEVRRA are successfully used by medical physicists and radiation protection officers from 27 radiotherapy services in 12 Latin American countries, demonstrating that this is a development that can be extended on a large scale in our region.

The specific results from each of the participating radiotherapy services allow each hospital to identify the accidental sequences with highest risks and the barriers and mitigators they would need to implement to reduce risk.

Publications

- 2012: *SEVRRA 3.0 tool in Spanish, English and Portuguese in its online and offline versions*, available on La RED, FORO's webpage.
- 2012: *Aplicación de los Resultados de los Análisis de Riesgo en Radioterapia para Avanzar hacia una Regulación Informada en Riesgo*, available on La RED, FORO's webpage.
- 2012: *Guía para la realización de Análisis de Riesgos en los Servicios de Radioterapia*, available on La RED, FORO's webpage.

Presentations

- 2012: *Main results of the risk assessments to some Ibero- American radiotherapy facilities using SEVRRA Software*, IAEA International Conference on Radiation Protection in Medicine (Bonn, Germany).
- 2013: *Prevención de Accidentes en Radioterapia*, 4th IRPA Latin American Regional Radiological Protection and Safety Congress (Rio de Janeiro, Brazil).
- 2015: *Accident prevention in radiotherapy. Using of the software "SEVRRA" to implement the risk matrix method*, 10th IRPA Latin American Regional Radiological Protection and Safety Congress (Buenos Aires, Argentina).
- 2017: *Ibero-America in the prevention of accidents in radiotherapy. Using of the risk matrix methodology and the SEVRRA tool*, IAEA International Conference on Radiation Protection in Medicine (OIEA, Vienna, Austria).

Participants

Ramón López Morones, project leader (CNSNS, Mexico); Susana Papadopulos (ARN, Argentina); José McDonnell (National University of Rosario, Argentina); Marcelo Gonçalves (CNEN, Brazil); Pedro Paulo Pereira Jr. (National Cancer Institute, Brazil); Cruz Duménigo (CNSN, Cuba); Alba Guillén (CNSN, Cuba); Juan José Vilaragut (CNSN, Cuba); Rubén Ferro (CNSN, Cuba); Carmen Álvarez (CSN, Spain); María Luisa Ramírez (CSN, Spain); Manuel Rodríguez (CSN, Spain); Arturo Pérez Mulas (CSN, Spain); José Miguel Delgado (Madrid Institute of Oncology, Spain); Carlos Sánchez Cayuela (Madrid Institute of Oncology, Spain); Verónica Godínez Sánchez (CNSNS, Mexico); Adrián López García (CNSNS, Mexico); Ángel Bernardo Paz García (CNSNS, Mexico); Ricardo Rodríguez (National Cancer Institute, Mexico); Jorge Morales (National Institute of Oncology and Radiobiology, Cuba); Pedro Ortiz López (IAEA).

Self-Assessment of the Regulatory Program for Radiological Protection in Medical Exposures (PATIENT PROTECTION Project)

Objective
The objective of the project was to develop guidelines for a self-assessment of the regulatory program for medical examinations, with the aim of providing the regulatory body with a method for evaluating its program in this area and, consequently, facilitating the development of more efficient regulatory programs that promote compliance with the radiation protection requirements for patients, as established in the basic safety standards.

Scope
The document is aimed particularly at regulatory bodies and health authorities, and is also of interest to owners of medical facilities and to professional societies involved in medical practices involving the use of radiation.

The project covers the regulatory programme for medical exposure, the difficulties that may hinder or prevent compliance with the standards, as well as examples of strategies to resolve them. The exposure of workers and the public has been excluded from the guidelines, although it may occasionally be mentioned because of its relationship to medical exposure.

The document produced also complemented the International Atomic Energy Agency's publications and tools available at the time and represents a series of good practices, which are useful for overcoming the obstacles that hinder compliance with the basic safety standards on radiological protection of patients.

Results
The result of this project presents an analysis of the most common difficulties encountered when developing a programme for the regulatory control of medical exposure, and suggests strategies for addressing and resolving these difficulties. In particular, the final document goes into detail about the common situations that hinder its control, such as:
– Division of control responsibilities between radiological and nuclear regulatory bodies and health authorities.
– Lack of regulation.
– Lack of infrastructure and specialised human resources.

The final self-assessment guidelines make it easier for countries to analyse the status of regulatory control of medical exposure.

Impacts of the project
The results of this project contributed to the development of more effective regulatory programs to facilitate the application of requirements on patient radiation protection and international basic safety standards for protection against ionising radiation and for the safety of radiation sources. They also enabled self-assessment of the performance of regulatory agencies in controlling medical exposures, contributing to their continuous improvement.

Information for prescribers of radiodiagnostic and nuclear medicine tests in paediatric patients

Prepared by

CSN CONSEJO DE SEGURIDAD NUCLEAR

MINISTERIO DE SANIDAD Y CONSUMO

With the collaboration of

SEPR SOCIEDAD ESPAÑOLA DE PROTECCIÓN RADIOLÓGICA

sefm SOCIEDAD ESPAÑOLA DE FÍSICA MÉDICA miembro de la EFOMP y de la IOMP

SERAM SOCIEDAD ESPAÑOLA DE RADIOLOGÍA

SEMN

Why is it so important that the medical use of ionising radiation in paediatric patients be justified?

- La prescripción de procedimientos con radiaciones ionizantes requiere una justificación basada en la relación riesgo beneficio obtenido por el paciente, siendo ésta especialmente crítica en el caso del paciente pediátrico dada su mayor esperanza de vida y radiosensibilidad, que es aproximadamente un orden de magnitud mayor que en el adulto. Se estima que la exposición a la radiación en los primeros diez años de vida tiene para ciertos efectos un riesgo de tres a cuatro veces mayor que si se produce entre los treinta y los cuarenta años, y de cinco a siete veces mayor si se compara con exposiciones recibidas después de los cincuenta años.

- Todo procedimiento con radiaciones ionizantes debe estar justificado, aunque la dosis recibida por el paciente sea muy baja, como es el caso de la mayoría de los exámenes de radiodiagnóstico y medicina nuclear. En la justificación deben estar involucrados tanto el médico prescriptor como el especialista en radiodiagnóstico o medicina nuclear a quien corresponde la decisión final de la justificación del procedimiento.

- En procedimientos que impliquen dosis comparativamente más elevadas, tal y como ocurre en el caso de la Tomografía Computarizada (TC), particularmente en sus modalidades helicoidal y multicorte, o en procedimientos intervencionistas, esta justificación reviste especial importancia.

El TC es una valiosísima modalidad de imagen. Sin embargo, como cualquier otra herramienta sólo ofrece los mayores beneficios cuando se usa apropiadamente.

- En referencia a la medicina nuclear, al paciente se le administra, por vía intravenosa generalmente, un radiofármaco o trazador, que tiene la particularidad de que uno de sus átomos ha sido sustituido por su isótopo radiactivo, el cual emite radiación electromagnética que puede ser detectada externamente con un equipo apropiado, que se denomina gammacámara, aportando información tanto morfológica como funcional.

Example of an instructional brochure

The IAEA organized several workshops to promote the use of this FORO project as a tool to assess the degree of implementation of basic safety standards in the countries of the region, with the participation of the World Health Organisation and the health regulators and authorities of Latin America and the Caribbean.

Publications

- 2013: *National Programme for Radiological Protection in Medical Exposure*, joint FORO-IAEA publication, TecDoc 1710.

Conference presentations

- 2008: *Self-assessment of the regulatory program concerning radiation protection in medical expo- su- res*, WHO Global Initiative on Radiation Safety in Healthcare Settings (WHO, Geneva, Switzerland).
- 2010: 8th Regional Congress on Radiological and Nuclear Safety I IRPA Latin American Congress (Medellin, Colombia).
- 2015: *Autoevaluación del programa regulador de la protección radiológica en las exposiciones médicas*, IAEA Regional Workshop (Santiago, Chile).
- 2015: *Autoevaluación del programa regulador de la protección radiológica en las exposiciones médicas*, IRPA 12, 12th Congress of the International Radiation Protection Association (Buenos Aires, Argentina).

Participants

Ana María Larcher, project leader (ARN, Argentina); Maria Helena Maréchal (CNEN, Brazil); Rubén Ferro Fernández (CNSN, Cuba); Ramón Hernández Álvarez (CNSN, Cuba); María Luisa Ramírez Vera (CSN, Spain); Natividad Ferrer (Ministry of Health, Spain); Antonia Castañeda Muciño (CNSNS, Mexico); Mario Reyes Sánchez (CNSNS, Mexico); Blanca Faller (ARNR, Uruguay); Alejandro Nader (IAEA).

Regulatory Practices in Aging and Life Extension of Nuclear Power Plants (PREEV Project)

Objective

The PREEV project makes it possible to establish the criteria to be applied by the regulatory bodies to require the implementation of an Aging Management (AM) system for the structures, systems and components (SSC) of a nuclear power plant, including the case of long-term operation (LTO) or life extension, which meets the expected objectives from the safety point of view. It also establishes general guidelines for the development and execution of regulatory practices for licensing, supervision and control of programmes and associated activities.

This development will improve the regulatory action related to AM/ LTO programs in nuclear power plants. To this end, for the execution of the project, the elements used in each country were standardised and contrasted with existing international standards.

Scope

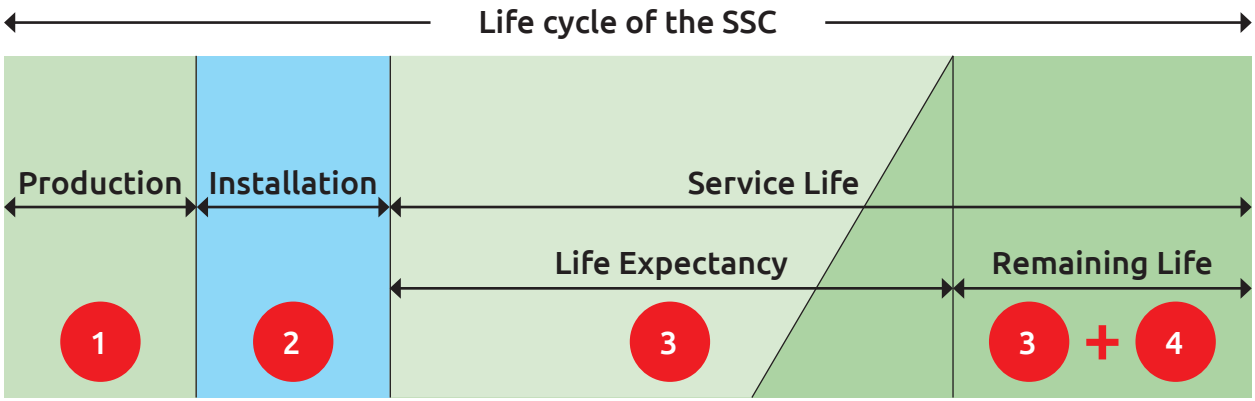
The project covers both the regulatory and licensing framework and the practices followed in the regulatory processes (evaluation and inspection, basically).

In addition to physical aging (degrading phenomena), the project also addresses technological aging (obsolescence) for nuclear power plants with PWR, BWR, CANDU and PHWR reactors, as this is applicable to all operating conditions of nuclear power plants.

Results

As a result, the following four guides were developed for full or partial use, both for development of plants' own regulations and for following regulatory practices. These are generally applicable criteria, but they also refer to different approaches or methodologies characteristic of certain reactor technologies:

- *DT1 Regulatory Criteria Guidelines:* Establishes the regulatory criteria for managing the aging of nuclear power plant components, including management in the case of long-term operation.
- *DT2 Evaluation Guidelines:* Provides guidelines to assess the safety aspects related to managing the aging of nuclear power plants, in order to verify that they operate safely until the end of their useful life. In this guide, as in DT3, the topics related to the evaluation of aging management, life extension projects and the management of long-term aging are addressed in a generic way. Occasionally, singularities are highlighted that are taken into account in some of the countries that have participated in its development; the same is applicable to DT3.
- *DT3 Inspection Guidelines:* Provides guidelines for inspecting the safety aspects related to managing the aging of nuclear power plants, in order to verify that the operators of these plants operate them safely until the end of their useful life.
- *DT4 Periodic Safety Review Guidelines:* Establishes guidelines for evaluating the documentation of the Periodic Safety Review of nuclear power plants applicable to aging of the structures, systems and equipment of such facilities, as well as to the licensing of long-term operation and to long- term operation itself.



