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# Regional Network of Research Reactors and Related Institutions in Latin America and the Caribbean (RIALC)

IPEN

## Nuclear Technology and Sustainable Development

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PERUVIAN INSTITUTE OF NUCLEAR ENERGY

RP-10 Nuclear Research Reactor Enclosure

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# Nuclear Research Reactors and the RIALC Network

Mario Mallaupoma Gutiérrez

President of the Peruvian Institute of Nuclear Energy

Since physicist James Chadwick discovered the existence of the neutron in 1932, multiple research efforts have been undertaken, particularly with the application of neutron scattering techniques. Currently, neutrons produced by research reactors are used to address diverse demands for products and services ranging from medicine and agriculture to industry and forensics.

The importance of countries possessing nuclear research reactors has been extensively discussed, emphasizing their various scientific and technological applications. However, time has shown that if each country utilizes these facilities in isolation, their potential contributions remain significantly limited.

In the Latin American and Caribbean region, only a few countries have nuclear research reactors. Despite many years of operation and various projects supported by the International Atomic Energy Agency (IAEA), these countries failed to unite and jointly identify possibilities and potentials to offer different products and services to meet regional needs. This situation led to the establishment of the Regional Network of Research Reactors and Related Institutions in Latin America and the Caribbean (RIALC) during a meeting in Vienna on February 28, 2023, promoted by the IAEA, with the attendance of representatives from Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, Jamaica, Mexico, and Peru.

RIALC aims to serve as a forum for professionals working in these facilities to exchange information, coordinate activities, and promote their services and products. The goal is to offer efficient and effective solutions to the sectors of health, environment, industry, and medicine.

A second meeting of the project “Improving the Satisfaction of Regional Demand for Products and Services of Nuclear Research Reactors” (RLA1022) took place in Lima from August 21 to 25, 2023. The objective was to discuss a methodology for developing a regional plan to meet the existing demand for

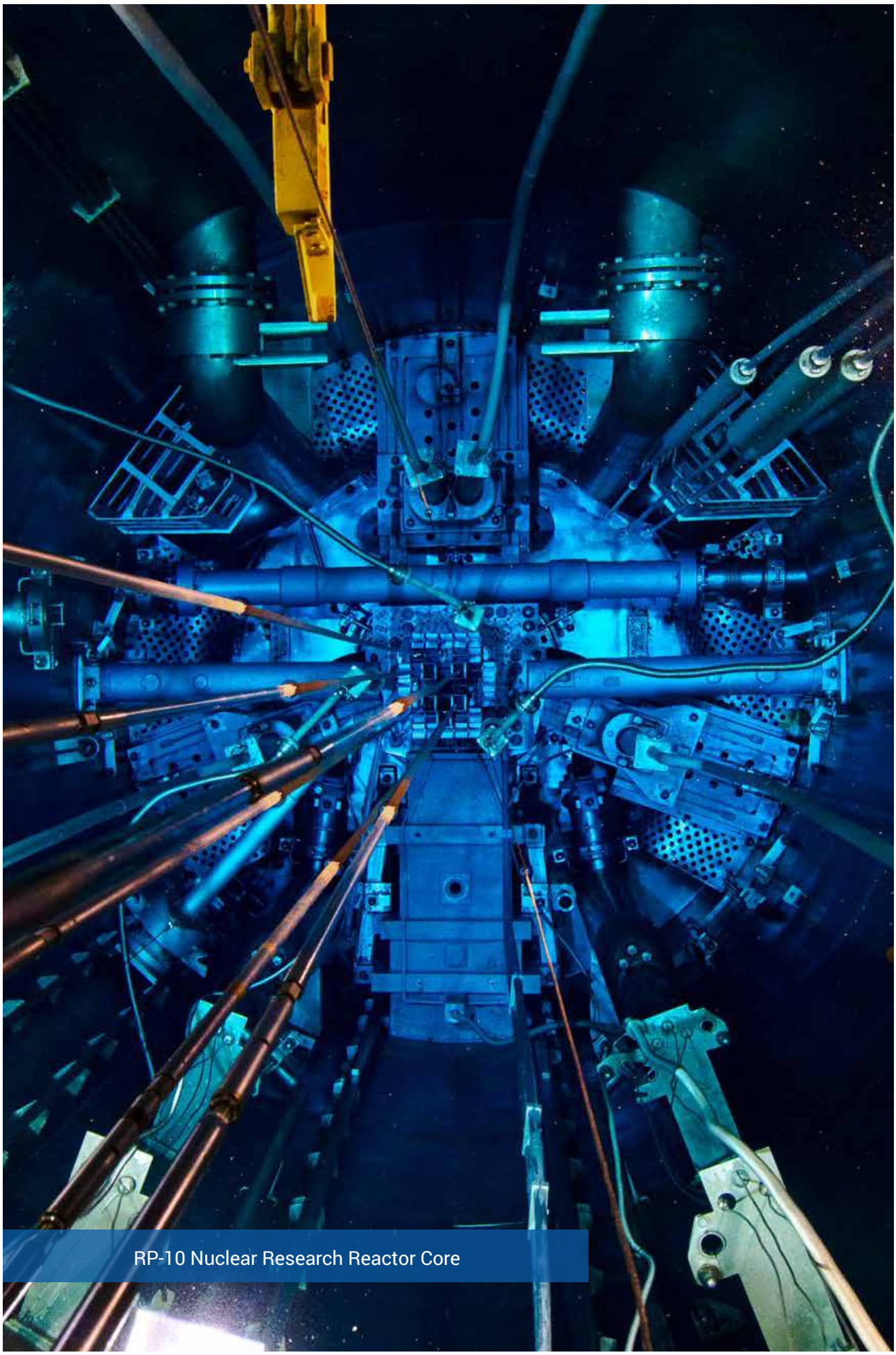
various applications of research reactors. Thematic areas such as production of radioisotopes and radiopharmaceuticals, nuclear education and training, neutron imaging, geochronology, neutron activation analysis including prompt gamma, and other areas like neutron scattering and BNTC were analyzed.

