# analysis of the regulatory frameworK

# and the interrelations between safety

# and sustainability during the back end

# of nuclear FUEL CYCLE FACILITIES

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**Abstract**

The paper aims to describe the interrelations between the regulatory framework of the Nuclear Regulatory Authority (ARN) and the sustainable development objectives (SDGs 2030) towards the back-end of nuclear fuel cycle facilities, as well as the perspectives and challenges. In addition, experiences will be presented from the regulatory oversight framed in the national legislation, intern policies of ARN and its strategic planning and international cooperation related to the fulfillment of the SDGs 2030. The paper points out regulatory safety requirements, taken from the current regulations and aligned with the SDGs 2030, the development by facilities to implement technologies and procedures that allow optimizing processes that aim to minimize radioactive waste and releases. A graded approach to regulatory verifications activities will be evaluated, considering the classification of the facilities and their associated radiological risks that may impact on the workers, the public and the environment. The justification of the practices and the principles of optimization of radiation exposures will be taken into account. Responsibilities of the interested parties involved in the licensing processes for the back end of nuclear fuel cycle facilities and their influence on decision-making considering economic, social and environmental factors will be described. Finally, the paper will bring conclusions and opportunities for improvement to be addressed in terms of updating the regulatory framework concerning the integration of the concepts of safety and sustainability.

## INTRODUCTION

Site remediation, spent fuel and radioactive waste management activities in Argentina are carried out within a legal and regulatory framework that includes the National Constitution, the Joint Convention, and national, provincial, and municipal laws. National Acts No. 24.804 and 25.018 designated the National Atomic Energy Commission (CNEA) as the responsible organization for the radioactive waste management, through the creation of the National Radioactive Waste Management Program (PNGRR) and the Nuclear Regulatory Authority (ARN) as the regulatory body.

The paper’s scope includes the following topics:

First of all, the regulatory framework applied to the back-end of nuclear fuel cycle facilities described, as well as the interrelationship between the sustainable development objectives (SDGs 2030) which allowed to identify the regulatory requirements aligned with the objectives and concepts of sustainability.

Next, a summary of the regulatory actions in environmental remediation and the management of spent fuel and radioactive waste and their relation with the SDGs.

Then, the responsibilities of the different interested parties and how the legal and regulatory framework involves them in the authorization processes to nuclear back-end.

Finally, the perspectives and challenges in the integration of the SDGs into the current regulatory framework and the conclusions drawn from the analysis carried out are mentioned, which could lead to future actions by the ARN, to improve the application of the SDGs in its regulatory actions and oversight.

## nuclear back end legal and regulatory framework

The Argentine legal and regulatory framework of back-end of nuclear fuel cycle facilities is composed by a national legal framework, which has incorporated the international legal framework and the provincial and municipal legislation, as described in the pyramidal Fig. 1.

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*FIG. 1. Nuclear back-end legal and regulatory framework.*

The Argentine legal system is supported on the National Constitution, as it is the “fundamental law” of our legal order. Regarding the nuclear activity, our country has had a specific Act since 1997, when the Nuclear Activity National Act No. 24804 was promulgated, and one year later, regulated by the Decree No 1390/98. This Act created a Regulatory Body which oversight the nuclear activities performed in the Argentine Republic.

Later, in 1998, Argentina passed Act No. 25.018 “Radioactive Waste Management Regime”, which provides the basic instruments for an adequate radioactive waste management, ensuring environmental protection, public health and prosperity rights.

International conventions on spent fuel management and on radioactive waste management safety have been incorporated to national legislation through Act No 25.279.

In the Argentine federal system, each province is sovereign and has its own legislation at both provincial and municipal level. Although that legislation does not take precedence over the national one, it affects nuclear matters, particularly the radioactive waste issue.

Moreover, the regulatory framework applicable to radioactive waste is composed of standards and guides issued by the Nuclear Regulatory Authority [1], in accordance with the article 16, section a) of Act No. 24.804. Part of the regulatory framework include general basics standards, licencing standards and guides, for example: AR 10.1.1 “Radiological Safety Standard”, AR 10.12.1 “Radioactive Waste Management”, AR 0.0.1, AR 2.12.1, AR 10.6.1, AR 0.11.1 and Guides AR 13 and AR14.

