

# SIXTY YEARS' EXPERIENCE ON SAFE TRANSPORT OF RADIOACTIVE MATERIAL IN ARGENTINA

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**Abstract:** This work aims to present an overview of the main activities related to the safe transport of radioactive material (RAM) in Argentina over the last sixty years. The review will provide evidence of the implementation of national Argentine regulatory standards in line with Safety Requirements and related documents published by IAEA and the compliance with all the applicable regulatory requirements. Argentinean experience in the design of packages and special form radioactive material (SFRAM) will be described in detail, as well as the implementation of a Quality Management System in the Transport sector of the Nuclear Regulatory Authority (ARN). It will be mention the projects being currently carried out related to the development of new multipurpose package designs, and the improvement by the ARN of the guide to prepare the Safety Report, in order to facilitate the work of designers and National Authority. Another important activity is the training in safety during the transport of RAM conducted by ARN since about 40 years and its participation in the international field. Finally, it will mention some future regulatory tasks intended to improve the activity.

**Key words:** transport, radioactive material, package, design, training

## 1. Introduction

This paper aims to present an overview of the main activities related to the safe transport of radioactive material (RAM) in Argentina over the last sixty years. The regulatory history and the main issues of the operators will be taken into account.

Currently, the Nuclear Regulatory Authority (in Spanish, Autoridad Regulatoria Nuclear, ARN) is the Competent Authority for regulating transport of RAM in Argentina.

In this country, the first activities related to nuclear technology began in the year 1946. They were institutionalized and consolidated on May 31, 1950, with the creation of the National Atomic Energy Agency (in Spanish, Dirección Nacional de Energía Atómica), later renamed National Atomic Energy Commission (in Spanish, Comisión Nacional de Energía Atómica, CNEA), by Decree No. 10936 [1]. Since then, this Commission has devoted to the study, development and application in all aspects related to the peaceful use of nuclear energy, becoming nowadays the promoter agency in this field in the country.

Two of the first Argentine persons involved in safety issues both domestically and internationally, including transport, were Dan J. Beninson and Alfredo L. Biaggio.

In 1994, the Nuclear Regulatory Agency (in Spanish, Ente Nacional Regulador Nuclear, ENREN) was established by Decree No. 1540 [2], with the objective to supervise and regulate the nuclear activity, previously in charge of CNEA.

Few years later, ARN was established as an autonomous body reporting to the President of Argentina by Act 24804, known as the National Nuclear Activity Act [3], which came into force on April 25, 1997, replacing the ENREN. ARN is empowered to regulate and control the nuclear activity with regard to radiation and nuclear safety, physical protection and nuclear non-proliferation issues. Its objective is to establish, develop and enforce a regulatory system applicable to all activities involving RAM carried out in Argentina. ARN is the advisor of the Executive on issues under its purview. The mentioned law was implemented by the Regulatory Decree No. 1390 of 1998 [4].

It is important to mention that since the 50's, it means before the IAEA's first "Regulations for the safe transport of radioactive material" (1961) [5], the transport of RAM is performed safely in this country.

## 2. Legal framework

An effective legal framework is essential to ensure and facilitate a safe transport of RAM. Domestic legislation and international recommendations have an active role strengthening long-term control over the transport of RAM, and are periodically reviewed to ensure they remain effective.

The Argentine regulatory standards are performance oriented: they are not prescriptive but define compliance with safety objectives. How these objectives are achieved is based on appropriate decision made by the organization that deals with the pertinent facility licensee or transport approval certificate. The organization must demonstrate to the Competent Authority that the technical means employed meet the objectives proposed by the standards.

Since the publication of 1961 Edition of IAEA "Regulations for the safe transport of radioactive material", Argentina has adopted this document to regulate the transport of such materials. In 1994 it was made effective through the application of National Standard AR 10.16.1 "Transport of radioactive materials" which has been literally taken from the Spanish version of IAEA Regulations TS-R-1. In this field, the objective of ARN is intended to ensure protection and safety of people, property and the environment from the effects of ionizing radiation during the transport of RAM.

At present, the transport of RAM must be undertaken in accordance with the provisions set in Revision 2 of Standard AR 10.16.1 [6] which concurs with the text of the 2009 Edition of the IAEA Regulations TS-R-1 [7]. ARN is the Competent Authority for the application of this standard.

There are also national and international regulations governing transport of dangerous goods by land, air and water, which related to RAM, are consistent with IAEA's TS-R-1 Regulations. Some of those regulations are:

1. The "Technical Instructions for the Safe Transport of Dangerous Goods by Air" [8] of the International Civil Aviation Organization (ICAO).
2. The "International Maritime Dangerous Goods Code" (IMDG Code) [9] of the International Maritime Organization (IMO).
3. The "Dangerous Goods Regulations" [10] of the International Air Transport Association (IATA).