The Lima meeting was crucial as it provided clearer insights into the existing potentials in different countries and the opportunities for regional or bilateral collaboration. In the subsequent months, various activities have been carried out among RIALC members, demonstrating that this network is becoming a reality in regional collaboration. However, it is essential to continue strengthening regional efforts so that, through a Joint Agreement, the sustainability of the network can be ensured, facilitating collaborative work in the Latin American and Caribbean region.

It is also recognized that empowering the participating technical personnel is necessary so that they can drive actions, better identify existing opportunities, and establish a joint work plan that contributes to improving the quality of life for the populations of the participating countries. We have highly qualified and specialized personnel in the region, whose contributions are and will be valuable and will allow them to lead various regional projects where the use of nuclear research reactors is necessary.

In conclusion, paraphrasing the poet César Vallejo, who said to us Peruvians, “Brothers, there is much to be done”, as the regional coordinator of RIALC, I could also say, “Brothers and Sisters of Latin America and the Caribbean, there is much to be done, and nuclear research reactors give us the possibility to join forces and seek synergies to fully exploit their diverse uses. In this way, we can address common problems and improve the quality of life for citizens”.

> Launch of the Regional Network of Research Reactors and Related Institutions in Latin America and the Caribbean (RIALC) at the 67th General Conference of the International Atomic Energy Agency.



RP-10 Nuclear Research Reactor Core

# INTERVIEWS

# Facundo Deluchi

Programme Management Officer
International Atomic Energy
Agency - IAEA

### What are the expectations of the IAEA for Project RLA1022?

The expectations for the project are significant, not only at the IAEA level but also regionally and internationally. This is especially true considering the interest generated in various regions worldwide, particularly with regards to one of its components—the creation of the Regional Network of Research Reactors and Related Institutions in Latin America and the Caribbean (RIALC).

The project encompasses several components, ranging from creating a space for information exchange and strengthening regional cooperation, such as the network, to conducting an assessment of the situation related to research reactors in Latin America and the Caribbean. It also includes the development and ongoing update of a work plan framed within regional strategic planning, as well as the design and execution of specific projects for cooperation, training, and technology transfer.

In this regard, the project aims to enhance existing capacities at the regional level, recognizing Latin America and the Caribbean as a region distinguished by the development level of personnel associated with research reactors and their applications, as well as the scale and operational experience of its facilities.

### What is your professional opinion on the operation of Nuclear Research Reactors?

As mentioned before, Latin America and the Caribbean stand out globally for their capabilities in applications derived from research reactors. What we are seeking is to strengthen the sustainability of such relevant facilities by reinforcing technical cooperation at the regional level. This serves as a complementary element to national efforts and as a tool to optimize resource utilization.

### Do you believe that the use of Nuclear Research Reactors can lead to better interaction among member countries in the Latin American and Caribbean region?

The fundamental principle driving the project is the strengthening of technical cooperation at the regional level. It is this conviction that leads us to believe that conditions exist to enhance interaction among

Latin American countries. While there are structural issues presenting challenges to regional cooperation, there are far more aspects that naturally lead to leveraging the benefits derived from increased regional interaction. In this context, research reactors and their applications are not an exception; there are numerous shared challenges and needs that complement each other at the regional level. The Latin American setting provides a cooperative and integrative environment to address these demands.

### What do you consider to be the main challenges that Nuclear Research Reactors must face?

The main challenges faced by National Nuclear Institutions in the region are varied and primarily concern how to strengthen and expand the benefits derived from the knowledge developed and the technological applications they produced, ensuring their sustainability over time. In this context, research reactors share this challenge and issues related to the renewal of operational staff, improved interaction with productive, scientific, and academic sectors.

### What are the main challenges that the implementation of Project RLA1022 must face?

In the regional context, the major challenges arise from the need to provide continuity to projects in contexts of instability. Therefore, the initiative to establish a network, identifying regional contact points, lays the groundwork to explore options through regional cooperation to enhance the sustainability of national facilities' operation and management.

### Do you think Project RLA1022 should be extended in its duration?

As long as countries in the region see benefits and utility in extending a framework through which the IAEA, through its regional cooperation program, can support countries in strengthening networking, strategic planning, and technology transfer, the project is available to cover the necessary timeframes. Additionally, upcoming project design cycles will present new opportunities for the natural evolution of this cooperative framework.