Life Cycle of Structures, Systems and Components

A technical report on the project was also prepared, summarising the technical activities carried out, highlighting the results, conclusions and recommendations obtained.

The guidelines developed are based on standards from the International Atomic Energy Agency and regulations from the most advanced countries in terms of nuclear technology, and they are in line with the reference levels established by the Western European Nuclear Regulators' Association (WENRA). They are also consistent with the regulatory framework of each member state represented in the project, and are intended to reflect the experience gained from regulatory practice in each of the project team member countries.

The PREEV documentary package (guidelines and technical report) constitutes a complete guide covering all regulatory activities within the framework of aging management. Within the IAEA, there was abundant guidance material in this field that was applicable to operators of facilities, but not to the activities of the regulator, which is covered by the PREEV project.

Impacts of the project

At a regional level, all countries with nuclear power plants (Argentina, Brazil, Cuba, Spain and Mexico) have used PREEV products. Furthermore, Chile has adapted the PREEV criteria to research reactors and Cuba has applied the DT4 guide to a Category 1 radioactive facility.

In terms of the impact of PREEV at an international level, two milestones should be highlighted:

1. After the project was presented at an international conference, regulatory authorities in the USA,

Switzerland, the Netherlands and China requested copies of the project documentation.
2. Due to the interest of the international community, a joint FORO-IAEA scientific publication was produced, which is essentially the English translation of the four PREEV guidelines.

Publications
- 2009: Article in the NUCLENOR INFO journal (Spain).
- 2010: Article in the Spanish Nuclear Safety Council's Alfa journal (CSN, Spain).
- 2014: *Regulatory Practices on Ageing Management and Long Term Operation of NPP in the Ibero-American Region,* FORO-IAEA joint scientific publication.

Conference presentations
- 2009: Participation in the round table on New Developments in the European and Ibero-American Regulatory Environment, 20th Annual Congress of the Mexican Nuclear Society, SNM (Puerto Vallarta, Mexico).
- 2009: Participation in the round table on Relations of the CEIDEN Technology Platform with Ibero-America, Meeting of the Management Council of the Spanish nuclear fission energy technology platform CEIDEN (Madrid, Spain).
- 2010: IAEA regional workshop on the development of regulatory structures (Santiago, Chile).
- 2011: *Actividades en el* Área *de Seguridad Nuclear del FORO*, 37th Annual Meeting of the Spanish Nuclear Society, SNE (Burgos, Spain).
- 2011: *Cooperación entre Organismos Reguladores. El Proyecto PREEV: Prácticas Reguladoras sobre Envejecimiento y Extensión de Vida*, Iberinco Ibero-American Seminar on Life Management (Madrid, Spain).
- 2012: *PREEV Project: Regulatory Practices on Ageing and Life Extension*, IAEA 3rd International Conference on NPP Life Management for Long Term Operations (Salt Lake City, USA).
- 2021: *FORO Activities in Nuclear Safety and AM&LTO*, Annual Congress of the Mexican Nuclear Society, LAS-ANS Symposium 2021 (Cancún, Mexico).

Participants

Diego Encinas Cerezo, project leader (CSN, Spain); Reinaldo Valle Cepero (ARN, Argentina); Alexandre Gromann Araujo de Góes, (CNEN, Brazil); Jaime Riesle Wetherby, (CCHEN, Chile); Conrado Alfonso Pallarés, (CNSN, Cuba); José María Figueras Clavijo (CSN, Spain); Ricardo Pérez Pérez, CNSNS (Mexico); Javier Yllera Sánchez (IAEA).

Strategy for the Prevention, Detection and Response to the Inadvertent Presence of Radioactive Material in Metal Recycling and other Associated Processes (SOURCES Project)

Objective
The purpose of this project is to help national governments and regulatory agencies to develop harmonised national strategies to prevent and mitigate the risks arising from the inadvertent presence of radioactive material, as well as to contribute to improving the control of radioactive sources by re-incorporating sources detected at any stage of the metal recycling process back into the regulatory system.

The final document includes a series of recommendations addressed to governmental and regulatory authorities on the implementation of technical, training, information and financial measures to establish a national system for radiological monitoring of scrap metal, products and by-products resulting from its recycling, as well as to deal with the detection of radioactive sources or material in this industry.

Scope
The scope of the document covered the development, implementation and maintenance of the strategy, for which the direct participation of all entities involved in the metal recycling process is essential, and this includes governmental and regulatory agencies, customs control agencies, radioactive waste managers, and the companies and business and labour organisations involved in this industrial activity.

Results
As a result of the project, a document was prepared with a harmonised strategy for the prevention, detection and response to the inadvertent presence of radioactive material in metal recycling and other associated processes, based on agreements, protocols and experiences; training programmes for personnel involved in these processes, including the staff from regulators and facilities; and a method for calibrating radiation detectionportals.

Procedures were also drawn up for recording operation of the detection systems (to be followed if radioactive material is detected at the entrance to the facilities) and for cleaning and decontamination should radioactive sources or contaminated materials be incorporated into the process. A mechanism was also developed for investigating the origin of the sources detected.

Finally, informative brochures, leaflets and posters were prepared for the public and the personnel working in the metal recovery sector.

Impacts of the project
As a result of the project, some countries established action protocols in two main activities. The first related to the management of radioactive materials concentrated during the production processes of the oil industry, especially in the extraction of fossil fuels, either by using the radiation sources utilised in this process or by detecting radioactive material of natural

Informative leaflet on the presence of radioactive sources in scrap metal

origin concentrated in the extraction pipes, following the guidelines developed in the FORO project.

The second activity corresponds to preventing the inadvertent presence of radioactive material in the smelting industry. According to information on the subject, thanks to the FORO project, during this process medium-sized and international companies, according to their budget, implemented detection systems both at the entrance and the exit of the production process and other systems for the receipt of raw materials, at the input level of the process, during the process itself and at the output level. Some companies even created a radiological safety group in charge of this specific process.

The procedures described in the project have been applied by the countries that participated in the project, each according to their particular capacities and interests.

Publications

- 2011: *Estrategia para la Prevención, Detección y Respuesta frente a la Presencia Inadvertida de Material Radiactivo en el Reciclado de Metales y otros Procesos Asociados* (final project report), available on La RED, FORO's webpage.

A joint FORO-IAEA publication in the form of a TecDoc is being developed.

Conference presentations

- 2013: *Control de fuentes Radiactivas en el Proceso de Reciclado de Metales*, 9th Regional Congress Latin American IRPA of Radiological Protection and Safety (Rio de Janeiro, Brazil).
- 2014: *Round table*, International Joint Conference RADIO 2014, (Gramado, Rio Grande do Sul, Brazil).
- 2017: *Round table*, International Joint Conference RADIO 2017 (Goiania, Brazil).

Participants

Walter Adrián Truppa, project leader (ARN, Argentina); Josilto Oliveira de Aquino (CNEN, Brazil); Igor Iván Sarabia Molina (CNSN, Cuba); Santiago Mansilla Pérez (Ministry of Health, Chile); Jorge Díaz Rivera (Ministry of Health, Chile), José Ignacio Serrano Renedo (CSN, Spain), Ignacio Jiménez Castro (CNSNS, Mexico); Mardonio Jiménez Rojas (CNSNS, Mexico), Walter Cabral (ARNR, Uruguay); Enrique Fernando Morales (ARNR, Uruguay); Diego Tellería (IAEA).

Establishment of a Common Methodological Guide for Radiological Emergency Analysis and Identification of Lessons (EMERGENCIES Project)

Objective
The objective of the project is to develop methodological guidelines and standardised tools to support nuclear or radiological emergency preparedness and response actions in FORO member countries. One of its milestones is to develop a methodological guide, which provides a standardised basis for the analysis of a nuclear or radiological emergency, in order to strengthen preparedness and response actions for this type of event. This guide proposes stages and steps to be followed, ranging from the collection of information at the beginning of the emergency, to the drafting of the final report.

This project was created in response to the need to strengthen the systematic work in the emergency field, promoted by the International Atomic Energy Agency. The basis for the preparation of the guide is based on the recommendations established in the IAEA Safety Standard "Preparedness and response for a nuclear or radiological emergency, general requirements", GSR Part 7, and, in particular, requirement No. 19 of said document: "*Analysing the nuclear or radiological emergency and the emergency response*". It also draws on the experience of the members of the emergency group, both locally and internationally.

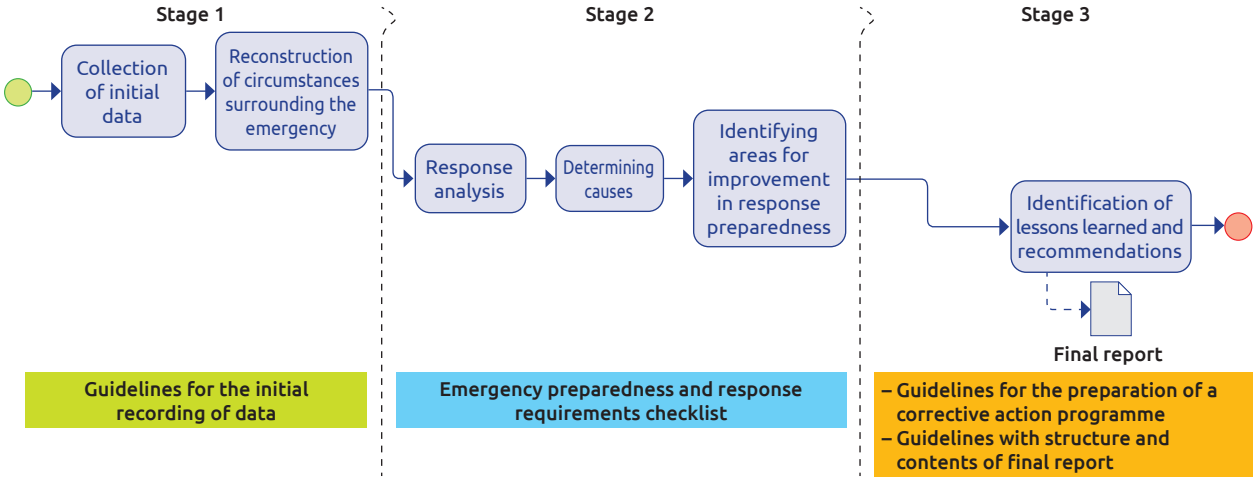
Scope
The methodological guides and support tools, developed within the framework of the project, are aimed at organisations responsible for the management of preparedness and response to nuclear or radiological emergencies, such as owners and operators of facilities, regulatory authorities or response organisations.

The project includes 3 stages: development of 2 guides (a methodological guide for the preparation of hazard and radiological risk maps, and a common methodological guide for the analysis of radiological emergencies and identification of lessons) and preparation of content for the FORO information platform on nuclear and radiological emergencies.

Results
The first guide, for the preparation of radiological hazard and risk maps, includes a series of guidelines for the preparation of radiological hazard and risk maps. The second is a common guide for conducting analysis of a nuclear and radiological emergency, establishing a standardised basis for analysing a nuclear or radiological emergency, thereby strengthening preparedness and response actions for this type of event. Finally, the third activity lays the foundations for the information architecture of the emergencies platform, which is expected to be set up on the FORO website.

The common methodological guide for the analysis of radiological emergencies and identification of lessons learned includes the following stages:

1. Investigate the event that occurred, identifying the conditions prior to its origin and the problem;



Flow chart of stages and steps included in the methodological framework

2. Examine the causes that triggered the event, determining the failure elements;
3. Determine conclusions and lessons learned from the event, in order to strengthen emergency preparedness and response actions.

For the stages mentioned above, the guide proposes a series of methodologies and tools to be used, such as work guidelines or checklists, as well as guidelines for use as support when carrying out each stage. The attached figure shows a flow chart for the respective stages and steps proposed for the evaluation of responses to radiological or nuclear emergencies.

Impacts of the project

The guidelines and methodological tools developed are expected to serve as a common basis for all organisations involved in the management of nuclear or radiological emergencies for the development of standards and procedures related to preparedness activities, action and response analysis for such events, according to their area of competence.

The use of this guide will increase the dissemination of guidelines, knowledge and experience, thus helping to strengthen understanding of nuclear or radiological emergencies, both locally and internationally.