For the transport of RAM, Argentina pertinent Authorities follow IMO, ICAO and IATA regulations which adopted the 2009 Edition of IAEA's TS-R-1 Regulations in 2011.

### **3. Argentine Designs, Licensing and Control Tasks**

Since the safety in transport of RAM has a strong dependence on the design of packages and materials, the licensing of such designs can be a complex process that requires many different skills.

Argentinean companies such as CNEA, INVAP S.E., DIOXITEK S.A., CONUAR S.A., POLYTEC RM S.R.L. and ASESORAMIENTO TECNOLOGICO S.R.L. have been involved in the design of special form radioactive material (SFRAM) and packages for over 30 years.

Transport of RAM is frequently carried out by the country. It can be mentioned that Argentina is the third largest producer of Co-60 following Canada and Russia. The Embalse Nuclear Power Plant (CNE), which is a CANDU type, generates Co-60 from the control rods with Co-59 located in the reactor core. Currently, DIOXITEK S.A. manufactures sealed sources of Co-60 approved as SFRAM for domestic medical and industrial uses and also exports these sources and bulk Co-60 to 'inter alia' the United Kingdom, China, Uruguay, Chile, Bolivia and Venezuela.

It was the necessity of reducing the number of shipments of RAM approved under special arrangements and minimizing the dependence on foreign suppliers, what promoted the development of national package designs in the early 80's. Many times, this dependence made the transports more expensive or delayed them unnecessarily because it was impossible to have the required package in a timely manner for such transports. It is noted that as regulatory policy, ARN decided to reduce the special arrangements as much as possible.

Simultaneously, ARN personnel have been learning and training in these issues since the mentioned companies began to develop SFRAM and package designs. This has allowed that the above companies possess the necessary know how for the development of such designs. In addition, ARN is qualified to verify the compliance of such designs with the applicable requirements of Standard AR 10.16.1, e.g., analysis, assessment and independent recalculation of shielding, criticality, radiological protection, materials, and tests. Analysis and assessment related to dynamic impact and mechanical tests with scale specimens of package designs are evaluated by ARN external consultants.

Up to now, a total of 21 Approval Certificates of package and SFRAM designs have been issued by ARN; being 2 more designs in a licensing stage (see TABLE 1). Of that total, 10 belong to SFRAM models consisting of Co-60 and Ir-192 sealed sources for medical and industrial uses, and the other 13 certificates are package designs. These last are distributed as follow:

- Five Type B(U) packages for transport of Co-60, Ir-192, and for Mo-99, I-131 and Ir-192 [11] [12];
- Two Type IF packages for transport of fuel elements plates (up to 20% U-235) and pellets of UO<sub>2</sub> (0.95% U-235);

- Two Type AF packages for transport of liquid solutions with U and for powder of U<sub>3</sub>O<sub>8</sub>, both with enriched U (up to 20% U-235);
- Four Type B(U)F packages for transport of research reactors fresh fuel elements, and for nuclear power plants or research reactors fuel elements (fresh or irradiated), both with enriched U (up to 20% U-235).

It is important to note that the first design certificates issued by the Argentinean Competent Authority were the RA/0027/S in September 1986 for a sealed source (SFRAM) for medical use and the RA/0033/B(U)F for transport of research reactor fresh fuel elements in February 1988.

A significant experience was that, as part of the licensing process of Type B(U) package design carried out by the Department for Transport (UK Competent Authority), ARN was invited to collaborate verifying mechanical tests conducted in Argentina. That was appreciated by ARN as it helped to exchange views between the two competent authorities on the preparation, conduct and outcome of such tests.

Currently, ARN is in process of licensing two Type B(U)F package designs. The model RLA4018, for transport of fuel elements, fresh or spent with enriched Uranium. This design is being developed under the framework of the IAEA Regional Technical Cooperation Project RLA/4/018 "Management of research reactors spent fuel elements", among Argentina, Brazil and Chile. This project has allowed qualification and experience in such relevant design. There have been significant advances in the design which would make possible its approval by ARN in 2013. The other model is called LEUPA, for the transport of different solid uranium compounds, enriched up to 20% in U-235, and it is in a preliminary stage of the licensing process.

In order to facilitate the work of designers, ARN has written, and maintains updated, guides to prepare the package [13] or SFRAM [14] Safety Report.

With the objective of controlling and monitoring the compliance with the applicable requirements of safety Standard AR 10.16.1, ARN performs inspections and regulatory audits, and verifies preventive and corrective actions taken by designers, consignors and other related users.

As part of the control tasks, the IMPO/EXPO Data Base is used by ARN for supporting and storage of relevant data of the endorsement of the Import and Export Application Form submitted by users. This Data Base records the user data (applicants), the probable date of importation or exportation, identification marks of approval certificates, amount and type of packages and radioactive contents involved in the importation or exportation.