## INTERRELATIONSHIP BETWEEN framework AND SdgS

Below is a description ofthe interrelations between the regulatory framework previously associated to back-end of nuclear fuel cycle facilities, internal policy and strategic planning of ARN and the sustainable development objectives (SDGs 2030).

### Economic sustainability goals

Regarding the integration of SDG 3 on "Good health and well-being" in the regulatory framework, it should be noted that Act 24.804, Article 8, mentions that one of the functions of the ARN is to protect people against harmful effects of ionizing radiation, aligning with the internal policy [2] and its Strategic Plan [3] in which it assumes the commitment to guarantee the protection of society in the present and in the future against the harmful effects of ionizing radiation, as well as promoting within its values a social commitment and sustainability in all its actions.

Likewise, Act 25.018, article 1, establishes the basic instruments for the adequate radioactive waste management that supports public health and in article 2, it raises the need to isolate radioactive waste from the biosphere for the time necessary so that it to does not imply a risk to people.

Act 25.279 in its article 1, it refers to ensuring that in all stages of the spent fuel management and radioactive waste, there are effective measures against potential radiological risks in order to protect people, environment and society so that the needs and aspirations of the present generation are met without compromising future generations.

On the other hand, the AR regulations establish requirements so that radioactive waste management is carried out with an adequate level of radiological protection of people and safety from radiation sources, for present and future generations. In requirement 34 and 62 of the AR10.12.1 standard, it is mentioned that the radiological protection of radioactive waste management shall be optimized and that in the safety assessments corresponding to normal migration scenarios, the estimated doses that future generations will receive shall not exceed the dose constraints established in the design of the Repository.

The AR 10.1.1 standard provides in its criterion 32, that the Responsible Entity shall justify the practices, carry out the optimization of radiological safety, respect the dose limits and the established dose restrictions. From the above mentioned, it can be said that the AR standards consider the fundamental principles of radiological protection.

SDGs 4 “Quality Education”, is included within the functions of the ARN in the framework of the agreement signed with the IAEA, in which our country assumes the responsibility of being the Regional Training Center in Latin America and the Caribbean for Safety, Transportation and waste management.

### Environmental and social sustainability goals

In relation to SDGs 6 "Clean water and sanitation, 13 "Climate action", 14 "Life below water" and 15 "Life on land", it can be mentioned that care for the environment is established in our "National Constitution" in its article 41, which quotes: "that all inhabitants enjoy the right to a healthy environment, so that productive activities meet present needs without compromising those of future generations and also prohibits the entry of radioactive waste into the national territory".

Act 24.804, article 16 m) mentions the functions of the ARN, where it confers on it the responsibility of assessing the environmental impact of any activity it licenses, understanding as such those activities of monitoring, study and follow-up of the incidence, evolution or possibility of environmental damage that may come from the licensed nuclear activity.

Act 25.018, article 11, mentions that the National Radioactive Waste Management Program will incorporate the recovery of sites affected by mining activity, considering the principle "environmental impact as low as possible", and shall be integrated with complementary development programs sustainable for the communities directly affected and being subject to the environmental impact assessment procedures established by the provinces.

 The ARN within its institutional policy incorporates the protection of the environment and also the regulatory framework has a series of requirements for discharges into the environment and recommendations for carrying out monitoring plans, which are mentioned below.

The AR 10.1.1 standard, requirement 14, states that the application for a license, registration or authorization of non-routine practice shall contain information on the generation of radioactive waste and proposals for its management and also discharges into the environment, to be evaluated. by the Regulatory Authority.

The AR 6.1.2 standard “Limitation of radioactive effluents from Class I radioactive facilities” establishes as an objective that the radiological protection criteria shall be taken into account in the design, in order to limit the discharges of radioactive effluents into the environment. In addition, it establishes dose constraints for the person representing the public. In criterion 8 of the same, it mentions that the systems for limiting radioactive effluent discharges shall be optimized, taking into account the cost of the various feasible alternatives and the collective effective doses due to the release of radioactive effluents throughout the life of the facility and in criterion 15, it mentions that monitoring of radioactive effluent discharges into the environment shall be foreseen, preferably continuously or as an alternative at intervals to be determined, according to the operating conditions and to the satisfaction of the Regulatory Authority.

