هيئة تنظيم قطاع الطاقة والمعادن

Energy & Minerals Regulatory Commission

The Hashemite Kingdom of Jordan

Energy and Minerals Regulatory Commission

Status Report

Convention on Nuclear Safety

August 2019

In the fulfillment of Article 5 of the

Convention on Nuclear Safety

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1 INTRODUCTION

This national report has been prepared by the Government of the Hashemite Kingdom of Jordan in fulfilment of Article 5 of the Convention on Nuclear Safety for submittal to the 8th Review Meeting of Contracting Parties that will be held in 2020.

According to the fact that there are no operational Nuclear Power Plants in Jordan, this report aims to demonstrate Jordan's national commitment to nuclear safety. Jordan is fully aware of the necessity of introducing and implementing the highest safety standards in all phases of the nuclear power plant project life cycle including selection of the site and technology design, construction, operation and maintenance, and plant decommissioning. This would also include accompanying activities, such as nuclear fuel and radioactive waste management.
Jordan has fully recognized the prime importance of safety in developing the Jordanian nuclear energy programme. All steps undertaken by the institutions involved demonstrate nuclear and radiation safety and security are fundamental aspects of Jordanian policy, and have the highest priority in the Jordanian nuclear programme.

Energy and Minerals Regulatory Commission (EMRC) is a governmental body that possess a legal personality with financial and administrative independence. Since its inception, EMRC has manifested its presence in the international arena. It has successfully participated in a large number of projects through the IAEA and EU programs, and with its worldwide partners. Furthermore, EMRC has joined a large number of prominent international conventions and agreements in the field of radiation and nuclear energy, focusing on regulatory matters. Moreover, EMRC has enhanced its relations of cooperation with various partners through signing and activating agreements and memoranda of understanding on a wide range of issues of mutual interest. Such relations aim at bringing together expertise and culminating in better serving EMRC's mission. Additionally, EMRC officials and staff members have been taking active parts in international meetings, training courses, symposia, and conferences held by prestigious institutions in the field.

Jordan Atomic Energy Commission (JAEC) empowered to lead the development and implementation of nuclear strategy and to manage the nuclear energy programme. JAEC has, been diligently working in the development of the different aspects of the nuclear energy program. The relation with the Jordan Atomic Energy Commission (JAEC), it is an integral relation governed by legislation and relevant regulations and stressed the commission's commitment to implementing all the requirements of the EMRC.

At Jordan's request, International Atomic Energy Agency (IAEA) integrated nuclear infrastructure review (INIR) mission and IRRS mission reviewed the country's preparations for nuclear power. Overall, the review teams concluded that Jordan has been responsive to each recommendation and suggestion made, and continues to place appropriate focus on improvement needed in infrastructure development, regulation, and coordinated government activities. Moreover, implementing a framework that provides for effective protection of public health and safety.

In 2014, Jordan announced the nuclear safety policy, which the Kingdom will adhere to as part of its peaceful nuclear power program the policy encompasses 12 elements that focus on national legislation regulating nuclear safety, and ensure financial and administrative independence of the nuclear sector regulator. The policy also focus on issues related to

transparency, nuclear non-proliferation, security and emergency, in addition to spent fuel management, radioactive waste, civil liability and public awareness of related dangers.

1.1 Background

The Hashemite Kingdom of Jordan signed the Convention on Nuclear Safety (hereinafter: the Convention) in December 1994. The agreement was ratified in June 2009 and entered into force in September 2009. In the ratification of the Convention, Jordan committed to a large extent on applying the obligations and the safety principles and safety standards published by the IAEA. These obligations cover legislative and regulatory frameworks, regulatory bodies and technical safety obligations. The safety obligations cover siting, design, construction, operation, adequate financial and human resources, the assessment and verification of safety, quality assurance and emergency preparedness.

The Vienna Declaration on Nuclear Safety (VDNS) has been unanimously adopted by the Contracting Parties to the Convention on Nuclear Safety (CNS). The Declaration, which is part of an ongoing international effort to strengthen nuclear safety in the wake of the Fukushima-Daiichi accident in Japan, was approved by consensus by the Contracting Parties to the CNS at a Diplomatic Conference held on 9 February 2015 at the Vienna headquarters of the International Atomic Energy Agency (IAEA). VDNS Offers peer review of the incorporation of appropriate technical criteria and standards used by Contracting Parties for addressing the principles of the VDNS in national requirements and regulations. Jordan provides a section in this report considering the experiences of the Contracting Parties in reporting on the principles of the VDNS for consideration and identification of possible action for the 8th Review Meeting.

Jordan became an IAEA member state on April 1966 and since then Jordan attaches the highest importance to international efforts to harmonize and increase all aspects of nuclear and radiological safety. Jordan works in very close cooperation with the IAEA and considers the IAEA's active participation as an assurance that all international IAEA safety standards will be properly reflected in Jordanian nuclear law and applicable regulations. Jordan was elected in September of 2010 to the Agency's Board of Governors for 2010-2012.

Over the years, the IAEA Technical Cooperation Programme with Jordan has been very comprehensive, covering a range of subjects. Technical Cooperation projects have been implemented, covering nuclear and radiation safety and nuclear security, general atomic energy development, application of isotopes and radiation in food and agriculture, and isotope hydrology and applications of isotopes and radiation in industry. In this respect, Jordan has initiated projects and bilateral agreements with other countries and participates, and contributes to the international activities, and benefits from worldwide nuclear experience and will strictly adhere to international nuclear standards.

1.2 Motivations for Nuclear Power Program

As Jordan imports more than 97 % of its energy needs, its energy sector is exposed, and thus its economy, to all the ripples of the global energy markets. Hence, the development of secure alternative energy options is a top priority, the Comprehensive energy sector strategy was revised and updated in 2007 to include the introduction of nuclear energy as an alternative to electricity generation and water desalination.

The main goals for Jordan developing a national strategy for civilian nuclear power include (but are not limited to):

- Diversify the electricity generation sources;
- Minimize energy supply and energy price risk exposures;
- Provide a competitive energy source;
- Reduce the imported fossil fuel bill;
- Exploit the national uranium resources;
- Encourage partnerships between the public and private sectors;
- Ensure the transfer of optimum technology and national worker's contribution in all stages;
- Develop industries related to the energy sector; and
- Reduce the greenhouse gas (GHG) emissions from power generation.

In January 2008, Law No. 42 for 2007 was amended, empowering the JAEC to lead the development and implementation of nuclear strategy and to manage the nuclear energy programme. JAEC has, and since 2008, been diligently working in the development of the different aspects of the nuclear energy program. One of the primary responsibilities is the development and eventual deployment of commercially viable nuclear power plants for energy generation in Jordan. This deployment comes as part of Jordan's efforts for energy diversification, and the implementations of Jordan's concurrent energy strategies where nuclear power generation will be an integral component.

Jordan has limited access to natural resources (especially water and energy), and thus far has been facing significant challenges in planning a stable energy future. These challenges include:

a. Electricity Generation

Jordan has until recently a complete dependency on imported energy to cover its primary energy needs. This exposure to supply risk has materialized in 2011-2013 with the repeated interruptions of the Egyptian gas, which caused havoc in electricity generation, with the government taking on huge debt from additional costs of energy generation. Albeit not in the same way, the negative impacts of repeated interruption of energy (due to over dependence on imports - without any realistic supply buffers) have been suffered from before without real alternatives being implemented.

Jordan's electricity generation fleet is relatively old, several renewable energy production projects are under operation and others are under construction, however, nuclear energy remains as one of the primary options in the planned Energy Mix. During the same timeframe, the anticipated increase in electricity consumption is substantial and will widen the gap between available electric capacity and electric demand. Projected electricity demand translates into a total electricity generation capacity need of more than 15,000 MW by 2040 (up from 2,800 MW in 2013), based on an annual average growth rate of approximately 6%.

b. Water Desalination

Jordan has one of the lowest water availability per capita levels in the world. There is a deficit between the water supply and water demand. This has been an ever-growing problem only exasperated by the geopolitical turmoil in the region (influx of Iraqis in the 2000s followed by an even more acute arrival of Syrian refugees) that wreaked havoc on the national domestic water system. As Jordan's population is expected to double by 2040, water as a resource is

becoming more valuable by the day for Jordan and a long term solution has to be found. Work is being conducted with several parties to address this national security issue.

Desalination of sea and brackish water (already implemented globally to provide clean drinking water in arid regions) has been addressed to solve this problem. This will be needed as part of an overall solution to help fill this gap. This deficit of water primarily affects agricultural production as national security (in addition to all other sectors for economic stability and growth purposes).

This said, it has to be made clear that the energy component of water desalination is the biggest hurdle. Jordan, in providing electricity at stable prices, will not only make desalination possible to fill in the deficit, but stable electricity is the foundation for long term economic growth of the economy.

Currently, JAEC is working with several nuclear technology providers in assessing their technologies, the viability of the technologies in Jordan, and the long-term sustainability and feasibility of deployment. JAEC is moving forward in two parallel tracks:

1. Large Nuclear Reactor

The first track is based on the construction of a Pressurized Water Reactor (PWR) with around 1000 MWe Net Output on a suitable selected site in Jordan – which has already been identified. Negotiations with Chinese companies on the feasibility of construction of 1000 MWe HPR1000 PWR (Hualong One technology) on BOT/BOOT basis with a provision for off-site infrastructure has initiated.

2. Small Modular Reactor (SMR)

The second track involves the assessment of SMR technologies, shortlisting of the most suitable for Jordan according to criteria set forth based on best practice for technology assessment (technical and economic assessment). Following, a detailed feasibility study (FS) will be conducted for the shortlisted technologies to select the most optimal technology.

A Justification for Investment (JI) will be based on the outcome of the FS and commercial offers received to proceed forth. Positive JI will initiate detailed project/contract negotiations with one technology vendors.

Since Jordan, Atomic Energy Commission (JAEC) is considering deploying SMRs, as a parallel option to large NPPs, for electricity generation and desalination. A feasibility study will be developed to deploy SMRs in Jordan, and as a first step, SMRs Reactor Technology Assessment (RTA) is currently being developed to shortlist 2-4 technologies out of preliminary list that includes : NuScale, UK-SMR, ACP100, SMART, RITM, HTR-PM, and XE-100. The following step will be preparing a Request For Proposal (RFP) and Bid Invitation Specification (BIS).

2 NUCLEAR SAFETY POLICY AND STRATEGY IN JORDAN

The Government of Jordan has fully recognized the prime importance of nuclear safety in developing the Jordanian Nuclear Energy Program. All the steps undertaken by its involved institutions demonstrate nuclear and radiation safety are fundamental aspects of the Jordanian Nuclear Safety Policy, and have the highest priority in the Jordanian nuclear program.

Jordan commitment to nuclear safety is quite apparent from the initiatives it has assumed during the past few years, where several achievements toward this trend have been accomplished, which include the following:

- Signature and ratification of the international legal instruments in the safe use of nuclear energy;
- Establishment of a clear organizational infrastructure for implementing its nuclear energy program;
- Clear division of responsibilities established by approved policies and legislations;
- Involvement of IAEA in developing Jordan's nuclear regulatory infrastructure, and receiving several IAEA missions in this regard;
- Signing several nuclear cooperation agreements and participating in several international cooperation activities;
- Jordan works in very close cooperation and in a transparent manner with the IAEA and the international community, and considers the IAEA's active participation as an assurance that all international IAEA safety and security standards will be properly reflected in Jordanian nuclear law and applicable regulations and instructions;
- Rescinding the Small Quantity Protocol (SQP) and implementing the Comprehensive Safeguards Agreement (CSA), in which it become effective in May 31st, 2015. Hence EMRC received several IAEA Safeguards Inspection and Verification mission;
- Jordan also benefits from worldwide nuclear experience through the involvement of the European Commission, US Nuclear Regulatory Commission and international cooperation agreements. Involving these and other international entities demonstrate Jordan's commitment to strictly adhere to international nuclear standards; and
- Jordan's commitment to ensure that selection, construction, and operation of Jordan's first nuclear power plant are conducted in a transparent manner.

2.1 International Legal Instruments

Jordan adheres strictly to international nuclear standards through signature and ratification of the relevant treaties and by involving IAEA in the development of Jordan's nuclear regulatory infrastructure.

From the time Jordan decided to embark nuclear energy, Jordan has decided to become a party to relevant international legal instruments (see Table 1) for nuclear safety, civil liability, emergency preparedness and response, spent fuel and waste management, security and nonproliferation, in which Jordan established and is currently updating the necessary national legal framework to accommodate these obligations.

Table 1: Status of International Legal Instruments

Title	In Force	Status
Agreement on the Privileges and Immunities of the IAEA.	1982-10-27	Acceptance: 1982-10-27
Vienna Convention on Civil Liability for Nuclear Damage.	2014-04-27	Accession: 2014-01-27
Convention on the Physical Protection of Nuclear Material.	2009-10-07	Accession: 2009-09-07
Amendment to the Convention on the Physical Protection of Nuclear Material.	2016-05-08	Acceptance: 2009-10-07
Convention on Early Notification of a Nuclear Accident.	1988-01-11	Signature: 1986-10-02 Ratification: 1987-12-11
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.	1988-01-11	Signature: 1986-10-02 Ratification: 1987-12-11
Convention on Nuclear Safety.	2009-09-10	Signature: 1994-12-06 Ratification: 2009-06-12
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.	2016-07-14	Accession: 2016-04-15
Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage.	2014-04-27	Accession: 2014-01-27
Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA).	1989-02-05	Signature: 1989-02-05
Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA) - First Extension.	2008-07-29	Acceptance: 2007-10-09
Application of safeguards in connection with the Treaty on Non-Proliferation of Nuclear Weapons. (1)	1978-02-21	Signature: 1974-12-05
Protocol Additional to the Agreement between the Hashemite Kingdom of Jordan and the IAEA for the Application of Safeguards.	1998-07-28	Signature: 1998-07-28

(1) Jordan rescinded the Small Quantity Protocol and implemented the Comprehensive Safeguards Agreement in May 2015.

