Chapter 15

Building the Nuclear and Radiological Safety and Security Authority in the Kingdom of Morocco: Sharing Experience and Lessons Learned

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Abstract Following the example of several countries, the Kingdom of Morocco adopted, in the middle of the twentieth century, nuclear techniques in the medical and industrial fields, which have experienced a greater and sustained growth following its membership of the IAEA in 1957. This chapter presents the evolution of the nuclear and radiological infrastructure in Morocco over the last 60 years and the prospects for its future development. The chapter outlines the continuous efforts made by public authorities to upgrade the national nuclear and radiological regulatory

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framework in compliance with international obligations related to safety, security and safeguards. In this regard, the Moroccan Agency for Nuclear and Radiological Safety and Security (AMSSNuR) has, since its inception, been driven by the will and ambition to achieve its vision of establishing itself at the national level as an independent, effective, credible and transparent regulatory body; as well as a leader at the African level and significant contributor in the international arena. The Moroccan experience in safety and security governance and management is highlighted, and the lessons learned and experience gained in this area by AMSSNuR are shared.

Keywords Nuclear techniques in the medical and industrial fields · Nuclear and radiological infrastructure · National nuclear and radiological regulatory framework · Moroccan Agency for Nuclear and Radiological Safety and Security (AMSSNuR) · Safety and security governance and management · Lessons learned · AMSSNuR strategic plan

15.1 Introduction

A report published by the International Atomic Energy Agency (IAEA) in September 2020 at the end of its 64th General Conference,¹ stated that nuclear technology is undergoing considerable development at the international level, particularly in the areas of energy applications, accelerator and research reactor applications, radioisotope and radiation technologies, human health and nuclear techniques in food and agriculture. In its Nuclear Safety Review 2020,² the IAEA described global trends and activities related to its various programmes, while highlighting progress and priorities for strengthening nuclear and radiation safety as well as transport and waste safety at the international level.

These statements are directly linked to, inter alia:

- The revision of the IAEA safety standards and security guidance, their application through education and training, peer reviews and advisory services undertaken by the IAEA at the request of its Member States, as well as the lessons learned from the accidents in Goiânia and at the Fukushima Daiichi and Chernobyl nuclear power plants and other accidents and incidents.
- The effectiveness of nuclear, radiation, transport, waste and safety emergency preparedness and response regulations and their implementation.

This progress also concerns the adoption by Member States of the internationally binding conventions and non-binding instruments such as the codes of conduct on the safety and security of radioactive sources, nuclear safety, and the safety of spent fuel management, as well as on the safety of radioactive waste management.

¹IAEA 2020a.

²IAEA 2020b.

In the area of nuclear security, an IAEA report³ to the 64th General Conference described the activities undertaken in this area, the external users of the Incident and Traffic Database (ITDB), and the past and planned activities of the education and training and collaboration networks.

To this end, States must commit to continuously strengthen safety, security and safeguards and to establish a nuclear governance structure that takes into account their interfaces and specificities. In addition, the IAEA must continue to support, at the request of its Member States, national efforts to establish and maintain effective and sustainable nuclear security regimes.

Within this framework, this chapter presents the evolution of the nuclear and radiological infrastructure in Morocco over the last 60 years and the prospects for its future development, as well as the continuous efforts made by public authorities to upgrade the national nuclear and radiological regulatory framework in compliance with international obligations related to safety, security and safeguards. It highlights the Moroccan experience in safety and security governance and management, and shares the lessons learned and experience gained in this area by the Moroccan Agency for Nuclear and Radiological Safety and Security (AMSSNuR).