Publications

A joint FORO-IAEA publication is currently being developed in the form of a TecDoc, with the title: *Establishment of a Common Methodological Guide for Radiological Emergency Analysis and Identification of Lessons.*

Conference presentations
The *Common methodological guide for the radiological emergency analysis and identification of lessons learned* is expected to be presented and distributed in Ibero-American countries, in collaboration with the IAEA Department of Technical Cooperation.

Participants
Osvaldo Daniel Jordán, in memoriam, (ARN, Argentina); Raúl Dos Santos (CNEN, Brazil); Héctor Basáez Pizarro (CCHEN, Chile); Pedro Ibrahim Díaz Guerra (CNSN, Cuba); María Josefa Granada Ferrero (CSN, Spain); Alejandro Cortés Carmona (CNSNS, Mexico); Santiago Regalado Campaña (IPEN, Peru); Marco Munive Sánchez (IPEN, Peru); Olga Edith González Granara (ARNR, Uruguay); Rodrigo Salinas Mariaca (IAEA).

Establishment of Licensing Criteria and Inspection Requirements for Facilities with Cyclotrons for the Production of Radioisotopes used in Medical Applications and Research (CYCLOTRONS Project)

Objective
There is a growing interest worldwide in positron emission tomography (PET), particularly with regard to research into and use of new radiopharmaceuticals. Therefore, the production of radiopharmaceuticals in cyclotrons is an area that is growing in importance and requires increasing efforts from regulators during their licensing process due to its complexity. Consequently, facilities that operate cyclotrons for the production of radiopharmaceuticals present important aspects for radiation protection that must be adequately assessed to ensure that operations are carried out without risk to the employees, the environment and the public. As such, the objective of the project was to establish the procedures for licensing and inspecting of facilities with cyclotrons for radioisotope production.

Scope
The project was carried out in two stages, starting with a document to serve as a guide for the licensing of cyclotron facilities for the production of isotopes. This was followed by the preparation of an inspection manual to serve as a reference for regulators in the region and other countries that have

cyclotron facilities for radioisotope production, with practical procedures to achieve this objective. This will help to make national inspection programmes more effective, taking advantage of the experiences accumulated in each country. The project addresses crucial aspects for this type of facilities, such as personnel (basic education and training) and minimum required safety systems, operational, maintenance and emergency aspects, etc.

Results
The project generated a licensing guide and a guide for inspections of radioisotope production for cyclotron facilities, proposing a structure and aspects to be verified in each phase of the licensing process, namely: notification and siting, construction, commissioning, operation and decommissioning. Throughout the project, tools were generated for their use during the licensing and inspection processes of their facilities, as well as a spreadsheet to assist in the shielding calculations and other support material for verifying the suitability of the ventilation systems.

Impacts of the project
The licensing and inspection guides have been used both by operators to quantify the radiological safety status of their facilities and by the regulatory authorities for their verification.

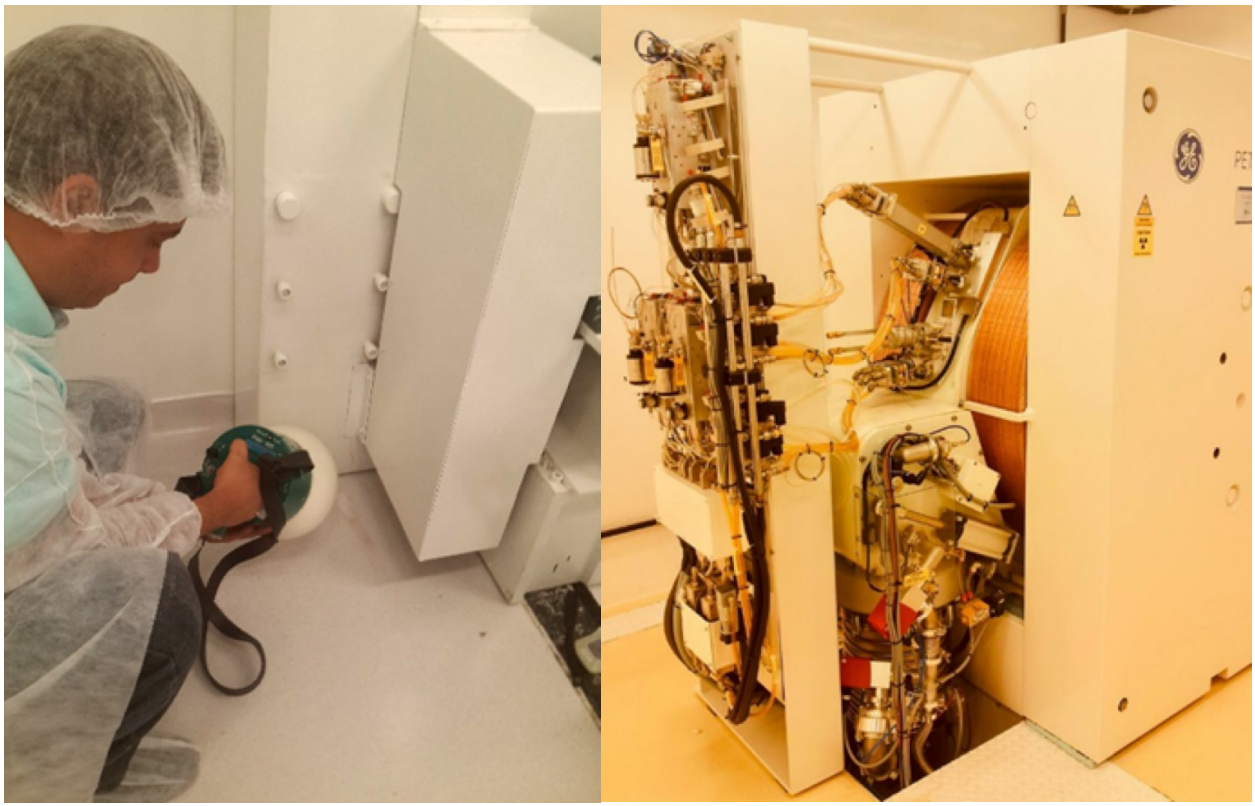
The results of this project have been used by several FORO member regulators and others in the Latin American and Caribbean region. Among them, Brazil was the main reference for the development of regulations for these installations.
The International Atomic Energy Agency also provided regional courses on regulatory control of cyclotron facilities using the results of the project as reference material.

Publications
- 2013: *Criterios para el licenciamiento y requisitos de inspección de instalaciones con ciclotrones para producción de radioisótopos utilizados en aplicaciones e investigaciones médicas* (final project report), available on La RED, FORO's webpage.

The results of the project are also being used to produce a joint FORO-IAEA publication in the form of a TecDoc.

Conference presentations
- 2015: *Criterios para el licenciamiento y requisitos de inspección de instalaciones con ciclotrones para producción de radioisótopos utilizados en aplicaciones e investigaciones médicas*, 10th IRPA Latin American Regional Congress on Radiological Protection and Safety IRPA (Buenos Aires, Argentina).
- 2017: *Licensing process of cyclotron facilities*, RADIO 2017 International Conference (Goiania, Brazil).
- 2019: *Planejamento e segurança para produção de radiofármacos em cíclotrons: como avaliar o impacto regulatório no cenário brasileiro*, RADIO 2019 International Conference (Foz de Iguazú, Brasil).

Participants
Alessandro Facure Neves de Salles Soares, project leader (CNEN, Brazil); Flavio Andrada Contardi (ARN, Argentina); Renato Di Prinzio (CNEN, Brazil); Ciro Cárdenas Eyzaguirre (CCHEN, Chile); Ramón Hernández (CNSN, Cuba); Arturo Pérez Mulas (CSN, Spain); Juan Gabriel Salinas Hernández (CNS- NS, Mexico); Yuri Ravello (IPEN, Peru); Beatriz Souto (ARNR, Uruguay); Ronald Pacheco (IAEA).



Inspector taking measurements during an inspection of a cyclotron facility

Safety Culture in Organisations, Facilities and Activities with Ionising Radiation Sources (SAFETY CULTURE Project)

Objective

The general objective of this project is to provide a framework for the introduction and practical application of the concept of safety culture in organisations that carry out activities with radiation sources, considering the particularities of radiological and physical protection and safety of the sources. Given that this remains an underdeveloped subject in the sector, the result of the project helps to establish a series of definitions, approaches and recommendations that constitute the initial reference base for organisations that carry out activities with radiation sources to assimilate and work on the subject, gradually and in accordance with their particularities. It also helps regulatory agencies to develop their work of promoting and monitoring the safety culture in organisations that carry out activities with radiation sources, and to promote its adoption by the regulator itself.

Scope

The aspects of safety culture developed in this project had the following scope:

a. They apply only to organisations that carry out activities with radiation sources for medical, industrial, research and training purposes; the transport of radioactive material; and the management of radioactive waste derived from these activities and irradiation plants. The application in nuclear facilities is beyond the scope of this document;
b. It applies to regulatory agencies, generally related to their work in promoting safety culture, and specifically for their own safety culture, in the corresponding points of the project;
c. It includes both safety aspects of radiation sources and radiological protection of people and the environment;
d. It includes aspects related to the physical security of radiation sources, as it is considered to be inextricably linked to radiation protection and safety;
e. It considers aspects related to both occupational radiological protection and radiological protection for medical exposure, members of the public and the environment;
f. It applies only to processes where radiation sources are present, from the commissioning of a facility until its decommissioning and eventual closure. The processes for selecting the site of a facility and the design of said facility and its systems and equipment are outside the scope of this document, even though behaviours and attitudes regarding the safety of facilities and activities with radiation sources (safety first) should be present in all these processes or phases.

Results

This is a groundbreaking project to adapt and develop the concept of safety culture in organisations with sources of ionising radiation in medicine, industry, research and training for the first time. The resulting guide allows for better understanding and increased awareness of this concept, which is considered to be one of the main contributing factors to the occurrence of radiological accidents and incidents over recent decades.

Impacts of the project

The guide has served as the main source of information for organising national and regional courses in Latin America and other regions, providing training for more than a hundred professionals in the region between 2016 and 2019. It has also formed the basis for teaching about safety culture in courses for new authorisations and license renewals for gammagraphy operators in Argentina since 2019.

Furthermore, many countries in the region have organised events to promote safety culture based on the FORO guide, and in Cuba a document was even produced that recommends the regulatory authority carry out self-assessments of safety culture based on the FORO guide.

For its part, the International Atomic Energy Agency provided national courses on safety culture using the FORO guide as its source material, and the guide was also used for three regional meetings on the training of professionals in Latin America, in collaboration with the regulatory agencies of Brazil and Chile.

Similarly, both the International Radiation Protection Association (IRPA) and the World Health Organisation (WHO) have expressed interest in collaborating with FORO in this area and have invited experts from the working group to perform presentations at international events sponsored by these institutions.

The FORO guide on safety culture is being applied in a pilot study for the practice of industrial radiography (Gammagraphy Project).

Publications

- 2015: *Cultura de Seguridad en las organizaciones, instalaciones y actividades con fuentes de radiación ionizante,* available on La RED, FORO's webpage.
- 2016: *Cultura de Seguridad en las organizaciones, instalaciones y actividades con fuentes de radiación ionizante*. ALFA journal no. 30 from the Spanish Nuclear Safety Council, ISSN-1888-8925.

A joint FORO-IAEA publication is currently being finalised in the form of a TecDoc (in the process of being printed).