The SHIP Data Base is used for recording the data related to Notice of RAM Transport forms submitted by users allowing, in this way, to have the orientative information about the quantity of land, air and water transports of these materials in Argentina. The the following data is recorded: consignor, consignee, origin, destination, carrier, radionuclides (physical form, activity, SFRAM or not), quantity, models and approval certificates of packages, transport index, route, starting and ending date and time, quantity of vehicles, and whether security measures are required.

#### **4. Quality Management System**

Sure of having developed its regulatory experience with a high level of confidence, ARN decided to implement its Quality Management System (QMS) in 2005 [15]. The objectives were to get higher efficiency and effectiveness, continual improvement of regulatory and supporting processes, as well as to ensure the best information for citizens and the transparency of ARN actions.

ARN has established a Quality Manual [16] based on standard ISO 9001:2008 "Quality management systems – Requirements" [17] and follows the IAEA recommendations of "PDRP-6 – Quality management of the nuclear regulatory body" [18].

The ARN process related to safety in the transport of RAM called "Protection against ionizing radiation in the transport of radioactive materials", TMR process, obtained ISO 9001 certification on May 20, 2008. It has received and maintained two certifications, the Certificate for Management Systems given by the Argentine Normalization and Certification Institute (in Spanish, Instituto Argentino de Normalización y Certificación, IRAM) and the International Certification Network (IQNet).

The application of TMR process takes place by implementing the TMR documents that follows the guidelines of the Quality Manual of ARN, 'inter alia' procedures, work instructions and forms developed for the necessary arrangements. This allows the generation of documents and performance indicator values that provide annual and quarterly status report on the results and proposals for improving the process.

## **5. Training provided and participation in IAEA activities**

Since about 40 years, ARN has provided training in safety during transport of RAM, conducting national and regional courses as well as developing the appropriate training material in Spanish for such courses (lectures notes, practical works, slides, presentations).

ARN personnel have been involved as lecturers during specific training courses on transport of radioactive material in the framework of the IAEA Latin America Programme, ARCAL: in Peru, Costa Rica and Chile in 1990. Additionally, ARN was involved as advisor in assessing on national regulations and in training courses on that matter in Guatemala, Brazil, Panama, Bolivia, El Salvador, Colombia and Venezuela, as well as in courses developed in Argentina at technical and professional level addressed to consignors, designers and security forces.

In cooperation with the IAEA, ARN co-ordinated and gave interregional training courses on transport of radioactive material addressed to Latin America and The Caribbean countries, developed in Buenos Aires, Argentina: 1999 (3 weeks), and 2000 and 2008 (two weeks).

Argentina is member of the IAEA Transport Safety Standards Committee (TRANSSC), and also of the working group formerly known as Senior Advisory Group on Safe Transport of Radioactive Material (SAGSTRAM). Additionally, there are experts in transport of RAM who have participated in IAEA related matter meetings in IAEA Headquarters in Vienna. ARN experts have collaborated in the development of the IAEA Transport Regulations and others related support documents as well as their Spanish translations.

ARN Senior experts took part of the IAEA Transport Safety Appraisal Service (TranSAS) missions in United Kingdom (2002) and Panama (2003). Since 2006 ARN is member of the International Steering Committee on Denials of Shipments of Radioactive Material that is co-ordinated by IAEA.

## **6. Future plans**

The following regulatory actions will be taken in order to achieve a further improvement in the activities related to transport of RAM [19]:

- It is important to continue working on the harmonization and integration of the different ARN sections involved in the transport of radioactive material in order to develop a strong Safety Culture.
- Further training and awareness of all sections involved in transport should be strengthened. In particular, ARN will continue giving specific courses aimed to consignors, designers, security forces and other similar audiences.
- In the framework of IAEA, ARN will continue working in order to solve the problems which interfere with the transport of RAM, and could result in delays or denials of shipments.
- Taking into account its expertise on transport safety as well as its experience in the preparation and/or modification of IAEA related documents, Argentina will try to share it with Latin America and The Caribbean countries promoting regional events.

## **7. Conclusions**

Considering the experience acquired since the formal beginning of nuclear activity in Argentina in 1950 and essentially the proceedings of ARN during the last 17 years, the conclusions of this work are:

- The transport of radioactive material is performed safely in this country due to the decision to maintain the highest standards in the activity.
- Argentina has a wide-ranging experience and capacity in the design and licensing of packages and special form radioactive material. Argentinean companies have designed several models of Type B(U) and B(U)F packages, and will continue developing new designs according to their necessities.
- Training is the key to developing the transport industry in the country and the region.
- It is important to participate in the elaboration or modification of IAEA Transport documents, and to implement and improve the Argentine ARN standards as well as maintain them updated as far as possible in line with the international recommendations.
- In the framework of implementation of a quality management system according to ISO 9001 standard, it is necessary to keep the continuous improvement tasks related to Safety in Transport.
- It is advisable to promote, through TRANSSC and other international related forums, the activities related to the harmonization in the implementation of regulatory requirements among competent authorities, regulatory bodies and international modal organizations.