15.2 Evolution of Nuclear Applications in Morocco

Following the example of several countries, the Kingdom of Morocco adopted, in the middle of the twentieth century, nuclear techniques in the medical and industrial fields, which have experienced greater and sustained growth following its membership of the IAEA in 1957. Within this framework, Morocco has progressively introduced new programmes in various socioeconomic sectors, particularly health, industry, mining, agriculture, higher education and research. The current situation in these sectors is as follows:

- Medicine (radiology, nuclear medicine, radiotherapy, etc.) accounts for more than 80% of the installations and activities using ionizing radiation sources. Thus, the field of health records over 7000 units of radiology equipment, over 300 scanners, 40 electron accelerators used for treatment and 24 nuclear medicine centres. These figures are expected to increase in the future with the construction of new regional centres and the expansion of mandatory health insurance.
- The production of radiopharmaceuticals is carried out in two cyclotrons in Bouznika and Bosker. These facilities are managed by private companies that supply nuclear medicine centres with radioactive products for radiodiagnostic purposes, in particular fluorine-18. The National Centre for Energy, Science and Nuclear Techniques (CNESTEN) produces other radioelements, such as iodine-131, through the TRIGA Mark II research reactor. CNESTEN also manages the regular import and distribution of several radioelements used by nuclear

³IAEA 2020c.

medicine centres, which generates an important activity involving the transport of radioactive material at the national level.

- The industrial sector includes several installations and activities using ionizing radiation sources (IRSs), particularly in such processes as the control of the production of sugar, cement, paper, oil refining, mining and metallurgy. More than ten companies provide technical services in industrial radiography with IRSs, the most important of which is the Public Laboratory of Studies and Tests (LPPE), which provides services for such civil engineering works as building construction as well as road and industrial sites.
- In agriculture, agronomic research studies are carried out by the National Institute of Agronomic Research (INRA), the Hassan II Agronomic and Veterinary Institute (IAV) and the Regional Offices for Agricultural Development (ORMVA). In its regional centre in Tangier, INRA operates a semi-industrial irradiator using a very high activity cobalt-60 source, and has laboratories dedicated to agronomic research and dosimetry. In the veterinary field, in addition to the Hassan II IAV, which provides teaching, training and research activities, a dozen public and private regional centres use radiology equipment for veterinary medicine. The National Office of Food Safety (ONSSA) plans to install an irradiation facility in Agadir using cobalt-60 sources to sterilize pests.
- In the areas of transport and border control, around ten companies are involved in the transport of radioactive material and have special vehicles and authorizations for this purpose. At the borders, ports and airports are equipped with scanners for the control of goods and for security. With regard to port and airport traffic, several security and control bodies, such as the Royal Gendarmerie, police, customs and others deal with safety and security aspects.
- Research and training are conducted mainly by CNESTEN, which has a 2 MW nuclear research reactor since 2009 at the Maamora Nuclear Research Centre (CENM). The CENM includes other facilities and activities using IRSs that are dedicated to the production of radiopharmaceuticals, the management of radioactive waste generated at the national level, industrial and environmental applications, research, calibration of radiation protection equipment, transportation and training. Universities also possess research laboratories that use IRS for research, calibration of measurement equipment, training and teaching in the fields of physics, metrology, medicine, geology, etc.
- In terms of radioactive waste management, CNESTEN was designated in its founding law as the national organization responsible for the centralized management of radioactive waste generated by all medical, industrial and other users. It has at its disposal the facilities and equipment required for the treatment of radioactive waste as well as its conditioning and storage. In cooperation with CNESTEN, AMSSNuR has developed a national policy and strategy for the safety of radioactive waste management and regularly prepares the national report required by the Joint Convention on the Safety of Spent Fuel Management.
- In the area of electronuclear power, in 2009 the Ministry of Energy, Mines and Environment (MEME) set up the Reflection Committee on Electronuclear Power and Seawater Desalination (CRED) and tasked it to study the conditions for

introducing electronuclear power in Morocco in accordance with the guidelines and recommendations of the IAEA. In this context, in 2015 Morocco hosted an IAEA Integrated Nuclear Infrastructure Review (INIR) mission, which resulted in around 15 recommendations and observations, many of which relate to the legislative and regulatory framework, nuclear safety and radiation protection.