2.2 Jordan Commitment to Nuclear Safety

Since 2001, the Hashemite Kingdom of Jordan has been developing a general and strategic policy on peaceful nuclear energy and radiation protection aimed at generating electricity through nuclear reactors to meet the growing demand for energy.

In 2007, the Government of Jordan took a strategic decision to adopt nuclear power as part of its energy mix to satisfy the growing demand on electrical power.
As a result, the comprehensive strategy for the energy sector has been modified and upgraded to include nuclear power, as an alternative for power production and water desalination.
The Government of Jordan approved two new national policies:

- National Policy on Nuclear Safety.
- National Policy on Spent Fuel and Radioactive Waste Management.

The EMRC developed a National Policy and Strategy for Nuclear Safety, which was reviewed by the stakeholders in Jordan. The Government approved the National Policy on 17 December 2015 following a resolution (No. 13019) of the Council of Ministers. The National Policy sets up the policy framework to implement the IAEA Safety standards and the Convention on Nuclear Safety and covers the following elements:

1. National legislations regulating nuclear safety;
2. Transparency;
3. Regulatory independence;
4. Nuclear safety;
5. Adopting highest international nuclear safety standards;
6. Roles and responsibilities assigned to the regulatory authority;
7. Treaties and Conventions;
8. Civil liability;
9. Non-Proliferation of nuclear weapons
10. Nuclear security and emergency preparedness;
11. Public awareness and stakeholders involvement;
12. Spent fuel and radioactive waste management.

The aim of this policy is to achieve the highest requirements for nuclear safety and to ensure the continuity of the Kingdom's readiness to regulate and control the peaceful nuclear program through the development of national legislation and ensure the financial and administrative independence of the nuclear sector regulator to enjoy objectivity and efficiency and abide by relevant international treaties and conventions and other issues related to transparency and non-proliferation of Nuclear weapons, nuclear security, emergency, spent fuel management, radioactive waste, civil liability and public awareness.

In 2015, National Policy for Radioactive Waste and Spent Nuclear Fuel Management was published. Jordan policy serves as a national commitment to address the management of spent nuclear fuel (SNF) and radioactive waste (RW) in a coordinated and cooperative manner with all competent national organizations and entities. Therefore, Jordan is working on the development of a Radioactive Waste and Spent Nuclear Fuel Management strategy to safely, securely and effectively control the Radioactive Waste and Spent Nuclear Fuel from nuclear or radiological applications and their associated activities. It also present the actions needed towards the implementation of Jordan’s policy. The objective of this strategy is to set out the main elements, technical means, various arrangements, required actions and measures of the national RWM system for the safe and secure management of RW and Spent Nuclear Fuel (SNF) to ensure the full implementation of the Jordan’s National Policy for RW and SNF Management under all conditions that protects human health and the environment in the present time and in the future without imposing undue burden on future generations, as per the IAEA Safety standards.

Jordan has signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management on 15 April 2016. The Convention has been ratified and entered into force on 14 July 2016. Jordan submitted the first National Report of Jordan for the sixth Review Meeting to the Joint Convention for reporting on the safety of spent fuel and radioactive waste management, which took place in 2018 at the IAEA in Vienna. It

satisfies the requirements of the Joint Convention for reporting on the safety of spent fuel and radioactive waste management facilities in Jordan.

At the request of the Government of Jordan, an international team of senior safety experts met with representatives of Jordan from 15 to 22 October 2017 to conduct an Integrated Regulatory Review Service (IRRS) follow-up mission. The purpose of the IRRS follow-up mission was to review Jordan's progress against the recommendations and suggestions identified in the initial IRRS mission (which was carried out from 14 to 25 June 2014). The mission took place at the Energy and Minerals Regulatory Commission (EMRC) Headquarters in Amman. The scope of the IRRS- follow-up mission was the same as the scope of the 2014 mission.

Jordan prepared a national follow-up report addressing the findings of the initial mission. The follow-up report and supporting documentation were provided to the IRRS team as advance reference material (ARM) for the mission.

The IRRS team carried out a review of the progress made on each recommendation and suggestion that is documented in the 2014 IRRS mission report. These recmmendations and suggestions cover the following areas: responsibilities and functions of the government; the global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body, including authorization, review and assessment, inspection, enforcement and the development and content of regulations and guides; emergency preparedness and response; occupational exposure control, patient protection and the regulatory infrastructure being developed to support the introduction of a nuclear power program. To assess progress, the IRRS team conducted a series of interviews and discussions with EMRC staff and reviewed the advance reference material provided by EMRC. All through the mission the IRRS team received excellent support and cooperation from EMRC.

Overall, the IRRS review team concluded that Jordan, through the EMRC, has been responsive to each recommendation and suggestion made in 2014, and continues to place appropriate focus on implementing a framework that provides for effective protection of public health and safety. The IRRS team determines that all of the 30 recommendations and all of the 26 suggestions made by the 2014 IRRS mission had been effectively addressed and therefore could be considered closed. This is a significant achievement in a period of three years. The IRRS team concluded that EMRC management and staff are dedicated to continuous improvement and they clearly recognize the importance of their mission towards the safety and protection of the Jordanian public. Throughout the mission, the IRRS team received full cooperation from all parties involved. In particular, EMRC staff was very open in the discussions and provided the best practicable assistance.

2.3 History of Regulating Radiation and Nuclear Sectors

Prior to 2001, nuclear materials and radiological facilities and activities were regulated by the Nuclear Energy Department at the Ministry of Energy and Minerals Resources. In 2001, the Nuclear Energy and Radiation Protection Law (Law No. 29 for 2001) established the Jordan Nuclear Energy Commission (JNEC) to promote and regulate nuclear and radiological activities in Jordan.

In November 2006, a high-level Ministerial Committee chaired by the Prime Minister was established to develop a roadmap for implementing the nuclear energy program. The Committee established the Nuclear Energy Program Implementing Organization (NEPIO).

In July 2007 two Laws (Nos. 42 and 43) took on the remit previously covered by Law No. 29 for 2001. Law No. 42 for 2007 covered the establishment of the Jordan Atomic Energy Commission (JAEC) and Law No. 43 for 2007 concerned the establishment of the Jordan Nuclear Regulatory Commission (JNRC).
In January 2008, Law No. 42 for 2007 was amended, empowering the JAEC to lead the development and implementation of nuclear strategy and to manage the nuclear energy programme. JNRC was empowered by the Parliament as a financially and administratively independent regulatory body with the authority to regulate nuclear and radiological facilities and activities, covering the nuclear safety, security, safeguards and emergency preparedness and response, and conducting the regulatory functions of safety reviews, inspections and enforcement through a systematic processes. In addition, JNRC was empowered to draft the regulatory legal document, and issuing legally binding instructions and regulatory decisions through its Board of Directors, where the higher levels of legally binding documents are to be issued by the Cabinet and the Parliament upon recommendations from JNRC. Moreover, JNRC was responsible for drafting the national Nuclear Safety and Security and Radiation Protection Policy. Thus, the division of responsibilities between the promotion and regulation of applications for nuclear plants was clearly defined.

In April 2014, the restructuring Law number (17) was issued by the Parliament. This law merged several regulatory bodies into the "Energy and Minerals Regulatory Commission EMRC" as financially and administratively independent regulatory body in Jordan. EMRC is the national nuclear regulator for Jordan, and is responsible for all aspects of regulating radiation safety, nuclear safety and security.

Since 2014, EMRC has taken positive steps to:

- Facilitate the approval by the Government of Jordan of a national policy and strategy for safety as well as a national policy for radioactive waste and spent nuclear fuel management.
- Develop a comprehensive legislative framework that includes a law on radiation and nuclear safety and security, which is awaiting final approval in Parliament, and a number of radiation and nuclear safety regulations and instructions.
- Establish arrangements to improve staffing level and competencies.
- Introduce the graded approach into its regulatory oversight of facilities and activities.
- Strengthen its core regulatory functions by developing various processes and procedures.
- Develop mechanisms for communication with the public, Stakeholders and interested parties.
- Improve emergency preparedness and response by formulating the regulatory requirements in this area and making practical arrangements.
- Strengthen the medical exposure control and the occupational exposure control.

EMRC, as a successor to JNRC, has continued the development of the regulatory framework. EMRC has issued more than 100 instructions for the radiation and nuclear sector, with several other instructions (final drafts) are currently under the issuance process. The issuance of legal documents by EMRC follows the systematic approach outlined in the Management System of EMRC in accordance to its Quality Management Manual. Figure 1 illustrates EMRC internal approach in developing and issuance of its Legal Documents.

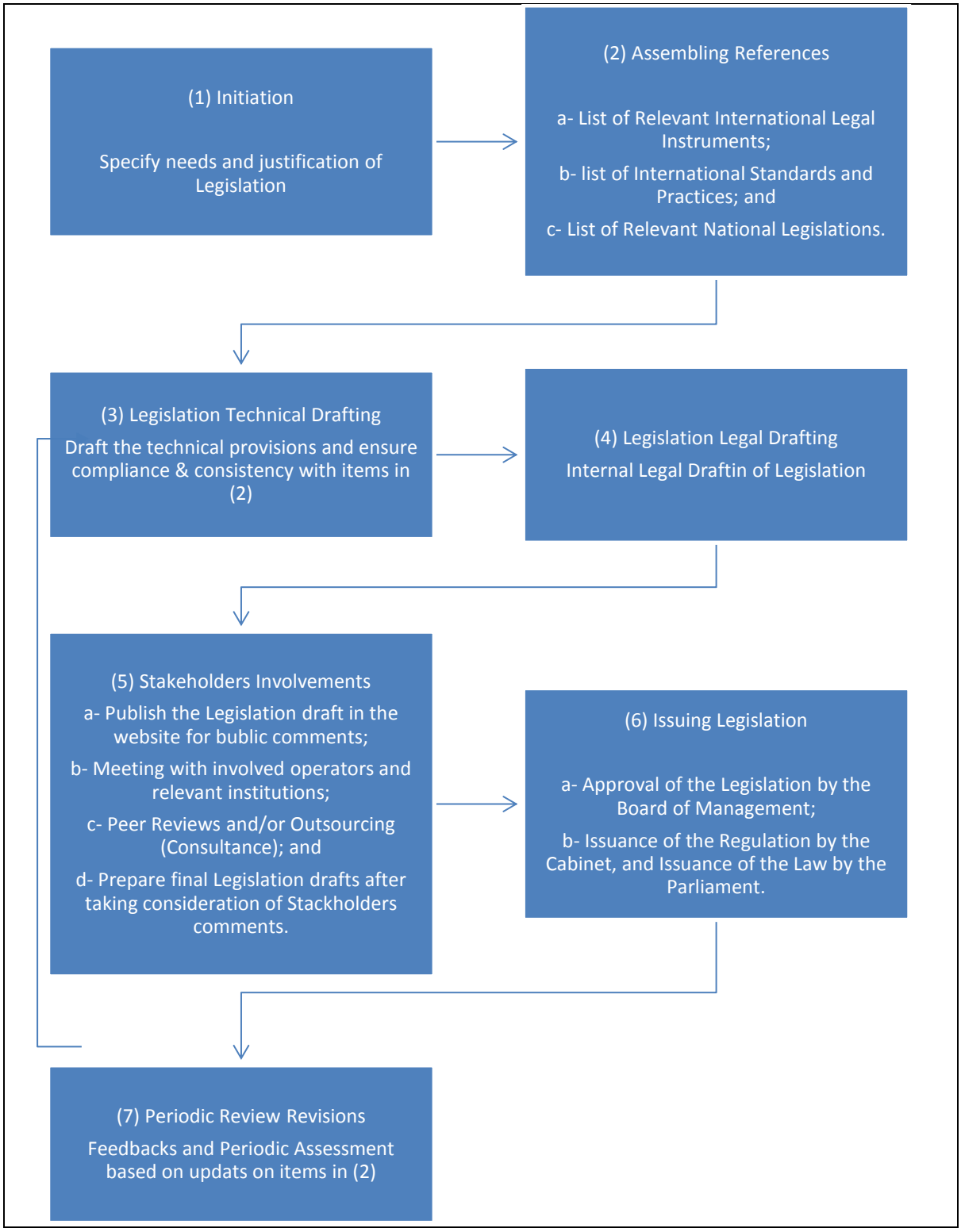

Figure 1: EMRC internal approach of the Legal Document development process

2.4 Jordan Atomic Energy Commission Commitment to Nuclear Safety

The Jordan Atomic Energy Commission (JAEC) is an independent body mandated to articulate a vision, strategy and roadmap to develop the use of nuclear technology for research, applications and generating electricity. JAEC acts as a member in NEPIO in Jordan, chaired by the Minister of Energy and Minerals Resources, and has members form several ministries, and membership of EMRC CEO. JAEC represents Jordan locally and internationally in all areas related to nuclear energy, manages, and executes various projects of Jordan's Nuclear Program.

JAEC policy is to leverage Jordan's industrial capacity, in particular construction companies, architecture and engineering firms, and the cement and steel industries, to support the construction of the nuclear power program.

JAEC has signed Nuclear Cooperation Agreements with several nuclear countries such as France, China, South Korea, Canada, Russia, United Kingdom, USA, Argentina, Spain, Japan, Ukraine and Romania For cooperation in the peaceful uses of nuclear energy. In addition, to develop the necessary qualified human resources, JAEC is constantly in pursuit of qualified and experienced staff in addition to training of new graduates to ensure that highly educated and motivated staff is available for NPP project. Moreover, JAEC is offering scholarships for continuing education in the nuclear fields.

Accordingly, the Jordan Atomic Energy Commission's strategy for developing the human resources in the nuclear energy field depends in the following options:

- Utilization of JSA and JRTR;
- Vendor supplied training;
- Support through Nuclear Cooperation Agreements;
- IAEA Technical Cooperation;
- Development of a Jordan-Specific Qualification and Certification Programs.