### Can you identify some actions that should be promoted within the work plan of Project RLA1022?

Based on the work done and discussions within the project framework, numerous options have been presented, and the challenges raised are very interesting. The possibility of opening the doors of facilities so that different operational teams from the region can meet people and share diverse experiences at the regional level would be important. Also, consolidating joint projects by some of the institutions forming the network would be significant. Furthermore, the consolidation of a strategic plan containing regional demands and objectives would be an important outcome of this project, which could be included in a regional agenda as a pillar to achieve sustainable development goals. Finally, I believe that taking advantage of this opportunity to bring the facilities and the work carried out in them closer to society, not only at the national level but also at the regional level, including those countries that do not have reactors, would be a significant achievement. This is especially true regarding the inclusion of young individuals who can contribute to the future teams associated with these facilities.


# Ariel Norberto Bellino

National Atomic Energy Commission - CNEA

**Argentina**

How many nuclear research reactors exist in your country and how long have they been in operation?

In Argentina, we currently have 5 nuclear research reactors:

- RA-0, located at the University of Cordoba, has been in operation since the 1960s. This reactor has the peculiarity that its core was also the core of the RP-0.
- RA-1, located at the Constituyentes Atomic Center, is the first reactor in Latin America, operational since 1958.
- RA-3, located at the Ezeiza Atomic Center, is the largest producer of radioisotopes in the region, operational since 1967.
- RA-4, located at the National University of Rosario, has been in operation since 1971.
- RA-6, located at the Bariloche Atomic Center, has been in operation since 1982.

Additionally, the construction of the RA-10 multipurpose reactor is underway at the Ezeiza Atomic Center.

What are the main research lines currently developed in your research reactors?

Argentina's nuclear reactors are involved in the production of radioisotopes, neutron activation analysis, neutrography, geochronology, research and development, training activities, among others.

One of the notable research lines developed in the reactors is BNCT (Boron Neutron Capture Therapy), which uses boron-10 compounds, a non-radioactive element capable of delivering a highly localized radiation dose to tumor cells without affecting healthy tissue. It utilizes a low-energy neutron beam from a nuclear reactor.

It's worth noting that each reactor is somewhat specialized in certain applications, and researchers can

use the reactor for various investigations. In many cases, the research lines depend on external users rather than the reactor itself.

### What do you consider to be the most important milestones for your country using its nuclear research reactors?

I would consider the criticality achievement of RA-1 as a significant milestone, marking the beginning of the nuclear era in Latin America. The continuous commercial-scale production of radioisotopes by RA-3 is another milestone due to its complexity and the positioning it provides to our country. Finally, the construction of RA-6 as a training reactor is a milestone that demonstrates the enormous potential of synergy with a university.

### Do you believe that the services and products generated in your research reactors meet the demand of your country?

I believe they do, but there is still great potential for growth in demand. We are working on increasing the capacities of our research reactors and fully coordinating activities among all reactors to achieve synergy.

### Tell us about your strategic allies or interest groups identified in your country and in the Latin American region.

Our main strategic allies are the users of the reactors and the universities linked to each reactor. In the case of RA-3, the production of radioisotopes also involves nuclear medicine services and industrial users of the produced radioisotopes as interest groups.

### What does it mean for you to be part of the RIALC network?

It represents a significant opportunity for the growth of all nuclear reactors in Latin America and the Caribbean, enabling us to better meet the needs of our respective countries and contribute to improving society in our region.

RA-0, located at the University of Cordoba, which has been operating since the 1960s

## Paulo De Souza Santos

Nuclear and Energy Research Institute - IPEN

**Brazil**

How many nuclear research reactors exist in your country and how long have they been in operation?

In Brazil, we have 4 nuclear research reactors:

- IEA-R1, operational since 1957, with 5 MW, in Sao Paulo. It was designed and built by the United States of America under the Atoms for Peace program.
- IPEN-MB-01, operational since 1988, with 100 W, in Sao Paulo. It is operated by the University of Sao Paulo.
- IPR-R1, operational since 1961, with 100 kW, in Belo Horizonte. It is a TRIGA type reactor and is currently operated by the Nuclear Technology Development Center (CDTN).
- Argonauta, operational since 1962, with 500 W, in Rio de Janeiro. It is operated by the National Nuclear Energy Commission (CNEN).

What are the main research lines currently developed in your research reactors?

Brazil's nuclear research reactors are used for Neutron Activation Analysis, neutron imaging, production of radioisotopes for the health sector (nanoparticles, iodine seeds, microspheres, Lutetium, among others), as well as for training activities.

What do you consider to be the most important milestones for your country using its nuclear research reactors?

Brazil has actively participated in the development and implementation of products and services, as well as in personnel training in almost all areas involving peaceful applications of nuclear technology. These areas include human health, radiological and nuclear safety, industry, environment, research reactors, food and agriculture, physical and chemical sciences, information management, among others.

Do you believe that the services and products generated in your research reactors meet the demand of your country?

