Convention on Nuclear Safety

Joint 8th and 9th Review Meeting

National Report of Kingdom of Saudi Arabia

هيئة الرقابة النووية والإشعاعية
Nuclear and Radiological Regulatory Commission

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هيئة الرقابة النووية والإشعاعية
Nuclear and Radiological Regulatory Commission

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PART I: Executive Summary

The Kingdom of Saudi Arabia (KSA) is a signatory to the 1994 Convention on Nuclear Safety (CNS) since September 1994. The KSA has deposited the instrument of ratification with the depositary on March 18, 2010. Since that time, the KSA has endeavored to achieve a high degree of nuclear safety measures by enhancing national practices and international cooperation, as well as by adhering to all the commitments outlined in the Convention's provisions. The National Policy for the Atomic Energy Program (Saudi National Atomic Energy Project (SNAEP)) has been approved by the Kingdom of Saudi Arabia (KSA). The Kingdom's commitment to operational transparency and the highest standards of safety, security, and non-proliferation throughout the life of the nuclear program is outlined in the national nuclear policy, which also describes the role of the Kingdom's energy program.

The Nuclear and Radiological Regulatory Commission (NRRC) has prepared, in coordination with relevant entities in the Kingdom, the Convention on Nuclear Safety Joint 8th and 9th report. It demonstrates how the KSA continues to fulfil its obligations under the terms of the CNS during the reporting period. The KSA effectively maintained and, in many cases, enhanced its measures to meet its obligations under the CNS. These measures, which focus on the protection of the people and the environment, are implemented by the KSA’s nuclear regulatory authority, the NRRC, and enabled by a comprehensive national legislative framework. The KSA remains fully committed to the principles and implementation of the CNS by implementing ongoing improvements to ensure the greatest level of safety in the Kingdom and the world.

The Kingdom's efforts to fulfil the CNS obligations are detailed in this report. This report was prepared in accordance with Article 5 of the Convention (INFCIRC/499), which states: "Each Contracting Party shall submit for review, prior to each meeting referred to in Article 20, a report on the measures it has taken to implement the obligations of this Convention". The report follows the International Atomic Energy Agency (IAEA) information circular INFCIRC/572/Rev.6, titled "Guidelines for National Reports under the Convention on Nuclear Safety". The report provides the most recent developments, ongoing operations, and future intentions of the Kingdom's nuclear program the Saudi National Atomic Energy Project (SNAEP). It also describes the CNS-structured and-specified nuclear energy-related safety procedures. Relating to the CNS convention, this report demonstrates how the Kingdom meets the following objectives described in Article 1 of the Convention:

(i) to achieve and maintain a high level of nuclear safety worldwide through the enhancement of national measures and international cooperation including, where appropriate, safety-related technical cooperation

(ii) to establish and maintain effective defenses in nuclear installations against potential radiological hazards to protect individuals, society, and the environment from harmful effects of ionizing radiation from such installations

(iii) to prevent accidents with radiological consequences and to mitigate such consequences should they occur.

During the reporting period, the KSA addressed the two specific CNS challenges that were identified for the Kingdom at the Seventh Review Meeting:

> "Challenge 1: To develop academic, training, and licensing programs that serve the regulatory infrastructure human resources requirements needed to enable the spin-off of an effective independent Regulatory Body in 2020."
>
> "Challenge 2: To develop the nuclear safety regulatory infrastructure according to international best practices to ensure safety requirements in design, construction, and operation of nuclear facilities.

In relation to the first challenge, the Charter of the NRRC was approved on March 13, 2018 establishing the NRRC as "an independent legal entity with independent financial and administrative autonomy" and administratively linked it to the Chairman of the Council of Ministers, (Article 2) of the Charter.
To address the second challenge, the NRRC has commenced several activities to establish regulations on safety, security, and nuclear safeguards and ensuring their implementation. The regulations are based on the IAEA safety standards and international best practices. They address regulatory needs for safe operations of nuclear facilities at all stages.

PART II: INTRODUCTION

1. Overview:

The Kingdom of Saudi Arabia is transitioning from an oil-based economy to a diversified and productive economy founded on the principles of sustainability, competitiveness, fairness, transparency, and fostering a suitable investment climate for economic and social development, as well as the protection and development of national treasures. One of the challenges faced by the energy sector in the Kingdom is the consistent increase in fossil fuel-based energy consumption. This challenge necessitates the establishment of an energy sector capable of meeting the Kingdom's energy needs to produce electricity, desalinate water, and be used in various ways to help balance the Kingdom's economic development. This is essential for introducing peaceful nuclear energy into the national energy mix and maintaining the Kingdom's position as an energy-efficient country to achieve the ambitious Saudi Vision 2030. On July 24, 2017, the government in the Kingdom has approved the Saudi National Atomic Energy Project (SNAEP). The main objective of SNAEP is to introduce peaceful nuclear energy into the national energy mix and contribute to fulfilling Saudi Vision 2030.