Among the ARN guidelines is AR 14, in which it mentions recommendations for the design and development of an environmental radiological monitoring plan, considering the different environmental matrices.

Continuing with SDG 9 "Industry innovation and infrastructure", it can be mentioned that industrial and technological innovation through Act 24.804 in its article 2, confers on the National Atomic Energy Commission to promote the development of science and technology in nuclear matters, including the implementation of development programs and promotion of technological innovation ventures. Regarding the ARN, the same Act in article 16 j) mentions that it has the responsibility to protect restricted information in order to ensure the proper preservation of technological, commercial or industrial secrets.

Regarding Act 25.279, it states that the technologies incorporated in the design and construction of a spent fuel management facility shall be supported by experience, tests or analysis.

The AR 10.6.1 standard, through requirement 28, establishes that updates or modifications to processes and new processes shall be designed, verified, validated when relevant, approved and applied in such a way that safety is not compromised. In addition, in its requirement 40, it mentions that the management system shall be evaluated considering technological advances and research and development results.

Within the regulatory infrastructure, it can be mentioned that the ARN has its own laboratories for the analysis of environmental samples and effluents, allowing independent assessments to be carried out and verifying the results obtained by those regulated. These participate in intercomparisons with other laboratories to validate the quality of the results.

SDG 12 "Responsible consumption and production" is linked in the regulatory framework through the minimization of the generation of radioactive waste. This fundamental concept is applied in Argentina in order to minimize radiation doses and environmental impact, as well as save costs. For this, the minimization of waste is taken into account in the place and at the time it is generated (minimization of origin). AR 10.12.1, in criterion 33 mentions that the generation of radioactive waste must be minimized to the lowest level reasonably possible. Compliance with this requirement shall be contemplated from the design phase, continuing with operation and decommissioning. Additionally, in requirement 56 it mentions that radioactive waste generators will be responsible for carrying out the necessary operations prior to the waste treatment stage, such as collection, segregation and decontamination, as well as in point 12 of the AR Regulatory Guide 13 “Radioactive Waste Storage” establishes that the design of the building for the storage of radioactive waste and its safety systems should minimize the probability of dispersion of radioactive material during the expected storage time.

Another Radioactive Waste minimization strategy used in the country is the clearance and exemption of radioactive material based on Regulatory Guides AR 8 “Generic dispensation levels” and AR 6 “Generic exemption levels”.

However, SDG 16 "Peace, justice and strong institutions" can be seen included in the ARN quality policy that promotes transparency in access to information on radiological and nuclear safety aspects for interested parties. In addition, in the processes of remediation of environmental liabilities, the ARN participates in public hearings and through different communication media provides information to the community.

Finally, it can be said that the contribution to SDG 17 "Partnerships for the goals" can be seen reflected mainly in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, allowing a peer review of the commitments and responsibilities assumed at the country level, on spent fuels and radioactive waste from the nuclear fuel cycle. This presents the current state of affairs regarding long-term management policies, responsibilities for funds to be able to carry out projects, describing current practices and facilities and those planned for the future.

It should also be mentioned that the objective of the Joint Convention is to achieve and maintain a high degree of safety in the management of spent fuel and radioactive waste worldwide through the enhancement of national measures and international cooperation, including where appropriate, security-related technical cooperation [4].

The ARN actively participates in technical meetings that involve issues related to the nuclear back-end in the "Ibero-American Forum of Radiological and Nuclear Regulatory Organizations" of which it is a member, with the objective of promoting safety in all practices with radioactive materials in Latin America. The ARN also participates in international meetings of the IAEA Standards Committee in the WASSC (Waste Safety Standard Committee).

The control of nuclear materials and the verification of the peaceful use of nuclear materials is carried out through the only existing binational safeguards organization in the world and the first binational organization created by Argentina and Brazil called: Brazilian Agent Agency for Accounting and Control of Nuclear Materials (ABACC).