Presentations

- 2013: *Proyecto de Cultura de la Seguridad del FORO*, 9th IRPA Latin American Regional Congress on Safety and Protection (Rio de Janeiro, Brazil).
- 2014: *FORO Project on Safety Culture in organisations, facilities and activities with ionising radiation sources*, IAEA International Conference on Occupational Radiation Protection (IAEA, Vienna, Austria).
- 2015: *Cultura de Seguridad en las organizaciones, instalaciones y actividades con fuentes de radiación ionizante*, Latin American Regional Workshop on Radiological Protection Culture in Medicine (Buenos Aires, Argentina).
- 2015: *Proyecto del FORO sobre Cultura de Seguridad en el área radiológica*, 10th IRPA Latin American Regional Congress on Radiological Protection and Safety (Buenos Aires, Argentina).
- 2015: *Proyecto del FORO sobre Cultura de la Seguridad*, 4th Joint Congress of the Spanish Society of Medical Physics and the Spanish Society for Radiological Protection (Valencia, Spain).
- 2015: *FORO Project on Safety Culture in organizations, facilities and activities with sources of ionizing*

Ten basic elements of safety culture in organisations, facilities and activities detailed in the FORO guide

radiation, Regional European Workshop on Radiation Protection Culture in Medicine (Geneva, Switzerland)

- 2016: *FORO Project on Safety Culture in Organizations, Facilities and Activities with Sources of Ionizing Radiation*, IAEA International Conference on Human and Organizational Aspects of Assuring Nuclear Safety (OIEA, Vienna, Austria).
- 2016: IRPA 14 International Congress (Cape Town, South
- Africa).
- 2016: *Proyecto del FORO sobre Cultura de la Seguridad*, Ibero-American Conference on Radiological Protection in Medicine, CIPRaM (Madrid, Spain).
- 2017: International Symposium on Radiological Protection in Medicine (Arequipa, Peru).
- 2018: *Proyecto del FORO sobre Cultura de Seguridad en el área radiológica*, 11th IRPA Latin American Regional Congress on Radiological Protection and Safety (Havana, Cuba).
- 2020: IAEA International Conference on Radiation Safety: Improving Radiation Protection in Practice (IAEA, Vienna, Austria).

Participants

Rubén Ferro Fernández, project leader (CNSN, Cuba); Ana María Bomben (ARN, Argentina); Claudia Da Silva Silveira (CNEN, Brazil); Ricardo Videla Valdebenito (CCHEN, Chile); Ana Blanes Tabernero (CSN, Spain); Jorge Arciniega Torres (CNSNS, Mexico); Emilio Ordóñez Gutiérrez (CNSNS, Mexico); Renán Ramírez Quijada (IPEN, Peru); Jorge F. Perera Meas (ARNR, Uruguay); Rodolfo Cruz Suárez (IAEA).

Guide to Producing a Programme for the Creation and Development of NPP Regulator Competencies (CReAN Project)

Objective

The overall objective of the CReAN project is to improve systems, programmes and practices for training and developing skills among nuclear power reactor regulatory personnel. This project establishes the principles of a programme to strengthen regulatory competencies, based on the operating experience of FORO countries with nuclear infrastructure, and is designed to maximise the use of the Ibero-American region's own resources.

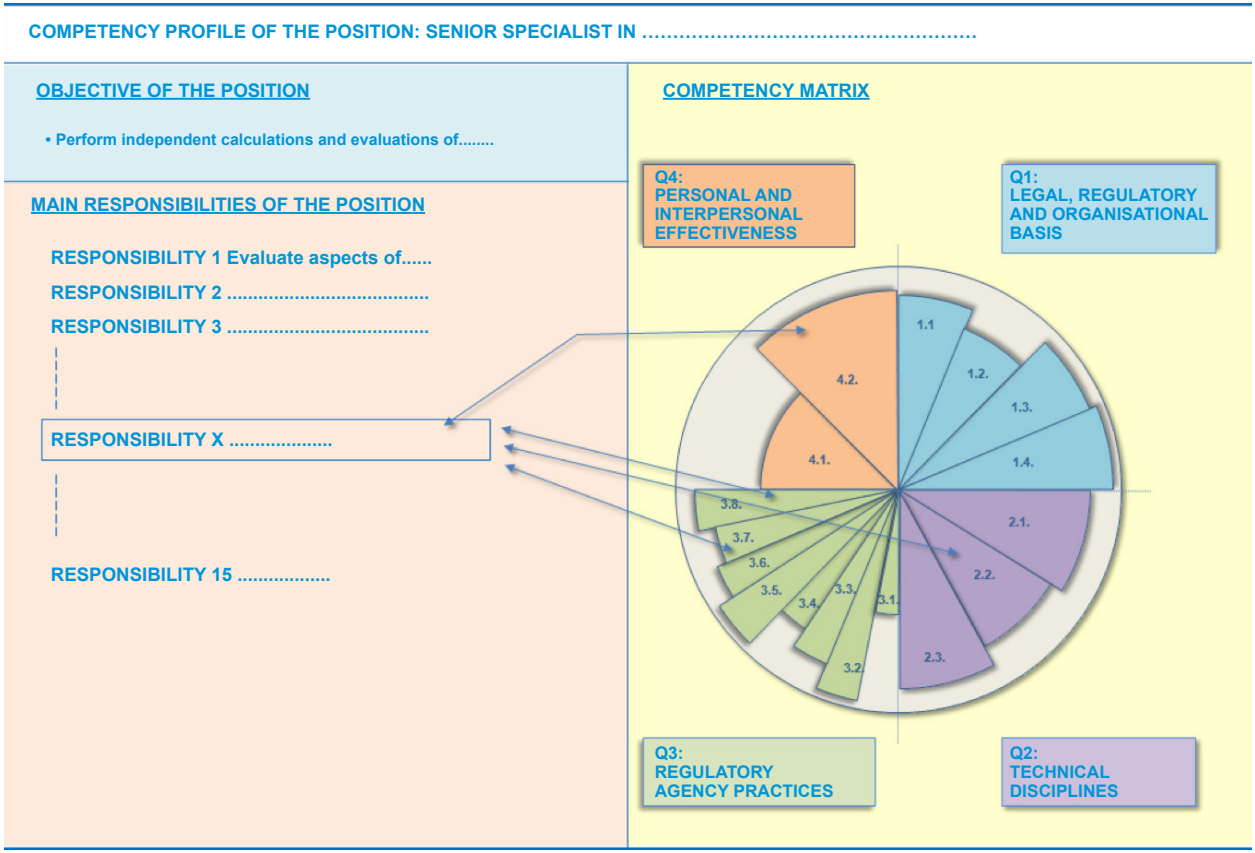
The resulting guide provides concrete elements for developing specific aspects based on the analyses and exercises developed in the project, as well as a series of good practices identified in different countries. It can also be useful both for a regulatory agency in a country embarking on a nuclear programme, and for evaluating, developing or improving the competency management programme of an agency that already has extensive experience in the regulation of nuclear power reactors.

Scope

The guide complements and expands upon the methodology developed by the IAEA for competency management in nuclear regulatory agencies, with regard to the implementation of the main competency management processes. As such, it focuses on processes related to competency analysis and overcoming competency deficiencies. The other

two main processes— competency management and knowledge management and participation in knowledge networks—are dealt with in less detail.

The structure of the guide makes it possible to establish general guidelines while also introducing specific elements, examples and good practices provided



Example of a generic competency profile

throughout the development of the project, which can be used as a reference to address specific aspects regarding the implementation of the strategic plan that are considered of special interest or importance.

Results

The main innovative contributions of the guide are the following:

1. Infrastructure and mechanisms for creating competencies.
   It presents an evaluation of the infrastructure and mechanisms for creating competencies in each regulatory agency and a comparative analysis of them, as well as a summary table of the academic offerings on nuclear technology and safety available in the region.
2. SWOT analysis of the situation in the region.
   On the basis of this diagnosis, it is possible to draw up action plans with the necessary strategies for implementing the competency creation and development programme.
3. Identification and description of good practices.
   Best practices are identified in relation to the regulator's proactive approach to vocation development, onboarding policies and immersion in the regulatory body, implementation of performance indicators and certification of regulatory competencies.
4. Identifying basic regulatory staff.
   28 regulatory positions were identified, with the objective and main responsibilities determined for each position, as well as the staffing needs for each stage of the facility's life cycle, from site request to decommissioning and site release.
5. Review and adaptation of the regulatory competency model.
   Based on the IAEA's SARCoN model, a new model adapted to the regulatory structures of the region was developed with important innovations, establishing a methodology to build a competency profile for each staff member, which is summarised in the diagram. The pie chart of competencies represents the average level of performance required, extended to each group of competencies in each of the quadrants.
6. Basis for the establishment of a regional on-the-job training network.
   Based on the information gathered, a series of elements were developed that can be used as a starting point for the implementation of a training network in the region.
7. Career development model in stages.
   An outline of the professional career development of a regulatory technician was developed, which summarises the guidelines for producing a competency creation and development programme contained in the guide.

Impacts of the project

The results of the project in terms of the creation and management of regulatory competencies in nuclear safety are being incorporated into various regulators in the region, such as the development of the Systematic Approach to Training (SAT) for the Spanish Nuclear Safety Council, for example.

Publications

- 2016: *Guidelines on Devising a Programme for Competence. Acquisition and Development among Nuclear Regulators,* joint FORO-IAEA publication: TecDoc 1794.

Conference presentations

- 2014: *Final Results of Project CReAN of the Iberoamerican FORO*, 6th Meeting of the Steering

Committee on Competence of Human Resources for the Regulatory Bodies (OIEA, Vienna, Austria).
- 2015: *Resultados del Proyecto CReAN del FORO Iberoamericano*, 10th IRPA Latin American Regional Congress on Radiological Protection and Safety (Buenos Aires, Argentina).
- 2015: *El Proyecto CReAN del Foro Iberoamericano: Resultados, Aplicaciones y Perspectivas de Futuro*, International Symposium on Education, Training and Knowledge Management in Nuclear Energy and its Applications (Cusco, Peru).
- 2015: *Competence of Regulators in the Nuclear Area, Final Results of the FORO Project "CReAN"*, Technical Meeting on Capacity Building and Human Resource Development for New and Expanding Nuclear Power Programmes (Lyon, France).
- 2019: *FORO's technical projects outcomes in regulatory competencies building and training. Their contribution to knowledge management in nuclear reactors and medical and industrial radiological applications*, FORO event during the IAEA General Conference (IAEA, Vienna, Austria).
- 2021: *FORO Technical Projects on Regulatory Competences*, IAEA Regional Training Course on Regulatory Body Integrated Management System and Human Resources Planning (IAEA, Vienna, Austria).

Participants
José María Kay, project leader (ARN, Argentina); Ana María Larcher (ARN, Argentina); Alexandre Gromann (CNEN, Brazil); Jaime Riesle (CCHEN, Chile); Conrado Alfonso (CNSN, Cuba); Diego Encinas (CSN, Spain); José Luis Esquivel (CNSNS, Mexico); Enrique Morales (ARNR, Uruguay); María Josefa Moracho Ramírez (IAEA).

Application of the Risk Matrix Method in Industrial Radiography (SEVRRA INDUSTRY Project)

Objective
The objective of this project is the implementation of risk analysis techniques in the practice of industrial radiography, with a view to identifying measures that can prevent accidental exposure with adverse radiological consequences for employees and members of the public. With this in mind, the "Risk matrix" method was used for the project, both for techniques using radioactive sources and those using X-rays.

Specifically, work was carried out to:
1. Provide a risk profile of hypothetical reference entities in the field of industrial radiography, adapting and implementing the "Risk Matrix" method.
2. Adapt the SEVRRA software tool, used in radiotherapy risk analysis, to entities that carry out these industrial practices.
3. Determine the accidental sequences of greatest risk, as well as the barriers and mitigators that have the greatest impact on reducing risk in these practices.

This project aims to help companies engaged in industrial radiography with their self-assessment, by identifying those measures that have the greatest impact on risk reduction. It is also very useful for strengthening the regulatory agency's procedures for evaluating and inspecting these practices.

Scope
The project was carried out in stages, starting with the use of industrial radiography with radioactive sources,

the most complex due to the risks involved, taking into account the large number of radiological incidents and accidents that have occurred in recent times.

The second part of the project was extended to the methodology of the use of X-ray generators in on-site industrial radiography, expanding the number of techniques involved to cover the most commonly used industrial radiography techniques. This part also included radiography in shielded enclosures, with the use of X-ray generators and industrial gammagraphy equipment.

In order to identify events, barriers and realistic consequences, industrial radiography operators from Spain and Mexico were invited to participate in two of the working meetings.

Results
As a result of this project, a technical document was prepared that develops both conceptual aspects and practical suggestions for risk analysis in the practice of industrial radiography, and a software tool was also developed, called SEVRRA Industry, which is the result of applying the Risk Matrix methodology in a practical way.

Both the technical document and the SEVRRA tool are available in online and offline versions on La RED, FORO's webpage, and work is currently underway with the International Atomic Energy Agency (IAEA) to produce a joint FORO-IAEA publication in the form of a TecDoc.

Impacts of the project
The technical document, as well as the SEVRRA tool, can be used as a reference guide for applying the risk matrix method in industrial radiography.