- Preparing for and managing nuclear or radiological emergencies according to the IAEA safety standards have led to the implementation of specific regulations and an organization involving all stakeholders, such as the Ministries of Interior and Defence, the General Directorate of Civil Protection (DGPC), the Royal Gendarmerie (GR) and the General Directorate of National Security (DGSN).

15.3 Evolution of the National Regulatory Framework of Nuclear and Radiological Safety and Security

Since it became a member of the IAEA in 1957, the Kingdom of Morocco has been committed to implementing the IAEA safety standards and later security guidance. Thus, the promotion of nuclear and radiological techniques has been pursued in a safe, secure and peaceful manner.

In line with the above, in 1971 Morocco adopted Law No. 005-71⁴ relating to the protection against ionizing radiation, as well as its enforcement decrees, to set the general principles of protection against the risk of IRSs in all installations and activities from design through construction, commissioning, use and decommissioning, including the unique research reactor facility in the country. This facility was authorized under joint decrees by the Ministries of Energy and Health, which were in charge of nuclear safety and radiation protection until October 2016.

By adopting a new law, No. 142-12,⁵ in 2014 on nuclear and radiological safety and security and the creation of AMSSNuR, Morocco took a significant step towards strengthening its regulatory framework in line with the IAEA's safety standards and nuclear security guidance. This law is based on the IAEA's model legislation integrating safety, security and safeguards (the '3S concept').

The establishment of AMSSNuR as the unique regulatory body was intended to regulate nuclear and radiological safety and security and nuclear safeguards, and separate activities dedicated to promotion from those devoted solely to regulatory control. At the international level, the Kingdom of Morocco has signed and ratified all international treaties and conventions on nuclear safety and security, the latest being the Convention on Nuclear Safety in May 2019.

⁴Official Gazette 1971, p. 1204.

⁵Official Gazette 2014, pp. 4090–4113.

15.4 Role and Achievements of AMSSNuR

AMSSNuR is a public establishment of strategic nature whose mission is to ensure that nuclear and radiological safety and security, as well as activities and facilities involving ionizing radiation sources, are in compliance with the provisions of Law No. 142-12 and related regulations, which in turn are compatible with relevant international instruments, safety standards and nuclear security guidance. Its main functions are to regulate, review and assess, authorize, inspect, sanction and inform the public of safety and security issues while protecting sensitive and confidential information, provide support to the State on relevant issues, and promote regional and international cooperation.

Following the creation of AMSSNuR by Law No. 142-12, I was appointed in 2016 as the first Director General by His Majesty King Mohammed VI to build this strategic institution and establish it as an independent, effective, credible and transparent regulatory body at the national, regional and international levels.

15.4.1 AMSSNuR Governance and Management Model

Based on solid professional experience in safety and security at the IAEA over three decades, I presented the vision, strategic plan 2017–2021 and the associated roadmap, as well as the governance and management mechanisms that were adopted at the first meeting of the Board of Directors, held in October 2016 under the chairmanship of the Head of the Moroccan Government.

15.4.2 Long Term Vision

From its inception, AMSSNuR has been driven by the will and ambition to achieve its vision of establishing itself at the national level as an independent, effective, credible and transparent regulatory body and as a leader at the African level and significant contributor in the international arena.

15.4.3 Strategic Objectives 2017–2021

Considering the prevailing national and international environment at the time of its creation, AMSSNuR has set up its strategies and objectives for the 2017–2021 period to:

- (a) Upgrade the national regulatory framework for nuclear and radiological safety and security;

- (b) Strengthen the level of nuclear and radiological safety and security at all facilities and activities involving ionizing radiation sources;
- (c) Establish and implement the national nuclear security system and the national nuclear or radiological emergency response plan;
- (d) Establish a transparent and reliable communication policy on safety and security issues.
- (e) Develop and maintain human and organizational capabilities;
- (f) Contribute to and strengthen regional and international cooperation;
- (g) Monitor experience in the fields of nuclear and radiological safety and security.