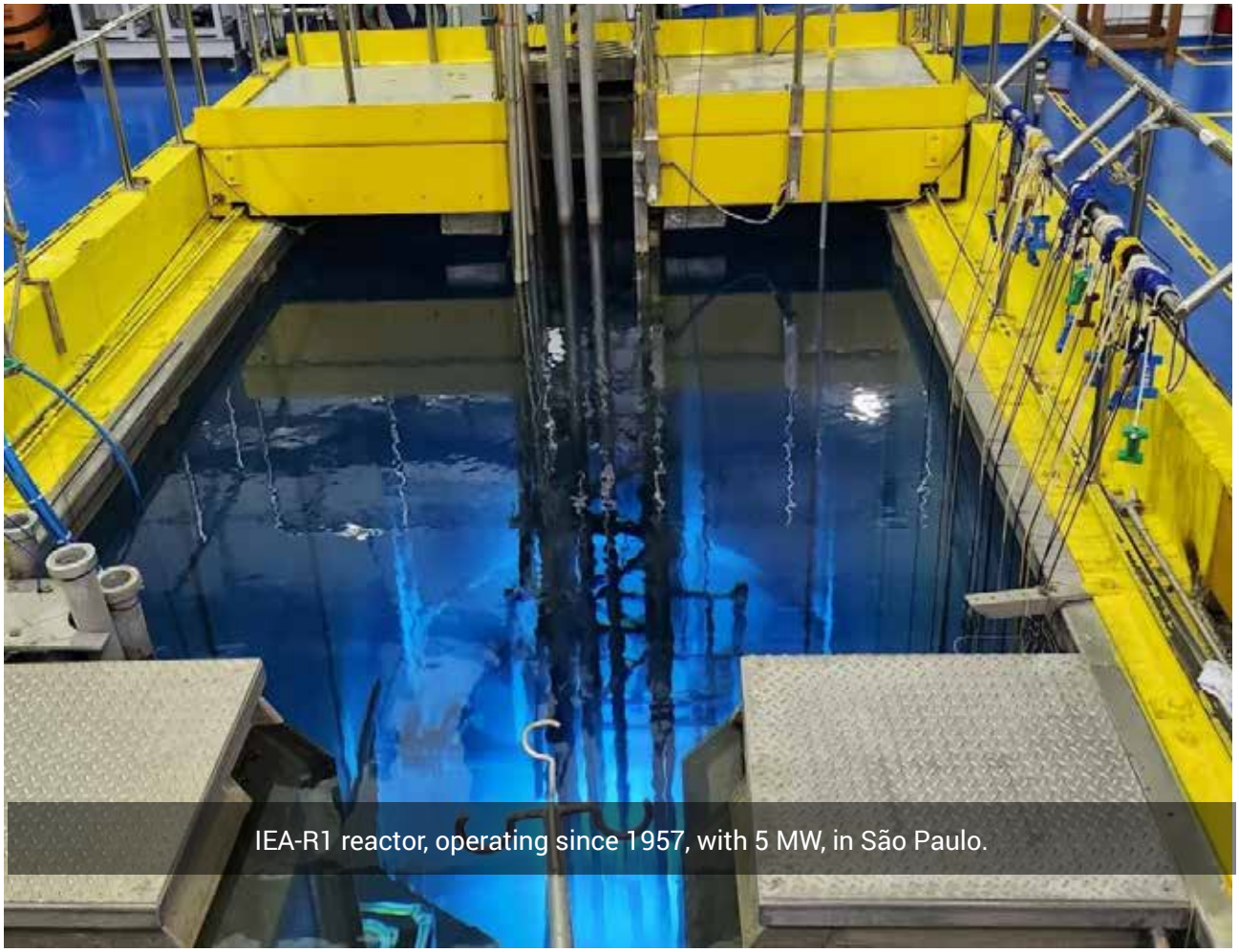
Currently, there is a demand to be met, so we are working to increase the operating time of IEA-R1 within a few years to meet the demands for iodine and lutetium. The power increase of Argonauta to 1.5 kW is underway, which will enhance the quality of Neutron Activation Analysis and neutron imaging, as well as supply some radiotracers.

Tell us about your strategic allies or interest groups identified in your country and in the Latin American region.

For us, Argentina is the main collaborator, providing molybdenum-99 and engineering projects through INVAP. Likewise, we offer training for some countries in the region.

What does it mean for you to be part of the RIALC network?

Being part of the network provides us with the opportunity to exchange experiences in person and find new opportunities to develop joint research projects that address common issues in the region.



IEA-R1 reactor, operating since 1957, with 5 MW, in São Paulo.

# Renzo Bruno Crispieri Thomas

Chilean Nuclear Energy Commission - CCHEN

**Chile**

How many nuclear research reactors exist in your country and how long have they been in operation?

Chile has two nuclear research reactors:

- RECH-1, a pool-type reactor with a maximum thermal power of 5 MW, operational since October 1974, managed by the Chilean Nuclear Energy Commission.
- RECH-2, which is currently in extended shutdown.

What are the main research lines currently developed in your research reactors?

The reactor team is currently focused on neutron tomography and its various applications. For a long time, they have also been supporting Geochronology and the various applications of Neutron Activation Analysis, such as environmental studies, mining, geochronology, and to a lesser extent, forensics, archaeology, and agriculture. Additionally, the reactor produces radioisotopes and engages in research and development activities.

What do you consider to be the most important milestones for your country using its nuclear research reactors?

Controlling nuclear fission is a significant milestone for our country, and the successful application of nuclear technology in medicine is undoubtedly a great achievement that reaches society.

Do you believe that the services and products generated in your research reactor meet the demand of your country?