One of the key components of the SNAEP is the construction of nuclear power plants (NPPs). Currently, there are no nuclear power plants in the Kingdom; however, the tendering process with vendors has begun and a site license application has been submitted to the regulatory authority, NRRC, for two pressurized water reactors (PWR) units ranging from 1.0 GWe to 1.7 GWe; however, the vendor has not yet been selected. The National Policy for the Atomic Energy Program has been approved by the KSA. The Kingdom's commitment to operational transparency and the highest standards of safety, security, and non-proliferation throughout the life of the nuclear program is outlined in this nuclear policy, which also describes the role of the Kingdom's energy program. This nuclear strategy takes into account the Kingdom's desire to develop its domestic nuclear power capacity for peaceful purposes in the most sustainable way possible.

The instrument of ratification of the Convention on Nuclear Safety was submitted by the Kingdom to the depositary on March 18, 2010. For the Joint 8th and 9th Review Meeting, the Kingdom is submitting its third national report under the CNS. The Kingdom's efforts to uphold the CNS obligations are detailed in this report. These responsibilities include those related to the legal and regulatory environment, the regulatory body, and technical safety obligations regarding the location, planning, development, and operation of nuclear facilities, the availability of sufficient financial and human resources, the assessment and verification of safety, quality control, and emergency preparedness.

The 8th Review Meeting was postponed due to the COVID-19 pandemic, and the 8th and 9th Review Meetings will be conducted jointly. This report was prepared in accordance with Article 5 of the Convention (INFCIRC/499), which states: "Each Contracting Party shall submit for review, prior to each meeting referred to in Article 20, a report on the measures it has taken to implement the obligations of this Convention." The report illustrates the most recent developments, current activities, and plans of the Kingdom's nuclear program (SNAEP). It also describes the CNS-structured and CNS-specified nuclear energy-related safety measures. This report is structured in accordance with the IAEA

Information Circular INFCIRC/572/Rev.6, titled "Guidelines for National Reports under the Convention on Nuclear Safety". The report consists of three main parts. The first part is the Executive Summary. The second part is the Introduction, where a recap of the key advancements in the nuclear energy program of the Kingdom is provided. Part III describes the nuclear safety measures of the Kingdom's obligation to the CNS (i.e. Articles 6 through 19 of the Convention).

The Kingdom of Saudi Arabia has made progress in its pursuit of introducing nuclear energy into its energy mix. The key accomplishments of the Kingdom over the past several years (2017–2022) to proceed in the SNAEP will be described in details in following parts of the report, which includes the approval of the national policy for the atomic energy program of the KSA [1.1], the approval of the relevant laws [1.2], the establishment of the national regulatory authority, the Nuclear and Radiological Regulatory Commission NRRC [1.3], and several other activities performed under King Abdullah City for Atomic and Renewable Energy K.A.CARE - as the promoter of the nuclear energy [1.4], and the newly established Saudi Nuclear Energy Holding Company (SNE) [1.5].

The Kingdom has expanded its efforts to fulfil its growing energy demands and reduce its reliance on fossil fuels by incorporating alternative sources of energy into its energy mix. The SNAEP was approved on July 24, 2017 to conduct a civil nuclear program with the purpose of contributing to the realization of Saudi Vision 2030. The SNAEP is focused on the deployment of the first nuclear power plant in the kingdom with two reactors, and this report will address the progress made in this project. Recently, SNE has submitted a site license application for the first NPP. In addition, the SNAEP contained other activities, including conducting feasibility studies on the use of small modular reactors for power generation, water desalination, and thermal applications. These feasibility studies have been conducted for the Korean System-Integrated Modular Advanced Reactor (SMART) and are being considered for other SMRs, such as the Chinese High-Temperature Gas-Cooled Reactor (HTGR). The NRRC has participated in the SMR regulatory forum's second phase. K.A.CARE has developed a special on the job training program with the Korea Atomic Energy Research Institute (KAERI). The program aimed to train K.A.CARE participants on the important features in designing the Korean System-Integrated Modular Advanced Reactor (SMART). Approximately forty engineers have been engaged in the program for more than two years. K.A.CARE withholds its activities for planning to construct SMRs as the Kingdom is focusing at this stage on the deployment of its first NPP. Uranium exploration is also considered in the SNAEP, feasibility studies are going on for uranium mining consideration.