In its roadmap, in accordance with Law No. 142-12 and national and international best practices, AMSSNuR has, over the past five years, regularly reported on a yearly basis to the Board of Directors, chaired by the Head of the Moroccan Government, and has carried out self-assessments that have enabled it to continuously improve safety and security nationally and contribute to their strengthening regionally and internationally. AMSSNuR has also planned peer reviews, starting in 2021, including IAEA International Regulatory Review Service (IRRS) and Emergency Preparedness Review (EPREV) missions, which have been postponed until 2022, as well as other IAEA peer reviews such as International Physical Protection Advisory Service (IPPAS) and International SSAC Advisory Service (ISSAS).

15.4.4 Adoption of the Principles of Good Governance Practices

To achieve its strategic objectives and ambitions, AMSSNuR has adopted the principles of the Moroccan Code of Good Governance Practices for Public Enterprises and Establishments (EEP), which have enabled the establishment in 2018 of both the Audit Committee and the Scientific Committee. It also applied the decisions made by its Board of Directors at its yearly meetings, and those of its supervisory authority and the Ministry of Economy and Finance, which aim at accountability, performance and transparency.

15.4.5 Development of the Integrated Management System

Based on IAEA recommendations, AMSSNuR initiated in 2018 the design and implementation of its Integrated Management System (IMS) that covers its regulatory functions as well as the components dealing with the development of its human, financial and quality resources and organizational aspects. The IMS has been designed and implemented as part of AMSSNuR's cooperation with the European Union and has benefited from the feedback of several European regulatory authorities. AMSSNuR's IMS can therefore be considered as being compliant with national regulatory requirements in force in terms of safety, security, safeguards and governance, and with

international standards for quality, environmental protection, health protection and information and security systems. The objectives of the IMS contribute to anchoring the culture and leadership of safety and security at AMSSNuR and consequently to maintaining a high level of safety and security in facilities and activities involving ionizing radiation sources in Morocco.

15.5 Main Achievements by Strategic Area

This section highlights the main achievements of the 2017–2021 strategic plan on its conclusion by strategic axis. It also presents the lessons learned as well as the experience gained and the impact of its activities on improving safety and security with a view to sharing them with all sister authorities.

15.5.1 Upgrading the National Regulatory Framework for Nuclear Safety, Security and Safeguards

In accordance with its main functions on the development of national regulations, AMSSNuR has implemented since 2017 a strategy to upgrade the regulatory framework of nuclear and radiological safety, security and safeguards, work that is among its priority obligations as enacted by Law No. 142-12 as well as by the strategic directions adopted by its Board of Directors.

At the end of the 2017–2021 five year plan, AMSSNuR was able to develop and submit to the Head of Government 56 draft regulatory texts necessary for the implementation of Law No. 142-12 covering all aspects of safety, security and safeguards (see Fig. 15.1). These results are the fruit of the consultation work with all the national stakeholders within a national committee composed of more than 30 members. It was set up to upgrade the regulatory framework for nuclear and radiological safety and security established in 2017 with a clear policy and strategy endorsed and implemented by all members of the committee.

15.5.2 Strengthening Safety and Security at the National Level

As part of the implementation of its regulatory functions relating to the review and assessment of safety and security and to regulatory oversight, AMSSNuR has implemented a plan to strengthen nuclear and radiological safety and security at all facilities and activities involving IRSs. In terms of results, over the 2017–2021 period, these activities have resulted in:

Fig. 15.1 Hierarchy of regulatory texts. *Source* Official Bulletin 2014

- The granting of more than 4650 authorizations;
- The inspection of more than 2540 activities and facilities;
- The organization of six regulatory inspections of the CNESTEN research reactor;
- The establishment of the national register of IRSs.

These results were obtained within the framework of a participative and graduated approach adopted by AMSSNuR with all stakeholders. They contributed significantly, inter alia, to the improvement of safety and security cultures.