They are undoubtedly in line with what our country demands, but it's never enough. Considering also that there are constant investigations opening up new possibilities.

Tell us about your strategic allies or interest groups identified in your country and in the Latin American region.

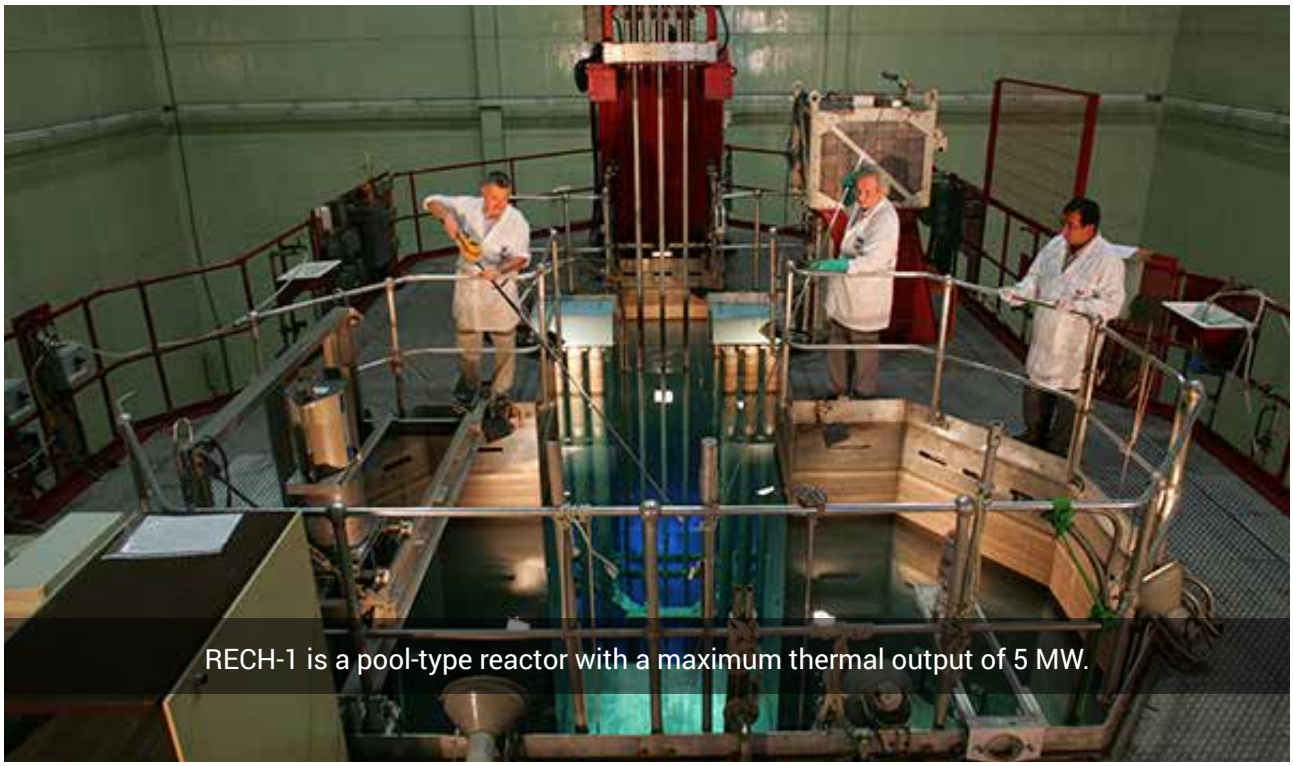
Universities are particularly powerful allies within our country, serving as a link to new research areas and the community. In the region, RIALC becomes an important new ally.

### What are the future prospects for the use of your research reactors?

The goal is to increase the use and applications currently available, for which our facilities are being modernized. There are plans to open new research lines and produce new radioisotopes.

### What does it mean for you to be part of the RIALC network?

It is a fruitful space to support the community not only in my country but throughout the region. It is a means to bring nuclear technologies to society.



RECH-1 is a pool-type reactor with a maximum thermal output of 5 MW.


# Edgar Mauricio Lopez Rodriguez

Colombian Geological Service - SGC

**Colombia**

How many nuclear research reactors exist in your country and how long have they been in operation?

Colombia operates only one nuclear facility, which has been in operation since 1965. It is the IAN-R1 Nuclear Research Reactor operated and used by the Colombian Geological Service. It is a TRIGA conversion-type reactor with TRIGA nuclear fuel. Initially, it was an MTR-type reactor with physical dimensions of 5.25m X 2m in diameter. Its current operating power is 30 kilowatts. In terms of instrumentation and control, it has technological developments in digital instrumentation supported by PLCs.

What are the main research lines currently developed in your research reactor?

The Colombian reactor is primarily used for the analysis of geological samples through Neutron Activation Analysis and fission track dating. However, the reactor's services will be expanded to include irradiation of targets for radioisotope production and neutron radiography using two beam tubes.

What do you consider to be the most important milestones for your country using its nuclear research reactor?

In recent years, Colombia has invested resources in updating and maintaining its only reactor, as well as accrediting its services to be on par with laboratories worldwide that depend on nuclear reactors. Currently, the reactor's services focus on the geological needs of the country, taking into account the limitations in reported neutron flux values. The reactor operated by the Geological Service represents the flagship of nuclear technology in Colombia, and guided tours are frequently offered to universities, industries, schools, among others, to showcase the contributions of nuclear technology and its benefits to the Colombian population.