**TABLE 1. ARGENTINE PACKAGE AND SPECIAL FORM RADIOACTIVE MATERIAL DESIGNS**

<b>Current identification mark</b>	<b>First issue date</b>	<b>Models</b>	<b>Radioactive contents</b>	<b>Designer</b>
<b>RA/0027/S</b>	<b>SEP 1986</b>	FSM 60-02	Up to 400 TBq of Co-60. Discontinued.	CNEA
<b>RA/0030/S-96</b>	<b>FEB 1987</b>	FIS 60-04	Up to 650 TBq of Co-60.	CNEA / DIOXITEK SA
<b>RA/0032/S-85</b>	<b>MAY 1987</b>	FIS 60-05	Up to 650 TBq of Co-60. At present it is not renewed.	CNEA
<b>RA/0033/B(U)F-96</b>	<b>FEB 1988</b>	GURI 100	Up to 20% U-235; research reactors fuel elements. At present it is not renewed.	INVAP SE
<b>RA/0040/S-96</b>	<b>OCT 1989</b>	RM-10 and RM-19	Up to 4.44 of TBq of Ir-192.	POLYTEC RM SRL
<b>RA/0042/S-96</b>	<b>MAY 1990</b>	FIS 60-03	Up to 940 TBq of Co-60.	CNEA / DIOXITEK SA
<b>RA/0043/S-96</b>	<b>JUN 1990</b>	FSM 60-03	Up to 444 TBq of Co-60.	CNEA / DIOXITEK SA
<b>RA/0045/S-96</b>	<b>SEP 1990</b>	AC-345P and AC-345S	Up to 1.295 PBq of Co-60, to industrialize.	CNEA / DIOXITEK SA
<b>RA/0051/IF-96</b>	<b>JAN 1991</b>	CPC	Up to 20% U-235; fuel element plates.	CNEA
<b>RA/0064/S-96</b>	<b>OCT 1992</b>	COB-9-A	Up to 940 TBq of Co-60.	CNEA / DIOXITEK SA
<b>RA/0068/AF-96</b>	<b>NOV 1993</b>	TRPOL-1	Up to 20% U-235; U <sub>3</sub> O <sub>8</sub> powder.	CNEA
<b>RA/0072/B(U)-96</b>	<b>OCT 1994</b>	GURI 01	Up to 12,95 PBq of Co-60 (SFRAM).	INVAP SE / CNEA / DIOXITEK SA
<b>RA/0074/B(U)-96</b>	<b>JUL 1995</b>	CONTRAS	Up to 555 TBq of Co-60 (SFRAM).	INVAP SE
<b>RA/0090/B(U)-85</b>	<b>DEC 2000</b>	EMI-9	Up to 2.96 PBq of Co-60, FIS 60-03.	SINERCOM S.A.
<b>RA/0092/IF-96</b>	<b>FEB 2003</b>	UTNEC	Up to 0.95% U-235; fresh UO <sub>2</sub> .	CONUAR S.A.
<b>RA/0096/B(U)-96</b>	<b>AUG 2007</b>	DRAGON	Up to 18.5 TBq or up to 37 TBq of Ir-192; flakes.	Asesoramiento Tec. SRL
<b>RA/0097/S-96</b>	<b>AUG 2005</b>	FIS 6007	Up to 590 TBq of Co-60.	DIOXITEK SA
<b>RA/0098/S-96</b>	<b>JUN 2006</b>	FIS 6008	Up to 740 TBq of Co-60.	DIOXITEK SA
<b>RA/0099/B(U)F-96</b>	<b>APR 2008</b>	MG1	Up to 20% U-235; research reactors fuel elements.	INVAP SE
<b>RA/0100/B(U)F-96</b>	<b>Under licensing tasks</b>	RLA4018	Up to 20% U-235; fresh or irradiated fuel elements	CNEA (with CNEN Brazil, under an IAEA Project)
<b>RA/0101/B(U)-96</b>	<b>SEP 2011</b>	BU-MAN	Up to 55.5 TBq of Mo-99, I-131, Ir-192.	CNEA
<b>RA/0102/AF-96</b>	<b>DEC 2011</b>	DALMA 25	Up to 20% U-235; liquid solutions.	CNEA
<b>RA/0103/B(U)F-96</b>	<b>Under licensing tasks</b>	LEUPA	Up to 20% U-235; different solid uranium compounds.	INVAP SE

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