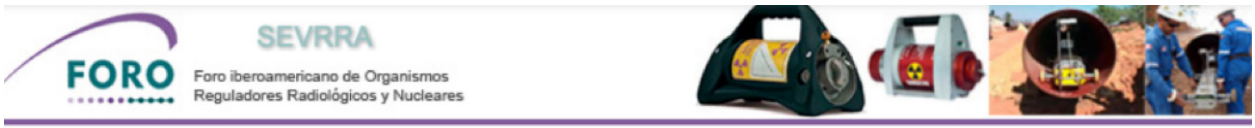
The results can be used by both industrial radiography organisations and regulatory authorities. For users performing industrial radiography, whether using radioactive sources or X- ray generators, it improves protection and safety for employees and the public, and prevents unintentional events. In respect to regulatory agencies, it can be applied when carrying out the evaluation and inspection process in this field, not only to improve procedures but also as a tool for independent verification.

At the regional level, many FORO countries have held workshops and local/national meetings to disseminate project results and carry out practical exercises of the methodology. The objective of these activities was to implement the tool in a practical way and to gather evidence on the safety impact and improvement possibilities of the SEVRRA Industry process and tool. The tool is already being used in several countries within the region as part of the safety assessment of facilities.

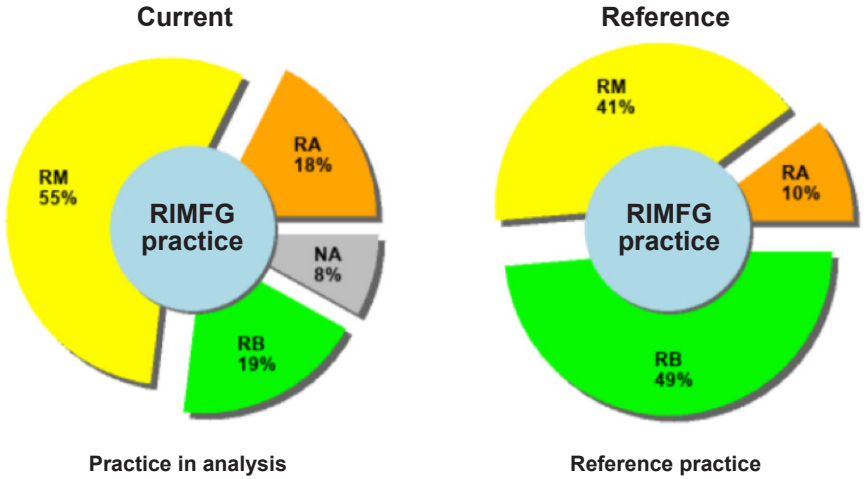
Publications
- 2016: *Aplicación del Método de la Matriz de Riesgo en Radiografía Industrial* (final project report), available on La RED, FORO's webpage.

A joint FORO-IAEA publication is also currently being finalised in the form of a TecDoc.

Conference presentations
- 2016: *Preliminary results of the FORO project "Application of risk matrix method in industrial radiogra-phy",*16th European ALARA Network Workshop: ALARA in industrial radiography - How can it be improved? (Bern, Switzerland).



3.2 Graphics: Practice in analysis vs. Reference practice



SEVRRA tool report. Comparison of the risk profile of a real entity versus a hypothetical reference entity in the field of industrial radiography

- 2017: *Aplicación del Método de la Matriz de Riesgo en Radiografía Industrial (SEVRRA Industria)*, RADIO 2017 International Conference (Goiania, Brazil).
- 2018: *Aplicación del Método de Matrices de Riesgo para Evaluaciones de Riesgos en Radiografía Industrial*, 11th IRPA Regional Congress on Radiological and Nuclear Safety (Havana, Cuba).
- 2019: Participation in a round table at the Workshop on Updating Radiological and Physical Safety in Industrial Gammagraphy and the Workshop on

the Risk Matrix in Industrial Radiography (Buenos Aires, Argentina).
- 2019: *Actividades del Foro Iberoamericano de Reguladores*, RADIO 2019 International Conference (Foz do Iguaçu, Brazil).
- 2020: *The Application of Risk Matrix Methodology to avoid Radiological Accidents in Industrial Radiography*, IAEA International Conference on Radiation Safety: Improving Radiation Protection in Practice (IAEA, Vienna, Austria).

Participants
Walter Adrián Truppa, project leader (ARN, Argentina); Josilto Oliveira de Aquino (CNEN, Brazil); Miguel Aravena González (CCHEN, Chile); Rubén Darío Quintero Londono (INGEOMINAS, Colombia); Yolanda Pérez Reyes (CNSN, Cuba); Cruz Du ménigo González (CNSN, Cuba); Belén Tamayo (CSN, Spain); Blanca Alfonso Nicolás (CSN, Spain); Laura Urteaga García (CSN, Spain); Mardonio Jiménez Rojas (CNSNS, Mexico); Adrián López García (CNSNS, Mexico); Gerardo Lázaro Moreyra (IPEN, Peru); Blanca Faller (ARNR, Uruguay); Rodolfo Cruz Suárez (IAEA).

Practical Guide for the Implementation of Disposal in Radioactive Facilities (CLEARANCE Project)

Objective
The objective of the guide is to support operators of radioactive facilities that generate small amounts of waste, with a methodology for carrying out the clearance process in accordance with the criteria established in IAEA publications and in the regulations of most FORO countries. It is also designed so regulatory agencies can implement it to clearance control.

Scope
The guidance developed is applicable to radioactive facilities that generate small quantities of solid and liquid radioactive waste containing radionuclides with very short half-lives (less than 100 days), such as: nuclear medicine centres, research facilities, agricultural and industrial applications, etc.

The guide also includes a methodology that can be applied to the management of disused sealed sources with low activity and very short semi-disintegration periods.

The guide does not apply to facilities associated with the nuclear fuel cycle or to waste generated from activities and practices where radionuclides of natural origin are present, either in natural or increased concentrations.

Results

As a result of the project, the document "*Practical guide for the implementation of clearance in radioactive facilities*" was prepared, which includes:

– the radiological criteria for clearance and the disposal levels that can be used,
– the methodology for the implementation of clearance for both solids and liquids, diagrams for the implementation and presentation of the records for the control of this activity,
– recommendations for the clearance of disused sealed sources,
– control of clearance by the regulatory agency.

In addition to the guide, three computer tools and a manual for their use were developed, which allow the recording and calculation of clearance to be carried out in a simple and practical manner for solids, liquids and sealed sources. The methodology designed in the guide was incorporated in these, so that the operators can easily determine the date when the waste will reach the clearance levels and after which it can be released into the environment. The results can be submitted virtually and periodically to the regulatory agencies for follow-up in the established formats.

As it is a practical and easy-to-use document, it can have a very important impact in the countries in the region, taking into account that this issue has not yet been suitably applied in most countries and constitutes an important contribution for both operators and regulatory agencies, which should promote its dissemination and implementation.

Impacts of the project

Colombia and Uruguay have incorporated part of the guide into their national regulations. Mexico, Cuba and Peru are considering it in order to update their regulatory framework for the practices carried out in their countries. Despite not being a member of FORO, Guatemala has used part of the results of the project for its "Guide for the Safe Management of Radioactive Waste from Nuclear Medicine Facilities".

Work has been carried out jointly with the International Atomic Energy Agency so that a practical example of the application of the methodology pro-

[ID] Waste identification	[RN] Radionuclide	[$T_{1/2}$] Semi-disintegration period	[V] Volume [l]	[A_0] Estimated activity [Bq]	Estimated date of activity	[CA] Concentration of activity [Bq/l]	[Nd] Clearance Level [Bq/l]	[t] Decay time [d]	Likely disposal date	Verification measurement	Date of release	Annual release activity [Bq/year]	Annual release limit [Bq/year]

Table: Harmonised recording format for liquid waste clearance

posed in the project will be included as an annex in the new Safety Guide "Application of the concept of clearance". One of the advantages of this guide is that it will help users in any country to carry out clearance in a faster and more efficient way, since the proposed methodology will help radioactive waste to be released once it reaches the corresponding clearance levels (thanks to the automatic calculation that is performed by the tools), and it also avoids the accumulation of waste that unnecessarily occupies space in the radioactive facilities.

Publications

- 2018: *Guía para la implementación de la Dispensa en Instalaciones Radiactivas; Manual de Uso de las Herramientas; Herramienta para el cálculo de dispensa de líquidos; Herramienta para el cálculo de dispensa de sólidos; Herramienta para el cálculo de dispensa de fuente en desuso* (final project reports), available on La RED, FORO's webpage.
- 2018: *Implementación de la dispensa en instalaciones radiactivas*, Proceedings of the 11th IRPA Regional Congress on Radiological and Nuclear Safety, ISBN 978-959-7231-06-6.

The *IAEA DS500 guide "Application of the Clearance Concept"*, which is a revision of Safety Guide RS-G-1.7, is under revision. A practical example of the clearance methodology proposed by the project for a small radioactive facility is included as an annex.

Conference presentations

- 2016: *Guía Práctica para la Implementación de la Dispensa en Instalaciones Radiactivas*, Regional Meeting of Experts on the "Regulatory Approach for the Decommissioning of Small Facilities" (Uruguay).
- 2017: *Clearance for Small Facilities and Activities*, Workshop on Derivation of Specific Clearance Levels for Materials that are Suitable for Disposal in Landfills (IAEA, Vienna, Austria).
- 2018: *Implementación de la Dispensa en Instalaciones Radiactivas*, 11th IRPA Regional Congress on Radiological and Nuclear Safety (Havana, Cuba).
- 2020: *Guía Práctica para la Implementación de la Dispensa*, LAPRAM Network Webinar (virtual).

Participants

Alma Arnau, project leader (CNSN, Cuba); Cecilia Bossio (ARN, Argentina); Walter Méndez (CNEN, Brazil); Mónica Pastor (CCHEN, Chile); Juan P. Parra (INGEOMINAS, Colombia); Pilar Lorenz (CSN, Spain); Alberto Mut (CNSNS, Mexico); Carlos Ampuero (IPEN, Peru); Alejandro Nader (ARNR, Uruguay); Diego Tellería (IAEA).

Stress Tests of the Nuclear Power Plants in the FORO Member Countries (STRESS TESTS Project

Objective
The first objective of this activity is to gather the conclusions reached as a result of the stress tests assessment carried out by FORO member countries with nuclear power plants in operation, taking into account the lessons learned after the accident at the Fukushima Daiichi nuclear power plant.

The second objective is to share the results with other regulators in the region to inform them first-hand about the safety status of these nuclear power plants.

Scope
The evaluation carried out by FORO is designed to determine the safety margins of nuclear power plants, analysing their behaviour and considering their response to the occurrence of extreme events that cause consequences beyond the design basis, such as a total loss of power supply and the ultimate heat sink, as well as assessing their ability to manage such circumstances.

The scope for the development of this activity within the FORO framework was as follows:
- To reach a consensus on the scope and harmonise the technical criteria for evaluation in all FORO member countries with nuclear power plants.
- To increase the safety of nuclear power plants so they can cope with extreme events beyond the design basis.
- Peer Review with all FORO members the results of the respective National Assessment Report from each regulatory authority on the evaluations carried out.

Results
Once the evaluation had been carried out in each nuclear power plant and the required report was submitted to its regulatory authority, the latter submitted a National Assessment Report with the results obtained and the regulatory position on the implementation of the improvements that arose, to be peer reviewed by all the FORO member countries participating in the project.

In order to facilitate subsequent analysis, a structure was agreed upon for both the National Assessment Reports submitted by the countries, as well as for the national summary presentations. This structure included general information on the concept of the National Action Plan and a strategy for the measures, followed by specific information on the actions associated with the core areas for the evaluation, which are:
1. Actions related to the protection of sites and units against external hazards of a magnitude greater than that considered in the licensing basis.
2. Actions related to reinforcing plant safety in the event of loss of function of external systems or supplies.
3. Actions related to strengthening the capacity to deal with severe accidents.
4. Actions related to emergency management.

These National Assessment Reports, along with the Action Plans for implementing the identified improvements, were reviewed jointly in line with the

Storage building for portable equipment, portable water injection pumps, flexible hoses, quick connectors for extensive damage mitigation strategies and the Alternative Emergency Control Centre at the Ascó nuclear power plant in Tarragona, Spain

methodology proposed in the International Atomic Energy Agency's Action Plan.