1.1 National Policy for the Atomic Energy Program

Stemming from its desire to fulfil its obligations to the international community, as stipulated by international treaties and conventions, and to adhere to international best practices, the Kingdom has adopted the following basic characteristics and principles in its atomic energy program:

1. Limiting all nuclear development activities to purposes within the limits of legislation, and international treaties and conventions;
2. Complying with the principle of transparency in all regulatory and operational aspects of the program;
3. Applying nuclear safety and security standards in nuclear and radiological facilities in accordance with the independent regulatory and monitoring framework;

4. Ensuring optimal use of the Kingdom's natural resources of nuclear material and applying international best standards and practices for radioactive waste management; and
5. Achieving sustainability by developing local content in the atomic energy sector.

1.2 Legislative Framework

The highest level of the legislative framework in the Kingdom has been established by the approval and enactment of three major legal documents. These instruments are:

1. The Charter of the Nuclear and Radiological Regulatory Commission (the Charter, approved on March 13, 2018).
2. The Nuclear and Radiological Control Law that was approved by Royal Decree on April 10, 2018. It aims to achieve the highest standards of security, safety and nuclear safeguards for activities and facilities, provide adequate protection for human beings and the environment against the harmful effects of ionizing radiation, and to fulfil the Kingdom's obligations under treaties and conventions.
3. The Law of Civil Liability for Nuclear Damage that was approved on April 10, 2018 and is intended to regulate the provisions on compensation for nuclear damage caused by a nuclear accident within the territory of the Kingdom, as well as the accidents occurring outside the Kingdom during transfers to and from the Kingdom for which the operator is responsible. The law is in line with the Vienna Convention on Civil Liability for Nuclear Damage and its amendments, as the KSA is a party to the Vienna Convention and Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage.

1.3 Nuclear and Radiological Regulatory Commission (NRRC)

After the approval of the NRRC charter, all regulatory activities and functions were moved from the Atomic Energy Regulatory Division (AERD) of K.A.CARE to the newly formed commission. The NRRC is currently working on completing its regulatory framework. Sixteen (16) regulations have been approved. Further details will be provided in Section (7) and (8) of this report.

Early engagement plan has been developed between the NRRC and both K.A.CARE and SNE to provide regulatory requirements and feedback on the NPP project. A communication protocol has been developed to control the communication with NRRC in this matter. Moreover, the NRRC has hired national and international expertise to support the NRRC in its mandate. NRRC is also supported by technical support organizations in certain technical areas. Presently, the NRRC is reviewing the site license application submitted by the SNE on May 31st, 2022.

1.4 King Abdullah City for Atomic and Renewable Energy (K.A.CARE)

Since its establishment in 2010, King Abdullah City for Atomic and Renewable Energy (K.A.CARE) is promoting nuclear energy in the Kingdom, leading the efforts in the Saudi National Atomic Energy Project (SNAEP), setting up the infrastructure for introducing nuclear energy to the Kingdom, and incubating national regulatory as well as the owner/operator activities. Regulatory activities have been completely transferred to NRRC while owner/operator activities have been transferred to SNE gradually. Below are some of the activities conducted by K.A.CARE:

1. An Integrated Time Schedule for the first nuclear power plant in the Kingdom was developed and approved by the government.
2. Nuclear power plant bid package development and Bid Invitation Specification (BIS/RFP) was prepared and launched.
3. Competitive dialogue with the vendors of nuclear technology was initiated.
4. Comprehensive site survey for the first NPP in the Kingdom has been completed and full site characterization studies for the site of the first nuclear power plant, utilizing technical support organizations, was carried out for the preferred site.

After the establishment of NRRC and SNE, the mandate of has been reviewed. In June 2022, the government has approved the new mandate which includes:

1. Managing radioactive waste at the national level.
2. Conducting studies and research in the fields and applications related to atomic and renewable energy to develop the local content.
3. Providing technical and advisory services to support the peaceful uses of atomic energy and renewable energy applications and raise their contribution to the energy mix.
4. Develop programs to stimulate the private sector to support research and innovation programs and develop human capabilities and local content in the fields and applications of atomic and renewable energy.
5. Raising awareness in the fields and applications of atomic and renewable energy.