Do you believe that the services and products generated in your research reactor meet the demand of your country?

As mentioned, the Colombian reactor operates at an authorized maximum power of 30 kW, limiting its use to certain applications. Considering its scope, it is focused on meeting the needs of the Geological

Service, leaving the demand for radiopharmaceuticals from nuclear medicine centers unmet, as they have to import all the material they require.

**Tell us about your strategic allies or interest groups identified in your country and in the Latin American region.**

Among the main strategic allies of the IAN-R1 reactor are the Geological Service itself, all institutions involved in mining, oil, and material studies, as well as secondary and higher education institutions. Also, considering the creation of the Network of Research Reactors in Latin America and the Caribbean, all reactors in the region are strategic allies, given their experience and trajectory over the past decades.

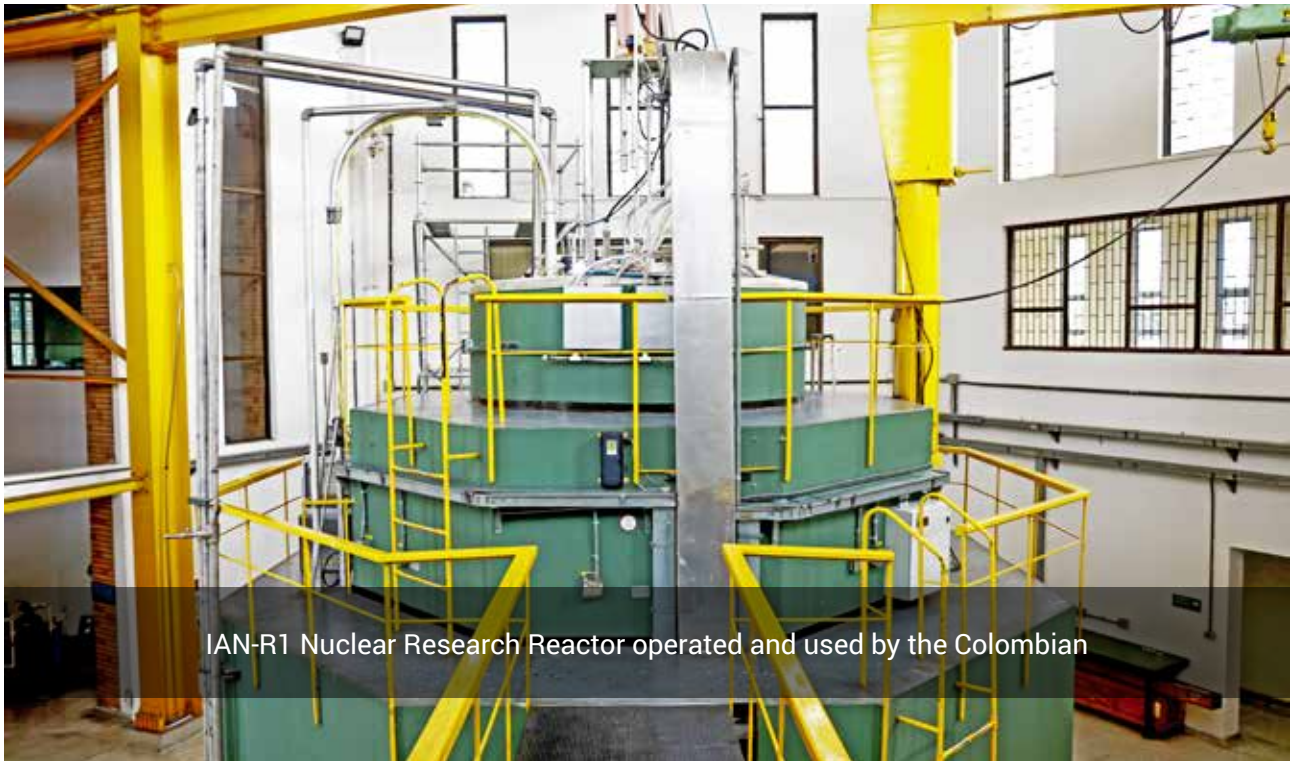
**What are the future prospects for the use of your research reactor?**

The expectations include meeting the needs of the Colombian market, for which the following is planned:

- Continuing research to provide services related to Colombian geological prospecting, with a specific case study being the future implementation of the Ar-Ar dating method.
- Conducting a feasibility study on increasing the power from 30 kW to 100 kW.

What does it mean for you to be part of the RIALC network?

Being part of this select network means concentrating knowledge about the use of nuclear research



IAN-R1 Nuclear Research Reactor operated and used by the Colombian

# Haile Dennis

International Centre for Environmental and Nuclear Sciences - ICENS

**Jamaica**

¿Cuántos reactores nucleares de investigación existen en su país y cuánto tiempo llevan funcionando?

Jamaica tiene un reactor de investigación nuclear de tipo piscina SLOWPOKE-2 diseñado por Atomic Energy of Canada, Ltd. (AECL). Ha sido operado desde marzo de 1984 por el Centro Internacional de Ciencias Ambientales y Nucleares (ICENS) de la Universidad de las Indias Occidentales, Campus Mona. Después de funcionar con combustible de UME durante más de tres décadas, el reactor se convirtió a combustible de UPE en 2015.