The Hashemite Kingdom of Jordan requested the IAEA to carry out an Integrated Nuclear Infrastructure Review (INIR) mission-Phase II in a letter dated 13 February 2013. A preparatory mission was conducted in March 2014 to provide clarification on the evaluation methodology and support the development of a Self-Evaluation Report (SER). The SER from the Government of Jordan was received by the IAEA on 13 May 2014. A previous INIR mission had been conducted in August 2009, which focused primarily on Phase 1 activities around the decision-making process. A follow-up to the August 2009 INIR mission had been conducted in 2012 and in 2017, which reviewed progress toward fulfilling the recommendations made in 2009.

Jordan has made notable progress in the development of its national infrastructure for nuclear power since the first INIR mission in 2009. The INIR team found that JAEC is leading the development of nuclear power and is aware of the main actions necessary to implement the programme. Though steps have been taken towards the procurement of the NPP, further work is needed to develop the nuclear infrastructure required to be ready for the next significant steps in the project—the investment decision and signing of the EPC contract. In order to

assist Jordan in making further progress in its infrastructure development, the INIR team made 44 recommendations.

JAEC is now implementing the Action Plan to ensure the implementation of the IAEA recommendations and suggestions. The INIR mission defined several gaps (based on the IAEA SSG-16) in the safety infrastructure for Nuclear Power Program, and the developed action plan was reflected in the JAEC-IAEA Integrated Work Plan (IWP).

3 STATUS OF CONVENTION ON NUCLEAR SAFETY

The goal of the Convention on Nuclear Safety (CNS) was not to impose additional legal requirements nor to increase the commitments of an operating facility, but rather to provide an incentive-based instrument for nuclear plant operators, which share a common interest in sharing methods and procedures that improve nuclear operation safety.

The Convention allows a participating contracting party to submit reports that are peer reviewed at scheduled review meetings. This essentially provides a forum for exchange of ideas and methods practiced at the contracting party's facility, which contributes to the knowledge pool to enhance safe and efficient operations. The process of presenting reports at the forum and responding to questions from other parties helps each contracting party to achieve a high level of safety in its civil nuclear program.

In an effort to promote continuous improvement in the safe operation of a nuclear facility and to legally commit states to maintain a high level of safety, The Hashemite Kingdom of Jordan signed the Convention on Nuclear Safety in December 1994. The agreement was ratified in June 2009 and entered into force three months later in September 2009

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The obligations of the contracting parties, as well as Jordan, are based to a large extent on applying the safety principles for nuclear installations contained in the IAEA Safety standards. These obligations cover legislative and regulatory frameworks, regulatory bodies and technical safety obligations. The safety obligations cover siting, design, construction, operation, the availability of adequate financial and human resources, the assessment and verification of safety, quality assurance and emergency preparedness.

The process of presenting reports at the review meetings and answering questions from the other parties helps each contracting party to achieve a high level of safety in its civil nuclear programme.

In the next subsections, Jordan relevant institutions prepared interpretations on how fulfilling the Convention on Nuclear Safety.

3.1 Article 4: Implementing Measures

CNS Text:	Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

Discussion:

This report explains and discusses the actions, including legislative, regulatory, administrative and other actions, taken by the Jordanian relevant entities for implementing Jordan's

obligations under the CNS. In addition, this report reflects the approach of taking relevant actions toward continued commitment for fulfilling Jordan's obligations to the CNS.

The Government has ensured that EMRC is effectively independent in its decision making and reports directly to the Prime Minister. EMRC has made significant progress in enhancing the regulatory framework and carrying out its activities in a systematic manner. In implementing its regulatory functions, EMRC has established clear mission and vision for the organization that is focussed on safety. EMRC has shown commitment to continuously improve its regulatory practices, including the development of an integrated management system. EMRC is fully engaged in the global nuclear safety regime, being part of the international conventions.

EMRC is further expanding its scope and programme to address the regulation of the nuclear power programme while maintaining its focus on the safety of current facilities and activities.

The Government has, in the National Policy and Strategy for Safety and Article (7)A2 of the EMRC Law, expressed that safety is paramount and the making of regulatory judgements and decisions should be on sound technical basis.

3.2 Article 5: Reporting

CNS Text:	Each Contracting Party shall submit for review, prior to each meeting referred to in Article 5, a report on the measures it has taken to implement each of the obligations of this Convention.

Discussion:

This report is intended to fulfill the requirements of and to be in accordance to this Article. This national report has been prepared by the Government of the Hashemite Kingdom of Jordan in fulfilment of Article 5 of the Convention on Nuclear Safety for submittal to the 8th Review Meeting of Contracting Parties that will be held in 2020.
According to the fact that there are no operational Nuclear Power Plants in Jordan, this report aims to demonstrate Jordan's national commitment to nuclear safety. Jordan is fully aware of the necessity of introducing and implementing the highest safety standards in all phases of the nuclear power plant project life cycle including selection of the site and technology design, construction, operation and maintenance, and plant decommissioning. This would also include accompanying activities, such as nuclear fuel and radioactive waste management.
Jordan has fully recognized the prime importance of safety in developing the Jordanian nuclear energy programme. All steps undertaken by the institutions involved demonstrate nuclear and radiation safety and security are fundamental aspects of Jordanian policy, and have the highest priority in the Jordanian nuclear programme.

3.3 Article 6: Existing Nuclear Installations

CNS Text:	Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shutdown may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

Discussion:

There is no operating Nuclear Power Reactor for time this report prepared. Nuclear Power Plant is at the stage of site survey and site selection (See sections 1.2,3.13).

Jordan currently has two facilities in operation, Jordan Research and Training Reactor (JRTR) and Jordan Subcritical Assembly (JSA). JRTR, an open-tank-in-pool-type 5 MW research reactor, is designed to serve as an integral part of the nuclear technology infrastructure in Jordan, which encompasses a training center to support the education and training of future engineers and scientists. The JSA is built to fulfill the training needs of the academic university students and it is well equipped to perform all of the fundamental experiments required for a typical nuclear engineering university program.

3.4 Article 7: Legislative and Regulatory Framework

CNS Text:

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.
2. The legislative and regulatory framework shall provide for:
   i. the establishment of applicable national safety requirements and regulations;
   ii. a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license;
   iii. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;
   iv. the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.

Discussion:

The legislative and regulatory framework in Jordan is comprehensive, effective, and covers all obligations mentioned in CNS Article 7 (Legislative and Regulatory Framework). The legislative and regulatory framework in Jordan consists of Law (No. 43) for the Year 2007, Radiation Protection and Nuclear Safety and Security Law, and a number of legally binding Regulations were issued pursuant to the Article (26) of the aforementioned Law. Moreover, a large number of legally binding Instructions were issued pursuant to these Regulations,

given that EMRC periodically reviews and amends these legal documents upon updates in the international legal instruments, standards and good practices.

The legislative and regulatory framework provide for:

i. the establishment of applicable national safety requirements and regulations;
ii. a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license;
iii. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;
iv. the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.

Most of EMRC regulations and instructions were reviewed through workshops, and expert missions by the IAEA, EC, national and international consultants, parties and experts, and all Regulations and Instructions are deemed to be in compliance with IAEA requirements.

In addition, according to Jordan's Legislative hierarchy, international treaties, conventions and agreements are legally located above the national laws, and come into force after the ratification. Jordan is a party to a number of relevant Nuclear Safety and Security international legal instruments, as shown in Table 1.

The history and status of regulatory framework in Jordan is described in the following subsections.

3.4.1 The Law

According to Jordan's Legislative framework, the law is issued after the approval of Cabinet and the Parliament upon the competent authority's recommendation, and implemented after being published in the official gazette. The status and history of laws in Jordan which establish the regulatory framework for safety can be summarized as:

a. Law (No. 14) for the year 1987, Nuclear Energy Law (Implemented from 1987 to 2001);
b. Law (No. 29) for the year 2001, Nuclear Energy and Radiation Protection Law (Implemented from 2001 to 2007);
c. Law (No. 43) for the year 2007, Radiation Protection and Nuclear Safety and Security Law (Implemented since 2007 until now);
d. Law no. (8) for the year 2017, law of the Energy and Minerals Regulatory Commission;

3.4.2 Regulations

The regulations are issued by the Cabinet upon the competent authority's recommendation, and these regulations explain in detail the provisions of the governing law. The regulations under the previous laws (Law (No. 14) for the year 1987 and Law (No. 29) for the year 2001) were replaced by the new regulations under Law (No. 43) for the year 2007. These regulations are:

e. Regulation on the safe use of nuclear energy (Approved by the Cabinet, published in the official gazette in April 2014);
f. Regulation on the Basis and conditions for granting licenses and permits for the radiation work (issued and implemented since February 2013);

g. Regulation on the Fees for licenses and permits for the radiation work (issued and implemented since February 2013);

h. Regulation on Radiation Protection (issued and implemented since March 2015); and

i. Regulation on the Safe Transport of Radioactive Materials (issued and implemented since April 2016).

3.4.3 Instructions

According to Jordan Legislative framework, the instructions are legally binding and implemented after approval from the competent authority's Board of Commissioners. The status of the EMRC instructions relevant to Nuclear Safety, Security and Safeguards are:

- **Instructions issued under the Regulation on the Safe Use of Nuclear Energy issued by EMRC in 2015 and its main reference(s) are cited as follows:**

  1. Instructions on the procedures for issuing site permit for nuclear power plants. Ref.: IAEA SSG-12, IAEA SSG-9, IAEA NS-R-3 and international practices;
  2. Instructions on the procedures for issuing construction permit for nuclear power plants. Ref.: IAEA SSG-12, IAEA SSR-2/1;
  3. Instructions on the Safety of Nuclear Power Plants. Ref. IAEA SSR2/1, SSR2/2, SSR1
  4. Instructions on the approval of specialized training, qualification programs and nuclear power plant personnel licenses issuance
  4. Instructions on the Safety of Radioactive Waste Management. Ref.: IAEA GSR Part 5, Joint Convention on Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (JCSSFM&SRWM);
  5. Instructions on the Safety of Spent Fuel Management. Ref.: JCSSFM&SRWM;
  6. Instructions on the Decommissioning of Nuclear Facilities. Ref.: IAEA GSR Part 6;
  7. Instructions on the nuclear safety, security and radiation protection requirements in the organizational structure in research reactors. Ref.: International Practice;
  8. Instructions on the on-site emergency preparedness in nuclear and radiological facilities. Ref.: IAEA GSR- part 7 & International Practice;
  9. Instructions on off-site emergency preparedness for nuclear and radiological facilities. Ref.: IAEA GSR-part 7 & International Practice;
  10. Instructions on Safeguards and the State System for and inventory of nuclear material, Ref.: Safeguards Agreement & Additional Protocol to the Agreement;
  11. Instructions on the Safety of Research Reactors. Ref.: IAEA NS-R-4;
  12. Instructions on the conditions and procedures for notification of EMRC about events in research reactors;
  13. Instructions on licensing specialized training and personal licenses in research reactors. Ref.: International Practice;
  14. Instructions on the Trustworthiness of the research reactors workers. Ref.: International Practice;
  15. Instructions on the Radiological Environmental Impact Assessment. Ref.: USNRC 1555 & International Practice;
  16. Instructions on issuing licenses and permits for Subcritical Assemblies. Ref.: International Practice; and

17. Instruction on Fund for Decommissioning. Ref.: International Practice.

- **Issued Under Law no. (43) For the year 2007, Radiation Protection, and Nuclear Safety and Security Law.**
    1. Instruction on Enforcement policy
    2. Instructions on Irradiation of food and medical supplies
    3. Instructions on the radiation dose constraints
    4. Instructions on licensing requirements for facilities of transport of radioactive materials.
    5. Instructions on Justification of Radiation Practices, Medical Exposure Conditions and Requirements of Radiation Protection for Non-Medical Imaging of the Individual.
    6. Instructions on Radiation Protection for Classification of Areas within the Facility.
    7. Instructions on Limits of Radiation Doses.
    8. Instructions on Radiation Protection Equipment that shall be provided in the Facility.
    9. Instructions on the Bases and Procedures for the Tests, Periodic Calibration, Dosimetry, Quality Control Tests for Radiation Sources and Medical Radiation Practices and Bases of Radiation Safety Assessment of The Radiation Sources.
    10. Instructions on Radiation Protection Requirements against Occupational Exposure.
    11. Instructions on Radiation Protection Requirements for Pregnant or Breast-Feeding Female.
    12. Instructions on controls of the radiation protection program, safety of radiation sources, the management system, quality of radiation sources and radiological practices, accidents and verification of compliance.
    13. Instructions on Programme for Workers' Health Surveillance.
    14. Instructions on Requirements and Measures for Protecting the Public against Radiation Exposure.
    15. Instructions on Radiation Protection Requirements for the General Use of Consumer Products that Contain Radioactive Material or Emit Ionized Radiation.
    16. Instructions on Establishment of Reports and Records of Ionizing Radiation Sources.
    17. Instructions on the personal and work place monitoring systems.
    18. Instructions for the Accreditation of Specialized Institutions to hold Radiation Protection Courses.
    19. Instructions on Exempted Practices from Radiation Protection Requirements and the Criteria for Clearance of radioactive materials.
    20. Instructions on the licensing requirements for the personal monitoring service provider.
- **Issued Under the Regulation no. (8) for the year 2013, basis and conditions for granting licenses and permits for radiation work:**
    1. Instructions on Licensing Requirements for Cyclotron Facilities.
    2. Instructions on Licensing Requirements for Diagnostic Radiology.
    3. Instructions on Licensing Requirements for Dental Centers and clinics.
    4. Instructions on Licensing Requirements for Industrial Radiography.
    5. Instructions on Licensing Requirements for Irradiators.
    6. Instructions on Licensing Requirements for Luggage Inspection.
    7. Instructions on Licensing Requirements for Nuclear Gauges.