## regulatory oversight Experiences related TO sdgs

Table 1 below shows a summary of the regulatory actions in some facilities during the nuclear back-end, relating them to the SDGs, considering a graduated approach according to the classification of the facilities based on the radiological risk graded. This contributes to the definition of different levels of regulatory control, ensuring safety and optimizing regulatory costs.

table 1. FACILITIES AND regulatory actions, RELATED TO THE SDGS

|  |  |
| --- | --- |
|  |  Environmental Remediation Radioactive Waste and Spent fuel Management |
| SDGs | Malargüe[5] | Class 2 facility:San Rafael (CMF) | Class 1 facility: Área Gestión Ezeiza (AGE)  | Class 1 facilities:Nuclear Power Plants (NPP) and Research Reactors |
|  | * Safety assessment of encapsulation of uranium tails
* Requirement to define time under Institutional Control (monitoring)
 | * Final disposal dam safety assessment
* Dose assessment of practice of effluents neutralization and treatment of radioactive waste
 | * Safety assessments in superficial final disposal systems
* Assessment of Radiometry of the shielding for the transfer of fuel elements
 | * Assessment of procedures to optimizing protection on workers during Long Term Operation (LTO) project in Embalse NPP.
 |
|  | * Regional Training Center in Latin America and the Caribbean for Safety, Transportation and waste management (CCR).
 |
|  | * Assessment of the environmental impact
* Environmental Radiological Monitoring
* Hydrogeological studies
 | * Measurement of the extraction system in the effluent neutralization plant
* Assessment of the gas extraction system for the drum opening system
 | * Requirement to modify the extraction and sampling system in operating facilities to optimize them.
 | * Assessment of Environmental Impact Studies (EIS) for LTO project in Embalse NPP.
* Regulatory release process of RA-8 Research Reactor from regulatory control
 |
|  | * Collection of environmental and effluent samples for analysis in ARN laboratories
 |
|  | * Verification of the calibration and maintenance of the measuring equipment
 |  | * Assessment of the new radioactive waste treatment processes in a remodeled plant
 |  |
|  | * Authorization to clearance of trees
* Creation of the park "El Mirador"
 | * Assessment of Re-use of the concentrate plant for treatment of environmental liabilities
* Recovery of uranium from solid waste
* Requirement to record the movement of the radioactive inventory of quarries and dikes
 | * Requirement of Complete characterization of drums of radioactive waste extracted from the surface final disposal system
* Assessment of the reuse of materials in new treatment plants
* Verification of the radiological characterization of effluents to be cleared
 | * Assessment of dry storage of spent fuels for Predisposal management
* Radioactive waste management from LTO project in Embalse NPP
 |
|  | * Participation by ARN in public hearings on the remediation
 | * Participation by ARN in public hearing for phase I of remediation of environmental liabilities
 | * Involvement by ARN in technical training visits
 | * Participation by ARN in public hearing to discuss the EIS of the LTO project in Embalse NPP
 |
|  |  |  | * Brazilian-Agentine Agency for Accounting and Control of Nuclear Materials (ABACC)
 |
|  | * Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
* Conference of the Parties to the Amendment to the Convention on the Physical Protection of Nuclear Material (A/CPPNM)
 |

## responsibilities of interested parties

National legislation considers the interested parties, mentioning in article 10 of Act No. 25.018, that the CNEA through the PNGRR must permanently inform the community about the scientific and technological aspects of radioactive waste management, as well as also in Act No. 25.279, article 13 establishes that information be provided to members of the public on safety for a projected installation.

In addition, the AR 10.6.1 standard, in its requirement 7, confers on the Responsible Entity the duty to identify the interested parties and define an appropriate strategy to interact with them, likewise requirement 8 mentions that the Responsible Entity shall ensure that the processes and plans for interacting with interested parties are timely and effective with respect to communication of radiation risks, unforeseen circumstances, dissemination of information relevant and necessary for safety, and consideration of stakeholder interests and expectations interested in safety related decision-making processes. The same norm also establishes in its requirement 4, providing adequate resources and financing for all stages of the life of the facility or practice and mentions in its requirement 35, that the Responsible Entity shall promote and maintain a strong safety culture at all the levels of the organization.