¿Cuáles son las principales líneas de investigación que están desarrollando actualmente en su reactor de investigación?

La investigación en las instalaciones de JM-1 está relacionada principalmente con estudios ambientales, agrícolas y de salud, siendo las principales técnicas analíticas el Análisis de Activación de Neutrones, la espectrometría de fluorescencia de rayos X, la espectrometría de absorción atómica y la espectrometría de emisión óptica. Voltametría de separación anódica y plasma acoplado inductivamente. Asimismo, el reactor se utiliza para desarrollar actividades de capacitación y servicios de seguridad radiológica, extendiéndose a países de la región del Caribe.

¿Cuáles considera que son los hitos más importantes de la utilización de sus reactores nucleares de investigación por parte de su país?

Entre nuestros principales hitos podemos mencionar la publicación del Atlas Geoquímico de Jamaica. Este fue el primero de su tipo en el Caribe de habla inglesa, y la mayoría de los datos se generaron mediante Análisis de Activación Neutrónica.

El hito más importante fue el desarrollo de un mapa detallado de trazas y elementos principales en Jamaica, y la exitosa conversión del reactor de UME a combustible UPE. Esta conversión liberó a la región del Caribe del uranio altamente enriquecido (HEU).

¿Considera que los servicios y productos generados en su reactor de investigación satisfacen la demanda de su país?

Los productos y servicios del reactor de investigación sólo satisfacen aproximadamente el 40% de la demanda del país, y están limitados principalmente por la falta de disponibilidad de recursos suficientes (equipos y personal).

### Cuéntanos sobre tus aliados estratégicos o grupos de interés que identifiques en tu país y en la región latinoamericana.

Las principales partes interesadas relevantes en Jamaica incluyen:

A nivel nacional: Ministerio de Ciencia, Energía, Telecomunicaciones y Transportes; Ministerio de Salud y Bienestar; Ministerio de Industria, Inversión y Comercio; Agencia Nacional de Planificación Ambiental; Universidad de las Indias Occidentales, Empresas exportadoras, entre otras.

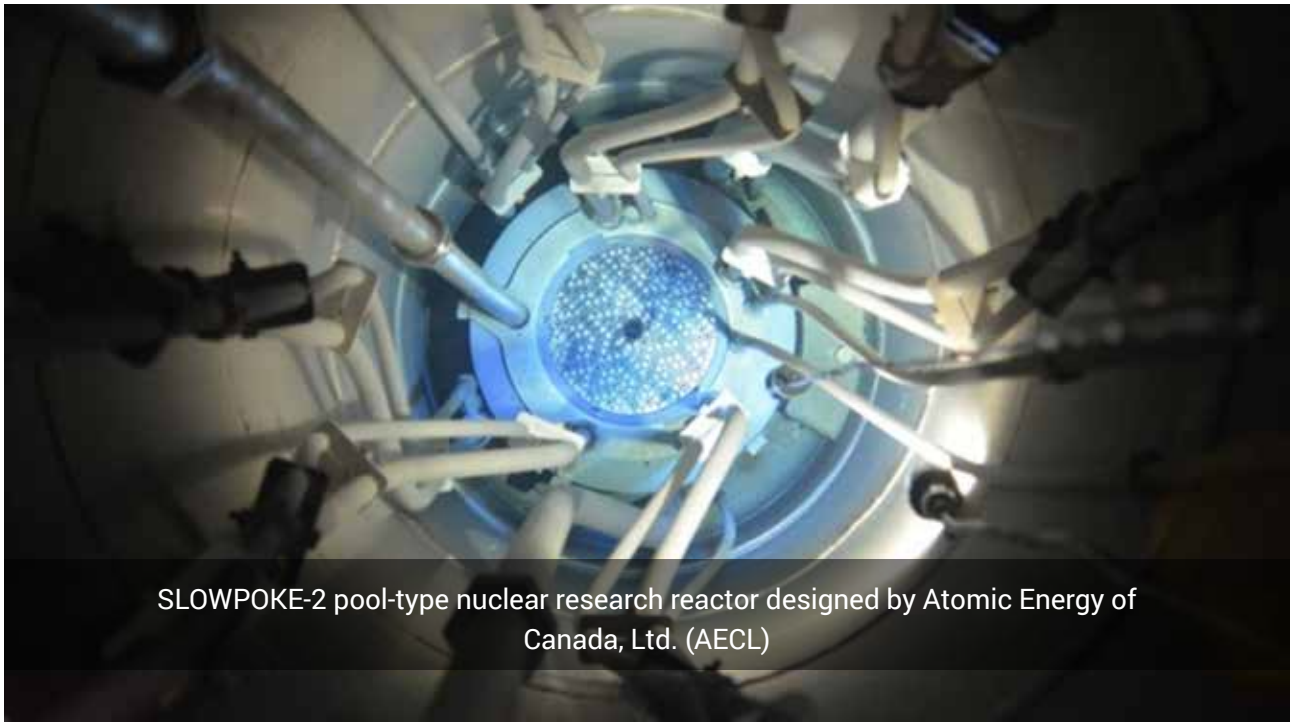
Asimismo, a nivel internacional, incluyendo países de la región, entre ellos: OIEA; Estados miembros de la CARICOM; Instalaciones de reactores de investigación dentro de ARCAL.