8. Instructions on Licensing Requirements for Nuclear Medicine.
9. Instructions on Licensing Requirements for Radiotherapy.
10. Instructions on Licensing Requirements for Well-logging.
11. Instructions on Licensing Requirements for Bone Densitometers.
12. Instructions on Licensing Requirements for Veterinary facilities.
13. Instructions on Requirements for granting licenses for Radiation Protection Officers
14. Instructions on licensing of radiation workers in the Diagnostic radiology field.
15. Instructions on licensing of radiation workers in the Radiotherapy field.
16. Instructions on licensing of radiation workers in the Nuclear Medicine field.
17. Instructions on licensing of radiation workers in the industrial radiography field.
18. Instructions on licensing of radiation workers in the Nuclear Gauges and well-logging field.
19. Instructions on licensing of radiation workers in the Irradiators field.
20. Instructions on licensing of radiation workers deals with transported radioactive material.
21. Instructions on the categorization of radiation facilities
22. Instructions on the requirements for licensing the practice of inspecting cargo, luggage and vehicles using X-ray that operate on a voltage difference of 300 kV or above.
23. Instructions on the requirements for licensing the practice of inspecting cargo, luggage and vehicles using radioactive sources.

- **Issued Under Regulation no. (108) for the year 2015, Radiation Protection:**
    1. Instructions of the personal training related to protection of the patient.
    2. Instructions on the release of patients after radionuclide therapy

- **Issued Under Regulation no. (32) for the year 2016, Transport of Radioactive Materials:**
    1. Instructions on the Radioactive Materials that are not subject to the Transport of Radioactive Materials Regulation, and Transport of the low Specific Activity Materials.
    2. Instructions on the Documents and Information that should be attached and submitted with the Application of the Authorization or the Permit of Transport of Radioactive Materials and the Documents that should be attached with the Shipping Document.
    3. technical specification and conditions for each type or category of packages, including tanks and freight containers
    4. Instructions on the basis for Classification of Radioactive Materials and Identification of the type and category of the Packaging.
    5. Instructions on the Activity limits for Transport of the Radioactive Materials in a single package or a single Consignment related to the quantity, mass, radiation doses or radiation levels of contamination.
    6. Instructions on the Requirements for Marking, Labelling and Placarding.
    7. Instructions on the Requirements, Technical Specifications, Maintenance, Testing of the conveyance, and the Equipment and Devices that should be available in the conveyance.
    8. Instructions on the Controls of the Safe Transport for the Packages on the Conveyance, and the Requirements and Controls for the Storage of the radioactive materials.
    9. Instructions on the Security in the Transport of Radioactive Materials.

10. Instructions on the Requirements and Controls for Packages Containing Fissile Materials and its scope.
11. Instructions on the Requirements and Controls for Transport of Empty Packages, and the limits of the contamination for the empty packages and conveyances.
12. Instructions on the Requirements for the Authorization of the Workers of Transport of Radioactive Materials.
13. Instructions on the Records and Reports that should be established in the Facilities of Transport of Radioactive Materials.

3.5 Article 8: Regulatory Body

CNS Text:	1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities. 2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy

Discussion:

In July 2007, two Laws (No. 42 and No. 43) replaced Law No. 29 for 2001. Law No. 43 for 2007 established the Jordan Nuclear Regulatory Commission (JNRC); and Law No. 42 for 2007 established the Jordan Atomic Energy Commission (JAEC). JNRC was empowered by the Parliament as a financially and administratively independent regulatory body with the authority to regulate nuclear and radiological facilities and activities, covering the nuclear safety, security, safeguards and emergency preparedness and response, and conducting the regulatory functions of safety reviews, inspections and enforcement through a systematic processes Thus, the division of responsibilities was clearly defined between the promotion and regulation of nuclear and radiological facilities and activities by these two laws (see Section 2.3).

In Section 3.5, a discussion on CNS Article 7 about EMRC and its legal framework, and the independence of EMRC to adopt technical requirements through EMRC instructions is presented.

According to articles number (3), (4) and (5) of Law (No. 43) for the year 2007, the Radiation Protection and Nuclear Safety and Security Law, JNRC (now EMRC) shall be established in Jordan, being a legal entity, financially, and administratively independent. EMRC carries out all legal actions to achieve its objectives that include possession of movable and immovable properties; enter into contracts; apply for loans; and accepts aid, donations, contributions, and grants. Moreover, EMRC shall have the right to litigation in the legislature judicial proceedings and has the right to appoint the civil attorney general as its representative in the courts or any other lawyer for such purposes. In addition, EMRC shall be linked and reports to the Prime Minister.

3.5.1 EMRC Objectives

EMRC, in coordination and cooperation with relevant authorities aims to achieve the following:

a. Regulate and control the use of nuclear energy and ionizing radiation;
b. Protect the environment, human health and property from the harmful effect of radiation and exposure to ionizing radiation in accordance with the provisions of the law number (43) for the year 2007;
c. Ensure the fulfilment of requirements of public safety, radiation protection, and nuclear safety and security; and
d. Establish the State System for Account and Control of Nuclear Material and fulfill the obligations of Safeguards Agreement and the Additional Protocol, and
e. Other obligations under relevant international legal instruments.

The organizational structure of EMRC is shown in Figure 2, where only the sections related to the Nuclear Safety, Security and Emergency are illustrated.

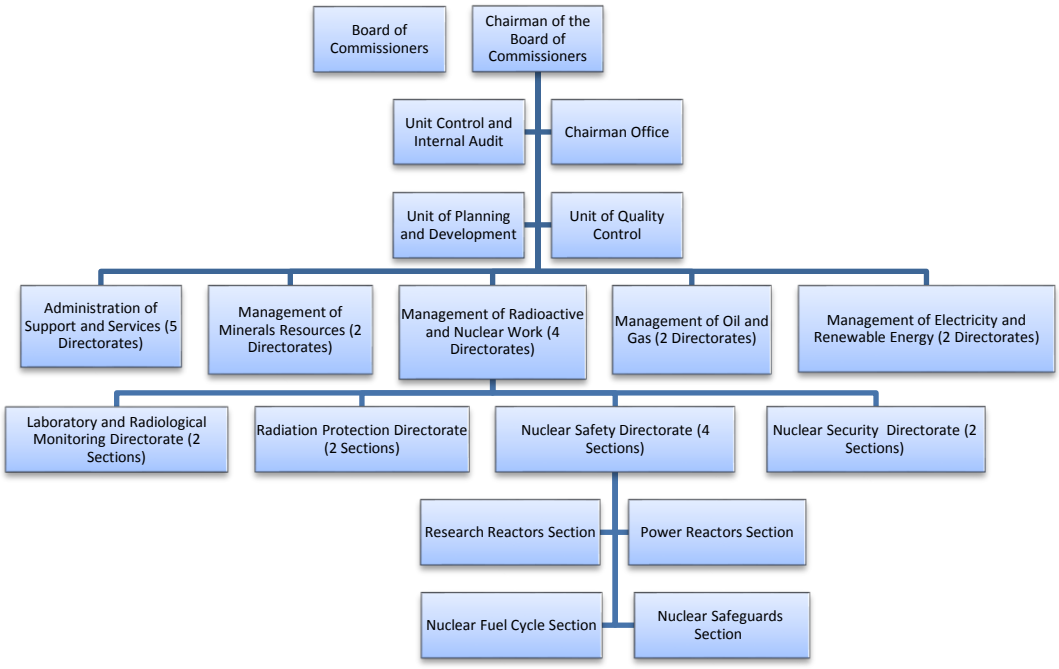


Figure 2: EMRC Organizational Structure

3.5.2 EMRC Duties and Powers

Moreover, EMRC shall undertake the following duties and powers:

a. Granting licenses and permits for radiation and nuclear facilities, and workers in the radiation and nuclear fields.
b. Verify the commitment of the licensees to implement the terms of the law number (43) for the year 2007, and regulations and instructions issued accordingly.

c. Control on the implementation of the terms of the law number (43) for the year 2007 and conduct inspection for any installation or body for this purpose.
d. Contact institutions and commissions concerned with regulating and control of nuclear energy, radiation protection, and nuclear safety and security in the Arab and foreign countries to benefit from the expertise, scientific research, and assistance in their field of work.
e. Participate in Arab, regional and international projects concerned with nuclear energy, radiation protection, and nuclear safety and security, related to expertise or research with the consent of the cabinet.
f. Regulate relations between Jordanian entities concerned with radiation protection, and nuclear safety and security; and relevant international, regional and Arab organizations and agencies.
g. Implement comprehensive safeguards agreement and additional protocol, and establish a system to account for and control of all nuclear materials subject to these safeguards.

3.5.3 Capacity Building

A national committee has been established according to a prime ministry decision to develop human resources capabilities and plan for the Jordanian nuclear programme. The recommendations made by this committee will be considered in the future employment and to train the current staff in the issues needed.

There are two education programs related to nuclear energy field in Jordan:

- B. Sc. Nuclear Engineering at Jordan University of Science & Technology (JUST):

  A Bachelor of Science program has been established and started in 2007 at one of the Jordanian universities (JUST) in the north of Jordan. Nowadays, the following facilities are available in the nuclear engineering department to support the educational program:

  - High Performance Computing lab.
  - Radiation Detection and Measurement Labs.
  - Internet Reactor Lab. (IRL)
- M. Sc. Nuclear Physics at University of Jordan, Yarmouk University and AL Balqa Applied University.

The JRTR and sub-critical assembly at the Jordan University of Science and Technology facilities will be an integral part of a future nuclear research and development center in Jordan.

Jordan policy is to leverage Jordan's industrial capacity, in particular construction companies, architecture and engineering firms, and the cement and steel industries, to support the construction of the nuclear power program.

Jordan has signed Nuclear Cooperation Agreements with several nuclear countries such as France, China, South Korea, Canada, Russia, United Kingdom, USA, Argentina, Spain,

Japan, Ukraine and Romania For cooperation in the peaceful uses of nuclear energy. In addition, to develop the necessary qualified human resources, Jordan is constantly in pursuit of qualified and experienced staff in addition to training of new graduates to ensure that highly educated and motivated staff is available for NPP project. Moreover, Jordan is offering scholarships for continuing education in the nuclear fields.

Accordingly, Jordan strategy for developing the human resources in the nuclear energy field depends in the following options:

- Utilization of JSA and JRTR;
- Vendor supplied training;
- Support through Nuclear Cooperation Agreements;
- IAEA Technical Cooperation;
- Development of a Jordan-Specific Qualification and Certification Programs.

For the authorization process of the planned Nuclear Power Plants, depending on the progress in the nuclear program, including the safety assessment of siting, design, commissioning, operation, decommissioning, and management of Consultant Services and Technical Support Organizations, EMRC is planning to recruit as shown in Figure 3, in the following fields:

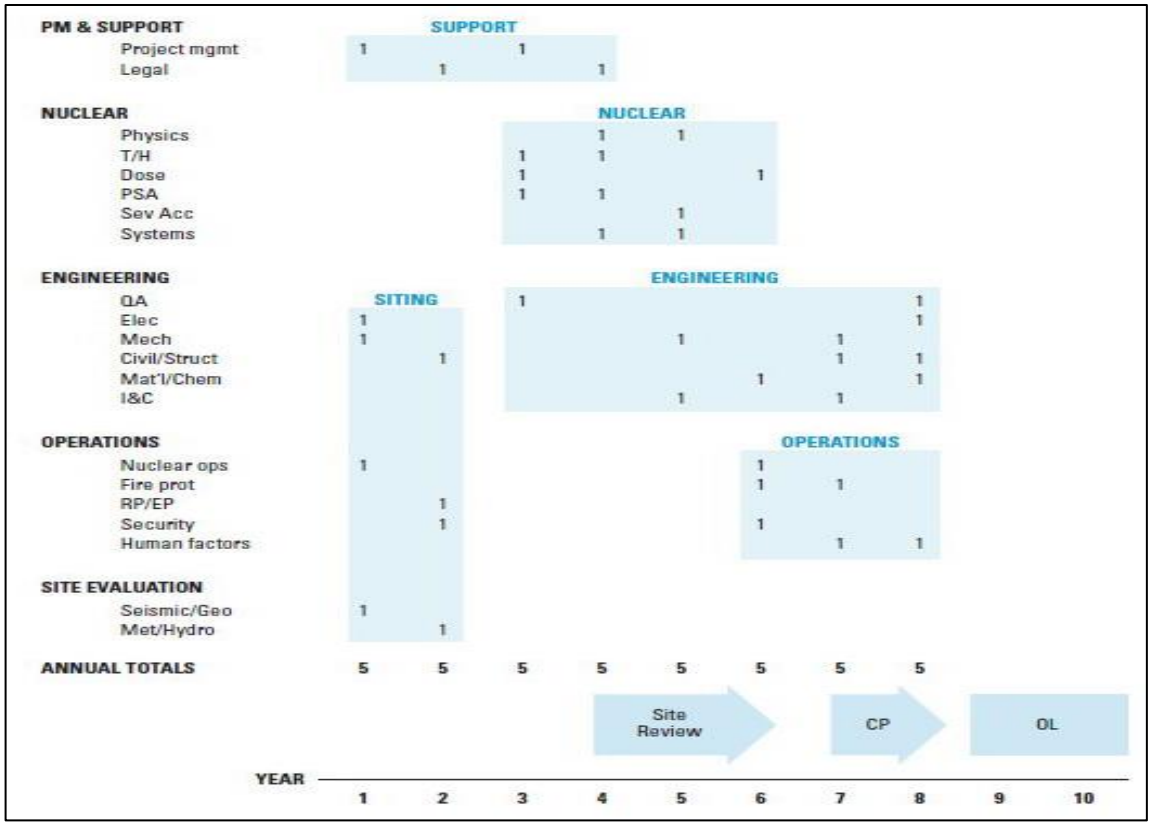


Figure 3: Adopted EMRC Nuclear Safety Staffing Plan

3.5.4 EMRC Quality Policy and Safety Culture

The EMRC has established an internal unit called the Quality management Unit. This unit has been given the responsibility to develop the management system. The Unit will be the responsible for developing, maintaining, assessing, and improving the Integrated Management System (IMS). The unit reports directly to the Chairman and senior management of EMRC on any issue related to the management system. The Unit is now undertaking a gap analysis in every directorate of the EMRC in order to determine the scope of work to develop the Management System.