The ARN has identified the internal and external interested parties, as well as their needs and expectations. Regarding communication with stakeholders, it prepares an "Annual Report" of the activities that were carried out during the year to inform them and is updating its management system.

The responsibility of the government should be to determine the extent of interested parties decision-making and influence. It should also create the conditions for decision-making processes in nuclear back-end to be consistent with intergeneration equity and the social objectives and environmental protection goals of sustainable development and thus, meets the needs of the present generations without compromising the ability of future generations.

Fig. 2 shows the responsibilities of the different interested parties in the authorization processes.

*FIG. 2. Responsibilities of interested parties in authorization processes.*

## pERSPECTIVES AND CHALLENGES

Mentioned below are the perspectives and challenges in terms of updating the regulatory framework during back-end and the actions that the ARN should carry out considering the SDGs:

* The introduccion of principles “waste hierarchy” and “circular economy” into framework will encourage the recycling and re-use of materials in the facilities;
* Taking into account the existence of deferred costs in the radioactive waste and spent fuel management, these should be subject to change and need to be re-assessed periodically. Likewise, it could be mentioned into the legal and regulatory framework, the need to ensure an appropriate financing that guarantee their availability on time, based on well established decomissioning and radioactive waste management programmes.
* So far, regulators have tended to focus on their specific risk responsibilities while integration might enhance the overall effectiveness of regulation. Consequently, a regulatory cooperation with other regulatory agencies to establish and unify requirements for oversight.
* ARN could oversee that the processes and plans for interacting with interested parties and communication plans are timely and effective;
* Technology is critical to support economic development but needs careful control and monitoring. Therefore, it is necessary to consider the impact of the implementation of new technologies in the facilities, taking into account safety and sustainability;
* Generate guidelines for the safety in the storage of spent fuels and remediacion site considering sustainability aspects;
* ARN could include in its Annual Report how its functions are aligned with the SDGs, including oversight during the nuclear back-end, as well as assessing their compliance through indicators;
* ARN could develop independents assessments of safety culture in organizations and early intervention tools to correct deficiencies.

## Conclusions and opportunities for improvement

As a result of the analysis carried out on the legal and regulatory framework of the nuclear back-end in relation to the SDGs, it can be mentioned that sustainability concepts are included in relation to safety and these are being applied during the oversight of the facilities.

However, the SDGs identified in this document could be included in the ARN's strategic plan and in the public annual report. This will allow interested parties to show the ARN's commitment to them, as well as incorporate other SDGs applicable to their functions.

In relation to the management of SDGs, it is necessary to explore strategic planning tools in order to improve the monitoring and outcomes of the SDGs.

In addition, it would be recommendable that the back-end of regulatory framework would be gradually updated to include the SDGs and the principles of “waste hierarchy” and “circular economy” mentioned in this document.

Financing for decommissioning, remediation of sites and radioactive waste management available on time, is of high importance to develop the projects timely and avoiding unexpected interruptionsof the projects, that could have an impact on safety and sustainability. A suggested manner to comply with the set activities is to count with a working program and the administrator for the financing, both supported by the legal and regulatory framework, which need to be complemented to reach this purpose.

ARN facilities classifications for the nuclear back-end is based on radiological risk and the complexity of the facilities, as identified in Table 1. Different levels of control are established, ensuring the safety and optimization of regulatory costs.

The impact of new technologies related to social, economic and environmental factors need to be considered in the regulatory framework. However, during the inspections and assessments of the technical documentation of the facilities, the new technologies introduced in the processes are monitored and controlled.

Cooperation between ARN and non nuclear regulatory agencies involved in the authorization processes at nuclear back-end facilities would facilitate decision-making and reduce time regarding the activities to be carried out at the facilities, optimizing regulatory control and benefiting interested parties.

Finally, ARN independent assessment of communication plans of the Responsible Entities and the verification of effectiveness of the interaction among  the interested parts, are essential activities to promote safety and sustainability.

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