Experiences related to the implementation of the aforementioned Action Plans were shared in an open and transparent manner, including both the difficulties in implementing the measures and possible solutions. Good practices and recommendations that each country could consider to improve its own National Action Plan were also identified.

Impacts of the project
FORO member countries with nuclear power plants have independently implemented their Action Plans that reflect the conclusions of the National Assessment Reports and have led to the adoption of various measures, including not only improvements in plant design and operating practices, but measures for accident mitigation and emergency management as well, which also involve organisations external to the operator. Many of the actions or measures developed are common to the various FORO countries, although there are also others that are specific to each country or each nuclear facility.

The National Assessment Reports show that the regulatory agencies have taken actions to incorporate the lessons learned from the Fukushima Daiichi accident into their regulatory framework, including the fact that the safety of nuclear power plants in the various FORO member countries has been significantly reinforced in comparison to the situation in 2012.

Publications
- 2018: *Informe de la Actividad de Evaluación de Resistencia de las Centrales Nucleares de los Países Miembros del FORO* (final project report), available on La RED, FORO's webpage.

Conference presentations
- 2012: *Assessment of the Stress Tests Performed to the NPPs belonging to the FORO Member Countries*, Side Event of the Second Extraordinary Meeting of the Convention on Nuclear Safety (IAEA, Vienna, Austria).
- 2014: *Actions taken as Stress Tests results in the NPPs Belonging to the FORO Member Countries*, Side Event of the 6th Review Meeting of the Convention on Nuclear Safety (IAEA, Vienna, Austria).

Participants
Rubén Navarro, project leader (ARN, Argentina); José Ramón Alonso Escós, project leader (CSN, Spain); Edgardo José Luis Marino (ARN, Argentina); Jorge Calvo (ARN, Argentina); Ricardo Waldman (ARN, Argentina); Alexandre Gromann (CNEN, Brazil); Marcos Eduardo Costa Nunes (CNEN, Brazil); Cristián Sepúlveda (CCHEN, Chile); Conrado Alfonso Pallarés (CNSN, Cuba); Sara González Veci (CSN, Spain); Víctor Manuel González Mer- cado (CNSNS, Mexico); Ricardo Pérez Pérez (CNSNS, Mexico); Gerardo Lázaro Moreira (IPEN, Peru); Enrique Morales (ARNR, Uruguay); Francisco Javier Yllera Sánchez (IAEA).

Competencies of Regulatory Agency Personnel in Medical and Industrial Radiological Applications (CReAR Project)

Objective
The acquisition, development and maintenance of competencies among regulatory body personnel are fundamental to the achievement of organisational goals. The overall objective of this project is to provide a tool that will enable the development of a program for the creation and development of regulator competencies in medical and industrial practices.

Certain parts of the final document are intended to provide assistance in the development of specific aspects of the programme. These parts are based on the exercises and analyses developed within the framework of the project, as well as on a series of good practices identified in various countries, and can be used partially or totally as a practical guide or as illustrative examples.

Scope
The scope of the project applies to the establishment of a methodology to determine and develop the competencies required by the regulatory body's employees according to the functions they perform in medical and industrial radiological applications. The final document focuses on employees who perform functions related to assessment and authorisation, inspection and enforcement, and development of regulations and regulatory guides.

Competencies are determined according to the tasks associated with each of the functions, in addition to the knowledge, skills and attitudes that are required.

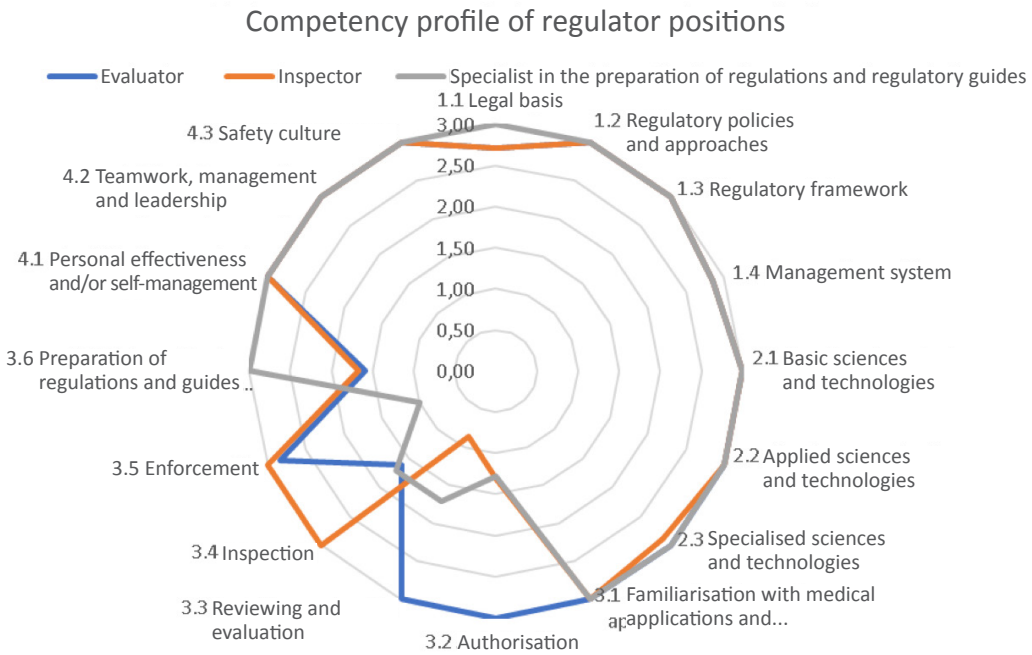
Once the competencies have been created and developed, the regulatory body will be in a position to identify the existing gaps and define a training plan adapted to its needs.

Results
As part of the new approach presented in the document, the general list of competencies proposed in the IAEA SARCoN Guide was adapted for application to regulators of medical and industrial applications, which led to the modification and regrouping of certain competencies from the IAEA model, as well as the redefinition of the three levels of development for each competency.

The competency profile of each position is made up of two elements: the main tasks associated with that position, and the set of competencies required according to their levels of development. The set of competencies linked to each task under consideration is selected based on the general list of competencies for regulators in medical and industrial applications.

The competency chart provides a simplified view of the competency profile of the position for assisting in recruitment and training. These competencies are represented in a graph, whose radius is proportional to the required development level of said competencies, as summarised in the following diagram.

The analysis conducted on the existing infrastructure of FORO members regarding the development



Competency profiles for medical and industrial regulator positions

of regulatory personnel competencies, and the specific contributions obtained as a result of the project activities, will help the regulatory bodies to adapt and implement the tool provided in this document for the preparation of a competency building and development programme, so they can perform their functions and responsibilities effectively.

Establishing the fundamental elements of a sustainable strategic plan for capacity building, in line with the document, may help regulatory agencies to run effectively and efficiently.

Impacts of the project

In Cuba, the methodology from the FORO project will be used as a reference to develop a system for selecting personnel, identifying the competencies required and monitoring their training and evaluation in accordance with the current national legislation. As such, in 2020, specialists from the Cuban

regulator worked on developing the functions of the position assessor's role, the general description of the tasks to be performed within the framework of this role and the competency profile required to fulfil the functions; aspects that are still under development. The tasks identified were based on those described in the FORO Project.

The results of the project are being incorporated by other regulators in the region, such as in the development of the *Systematic Approach to Training* (SAT) from the Spanish Nuclear Safety Council. Other FORO regulatory agencies have also already begun to use the results of the project as a benchmark, and although the continuity of its implementation has been impacted by the pandemic, they plan to resume activities as soon as possible.

Publications

- 2020: *Competencias del Personal de Organismos Reguladores en Aplicaciones Radiológicas Médicas e Industriales* (final project report), available on La RED, FORO's webpage.

A joint FORO-IAEA publication in the form of a TecDoc is being developed and the project may serve as the basis for an IAEA capacity building and training program, which will help with the effective implementation and dissemination of the project.

Conference presentations

- 2019: *FORO's technical projects outcomes in regulatory competencies building and training. Their contribution to knowledge management in nuclear reactors and medical and industrial radiological applications*, FORO event during the IAEA General Conference (IAEA, Vienna, Austria).
- 2019: *Competencies of the Staff of Regulatory Bodies in Medical and Industrial Radiological Applications*, IAEA International Conference on Effective Nuclear and Radiation Regulatory Systems (The Hague, The Netherlands).
- 2021: *Methodology for the Development of Competencies of Regulators of Medical and Industrial Radiological Applications*, 15th International Congress of the International Radiation Protection Association, IRPA (Seoul, Korea).
- 2021: *FORO Technical Projects on Regulatory Competences*, IAEA Regional Training Course on Regulatory Body Integrated Management System and Human Resources Planning (IAEA, Vienna, Austria).

Participants

Marcela Gisela Ermacora, project leader (ARN, Argentina); Anderson de Oliveira (CNEN, Brazil); Isabel Casas Morales (CCHEN, Chile); Mauricio Hernando Mañosca Ruiz (Ministry of Energy, Colombia); Conrado Alfonso Pallares (CNSN, Cuba); María Pinos (CSN, Spain); Diana Preza Hernández (CNSNS, Mexico); Fredy Aurelio Doncel Invernizi (ARRNN, Paraguay); Richard Rosalino Florentín Cano (ARRNN, Paraguay); Miguel Ángel Ticllacuri Carbajal (IPEN, Peru); Alejandro Nader (ARNR, Uruguay); Ro- nald Pacheco Jiménez (IAEA).

Pilot Application of the FORO Guide's Safety Culture Assessment Methodology to an Industrial Gammagraphy Company (GAMMAGRAPHY Project)

Objective

The main objective of this project is to carry out a pilot study to evaluate the radiological safety culture in an industrial gammagraphy company by applying the methodology designed in the FORO guide "Safety Culture in Organisations, Facilities and Activities with Ionising Radiation Sources". The study will make it possible to validate and adapt this methodology to the characteristics and unique nature of this type of practice, to subsequently be applied extensively to all gammagraphy entities in the region.

To this end, the following specific objectives are being promoted:

1. To develop the typical tools for assessing the radiological safety culture in an industrial gammagraphy company, based on the methodology of the FORO guide.
2. To apply the tools in a pilot industrial gammagraphy entity in each participating country.
3. To analyse the results of the pilot experience.
4. To develop methodological recommendations for the evaluation of safety culture in industrial gammagraphy companies.
5. To develop recommendations for improving the safety culture in industrial gammagraphy companies.

Scope

The project is being carried out through a series of tasks, which include familiarisation with the FORO guide methodology, designing evaluation tools adapted to the scope of an industrial gammagraphy company, applying said tools for a pilot trial at one organisation in each FORO member country, and working on processing the results to improve the tools that have been applied, documenting them for extensive use.

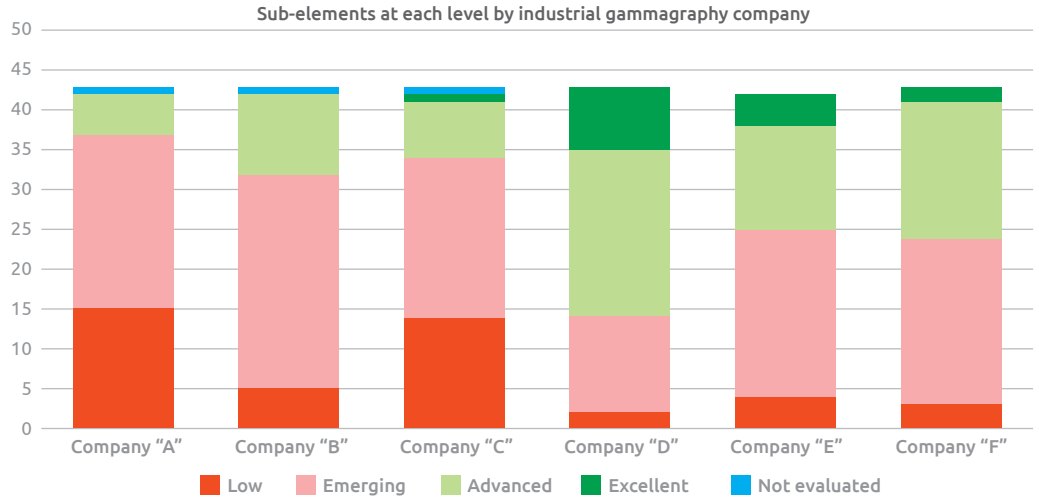
Expected results

The working group has already completed assessment activities for five of the ten core elements identified in the safety culture methodology (EB1, EB2, EB5, EB7 and EB8), and the remaining five are expected to be analysed over the coming months.