EMRC is committed to continually strive to meet and exceed the public expectations for quality. EMRC establishes quality objectives to accomplish its goal in a professional and ethical manner. The Quality Policy of EMRC is based upon the following:

a. Comply with statutory and regulatory requirements applying to multi-discipline and main core regulatory functions.

b. Develop and implement a systematic approach to achieve quality and reliability by driving continual improvement in all processes and procedures.

c. Cultivate and foster quality culture within EMRC.

d. Utilize EMRC resources and technical capabilities in processes to the extent possible in order to protect the health and safety of public and the environment.

e. Utilize communication methods and strategies to ensure that EMRC requirements are fully understood.

f. Develop comprehensive competency, trainings and qualifications program.

g. Develop and maintain relationships with public, stakeholders, and interested parties.

h. Identify, define and pursue continual improvement opportunities.

i. Continue to maintain a positive working environment that recognizes the importance of contribution at all levels of the commission.

j. Understand and maintain integrated management system, and effective communications between all departments in the commission.

The Quality Policy is communicated and understood within the commission and reviewed periodically for continual improvement. EMRC Management understands that Safety culture is an assembly of characteristics and attitudes in the organization and in individuals, which establishes that, as an overriding priority, nuclear safety issues receive the attention warranted by their significant.

EMRC commits to continuous improvement of its quality management system and to develop and improve its Safety Culture Program through employee awareness and preventive actions EMRC management will internally support improving the safety culture components, namely the EMRC internal framework for safety, the management hierarchy and responsibilities and the attitude of the EMRC staff at all levels in responding and benefiting from the framework for safety.

Thinking about safety culture is obvious at the management level through providing the means to enhance this critical concept. The EMRC management system, as established by the national framework for safety, shall be used to promote and support a strong safety culture by:

- Ensuring a common understanding of the key aspects of safety culture within the commission;
- Providing the means by which the commission supports individuals and teams in carrying out their tasks safely and successfully, taking into account the interaction between individuals, technology and the commission;
- Reinforcing a learning and questioning attitude at all levels of the commission;
- Providing the means by which the commission continually seeks to develop and improve its safety culture.

EMRC ensures that the licensee management system properly discharges prime responsibility for safety, where EMRC in achieving this goal should:

- ✓ Promotes an effective safety management system in the operating organization by ensuring that there is critical self-assessment, correction and avoids acting in a manner that diminishes the responsibility for safety of the Operating organization;
- ✓ Oversight the effective self-regulating safety management system of the operating organization; and
- ✓ Monitors the performance of the organization and takes either action if the safety management system becomes ineffective or the safety performance indicators of the organization declines.

EMRC ensures the existing of Safety Culture Programs in the operating organizations through the licensing process. Furthermore, it ensures that the safety culture requirements adopted in its relevant regulations and instructions are efficiently implemented. EMRC should ensure these requirements through regulatory inspections as the main element of EMRC oversight approach.

As a part of the OL conditions for JRTR, the safety culture and security culture programs had been developed and issued; the programs since then have been implemented and different procedures to support the implementation have been drafted, several questioners were conducted and some anonymous reports were evaluated and considered by JRTR management.

3.5.5 EMRC Quality Management:

EMRC has developed and is implementing Quality Management System (QMS) manual, this Quality Manual demonstrates and documents EMRC commitment to maintaining a high-level of quality within an environment that has safety as a first priority, focused on the stakeholders, and fosters continual improvement. Moreover, the quality management manual is intended to demonstrate conformance to IAEA safety standards.

EMRC QMS program is documented and is carried out in accordance with written policies, procedures, or instructions. The QMS policies, procedures, and instructions reflects a collective commitment, on the part of the organization, that emphasizes safety over competing goals,

such as resource expenditure and schedule, to ensure protection of people and the environment.

The quality assurance program provides control over activities affecting the quality of the review and assessment of applications for licensee or licensing activities to an extent consistent with their importance to safety. The program takes into account the need for reviewers to have appropriate technical skills to attain the required quality, and the need for verification of quality. The program provides for indoctrination and training of personnel performing technical review activities affecting quality as necessary to assure that suitable proficiency is achieved and maintained.

The QMS recognizes that the primary responsibility of a technical review body within the regulatory framework is to provide reasonable assurance that the public health and safety is achieved.

EMRC, as illustrated in Figure 2, EMRC is chaired by the Chief Executive Officer (CEO), with the consultation of the Board of Commissioners (hereafter referred to as the Board). The Board comprises of:

- The CEO of EMRC, who is also the Chairman of the Board.
- Nuclear and Radiation Commissioner;
- Electricity Commissioner;
- Minerals Commissioner; and
- Legal Commissioner.

EMRC reports directly to the Prime Minister, and it is functionally independent from any entity with responsibilities or interests that could unduly influence its decision making process. It is therefore an effective independent nuclear regulatory authority

EMRC has about 250 staff members working in the head office in Amman, including 100 staff members working in the nuclear Security Directorate/border control offices with responsibility for controlling the trans-border transfer or illicit trafficking of nuclear and radioactive material.

3.5.6 EMRC Contracting and management of Technical Support Organizations

EMRC contracted with two TSOs, with Korea Institute for Nuclear Safety-KINS and Advanced Systems, Technology and Management-AdSTM to help EMRC in licensing process for Jordan Research and Training Reactor (JRTR). The EMRC project managers were assigned from relevant staff, the competency of the Licensing Project Managers (PMs) was developed through periodic Project Progress Review Meetings, in addition to that the competences of the PMs Covers the main legal and technical aspects of their individual projects. Further, EMRC PMs participated in several occasions for training in Technical Cooperation Projects (such as with IAEA, EU), which includes a lot of knowledge and experience transfer and On the Job Trainings (OJT).

Besides extensive cooperation with the IAEA, EMRC currently receives support from a group of European Nuclear Regulatory Authorities (NRAs) and Technical Support Organizations (TSOs) within the European Commission (EC) cooperation project.
EMRC had signed two contracts to seek support and technical assessment for the site permit application. A contract with EMPRESARIOS AGRUPADOS for the site permit application which included the quality assurance program of the applicant and its main contractors, country wide survey report and associated reports, site selection and ranking reports and the site suitability report, in addition to the review and assessment inspections were conducted (quality assurance and field inspection). The second contract was signed with Pöyry and Arabtech Jardaneh for the Environmental Impact Assessment and associated documents (terms of references, and scoping sessions).

3.5.7 EMRC Future Development

Overall, EMRC has been responsive and continues to place appropriate focus on implementing a framework that provides effective protection of public health, safety and environment. EMRC management and staff are dedicated to continuous improvement and they clearly recognize the importance of their mission towards the safety.

In the near and mid-term, EMRC will continue to develop and further improve the expertise of its staff meeting high expectations regarding its staff performance with intermediate level of experience. It is very committed and ambitious in investing in its human resource capital so that its expertise meets the required international standards and its responsibilities within Jordan's nuclear energy program are fulfilled according to the IAEA's expectations. EMRC plans to establish strong relations with the NRA and the Technical Support Organization (TSO) of the vendor country. This approach will ensure the best possible transfer of experience and knowledge and will facilitate the Jordan-specific review of licensing applications.

3.6 Article 9: Responsibility of the License Holder

CNS Text:	Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant license and shall take the appropriate steps to ensure that each such license holder meets its responsibility.

Discussion:

According to EMRC Regulation on the Safe Use of Nuclear Energy for the year 2014, the prime responsibility for safety of nuclear facilities is assigned to the operator. In addition, EMRC has the capability with number of regulatory functions, which allows EMRC to ensure compliance with the regulatory requirements, includes inspections and enforcement actions. On the other hand, for the Civil Liability, Jordan joined the Vienna Convention on Civil Liability for Nuclear Damage, and ratified by National Law in 2015, in which the prime responsibility on Civil Liability for Nuclear Damage are assigned to the operator.

3.7 Article 10: Priority to Safety

CNS Text:	Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

Discussion:

The Government of Jordan has fully recognized the prime importance of nuclear safety in developing the Jordanian Nuclear Energy Program. All the steps undertaken by its involved institutions demonstrate nuclear and radiation safety are fundamental aspects of the Jordanian Nuclear Safety Policy, and have the highest priority in the Jordanian nuclear program (See sections 2, and 3.5).

Jordan Atomic Energy Commission (JAEC) is the governmental competent authority for developing Jordan's Nuclear Program; JAEC adopts high standards of safety in developing the nuclear energy program. JAEC has defined clear set of criteria for selecting the nuclear technology, and has proceeded with the bidding process on this basis. Most of these criteria have a direct or indirect impact on nuclear safety and security. This is shown by its decision to consider Generation III and III+ advanced reactor technology, in which only a contemporary design meeting the highest safety and security standards will be implemented. The main criteria used for selecting the future designs and design providers of Jordanian nuclear technology include in particular:

- Core damage frequency (CDF);
- Consideration of beyond design basis events (severe accidents) in the design of the plants – prevention and mitigation;
- Consideration of the impact of crashing a large commercial aircraft into the plant, and the effect of external explosions, seismic and other external events in the design;
- Consideration of operator accident mitigation;
- Radiological parameters during normal operation and accidents (design basis and beyond) – the effective dose to the population, quantity of releases to the environment;
- Modern man-machine interface;
- Minimization of the exclusion zone;
- Implementation of digital instrumentation and control;
- Redundancy and diversification of safety systems;
- Introduction of passive components and systems;
- Reliability and security of fuel supply and proposed options for spent fuel management;
- Generation, quantity and treatment of radioactive waste;
- Existence and implementation of a Quality Management Program; and
- Consideration of Jordan's site-specific seismicity.

Furthermore, JAEC has established a high level International Advisory Committee (IAC) to advise the Government in the progress of the Jordan nuclear program and in achieving and

maintaining the highest standards of safety, security, non-proliferation, transparency and sustainability. The IAC comprises independent international experts with broad experience in nuclear affairs, including safety.

3.8 Article 11: Financial and Human Resources

CNS Text:

- ✓ Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.
- ✓ Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

Discussion:

EMRC is administratively and financially an independent governmental body, where the recruitment process in EMRC is through the adopted governmental recruitment process. The human resources needs for a given calendar year shall be defined before the end of the preceding calendar year, and then the candidates come through the Civil Service Bureau where written examination and appointment arrangements shall be arranged with the recruiting body (i.e. EMRC). The EMRC budget is given from the State Budget, in which EMRC shall prepare a request budget including its projects and justifications in the preceding calendar year. This budget shall be approved by the Parliament (See section 3.5).

For JAEC, and as discussed in section 2.4 regarding the independence of JAEC and its objectives; JAEC is aimed to develop a plan for nuclear human resources, and carrying out impact assessments on various economic sectors throughout the cycle of nuclear use.

JAEC policy is to leverage Jordan's industrial capacity, in particular construction companies, architecture and engineering firms, and the cement and steel industries, to support the construction of the nuclear power program.

JAEC has signed Nuclear Cooperation Agreements with several nuclear countries such as France, China, South Korea, Canada, Russia, United Kingdom, USA, Argentina, Spain, Japan, Ukraine and Romania For cooperation in the peaceful uses of nuclear energy. In addition, to develop the necessary qualified human resources, JAEC is constantly in pursuit of qualified and experienced staff in addition to training of new graduates to ensure that highly educated and motivated staff is available for NPP project. Moreover, JAEC is offering scholarships for continuing education in the nuclear fields.

Accordingly, the Jordan Atomic Energy Commission's strategy for developing the human resources in the nuclear energy field depends in the following options:

- Utilization of JSA and JRTR;
- Vendor supplied training;
- Support through Nuclear Cooperation Agreements;
- IAEA Technical Cooperation;
  Development of a Jordan-Specific Qualification and Certification Programs.

3.9 Article 12: Human Factors

CNS Text:	Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

Discussion:

According to EMRC instructions on the safety of nuclear power plants, Article 21.b.5 and Article 31.b, and EMRC instructions on the safety of research reactors, EMRC requires that the human factors and human–machine interfaces shall be given. A systematic consideration at an early stage of the design and throughout the entire design process. In addition, EMRC requires that special consideration shall be given to human factors and the application of ergonomic principles in the design of the control room and reactor systems as appropriate.

For the Jordan Research and Training Reactor, EMRC requires the organization structure and operation staff to be submitted in accordance to specific EMRC developed regulatory instructions, where the Senior Reactor Operators, Reactor Operators, Fuel Handlers, RPO, Radiation and Maintenance Staff are subject to licensing process which includes specific experience, scientific and engineering background, special training, written and practical examination. In addition, the facilities operators shall submit their Operational Organization in accordance to specific EMRC developed regulatory instructions to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

Moreover, JAEC dispatched 40 nuclear engineers and scientific staff for Master Degrees academic program and long-term training programs to JRTR research reactor country of origin, South Korea (KAERI and KAIST university), to study nuclear safety and nuclear design. JAEC nuclear engineers and the scientific staff involved in the hot commissioning of the JRTR research reactor (See section 3.5.3).

3.10 Article 13: Quality Assurance

CNS Text:	Each Contracting Party shall take the appropriate steps to ensure that quality assurance programs are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

Discussion:

The EMRC has established an internal unit called the Quality management Unit. This unit has been given the responsibility to develop the management system. The Unit will be the responsible for developing, maintaining, assessing, and improving the Integrated Management System (IMS). The unit reports directly to the Chairman and senior management of EMRC on any issue related to the management system. The Unit is now undertaking a gap analysis in every directorate of the EMRC in order to determine the scope of work to develop the Management System (See section 3.5.4).