15.5.3 Support to Governmental Authorities

With regard to support to governmental authorities, in particular assistance to the State in the development of the national nuclear security system and the national emergency and response plan in the case of a radiological emergency, AMSSNuR has managed to fully implement its strategic plan for 2017–2021. In particular, at the end of the implementation of this plan, AMSSNuR was able to develop, in close cooperation with relevant departments and authorities, the following:

- The national nuclear security system;
- The Integrated Nuclear Security Support Plan;
- The national nuclear detection strategy;
- The plan for securing radioactive sources;
- Effective contribution to the implementation of the Global Initiative to Combat Nuclear Terrorism;
- Implementation of the provisions of the Treaty on the Non-Proliferation of Nuclear Weapons;
- The National Radiological Emergency Response Plan.

In addition, AMSSNuR assists and advises the State in the implementation of its commitments under the conventions and treaties ratified by Morocco (designation of points of contact, drafting and submission to the IAEA of national reports, participation in review conferences and review of conventions).

15.5.4 Public Information and Communication

Given the obligation to inform the public about the status of nuclear and radiological safety and security at the national level and to communicate with all stakeholders, AMSSNuR has established a policy and a strategy based on the mapping of stakeholders and has articulated internal and institutional communication as well as media, non-media and social network communication. The communication strategy also covers the international aspect and the monitoring of nuclear or radiological emergencies.

In terms of achievements, AMSSNuR currently has a directory, tools and experience based on:

- The institutional website and social network accounts;
- Annual activity reports, brochures and leaflets;
- Regional meetings with professionals and other conferences and seminars;
- Press coverage (more than 1000 media appearances), media kits and press conferences;

The objective, through the information and communication policy, is to strengthen the transparency and reliability of information.

15.5.5 Development and Maintenance of Human and Organizational Capacities

AMSSNuR is aware of the importance of developing and maintaining nuclear and radiological safety and security capabilities at the internal and national levels, as recommended by the IAEA and the Global Nuclear Safety and Security Network (GNSSN), particularly the four pillars dedicated, respectively, to human resources, education and training in safety and security, knowledge management, and partnership development. It has adopted specific plans for each pillar.

Regarding human resources development, AMSSNuR has increased its staff from one person in 2016 to 84 employees in 2021, while giving primary importance to gender equality, with 48% of employees being female and 43% of leadership positions being held by women. Priority is also given to skills development and continuous training, with approximately 2300 days, or an average of seven weeks, of training per person completed by AMSSNuR during the reporting period.

Fig. 15.2 Hierarchy of IMS documents. *Source* AMSSNuR

At the national level, AMSSNuR has established a strategy for theoretical and practical training in nuclear and radiological safety and security, which has enabled the identification of more than 13,000 people to be trained or qualified at the national level and over 300 people to be trained or qualified at the African level.

At the managerial level, AMSSNuR has set up a strategy for the design and implementation of its IMS by developing a manual, a process map, and process and procedure sheets covering the macro-processes dedicated to business, governance and support (22 process sheets, 36 procedures and 19 sub-procedures have been developed) (see Fig. 15.2).

As part of its graduated approach, AMSSNuR initiated the execution of three pilot business processes in 2020 (authorization, regulations and nuclear safeguards) and intends to complete testing, implementation and improvement research operation by the end of 2022 before updating its documentation.

In addition to processes and procedures, AMSSNuR's IMS aims to promote and develop a safety and security culture and leadership at the internal level as well as among the sector's operators. To this end, a number of managerial and national policies and strategies have been set up by AMSSNuR. They are related to:

- Radiological monitoring of the environment;
- Safety of the management of radioactive waste and disused sources;
- Nuclear safety;
- Detection of nuclear materials and other radioactive sources outside regulatory control;
- Preparedness and Response to Nuclear and Radiological Emergencies (PCI-SUNR);
- Training in nuclear and radiological safety and security.

It should also be noted that the major challenge of integrating these different policies and strategies into a single management system will ensure an even higher level of nuclear and radiological safety and security.

In parallel with the implementation of its IMS, AMSSNuR has put in place a set of information systems dedicated to:

- Digitization of business activities related to licensing, regulation, inspections, safeguards, sanctions and nuclear and radiological emergencies;
- Human resources management (HRIS);
- Budgetary and financial management.