### ¿Cuáles son las perspectivas futuras para el uso de sus reactores de investigación?

- En cuanto a las perspectivas futuras, el objetivo es mejorar la relevancia del reactor de investigación aumentando su contribución al desarrollo socioeconómico de Jamaica y la región del Caribe. Esto incluye:
- Desarrollar y mantener personal calificado y competente para la operación y mantenimiento del reactor, sus sistemas auxiliares e instalaciones complementarias.
- Mantenimiento de la infraestructura física del reactor y de las estructuras, sistemas y componentes asociados.
- Aumentar la base nacional de conocimientos sobre las aplicaciones de la tecnología nuclear en áreas como la salud y la energía nuclear.
- Ampliar el ámbito de aplicación del reactor de investigación a áreas relevantes para el desarrollo nacional.

### ¿Qué significa para usted ser parte de la red RIALC?

Estamos entusiasmados de ser parte de RIALC y esperamos colaboraciones dentro del alcance de esta red. Esperamos que esta red facilite la disponibilidad de productos y servicios de reactores de investigación e instalaciones asociadas que antes no estaban fácilmente disponibles para Jamaica.



SLOWPOKE-2 pool-type nuclear research reactor designed by Atomic Energy of Canada, Ltd. (AECL)

# Fortunato Aguilar Hernandez

National Institute for Nuclear Research - ININ

**Mexico**

How many nuclear research reactors exist in your country and how long have they been in operation?

Mexico has two nuclear research reactors:

- The TRIGA (Training, Research, Isotopes, General Atomics) Mark III is a pool-type research reactor with a movable core. It has been in operation since 1968 and is managed by the National Institute for Nuclear Research of Mexico.
- Nuclear-Chicago Model 9000, which is a pool-type subcritical assembly with zero power, was manufactured and built as a training reactor for students. It has been in operation since 1969 and is located at the Superior School of Physics and Mathematics in Mexico City.

What are the main research lines currently developed in your research reactors?

The TRIGA MARK III reactor is mainly used for Neutron Activation Analysis, production of radioisotopes, research and development activities, as well as training and education.

What do you consider to be the most important milestones for your country using its nuclear research reactors?

The conversion from high to low enrichment and the modernization of the facility.

Do you believe that the services and products generated in your research reactors meet the demand of your country?

Currently, no, as the capacity for the production of radiopharmaceuticals is very limited, with promising prospects in collaboration with universities.

Tell us about your strategic allies or interest groups identified in your country and in the Latin American region.

Universities in the country with studies in nuclear sciences.

### What does it mean for you to be part of the RIALC network?

The opportunity to share experiences.

The TRIGA (Training, Research, Isotopes, General Atomics) Mark III is a research pool-type reactor with a moving core.

# Agustín Zuñiga Gamarra

Peruvian Institute of Nuclear Energy - IPEN

**Peru**

How many nuclear research reactors exist in your country and how long have they been in operation?

Peru has two nuclear research reactors:

- RP-0, a pool-type reactor with a maximum thermal power of 1W. It has been in operation since 1978 and is managed by the Peruvian Institute of Nuclear Energy. It is currently in the process of reactivation.
- RP-10, a pool-type reactor with a maximum thermal power of 10 MW and uranium silicide fuel. It has been in operation since 1988 and is managed by the Peruvian Institute of Nuclear Energy.

What are the main research lines currently developed in your research reactors?

The RP-10 Nuclear Research Reactor is used in the production of radioisotopes; Neutron Activation Analysis; neutron dosimetry; X-ray fluorescence spectrometry; research and development; education, as well as training activities.

What do you consider to be the most important milestones for your country using its nuclear research reactors?

The training of qualified personnel in nuclear research reactors at the professional and technical levels in 1979 and 1981, respectively, to operate, maintain, and use reactors (radioisotope production, neutron activation, neutrography, neutron flux). Subsequently, the meritocratically selected personnel went to the atomic centers of Ezeiza and Constituyentes for specific training for a period of no less than 6 months. The first criticality of the RP10 in November 1988 with uranium oxide fuels. Also, the criticality with new uranium silicide fuels in September 2019.

Do you believe that the services and products generated in your research reactors meet the demand of your country?

Currently, no, because the number of nuclear medicine services in the country has increased; also, the requirements for neutron activation analysis services were minimal; in addition, scientific research acti-

vities were being carried out with limited participation from scientific research institutions and universities. Therefore, the new institutional management has decided to open up and work as a team with the participation of various strategic partners.

Tell us about your strategic allies or interest groups identified in your country and in the Latin American region.

Among our main strategic allies are public research institutions (IPI), national and some international universities, nuclear medicine services, the Ministry of Energy and Mines, and nuclear research reactors in the region.

What does it mean for you to be part of the RIALC network?

It means sharing our needs or difficulties but also our capacities to contribute to potential solutions in a timely manner, based on the human capital of our countries.

The RP-10 is a pool-type reactor with a maximum thermal output of 10 MW and uranium silicide fuel.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