EMRC has developed and is implementing Quality Management System (QMS) manual, this Quality Manual demonstrates and documents EMRC commitment to maintaining a high-level of quality within an environment that has safety as a first priority, focused on the stakeholders, and fosters continual improvement. Moreover, the quality management manual is intended to demonstrate conformance to IAEA safety standards (See section 3.5.5).

According to EMRC regulatory framework, namely EMRC regulation on the Safe Use of Nuclear Energy, Article 7.r, the applicant should submit QAP for all the stages of the nuclear facility and activities. For instance, JRTR operating organization submitted its QAP, which is applied to all design, procurement, and construction activities, such as procurement, manufacturing, installation, inspection and test. This organization was subject to several EMRC QA inspections (see discussion in 11- Article 14. Assessment and Verification of Safety).

Throughout the licensing process of the research reactor, EMRC performed daily inspections on various activities. Further, several QA inspections were conducted covering the operating organization, suppliers of the main reactor components (POSCO PANTEC in South Korea) and fuel (CERCA in France).
Table 2 shows the list of QA inspections conducted by EMRC with KINS, as well as EMRC with its TSO (AdSTM):

Table 2: List of QA Inspection Missions on JRTR Research Reactor Project

Mission Number	Inspection Subject	Start Date	End Date
1.	E&T: QA Inspection	04/29/2012	05/03/2012
2.	QA: Inspection (JAEC and KDC)	03/03/2013	03/12/2013
3.	QA: Inspection (POSCO Plantec)	10/14/2013	10/17/2013
4.	QA: Inspection (KDC)	06/29/2014	07/02/2014
5.	QA: Follow Up Inspection (POSCO Plantec)	09/29/2014	10/02/2014
6.	QA: Inspection (CERCA)	20/10/2014	20/10/2014
7.	E&T: Follow Up QA Inspection	6/1/2014	10/1/2014
8.	QA: Follow Up Inspection (JAEC)	14/2/2016	17/2/2016
9.	QA inspection on commissioning procedures	3/4/2016	7/4/2016

3.11 Article 14: Assessment and Verification of Safety

CNS Text: Each Contracting Party shall take the appropriate steps to ensure that:

i. comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

ii. verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

Discussion:

According to the law number (43), Radiation Protection and Nuclear Safety and Security Law, Articles 10.a.3 and 21.a, EMRC has the legal authority to conduct safety reviews and inspections to verify that nuclear installations are incompliance with the regulatory requirements throughout of its life. Additionally, Regulation on the Safe Use of Nuclear Energy number (43) for the year 2014, Article 6, empowered EMRC to issue, amend, suspend or revoke licenses and permits in accordance with the regulations and instructions in force by EMRC, based on a systematic approach and principles of fairness and transparency and the recommendations of the EMRC Board of Commissioners. Subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body.

EMRC applied its regulatory review and assessment process on Jordan Research and Training Reactor (JRTR) and Jordan Subcritical Assembly (JSA). In addition to EMRC local safety review capabilities, EMRC also had formal agreements in place for cooperation that enhanced safety, particularly through harmonized approaches and increased quality and effectiveness of safety reviews and inspections with KINS and AdSTM TSOs (See Section 3.5.6).

Licensing of JRTR is an example of EMRC approach for authorization of nuclear facilities. Several safety review rounds, Request for Additional Information third Party Opinions and Witness activities were performed. Figure 4 illustrates the flow charts of the adopted Safety Review Approach during the licensing process for JRTR research reactor for the two stages of license (namely Construction Permit and Operation License).

Several Progress Review Meetings with Korea Institute of Nuclear Safety and with AdSTM TSOs, inspections and witness have been conducted since 2010. Table 3 list the major inspection mission conducted on the JRTR project, where the inspection extended to the operator, designer, constructor and subcontractors, in addition to the daily and reaction inspections conducted by EMRC and its resident inspectors in the JRTR research reactor site.

Moreover, EMRC prepared its planned chart for issuance of Operation License for the JRTR; it consists of five licensing steps, defined as (see Figure 4):

Step 1: JAEC should submit the FSAR, Commissioning program, Accident Analysis Report, Operating procedures and Training & Qualification program;

Step 2: EMRC will review the submitted document in order to give JAEC the hot commissioning authorization to start fuel loading and power accession to full power

commissioning test. EMRC should make sure that CP conditions are completely fulfilled by JAEC.

Step 3: JAEC should submit the final commissioning report showing the results for commissioning tests;

The commissioning stages for the JRTR were divided into several stages as below:

- Cold Commissioning:
  - Stage A1 : Construction Acceptance Tests (CATs)
  - Stage A2 : System Performance Tests (SPTs)
  - Stage A3 : Integrated System Tests (ISTs)
- Hot Commissioning:
  - Stage B1 Fuel loading
  - Stage B2 Low-Power Tests
  - Stage C1 Power Ascension
  - Stage C2 Full-Power Tests
- Extended Hot Commissioning (Initial Operation Tests)
  - Repeated Hot Commissioning Tests

Step 4: EMRC will review the final Commissioning Report submitted by JAEC for OL issuance.

Step 5: EMRC will issue the operation license.

Table 3: List of Major Inspection Missions on JRTR Research Reactor Project

Mission Number	Inspection Subject	Start Date	End Date
1.	E&T: QA Inspection	04/29/2012	05/03/2012
2.	POI: Structural Area - 1st	01/28/2013	02/13/2013
3.	QA: Inspection (JAEC and KDC)	03/03/2013	03/12/2013
4.	Audit for EQ Testing of Electrical and I&C Equipment	05/06/2013	05/16/2013
5.	QA: Inspection (POSCO Plantec)	10/14/2013	10/17/2013
6.	POI: Structural Area - 2nd	01/23/2014	04/07/2014
7.	E&T: Welding and Facility Installation Inspection	04/27/2014	05/01/2014
8.	POI: Structural Area - 3rd	05/20/2014	06/05/2014
9.	POI: Facility installation (Mechanical Area) - 1st	10/05/2014	11/21/2014
10.	POI: Meteorological and Environmental Radiation Monitoring Area - 1st	12/01/2014	12/31/2014
11.	Flap Valve EQ test (Samshin)	06/23/2014	06/27/2014
12.	Performance Test of CRDM/SSDM (POSCO Plantec)	09/02/2014	09/02/2014
13.	QA: Inspection (KDC)	06/29/2014	07/02/2014
14.	Audit for EQ/SQ Test of Electrical and I&C Equipment	09/15/2014	09/24/2014
15.	QA: Inspection (POSCO Plantec)	09/29/2014	10/02/2014
16.	QA: Inspection (CERCA)	20/10/2014	20/10/2014
17.	E&T: QA Inspection	6/1/2014	10/1/2014
18.	POI: Structural Area - 4th	04/19/2015	04/23/2015
19.	POI: Facility installation (Mechanical Area) - 2nd	12/7/2015	15/7/2015
20.	POI: 2nd Pre-Operational Inspection of JRTR on Mechanical Area	15/7/2015	16/7/2015
21.	POI : 1st POI on electrical Area of the JRTR	29/11/2015	3/12/2015
22.	POI: 3rd POI on Mechanical Area of the JRTR	29/11/2015	3/12/2015
23.	1st Pre-Operational Inspection of JRTR on Radiation Protection Area	29/11/2015	3/12/2015
24.	1st Pre-Operational Inspection of JRTR On the Fire Protection System	10/1/2016	14/1/2016
25.	First Pre-Operational EMRC-KINS Team Inspection of the System Performance Tests (Commissioning Test Stage A2) for the Primary Cooling System and Connected Systems	10/1/2016	14/1/2016
26.	Second Pre-Operational EMRC-KINS Joint Team Inspection of the SPTs (System Performance Tests) (Commissioning Test Stage (A2)) &ISTs (Integrated System Tests) for the Primary Cooling System and Connected Systems	10/1/2016	14/1/2016
27.	Commissioning Inspection for I&C and his	13/3/2016	17/3/2016
28.	QA: Follow Up Inspection (JAEC)	14/2/2016	17/2/2016
29.	QA inspection on commissioning procedures	3/4/2016	7/4/2016

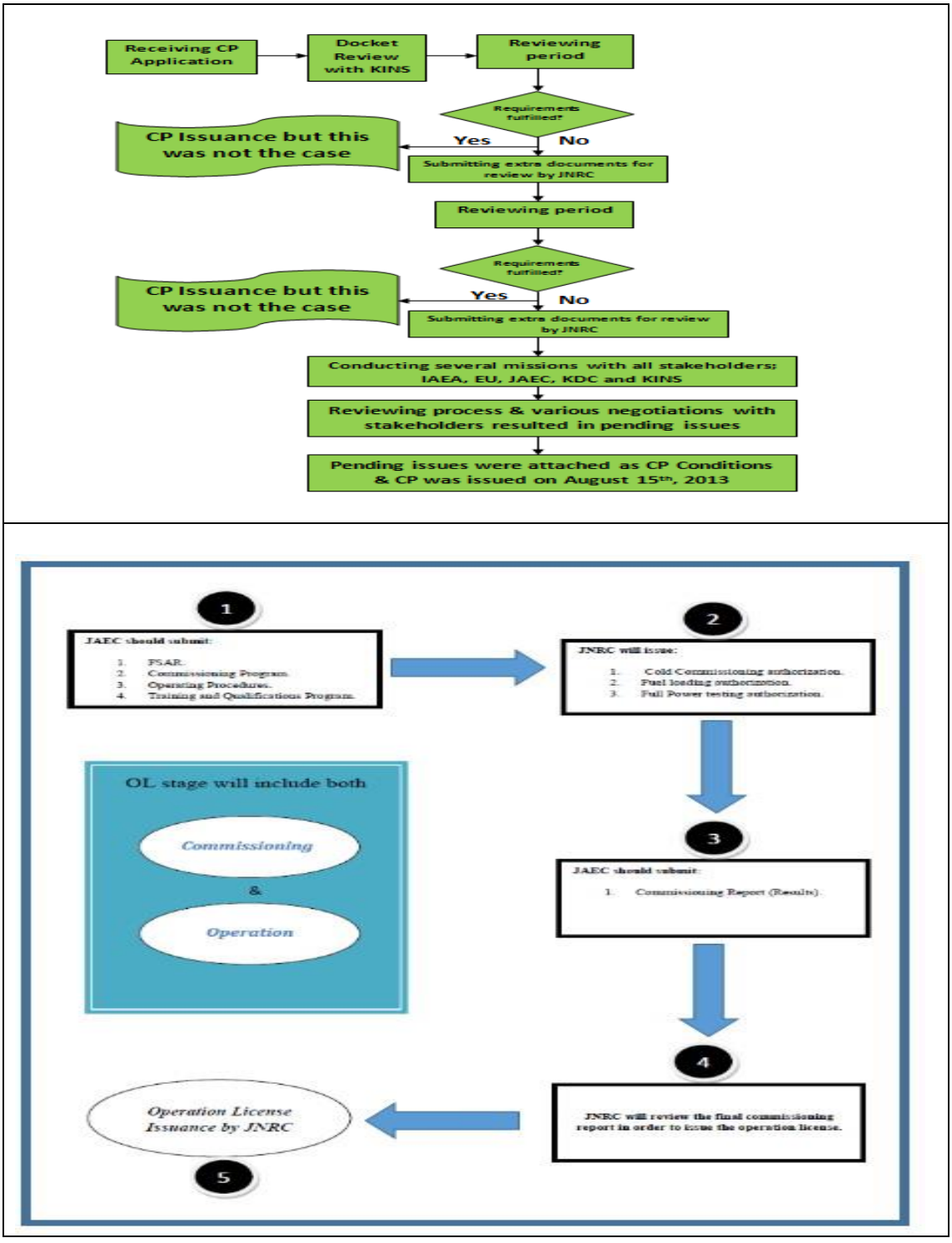


Figure 4: EMRC Licensing Flow Charts for JRTR Research Reactor

3.12 Article 15: Radiation Protection

CNS Text:	Each Contracting Party shall take the appropriate steps to ensure that in all operational states, the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses, which exceed prescribed national dose limits.

Discussion:

In 2015, the government of Jordan issued the Radiation Protection Regulation and it's implementing instructions, based on the IAEA GSR Part 3, after more than 2 years of technical and legal drafting. This regulation shall be applicable for nuclear facilities and activities.

In the JRTR research reactor project, the EMRC Radiation Protection Directorate staff conducted safety review on the Radiation Protection Program (RPP) jointly with Radiation Protection Experts from Korea Institute for Nuclear Safety (KINS), as well as they conducted several radiation protection inspections, which covers the implementation of the RPP. In addition, EMRC Radiation Protection Directorate is issuing radiation protection personal licenses based on regulatory requirements set forth in the regulation on the Bases for Issuing License and Permits for Radiation Facilities and Activities number (8) for the year 2013. According to EMRC Regulation on Radiation Protection for the year 2016, all practices and activities shall be deemed to meet the requirements if the following conditions are satisfied:

a. Such practices and use are justified.
b. The radiation exposures do not exceed the prescribed dose limit.
c. Radiation protection is optimized.

Moreover, and according to EMRC Regulation on the Safe Use of Nuclear Energy number (43) for the year 2014, Article 5, the occupational radiation exposure and public exposure shall always be As Low As Reasonably Achievable (ALARA) taking into account the economic and social factors, and not to exceed dose limits set by the Commission.

All these requirements are considered in the licensing process through EMRC dose assessment analysis, for instance, the design safety reviews of JRTR, and JSA Facility, conducted by EMRC ensures the dose optimization and limitation.