15.5.6 Development and Strengthening of Regional and International Cooperation

At the end of its 2017–2021 strategic plan, AMSSNuR was able to develop and strengthen its national and international partnership network by signing:

- Ten cooperation agreements with relevant departments and public authorities involved directly or indirectly in nuclear or radiological safety and security;
- Eight cooperation agreements with sister authorities in Canada, China, France, Germany, Hungary, Russian Federation, Spain and the United States of America;
- Four cooperation agreements with sister authorities in Burkina Faso, Côte d'Ivoire, Mauritania and Rwanda;
- A five year cooperation project with the European Union for €2 million;
- Two triangular IAEA–AFRA–African country cooperation contracts with Côte d'Ivoire and Mauritania, respectively.

AMSSNuR also proceeded, in the framework of the implementation of its cooperation strategy, with:

- The organization, over the period 2017–2020, of more than 100 events of national, regional and/or international scope;
- The contribution to the training of more than 2000 people, representing over 10,000 person-days;
- The mobilization of more than a hundred expert-weeks covering all safety and security activities of AMSSNuR;
- The hosting of more than 20 African fellows that contributed to the strengthening of their nuclear and radiological safety and security activities;
- The strengthening of AMSSNuR's capacity in inspection and control operations of facilities and activities involving ionizing radiation sources at the national level.

In addition, AMSSNuR's cooperation programme is marked by strong interactions with the IAEA, which remains its primary international partner, particularly through:

- (a) The recognition of AMSSNuR by the IAEA as:

- Regional Center for Capacity Building in Radiological Emergency Preparedness and Management;
 - First IAEA Collaborating Centre in Africa for capacity building in nuclear security.
- (b) Chairing cooperative networks:
- Forum of Nuclear Regulators in Africa (FNRBA);
 - Global Nuclear Safety and Security Network (GNSSN);
 - International Network for Education and Training in Nuclear and Radiological Emergency Preparedness and Response (iNET-EPR).

15.5.7 International Monitoring

By monitoring international developments and exchanging the experiences of other countries in nuclear and radiological safety and security, AMSSNuR:

- Contributes to the meetings of the contracting parties to relevant international conventions and instruments;
- Elaborates, in consultation with national stakeholders, national reports required by international instruments and presents them to their coordinating bodies (Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Convention on Nuclear Safety, Convention on Early Notification and Assistance in Case of Emergency, etc.).

The objective of this monitoring is to ensure adherence to and compliance with the international regime of nuclear and radiological safety and security and to act within the steering and governance bodies of international conventions and their commissions.

15.6 Conclusion

The implementation of AMSSNuR's 2017–2021 strategic plan and its assessment has allowed AMSSNuR to:

- Strengthen the national nuclear and radiological safety and security regime, reinforce the processes of openness, transparency and continuous improvement to which Morocco has subscribed in this field and, consequently, reinforce its credibility at the international level and its positioning at the regional level;
- Consolidate its competences and develop the national capacities of nuclear and radiological safety and security through, inter alia, its activities of sensitization of national stakeholders and of communication and transparency towards the international community;

- Support the development of safety and security culture and leadership at the national and regional levels while confirming its dynamism and leadership;
- Ensure a dynamic regulatory body, following relevant technological and scientific activities;
- Promote regional and international cooperation and partnership;
- Initiate external evaluation operations by the IAEA, in particular IRRS and EPREV, planned in 2022;
- Contribute to the promotion and continuous improvement of safety and security activities through knowledge networks, education and training and sharing of experience and lessons learned.

All these achievements confirm AMSSNuR's continuous commitment as a dynamic regulator and expert contributor to nuclear and radiological safety and security regulatory activities at the national, regional, and international levels. AMSSNuR is ready and willing to share its experience and strengthen its partnership with its sister organizations and relevant partners. In the future, AMSSNuR intends to further strengthen its cooperation with regional and international partners with a view to continuously improving safety and security regionally and globally.

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