1.5 Saudi Nuclear Energy Holding Company (SNE)

On February 12, 2020, the Saudi Nuclear Energy Holding Company (SNE) was established, and all nuclear power plant-related activities were transferred from K.A.CARE to the newly formed company. According to its establishment royal decree, the head office of SNE shall be located in the city of Riyadh, and branches or offices, inside or outside the Kingdom, can be established. The Company's purpose is to invest in the peaceful application of the nuclear energy sector, locally and internationally. The SNE will have subsidiaries, one of which will be the owner/operating firm of the NPPs and SNE may establish or own companies alone or jointly whether inside or outside the Kingdom.

The SNE will continue all the NPP-related activities that were previously conducted by the K.A.CARE. SNE and K.A.CARE is working together to ensure coordinated and smooth transition of activities. K.A.CARE staff who were working on NPP-related activities are working now for the SNE.

2. Seventh CNS Meeting Challenges

During the Seventh Review Meeting, two challenges for the Kingdom were identified:

> ***"Challenge 1: To develop academic, training, and licensing programs that serve the regulatory infrastructure human resources requirements needed to enable the spin-off of an effective independent Regulatory Body in 2020."***

On March 13, 2018, a royal decree was issued to establish the Nuclear and Radiological Regulatory Commission (NRRC). Subsequently, the legislative framework was approved and most recently, the regulations were also approved; additional information will be presented in Section (7). The

government, through the provisions in the law of Nuclear and Radiological Control, has empowered the NRRC to make any safety-related decisions deemed essential and ensured the regulatory body's independence by directly linking it to the prime minister of the government. The foundations of the regulatory authority were planned through a partnership between K.A.CARE and an internationally renowned regulatory organization. The partnership concentrated on planning for regulatory infrastructure, drafting its legislative and regulatory framework, conducting workshops to support the development of human capacity, and supporting regulatory oversight activities. Human capacity building has been one of the NRRC's main priorities since its inception; a specifically planned training program has been conducted with international organizations, in addition to the continued participation in IAEA training programs and technical seminars. Numerous projects have been initiated by the NRRC, with its establishment and the transfer of expertise being essential components of each of these projects.

"Challenge 2: To develop the nuclear safety regulatory infrastructure according to international best practices to ensure safety requirements in design, construction, and operation of nuclear facilities."

The statute of NRRC defines the powers and responsibilities of the commission, which include developing regulations on safety, security, and nuclear safeguards and ensuring its implementation. As a result of the partnership mentioned in Challenge 1, regulations were drafted by following a systematic procedure to ensure their adequacy and consistency with IAEA safety standards and international best practices. Section (7) in this report provides additional information on the regulations and its development process. These regulations address regulatory needs for the different stages of nuclear facilities. To complete its regulatory framework, the NRRC started the development of regulatory guidance materials.

Moreover, NRRC has established its own laboratories and its own necessary regulatory infrastructure to strengthen its technical capabilities to enable it to verify and assure safety in an independent manner.

3. International Peer Review Missions

3.1 Integrated Nuclear Infrastructure Review (INIR) Mission

A self-evaluation study of the infrastructure for nuclear power had been conducted by K.A.CARE with the participation of twelve organizations involved in the nuclear power program. The Integrated Nuclear Infrastructure Review (INIR) that had been resulted from this self-evaluation process was based on the IAEA Nuclear Series publication titled "Evaluation of the Status of National Nuclear Infrastructure Development" (NG-T-3.2 (Rev.1)). The INIR report was sent to the IAEA in May 2018, along with the supporting documents containing 19 infrastructure issues.

Phase two of the INIR was conducted between July 15, 2018 and July 24, 2018 and was held in K.A.CARE in Riyadh. The mission of phase two was conducted over a five-day period in a cooperative and open atmosphere. The IAEA conducted the assessment of the Saudi infrastructure and reported that significant progress in the development of nuclear power infrastructure has been achieved in the

Kingdom with a well-established legislative framework. Comprehensive studies were carried out to support the next steps of the program. The mission of phase two ended up assisting the Kingdoms infrastructure for further progress by giving 21 recommendations and 10 suggestions. It has also identified 5 good practices that may benefit newly countries in the introduction of nuclear power. As a result of the mission, an integrated work plan has been developed and implementation started.