3.13 Article 16: Emergency Preparedness

CNS Text:

1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.
2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.
3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

Discussion:

According to the law number (43) for the year 2007, Radiation Protection and Nuclear Safety and security Law, Article 15.a, each licensee shall provide the necessary precautions for radiation protection, and nuclear safety and security consistent with the nature of the radiation source and the expected hazard and it's extent, and appoint a radiation protection and nuclear safety and security officer, establishing measures for emergency planning and emergency preparedness and response proportionate with the nature of the work of the activities according to the regulations issued in accordance to the provisions of this law.

Besides that, EMRC Regulation on the Safe Use of Nuclear Energy, Articles (15, 16, 17, 18 and 19), and the licensee implementing activities related to design, construction, commissioning, operation and decommissioning of nuclear facilities and to manufacturing, transportation and storage of nuclear material shall establish measures for emergency planning and emergency preparedness and response. Emergency planning measures shall be established for:

a. protection of the population (off-site emergency plan), which regulates the emergency planning areas and determines the actions to be taken by the competent authorities to protect the population, property and environment in the case of an accident;
b. the nuclear facility (on-site emergency plan), which determines the actions to be taken by the licensee for accident mitigation and remediation of consequences in co-ordination with the off-site emergency plan.

Moreover, EMRC had issued Instructions on the Emergency Preparedness and Response for Nuclear Facilities, and EMRC National Rules for Emergency Preparedness and Response. These Instructions and Rules were established for the implementation of EPR, and was applicable for the JRTR research reactor, where the facility Emergency Plan was subject to review, inspections and drills.

Jordan National Committee for Nuclear Emergency was established in January 2014 by a prime ministry decree, to be under EMRC coordination. The Committee shall work on the preparation, drafting, review and coordinate the off-site National Emergency Plan, in addition to review the facility level (on-site) Emergency Plan, six months prior to the commissioning

of a nuclear facility, this review is the basis of EMRC approval of the plan in accordance to the licensing process.

Several national Emergency Exercises were conducted on the site of the JRTR research reactor, where the national competent authorities participated in this exercise, prior to JRTR research reactor fuel loading and hot commissioning. Emergency and Security Plans was approved by EMRC before fuel loading.

EMRC has received IAEA EPREV mission in 2013, and developed Action Plan to cope with the recommendation of the mission. This Action Plan was implemented and completed by the end of April 2016. In May 2016, IAEA and EMRC organized Regional workshop to develop the national EPR Self-Assessment Emergency Preparedness and Response Information Management System (EPRIMS) for the regional countries including Jordan where Jordan completed the National EPR Self-Assessment report (IAEA EPRIMS website).

3.14 Siting

CNS Text: Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

(i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

(ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

(iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

(iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

Discussion:

According to EMRC Instructions on the procedures for issuing site permit for nuclear power plants, the site selection process is divided into two stages (Figure 5 and Figure 6). The first stage "site survey" considers potential sites based on existing data. The second stage is the actual selection of the site and may be considered part of the "site evaluation" which aims to confirm the acceptability of the final site and to establish the parameters needed for the design of the nuclear power plant. Site evaluation continues throughout the entire life of the nuclear installation to take into account the changes of the site characteristics, evaluation methodologies and safety standards. After the site selection stage, the confirmation of site acceptability and a complete site characterization are performed during the site assessment stage. This process eventually leads to the preparation of the Site Evaluation Report as a basis to the Site Chapter of the PSAR. All the site related activities after the approval of the SER by the Commission and which involve confirmatory and monitoring work are in the pre-operational stage. With the approval of the FSAR the open-ended operational stage for site evaluation starts. This includes all confirmatory, monitoring and re-evaluation work throughout operation and especially during periodic safety reviews.

In the site survey studies, consideration should be given to Specific Screening Criteria, including:

- Population
- Feasibility of Emergency Plans
- Capable faults
- Foundation hazards
- Airplane crash hazard
- Other human-induced hazards
- UHS Safety

The details of these regulatory requirements are explained in the EMRC instruction on the Site Survey and Site Selection for NPPs, and in EMRC instruction on the Site Evaluation for NPPs.

In addition, EMRC requires different databases are needed to undertake the site selection process. The following databases should be established:

- Fault displacement database
- Volcanological database
- Coastal flooding database
- River flooding database
- Meteorological extreme events database
- Human induced events database
- Geological database
- Seismological database

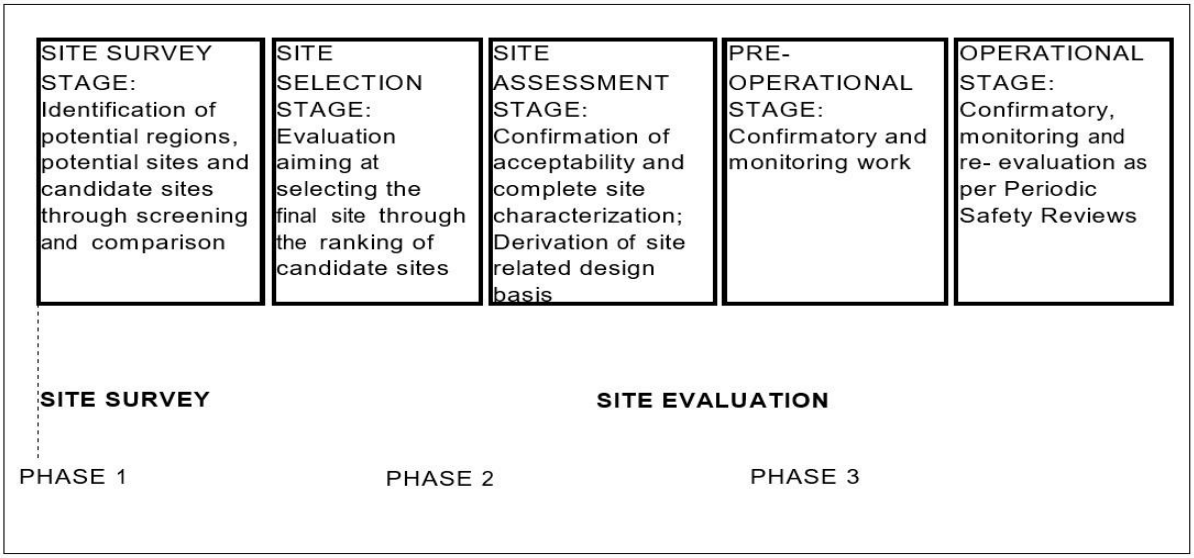


Figure 5: EMRC Siting Process Chart.

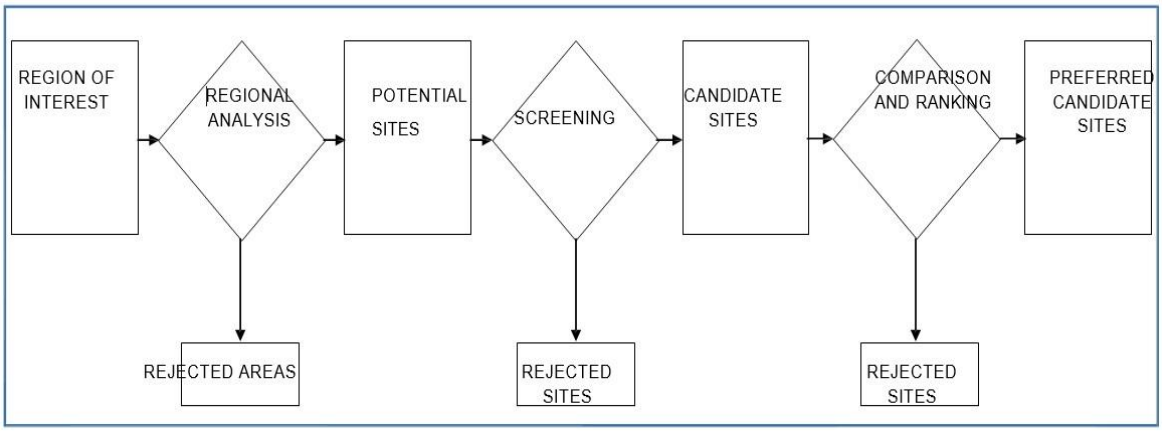


Figure 6: Site Selection Decision Tree Process

In 2015, JAEC contracted KEPCO from South Korea to conduct the siting studies for the planned Jordan Nuclear Power Plants. KEPCO conducted geologic investigations to check site suitability and acceptability by confirming the absence of geological hazards as defined in the exclusion criteria set out by EMRC, where the presence of a capable fault within the near region of the site is a defined exclusion criteria. The evaluation of such faults is commonly based on estimation of the time of the last movement.

Upon request from the Energy and Minerals Regulatory Commission (EMRC) and within the framework of the Technical Assistance and Co-operation Program between Jordan and IAEA, an IAEA Site and External Events Design (SEED) Follow-up Expert Mission was conducted from 22 to 24 May 2018 at Amman, Jordan to review the implementation of recommendations and suggestions made by previous mission organized in October 2017.

The objective of these missions was to study the site suitability aspects of the first Nuclear Power Plant in Jordan at Amra site, in compliance with IAEA Safety Standards. Jordan Atomic Energy Commission (JAEC), as Applicant for the Site Permit is managing the site studies. These studies were performed by JAEC's consultant, Worley Parsons, by using the earlier work done by KEPCO and making new studies to fill the gaps wherever required. The mission was mainly focused on fault capability and volcanic hazards, as other issues were mostly resolved during the previous mission. The Integrated Analysis Report, developed by incorporating IAEA comments and suggestions on the Site Suitability Report, only response to Issue Sheets included in the previous mission report was received.

The meetings were held at EMRC under excellent arrangements and all relevant technical experts from EMRC, its TSO, JAEC, JAEC's consultant and the National Technical Committee participated. Finally, the IAEA team concluded this Follow-up Expert Mission hoping that IAEA safety review services, expert missions or other types of services will be provided in a timely manner to support EMRC to close the current issues, and during the site characterization stage.

EMRC applied these criteria in JRTR in a graded approach, where further studies (such as Probabilistic Seismic Hazard Analysis, 1 km fault analysis) was requested by EMRC to the siting studies for the Jordanian research reactor (JRTR) based on the IAEA Guide (SSG-9, the Seismic Hazards in Site Evaluation for Nuclear Installations). EMRC, IAEA, KINS and EU reviewed these additional site studies. In addition, Radiological Environmental Report was required by EMRC as a part of the Environmental Impact Assessment, and reviewed by EMRC, IAEA, KINS and EU; the site evaluation studies for JRTR are listed in Table.4.

Table 4: Siting Submittals for JRTR Research Reactor Project

Submittal	Reviewers (in addition to EMRC)	Notes
Site Characteristics (PSAR, Ch-3)	IAEA, KINS, NucAdvisors, EU	N/A
PSHA & DSHA	IAEA, KINS, NucAdvisors, EU, National Expert (Prof. Najeeb Abu Karaki)	EMRC contracted the seismic national Expert (Prof. Najeeb Abu Karaki), because of the KINS recommendation that a seismic national expert should review seismic studies, since the subject of seismicity depends mainly on the experiences and the cumulative seismic history of the region under study.
1 km fault study	IAEA, KINS, NucAdvisors, EU, National Expert (Prof. Najeeb Abu Karaki)	N/A
Site survey studies and QA of the site selection process.	KINS	N/A
Soil Liquefaction and Rocks Studies	KINS	N/A
EIA	Ministry of Environment	National EIA Committee
RER	IAEA, KINS	Part of EIA

3.15 Article 18: Design and Construction

CNS Text: Each Contracting Party shall take the appropriate steps to ensure that:

i. the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

ii. the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

iii. the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

Discussion:

EMRC require three basic safety functions to have multi barriers defense in-depth precautions, namely: i) a reactor shutdown, ii) a decay heat removal, and III) confinement of radioactive materials shall be satisfied by implementing appropriate inherent and passive safety features, safety systems and engineered safety features.

Concerning the technologies incorporated in the design and construction of a nuclear installation, EMRC has several requirements and regulatory instruments to ensure the quality of Structures, Systems and Component (SSCs), services and activities relevant to nuclear

facilities and activities, these requirements and regulatory instruments (during construction, commissioning and operation), manufacturer and vendors, includes (see section 3.11) :

- QA Inspection on applicant
- Witnessing test activities.
- Witnessing installation activities.
- Requesting acceptance reports and internal audit reports.
- Requesting of certificates of service providers and chain suppliers in nuclear projects.

According to EMRC instruction on the safety of research reactors, Article 24, the EMRC criteria for assessing the acceptability of the design of research reactors is that the design shall ensure that the nuclear installation is suited for reliable, stable and easily manageable operation, and ensure that the design of SSCs complies with the requirements adopted by EMRC. The prime goal shall be the prevention of accidents. In addition, the design shall include the appropriate application of the defense in depth principle, and ensure that failures or combinations of failures that might lead to significant radiological consequences are of very low probability. Further, the design shall comprise features to minimize the possibility of failures due to a common cause by means of the independence, physical separation and diversity of systems.

According to EMRC instruction on the safety of research reactors, Article 27, EMRC require that the defense in depth concept being applied in the design to provide graded protection against various reactor transients, including transients resulting from equipment failure and human error and from internal or external events that could lead to a Design Basis Accidents (DBA).

In JRTR, the defense-in-depth strategy applied to design the facility against potential human errors and unexpected mechanical failures. A defense-in-depth principle adopted to ensure that the reactor design and operation incorporates multiple levels of protection against the release of radioactive materials. The successive level of defense- in-depth is the prevention of deviations from normal operation, and the mitigation of the radiological consequences of significant releases of radioactive materials.

The criteria of the JRTR design is an adoption of conservative design factors, completeness of quality assurance activities, and the completeness of test and monitoring activities. They strengthen the prevention of an abnormal radioactive material release. A prompt response and measure for an abnormal condition during an operation is reliable and prompt directions and measures against a system in line is provided in order to ensure a regulating capability of an operation.