All sub-elements are reviewed and reconciled based on the findings of the applied methodology. The review reflects all the modifications for each sub-element according to the particularities of the industrial gammagraphy practice.

The corresponding work being carried out includes:

– Review and reconciliation of the wording of the definitions of the basic elements and the objective of the evaluation.
– Review of each sub-element to analyse and reconcile the safety culture level criteria for each of them, their evaluation results by country, and the findings of each sub-element (identifying whether it is a visible manifestation, a declared value or a basic assumption).
– Reconciliation of the findings, conclusions and good practices derived from the evaluation of the basic elements.



Preliminary partial evaluation of all the sub-elements of 5 basic elements

– Reconciliation of the safety culture recommendations for the practice of industrial gammagraphy related to each basic element.
– Analysis of experiences and suggestions on the evaluation methodology for each basic element.

The differences between pilot entities and the findings emerging from the evaluation highlight cultural differences between private family-owned companies and companies belonging to state-owned institutions. Based on this, some of the evaluation criteria for the FORO Guide sub-elements will be modified. Cultural patterns that are similar in the participating countries in the region will also be identified in practice.

Potential impacts of the project

This project will confirm the validity and viability of the FORO guide on safety culture for evaluations and improvements in this field in industrial gammagraphy organisations, with criteria on the suitability of its use in this type of practice.

Specific guidelines will also be available for assessing basic elements of safety culture in the practice of industrial gammagraphy and for the application of the five assessment techniques recognised for this type of assessment. This will facilitate the work of regulatory specialists, entities and bodies that wish to perform or promote these evaluations as part of the promotion and development of safety culture in

industrial gammagraphy activities in their respective organisations or countries.

Finally, the findings and conclusions on safety culture in the pilot entities of this study will constitute an important source of lessons for learning and improving the safety culture in any entity working with industrial gammagraphy, and will also contribute towards the improvement of regulatory approaches and processes related to this practice.

Participants
María Teresa Alonso, project leader (ARN, Argentina); Cristiane Oliveira (CNEN, Brazil); Miguel Aravena (CCHEN, Chile); John F. Lozano (MINMINAS, Colombia); Yamil López Forteza (DSN, Cuba); Rubén Ferro Fernández (DSN, Cuba); Renán Ramírez Quijada (IPEN, Peru); Melina Andrea Mondelli (ARNR; Uruguay); Rodolfo Cruz Suárez (IAEA).

Extending the Application of the SEVRRA Risk Matrix Methodology to New Radiotherapy Techniques (SEVRRA II Project)

Objective
The objective of this project is to develop and implement a model for risk analysis in Intensity Modulated Radiation Therapy (IMRT) and Diagnostic Nuclear Medicine (DNM) practices, using the risk matrix methodology. This is in order to prevent the occurrence of accidents with adverse radiological consequences for patients, employees and members of the public, and to identify those barriers or defenses that have the greatest impact on risk reduction, in order to strengthen the regulatory authority's evaluation and inspection procedures for these practices.

For this purpose, the accident sequences with the highest risk are determined, as well as the barriers and mitigators that have the greatest impact on risk reduction in these practices, so improvements can be proposed to the regulatory authority's inspection and authorisation procedures.

Scope
For IMRT, the project focused on facilities using step-and- shoot, sliding window and arc therapy techniques, using "conventional" fractionation, which provides for 25 to 39 sessions, with an average daily dose of 2 Gy per session.

For DNM, the project focused on imaging using different techniques and modalities (full body, dynam-

ic and static tomography) acquired with a flat gamma camera, tomography (SPECT) and hybrid SPECT/CT and PET/CT systems.

Expected results

For IMRT, 151 equipment failures/human errors capable of initiating accident situations were identified, in addition to 216 safety elements (safety barriers and frequency and consequence mitigators) with the ability to prevent, detect and/or stop accident conditions or mitigate their consequences. The accident sequences were grouped into 13 main processes, separated by consequences for patients, employees and the public.

For its part, the DNM model identified 96 possible accident initiating events, with 80 barriers, 42 frequency mitigators and 13 consequence mitigators, which together cover the 12 main stages of the process from service design and construction to radioactive waste management.

For each technique, an ideal installation was modelled with the highest safety standards in the Ibero-American region. For testing purposes and to obtain feedback from end users on the risk models developed, the risk model for IMRT was tested in five hospitals, and in 14 hospitals for DNM (all in the Ibero- American region), protecting at all times sensitive information from all these centres.

For the IMRT technique, the "Acceptance and Start-up" and "Treatment Planning" process steps show the highest number of sequences with high risk, mainly due to the lack of certain safety barriers: "in-vivo dosimetry during the initial treatment session", "Redundant checks" and "Peer review". As for DNM, no accident sequences were detected with "Very High" risks; the majority of accident sequences show medium risk (tolerable), followed by those with low risk (widely accepted). The "Radiopharmaceutical Preparation" and "Image Acquisition" stages in DNM include almost 50% of the average risk sequences, so special attention must be paid to compliance with the working procedures established in these two stages. The risk models developed also allow the identification of safety elements (barriers and mitigators) with the greatest impact on risk reduction and the increase in risk for each facility analysed.

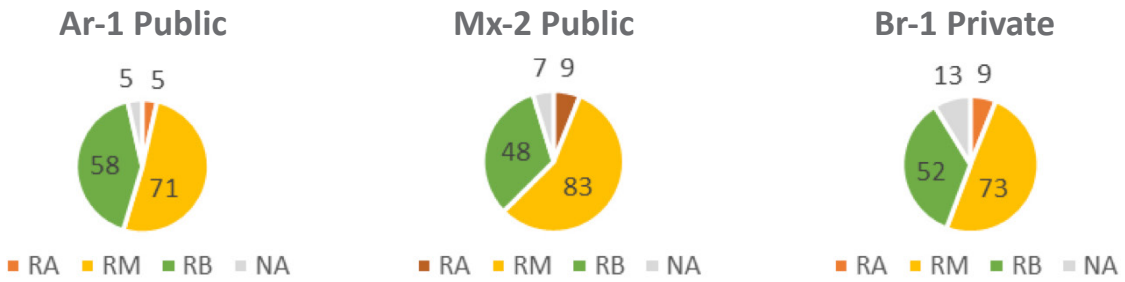
Potential impacts of the project

It is expected that the application of these risk models will allow regulators and end users to identify the risk profile of the facility, as well as the safety elements (barriers and mitigators) specific to their facility that have the greatest impact on reducing or increasing risk, thus facilitating risk management and focusing supervision and inspection efforts. Promoting better communication between the regulated parties and the regulators on relevant safety aspects will enable improvements to the radiological safety of facilities.

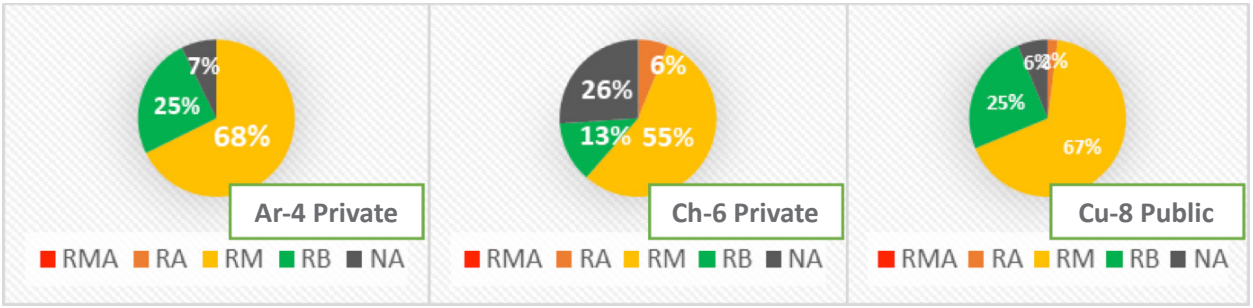
The final models of both practices will be incorporated into those that already exist on La RED, FORO's webpage, all of which are available for use by regulators, users and the general public.

Conference presentations

2020: *Overview of Risk Models and Results obtained by FORO Project (SEVRRA II) for IMRT and DNM Tech-*



Examples of the risk profiles (percentage of High, Medium, Low Risks and Not Applicable sequences) obtained for IMRT



Examples of the risk profiles (percentage of High, Medium, Low Risks and Not Applicable sequences) obtained for MND

niques, IAEA International Conference on Radiation Safety: Improving Radiation Protection in Practice (IAEA, Vienna, Austria).

Participants

Ramón López Morones, Project Leader (CNSNS, Mexico); Susana Papadopulos (ARN, Argentina); José McDonnell (Medical Physicist, Argentina); Georgia Joana (CNEN, Brazil); Guilherme Bittencourt (Medical Physicist, Brazil); Lorena Mariángel (CCHEN, Chile); Cruz Duménigo (DSN, Cuba); Jorge Morales (Medical Physicist, Cuba); María Luisa Ramírez (CSN, Spain); Arturo Pérez Mulas (CSN, Spain); José Miguel Delgado (Medical Physicist, Spain); Carlos Prieto (Medical Physicist, Spain); Mario Ángel Espinosa (CNS-NS, Mexico); Jorge Omar Hernández (Medical Physicist, Mexico); Gustavo Priz (Medical Physicist, Uruguay); Rodolfo Cruz (IAEA).

Standardising the Inspection Process for Nuclear Research Reactors (RESEARCH REACTORS Project)

Objective
The objective of this project is to standardise the manuals, guides, plans, processes, criteria, scope, depth and frequency of inspections for research reactors, in order to verify compliance with current legislation applicable to the conditions imposed and the relevant authorisations, and to achieve an adequate and similar level of safety at these facilities. The project also includes the development of standardised guidelines for the regulatory control of research reactor aging.

This will improve the effectiveness of national inspection programmes by establishing their frequency, scope and depth, and by defining safety and regulatory criteria applicable to inspections, according to the type of facility.

Scope
The scope of the manual is limited to radiological and nuclear safety of research reactors, including critical and sub-critical assemblies, and excluding those that require pressurised cooling systems. The activity focuses on improving the safety control process of research reactors in the Ibero-American region through the standardisation of inspection criteria, manuals, guides and procedures and the exchange of expert experiences during the project implementation.

Expected results
The project has produced a manual for the planning and management of regulatory inspections of nuclear research reactors. This manual provides recommendations on aspects related to the management, planning, development and evaluation of regulatory inspections, and on the training and qualification of inspection personnel. It also includes 13 Simulation of an inspector's visit with the checklist during a regulatory inspection regarding safety and the operation of a research reactor general inspection procedures that can be used by regulatory agencies to develop their own processes for different areas of regulatory inspection.

INSPECTION PROCEDURES	
1	RADIOLOGICAL PROTECTION
2	MAINTENANCE
3	NUCLEAR OPERATION AND SAFETY
4	USE OF THE REACTOR
5	EMERGENCIES
6	ENVIRONMENTAL MONITORING
7	ORGANISATION AND PERSONNEL
8	MODIFICATIONS AND NEW EXPERIENCES
9	SAFETY MANAGEMENT
10	MANAGEMENT SYSTEM
11	FIRE PROTECTION SYSTEM
12	PRELIMINARY SERVICE WITHDRAWAL PLAN
13	AGING MANAGEMENT

List of inspection procedures included in the Manual for the Planning and Management of Regulatory Inspections of Nuclear Research Reactors

In addition, the project is developing another manual for the regulatory control of aging management of research reactors that will include a guide with regulatory criteria, an evaluation guide and an inspection procedure, which will be included in the aforementioned inspection manual.

Potential impacts of the project

Some of the general inspection procedures included in the manual were tested for the inspection of the RP-10 reactor in Peru and are currently being used to develop the inspection programme for the research reactors in Chile. Other countries that participated in the project plan to use it as a benchmark for their inspection programmes.

Presentations

- 2019: *Standardization of the Inspection Process for Research Reactors*, IAEA International Conference on Research Reactors: Addressing Challenges and Opportunities to Ensure Effectiveness and Sustainability (Buenos Aires, Argentina).