An initial accident shall be prevented from spreading into a serious one with a reactor protection system and engineered safety features. Emergency and protective measures to the reactor auxiliary facilities shall be applied to prevent any release to the environment and dispersion of radioactive materials.

EMRC requires that the human factors and human–machine interfaces shall be given. A systematic consideration is required at an early stage of the design and throughout the entire design process. The design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface (See section 3.9).

3.16 Article 19: Operation

CNS Text: Each Contracting Party shall take the appropriate steps to ensure that:

(i) the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

(iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

(iv) procedures are established for responding to anticipated operational occurrences and to accidents;

(v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

(vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

(vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

Discussion:

There is no operational nuclear installations in Jordan until now, but EMRC has provided the applicant (JAEC) with the regulatory requirements for the operational stage of nuclear installations, set forth in EMRC instruction on Safety of NPPs and EMRC instruction on Safety of Research Reactors, where all safety requirements listed in CNS Article (19) are included in the mentioned EMRC instructions.

Late 2016, the JRTR was successfully commissioned and the results showed very good agreement between the design and the commissioning tests (See Section 3.10). The commissioning stages for the JRTR were divided into several stages as below:

- Cold Commissioning:
  - Stage A1 : Construction Acceptance Tests (CATs)
  - Stage A2 : System Performance Tests (SPTs)
  - Stage A3 : Integrated System Tests (ISTs)
- Hot Commissioning:

    - Stage B1 Fuel loading
    - Stage B2 Low-Power Tests
    - Stage C1 Power Ascension
    - Stage C2 Full-Power Tests
- Extended Hot Commissioning (Initial Operation Tests)
    - Repeated Hot Commissioning Tests

During that period, an expert mission from IAEA for INSARR was invited to provide the assessment of the Commissioning phase and provided the recommendations for a smooth transition from the commissioning phase to the operation phase of the reactor. The follow-up INSARR mission was invited in 2017 to evaluate the progress of JRTR since the INSARR mission 2016, and they found excellent achievements At the JRTR.

In 2017, a new operational organization was formed to fulfill the JAEC vision of having the JRTR operating safely and utilized efficiently; the INSARR recommendations and the ANSI/ANS standards were used in addition to the EMRC regulations were used as the foundation for this new organization. The Terms of Reference (ToR) of the safety committee were updated to provide the advice to JRTR director in the operation domain. During this period, the operating procedures were updated, the commissioning tests were replicated by Jordanian operators as part of the Initial Operating Tests (IOT) program, which aims were:

- To increase the confidence level in the Jordanian expertise in operating the reactor as per its procedures and governing documents,
- To assure the independence of Jordanian teams from the designer and the contractor,
- To orient the new employed engineers and technicians, who were recruited to serve in the maintenance activities, and
- To qualify the teams on different aspects such as the conduct of operations and JRTR utilization.

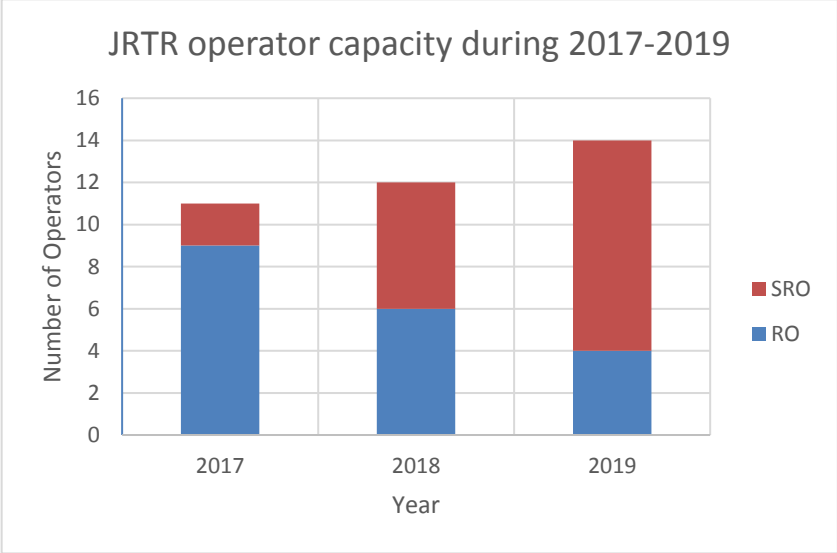
As a result of the IOT success at late 2017, the Operating License (OL) was granted by EMRC which meant that the JRTR was approved as a safe facility to operate and utilized as per the OL. The reactor is currently used for education and training and for production of radioisotopes. The efforts had been directed to fulfill the requirement of the JFDA (Food and Drug Administration) to grant the JRTR the necessary license for the production and marketing Iodine-131as a radiopharmaceutical product both in solution and capsule forms for oral use by patients in the HKJ. Since December 2018 till July 2019 the JRTR has marketed more than 40 Ci of Iodine-131 to about 13 nuclear medicine centers and hospitals for Jordanian patients.

In addition, and according to the law number (43) for the year 2007, Radiation Protection and Nuclear Safety and security Law, Article 15.g, the licensee should notify EMRC and the Civil Defense Directorate by any possible means immediately in case of any accident, or exposure to any person to a radiation dose exceeding the dose limits, or in case of loss, damage or loss of control of any source of ionizing radiation. Details of the accident and the reasons that led to the accident must immediately be followed by a written documentation of the notification.

EMRC issued Instructions on the conditions and procedures for notification of EMRC about incidents in the JRTR. Incidents significant to safety are reported in a timely manner by the holder of the relevant license to the EMRC.

In addition, several JAEC nuclear engineers acquired long-term training programs on research reactor operation in the JRTR designing institution (KAERI); the engineers were subject to EMRC-KINS written and practical examination to be Senior Reactor Operators and Reactor Operators for the JRTR research reactor.

During the IOTs, the reactor operation team consisted of two SROs (Senior Reactor Operators) and nine ROs (Reactor Operators). In 2018, the efforts of JAEC/JRTR continued to train and qualify more reactor operating staff, as a result; six ROs and six SROs were licensed by EMRC and ready to cover the needs of operating the reactor 24/7.



EMRC established a regulatory inspection programme for the Jordan Research and Training Reactor (JRTR) and the subcritical assembly on the basis of the IAEA safety standards and the supporting IAEA publications, including in particular the training material on Regulatory Inspection of Research Reactors (IAEA-TCS 66, 2018) and the Guidelines for the Review of Research Reactor Safety (Service Series No 25, 2013) with practical information on implementing the regulatory inspection programme concerning the preparation, conduct and reporting of findings of inspection of the JRTR.

The EMRC has established processes to identify and share lessons learnt from operating and regulatory experience. These include:

- A portal for sharing information and knowledge, into which training materials and any other information regarding the regulatory role of EMRC are uploaded.
- Access to the Incident Reporting System for Research Reactors (IRSRR) to share operating experience and knowledge and learn from those reported by other members.
- Access to the International Nuclear and Radiological Event Scale (INES).
- Participation in the Arab Network of Nuclear Regulators (ANNuR).

The Hashemite Kingdom of Jordan is committed to implementing radioactive waste management measures to avoid imposing undue burdens on future generations. Jordan is aware of the issues surrounding radioactive waste, whether it is low and intermediate-level waste, high-level waste or spent nuclear fuel.
In line with the national policy and strategy on Safety of Spent Fuel and the Radioactive Waste Management, and to investigate and evaluate all options for long-term management of spent nuclear fuel. The JRTR houses a Radioactive-Waste Treatment Facility (RTF) for ensuring the safe conditioning and storage of RW, which is designed to accept solid and liquid RW from the JRTR operations as well as RW from other generators that meet the RTF Waste Acceptance Criteria (WAC). The Centralized Storage Facility (CSF) at JAEC is another facility for safe and secure storage of disused sealed radioactive sources (DSRSs) and orphan sources, as well as other RW streams.

4 VIENNA DECLARATION ON NUCLEAR SAFETY (VDNS)

7 th Meeting President Report Text:

- Paragraph 58 of the President's Report from the 7th Review Meeting (RM) of the CNS recommended an action on the Officers to "consider the experiences of the Contracting Parties in reporting on the principles of the VDNS and provide a report to the Organizational Meeting of the 8th Review Meeting for consideration and identification of possible action for the 8th Review Meeting.".
- "peer review of the incorporation of appropriate technical criteria and standards used by Contracting Parties for addressing the principles of the VDNS in national requirements and regulations"

Jordan consider the experiences of the Contracting Parties in reporting on the principles of the VDNS and provide a report to the Organizational Meeting of the 8th Review Meeting for consideration and identification of possible action for the 8th Review Meeting.

The Hashemite Kingdom of Jordan is highly committed to safety include:

- Signature and ratification of the international treaties and conventions in the safe use of nuclear energy.
- Establishment of a clear organizational infrastructure for implementing the nuclear programme.
- Clear division of responsibilities.
- Involvement of IAEA in developing Jordan's nuclear regulatory infrastructure.
- Nuclear cooperation agreements and international cooperation.

The unfolding Japanese nuclear accident is a subject of major interest within the nuclear community. Generally, the nuclear community continues to believe that nuclear energy must be, and therefore will be, a growing part of the global energy portfolio for decades to come. With respect to the potential impact of the Japan accident on the Jordan nuclear programme, there are two points to note:

- ❖ All countries with an interest in nuclear power, including those with operating nuclear plants as well as countries such as Jordan, which are developing a nuclear energy programme, will need to assess the Japan event and determine any impacts on their respective nuclear programmes.
- ❖ The Japan incident is the result of rare and extreme natural events affecting -old plants. For Jordan, key actions are likely to include:

1. redoubled perusal of appropriate siting criteria and methodical review of the siting;
2. re-affirmation of the commitment to Generation III and III+ advanced reactor technology which could not suffer the types of failure that occurred in Japan;
3. carefully developed, modern operator accident mitigation strategies;
4. continued close cooperation with the IAEA and adherence to what are likely to be evolving international safety standards.

Vienna Declaration on Nuclear Safety (VDNS), adopted by the Contracting Parties meeting at the Diplomatic Conference of the Convention on Nuclear Safety Vienna, Austria 9 February 2015, on principles for the implementation of the objective of the Convention on Nuclear Safety to prevent accidents and mitigate radiological consequences. The Declaration, which is part of an ongoing international effort to strengthen nuclear safety in the wake of the Fukushima-Daiichi accident in Japan. VDNS Offers peer review of the incorporation of appropriate technical criteria and standards used by Contracting Parties for addressing the principles of the VDNS in national requirements and regulations.

The Contracting Parties to the Convention on Nuclear Safety:

i. **taking into account** the significant number of efforts and initiatives taken place after the accident at the Fukushima Daiichi Nuclear Power Plant on a national, regional and international level, to enhance nuclear safety;
ii. **noting** changes adopted in the Guidance Documents INFCIRC/571, 572 and 573 to strengthen the review process of the Convention on Nuclear Safety (hereinafter referred to as CNS);
iii. **recalling** the observations of the Contracting Parties of the CNS at the 2nd Extraordinary Meeting in 2012, confirmed at the 6th Review Meeting in 2014, that the displacement of people and the land contamination after a nuclear accident call for all national regulators to identify provisions to prevent and mitigate the potential for severe accidents with off-site consequences;
iv. **reaffirming** the fundamental safety principles provided by the CNS and the commitment it entails to the continuous improvement of the implementation of these principles;
v. **aware of** the world-wide Action Plan on Nuclear Safety endorsed by all Member States of the International Atomic Energy Agency in September 2011; and
vi. **having considered** the proposal by the Swiss Confederation to amend Article 18 of the CNS presented at the 6th Review Meeting of the CNS.

Contracting parties have adopted the following principles to guide them, as appropriate, in the implementation of the objective of the CNS to prevent accidents with radiological consequences and mitigate such consequences should they occur:

1. New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions (See Sections 3.10- 3.15).

2. Comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner (See Sections 3.10-3.15).

3. National requirements and regulations for addressing this objective throughout the lifetime of nuclear power plants are to take into account the relevant IAEA Safety Standards and, as appropriate, other good practices as identified inter alia in the Review Meetings of the CNS (See Section 3.4, 3.5).

5 SUMMARY

From a global perspective, many countries are increasingly turning to nuclear power as a safe, reliable and economically proven energy generation technology. Jordan is one of the countries currently expressing interest in nuclear power. The development of a peaceful, civilian nuclear energy programme is based on an in-depth evaluation and understanding of Jordan's future energy needs.

The Government of Jordan has fully recognized the prime importance of nuclear safety in developing the Jordanian Nuclear Energy Program. All the steps undertaken by its involved institutions demonstrate nuclear and radiation safety are fundamental aspects of the Jordanian Nuclear Safety Policy, and have the highest priority in the Jordanian nuclear program.

As a conclusion to the discussion contained in the status report of Convention on Nuclear Safety (CNS) and Principles of Vienna Declaration on Nuclear Safety (VDNS). Jordan has made many actions toward fulfilling its obligations to the CNS, including enforcing the necessary legislative regulatory framework, and building capacities and infrastructure for nuclear energy. The Government of Jordan Continues support commitment on cooperation and fulfilling obligations of the International Legal Instruments. This CNS status report emphasizes the commitment to safety in all EMRC and JAEC activities, decisions and considerations to protect public, properties and environment from harmful effects of radiation.

EMRC has developed capabilities for establishing Quality Management System to ensure the compliance with the provisions of CNS. In addition, EMRC built capabilities to conduct safety reviews on nuclear safety and radiation protection. Regarding Siting, Design, Construction and Operation of nuclear installations, EMRC has developed, and partially implemented to the extent of the progression in Jordan Nuclear Projects, most of safety requirements, which are in compliance with the IAEA safety standards.

The development of EMRC over the next few years will be an on-going challenge. EMRC also has to maintain and further develop its human resources and Maintaining and expanding staff competence, knowledge, and financial resources.