Participants

Gerardo Lázaro, project leader (IPEN, Peru); Carlos Perrín (ARN, Argentina); Marcelo Herrero (INVAP, Argentina); Eneida Dourado (CNEN, Brazil); Víctor Calzavara (CNEN, Brazil); Patricio Fonseca (CCHEN, Chile); Diego Encinas (CSN, Spain); Manuel Fernández (Tecnatom, Spain); Olgger Anaya (IPEN, Peru); Manuel Recio (IAEA).

Simulation of an inspector's visit with the checklist during a regulatory inspection regarding safety and the operation of a research reactor

Reactor Operator Training and Licensing (CLOR Project)

Objective

The overall objective of this project is to improve regulatory practices in the training and licensing processes for operating personnel through technical exchange, comparison and development of documentation, methodologies and support tools.

The project also has the following specific objectives:

– To exchange regulatory practices in all aspects and stages of this process;
– To share methodologies, resources, tools and infrastructure that can be used by regulators in the process;
– To develop support material (guidelines with good practices, technical documents applicable to certain activities in the process);
– To apply the best practices and lessons learned from the project to both power and research reactors, through mutual learning between the practices applied to both types of reactors;
– To disseminate and promote the application of the project at national, regional and international levels (the latter in collaboration with the IAEA).

Scope

The project covers all regulatory aspects related to the process of granting and renewing the licenses of nuclear power and research reactor operating personnel, as well as, in general, all regulatory activities related to the training of such operating personnel.

To this end, the project will establish a regional map showing the current status of the regulatory process associated with the training and licensing of nuclear reactor operators, based on a comparative exercise of processes and practices and a regional catalogue of methods, resources, tools and infrastructure used in the training and licensing of nuclear reactor operators.

Expected results

The main result of this project will be the development of a guide of good regulatory practices for the training and licensing of nuclear reactor operators, including the use of tools, with technical documents applicable to specific aspects of the process (e.g., examination techniques and resources), which have been identified as key issues whose development is considered to be of major interest.

The aim is to establish a proposal for actions to work towards regional standardisation of regulatory practices and to achieve optimum use of the means and resources available in the region through exchange and sharing.

A regional map will also be established showing the current status of the regulatory process associated with the training and licensing of nuclear reactor operators, based on a benchmarking exercise of processes and practices and a regional catalogue of methods, resources, tools and infrastructure used in the training and licensing of nuclear reactor operators. A guide of good regulatory practices in the training and licensing of nuclear reactor operators will also be developed, including the use of tools and infrastructure (e.g., replica simulators) based on a discussion of the practices established in each country, and taking into account the documentation developed by the IAEA, where applicable.

Potential impacts of the project

Based on the expected results, a proposal will be drawn up for actions to work towards regional standardisation in regulatory practices and to achieve optimum use of the means and resources available in the region through exchange and sharing, thereby strengthening the systematisation of training for employees throughout the region, not only those working in nuclear power reactors, but also those at research reactors.

Participants

Diego Encinas, project leader (CSN, Spain); Reinaldo Valle (ARN, Argentina); Marco Antonio Bayout (CNEN, Brazil); Cristian Sepúlveda (CCHEN, Chile); Enrique Meléndez (CSN, Spain); Noel Moreno (CNSNS, Mexico); Julio César Romaní (IPEN, Peru); María Josefa Moracho (IAEA).

Technical visit of CLOR project experts to the control room at the Laguna Verde Nuclear Power Plant, Mexico

Licensing Criteria and Inspection Requirements for Centralised Radiopharmacies (RADIOPHARMACIES Project)

Objective
Centralised radiopharmacy is an area that is growing in importance and requires increasing efforts from regulatory authorities during its licensing due to its complexity. There are currently no international recommendations published on licensing criteria and inspection requirements for this type of facility. These criteria depend, among other things, on the radionuclides and activities expected to be commercialised, the design of the plant, the personnel involved, transport requirements, etc. Consequently, centralised radiopharmaceutical facilities present important aspects for radiological protection that must be evaluated individually so that operations can be carried out without undue risk to employees, the environment and the public.

This project, based on the exchange of experience and knowledge regarding licensing (including inspections), aims to develop criteria for licensing and inspection requirements for centralised radiopharmacies.

Scope
The project focuses on the regulatory program for the licensing of radioactive facilities, including regulatory and health agencies.

Its purpose is to prepare two guides: one for regulatory inspections and the other for the licensing of centralised radiopharmacy facilities. It also aims to increase the effectiveness of national inspection programmes, taking advantage of the experience accumulated in each of the countries.

Expected results and possible impacts of the project
The project will result in the development of authorisation requirements and procedures for the inspection of radiopharmacies, with the aim of guiding regulators in an area with high growth prospects and few international recommendations available. Thus, the aim is to increase radiological safety by establishing technical procedures for licensing and regulatory inspections of centralised radiopharmacy facilities.

The documents resulting from the project are expected to serve as a guide and demonstrate the minimum parameters to be considered in the licensing of centralised radiopharmacy facilities, and to verify compliance and maintenance during inspections.

It should be noted that this project involves the participation of a representative from the U.S. Nuclear Regulatory Commission (NRC), making it the first project involving the participation of an organisation that is not a member of FORO. The aim is therefore to promote joint work and the participation of other experts from non-member organisations in the execution of projects.

Participants
Samira M. Carvalho, project leader (CE- NEN, Brazil); Germán Rabi (ARN, Argentina); Aylinne Román (CCHEN, Chile); Ramón Hernández (DSN, Cuba); Ana

Blanes (CSN, Spain); Mauricio Salvador Peralta (CN-SNS, Mexico); Yuri Roger Ravello Ratzenberg (IPEN, Peru); Luis Neves (NRC, United States); Ronald Pacheco (IAEA).

Examples of radiopharmacy services

Maintenance and Periodic Checks of Reusable Packages for the Transport of Radioactive Material Not Subject to Design Approval (TRANSPORT Project)

Objective
The objective of this project is to develop a guide that establishes criteria to assist in the development and implementation of programmes for the maintenance and periodic verification of reusable radioactive material packages that are not subject to design approval, in addition to their monitoring and control by the regulatory authorities.

To this end, firstly, the documents and good practices on maintenance and periodic verifications of packages that do not require approval were identified, as established in the IAEA's Regulations for the Safe Transport of Radioactive Material (SSR-6), and secondly, experience from Ibero-American countries was compiled regarding monitoring by regulatory authorities of the maintenance and periodic verifications of these packages, with any difficulties encountered being identified.

Scope
The project focuses on aspects related to checks and periodic maintenance of packages for the transport of radioactive material, exclusively those that do not require a design approval (except industrial and type A) and that are used repeatedly (reusable packaging). The sectors where this type of packaging is mostly used are those that involve medical and industrial applications of radioactive material, but the radioactive waste sector is also noteworthy, both in the nuclear and non-nuclear sectors.

The guide should be useful not only to those who use the packaging, but also to all the parties who are involved in the maintenance work in one way or another, and for this reason a section will be included with *the responsibilities of the different participants in maintenance activities*, describing the role of the designer, manufacturer, owner, user/shipper, as well as that of the competent authority, and what the relationship between the different parties should be.

The guide will also consider both periodic checks on packaging and preventive and corrective maintenance, and it will recommend the procedure to follow for the management of possible design modifications that may arise as a result of said corrective maintenance.

Expected results
The guide developed in this project will identify the basic elements of a maintenance programme, focusing on the most common types of reusable packaging. This identification will be based on a classification of the packages from the point of view of their use, taking into account the standard characteristics of the packaging according to its application (medical, industrial or waste), which will ultimately determine the type of periodic inspections and maintenance to be carried out.

For each group of packaging, according to this ad hoc classification, its safety characteristics will be determined as well as the usual problems encountered in operating experience, with illustrations, photos and

Reusable packages for the transport of radioactive material

diagrams to be provided as a detailed description. It will also point out the review and maintenance requirements for detecting and resolving these problems, and will provide information on good practices in the verification and maintenance programs that are applicable.

Finally, the guide will recommend the types of records for periodic verification and maintenance operations that will enable the service life of the packaging to be monitored by users and regulatory authorities.

Potential impacts of the project

The design of the packaging used for the transport of radioactive material is an essential element for safety. The IAEA regulations establish a graded approach by requiring higher packaging requirements for packages with higher risk. But even with suitable design, safety can be compromised if conditions are not properly maintained. Therefore, it is highly important to carry out regular inspections and maintenance of the packages for safety purposes.

However, the IAEA reference documents (SSR-6 and SSG-26) do not specify what the minimum characteristics of a maintenance programme should be. Although there are no official criteria for the content of maintenance instructions, they are systematically evaluated by the regulatory bodies in the licensing process.

In the particular case of packaging that is not subject to design approval, the lack of reference criteria complicates the development and implementation of maintenance and periodic inspection programmes, leads to a wide range of different approaches to maintenance and periodic inspections by consignors, and complicates the control of these activities by the competent authorities.

A review of this entire process would improve safety in the transport of packages not subject to approval, which account for approximately 90% of radioactive material shipments.

Participants
Engracia Rubio de Juan, project leader (CSN, Spain); Alejandro Gabriel Fernández (ARN, Argentina); Natanael Bruno (CNEN, Brazil); Maidelys Rosa Rodríguez Rodríguez (DSN, Cuba); Isabel Casas (CCHEN, Chile); Fernando Zamora Martín (CSN, Spain); Diego Martín Bautista Arteaga (CNSNS, Mexico); Miguel Ticllacuri Carbajal (IPEN, Peru); Blanca Esther Faller Velázquez (ARNR, Uruguay); Nancy Capadona (IAEA).

Assessing the Resilience of the Safe Operation of Nuclear Power Plants, Nuclear Research Reactors and Radioactive Facilities During a Pandemic (RESILIENCE Project)

Objective
The overall objective of the project is to create a harmonised regulatory position among the FORO countries aimed at ensuring and maintaining nuclear and radiological safety in the face of pandemic scenarios/simultaneous unavailability of personnel necessary for the safe and reliable operation of nuclear power plants, nuclear research reactors and complex radioactive facilities, in accordance with a graded approach.

The specific objectives include the following:
1. In reaction to COVID-19, to identify and establish a series of regulatory requirements that will allow regulators to ensure the nuclear and radiological safety of the operating plants and facilities mentioned above, covering all operating conditions (including the safe shutdown status in the case of nuclear power plants and nuclear research reactors).
2. To proactively clarify requirement 4 of IAEA SSR 2/2 Rev.1: *Safety of nuclear power plants: Commissioning and operation*, with regard to defining the term "sufficient", and to subsequently incorporate it into the corresponding national legislation, including operating licenses. In addition, to conduct a similar analysis of the "sufficiency" of inputs in pandemic scenarios.

3. To extrapolate the methodology and analysis to research nuclear reactors and radioactive facilities of greater complexity, following the application of a graded approach.

Scope

The scope of the project includes nuclear power plants, nuclear research reactors and more complex radioactive facilities (facilities that use or produce radioactive material or equipment that emits ionising radiation, such as cyclotrons, radioisotope and radiopharmaceutical production plants) currently in operation.

In the case of nuclear research reactors and radioactive facilities, the plan is to establish regulatory requirements/requirements based on a graded approach.

Expected results and possible impacts of the project

The results of this project will provide a document that will serve as a guide for both regulators and regulated parties to use as a basis for dealing with future disruptions in the normal operation of facilities, whether due to a pandemic or some other global phenomenon with the same consequences.

This will provide a reference document that details the areas of greatest regulatory interest on which efforts will be focused, prioritising nuclear and radiological safety. It will also include graduated requirements in order of importance for the continued operation of facilities, from electricity generation (nuclear power plants), to the production of radiopharmaceuticals for medical treatment, or the provision of support services in different industries.

List of participating experts

Roxana Barsi, project leader (ARN, Argentina); Adriana Politi (ARN, Argentina); Jefferson Borges de Araújo (CNEN, Brazil); Patricio Fonseca (CCHEN, Chile); Mauricio Hernando Mañosca Ruiz (Ministry of Energy, Colombia); Alma Arnau Fernández (DSN, Cuba); Benito Gil (CSN, Spain); Víctor González (CNSNS, Mexico); Enrique Ariel Páez Lovera (ARRNN, Paraguay); Olgger Anaya Garro (IPEM, Peru); Marco Munive Sánchez (IPEN, Peru); Olga González (ARNR, Uruguay); Ronald Pacheco (IAEA).

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