3.2 International Regulatory Review Service (IRRS) Mission

The NRRC is working with IAEA to plan an Integrated Regulatory Review Service (IRRS) mission to review regulatory framework and regulatory infrastructure for safety in accordance with IAEA safety standards. NRRC has started the self-assessment processes in preparation for conducting this mission. Initial plans for conducting the mission was delayed due to COVID-19 pandemic. Work is under progress to plan the mission before the end of 2023.

4. Communication with the Public

K.A.CARE has maintained active programs of public engagement. Those programs range from launching the website of K.A.CARE (which provides simplified information about the Kingdom's nuclear program) to an Interactive Exhibition called (Mishkat) located at K.A.CARE's headquarters. The exhibition is intended to introduce nuclear and renewable technologies to the general public and school children in a simplified and engaging manner, explaining the rationale and tactics for incorporating nuclear power safely into the nation's future energy mix.

NRRC also initiated public awareness programs to promote a culture of nuclear safety via social media platforms and participation in awareness-raising events. NRRC also engaged relevant stakeholders and members of the public in the development process of its regulations. After NRRC finalized its regulations and obtained stakeholder feedback, the regulations once again were shared in a national Public Consultation platform, which is a unified electronic platform affiliated with the National Competitiveness Center (NCC) to solicit the opinions of the public, the private sector and government agencies regarding the laws or regulations issued by government agencies. Through this platform, organizations or individuals can engage and review to raise comments or observations on NRRC’s published documents. The NRRC has received comments through this platform on its regulations, which was taken into consideration and addressed before the approval.

5. Emergency Exercises, Drills, and ConvEx-3 2021

The NRRC utilizes the IAEA-organized training programs, technical meetings, and seminars by exchanging knowledge and expertise in the field with other experts from the IAEA and other participating member states to enhance the capabilities of its human resources. Additionally, the NRRC organizes specialized training programs created in collaboration with international organizations, labs, and regulatory bodies to build specialized competencies in particular subjects.

The NRRC conducts and participates in multiple exercises and drills annually on the organizational, national, and international levels to test the response procedures to nuclear and radiological incidents or accidents. They include tabletop, functional, and full-scale exercises that were designed to ensure

that all the specified functions to be performed by NRRC's Emergency Operations Center (EOC) and First Responders Team (FRT) with national stakeholders are executed effectively and efficiently.

The KSA participated in the IAEA organized exercise (ConvEx-3 2021) to assess the arrangements for responding to a nuclear emergency. The Kingdom shares borders with the accident state (United Arab Emirates (UAE)), and Barakah NPP is located less than 60 km from the borders. The exercise provided a chance for the Kingdom to test the integration of its arrangements and coordination at the national and international levels in responding to such nuclear emergencies.

For Saudi Arabia, the National Plan for Radiological and Nuclear Emergency is the implemented plan for responding to nuclear emergencies. The exercise was an opportunity to assess the preparedness and response of all the national organizations involved in the National Plan for Radiological and Nuclear Emergency Response (NPRNER). During the exercise, the Emergency Operation Center (EOC) within the NRRC has modeled and simulated the radiation plume, extrapolating its behavior and its radiation effects and monitoring the radiation dose levels of the plume, and implemented proactive measures.

PART III: Compliance with Articles 6 to 19

6. Existing Nuclear Installations

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 shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

There are no operating nuclear power plants in the Kingdom currently. However, as per SNAEP, work is on progress for the tendering process for the first nuclear power plant. The site license application has been submitted to the NRRC on May 2022 by the SNE. King Abdulaziz City for Science and Technology – KACST – is constructing a Low Power Research Reactor located at KACST campus in Riyad.

7. Legislative and Regulatory Framework

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 licence;

iii. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;

iv. the enforcement of applicable regulations and of the terms of licences, including suspension, modification, or revocation.

7.1 Establishing and Maintaining a Legislative and Regulatory Framework

The nuclear legislative framework of the KSA consists of five different levels, as shown in Figure 1. The top level consists of the government-issued national policies for the Atomic Energy Program, Radioactive Waste Management, and Occupational Safety and Health (Royal Decree). The second level is legislation, which comprises of government-issued laws (Royal Decree). The third level is the regulations issued by the NRRC board, which contain mandatory regulatory requirements that licensees must fulfil. The fourth level consists of the technical codes and standards which is identified by NRRC and issued to Saudi Standards, Metrology and Quality SASO for authentication. The regulatory

guides, which are also issued by the chief executive officer of the NRRC and provide guidance and interpretations on how to implement the regulations, comprise the fifth level of the legislative structure.

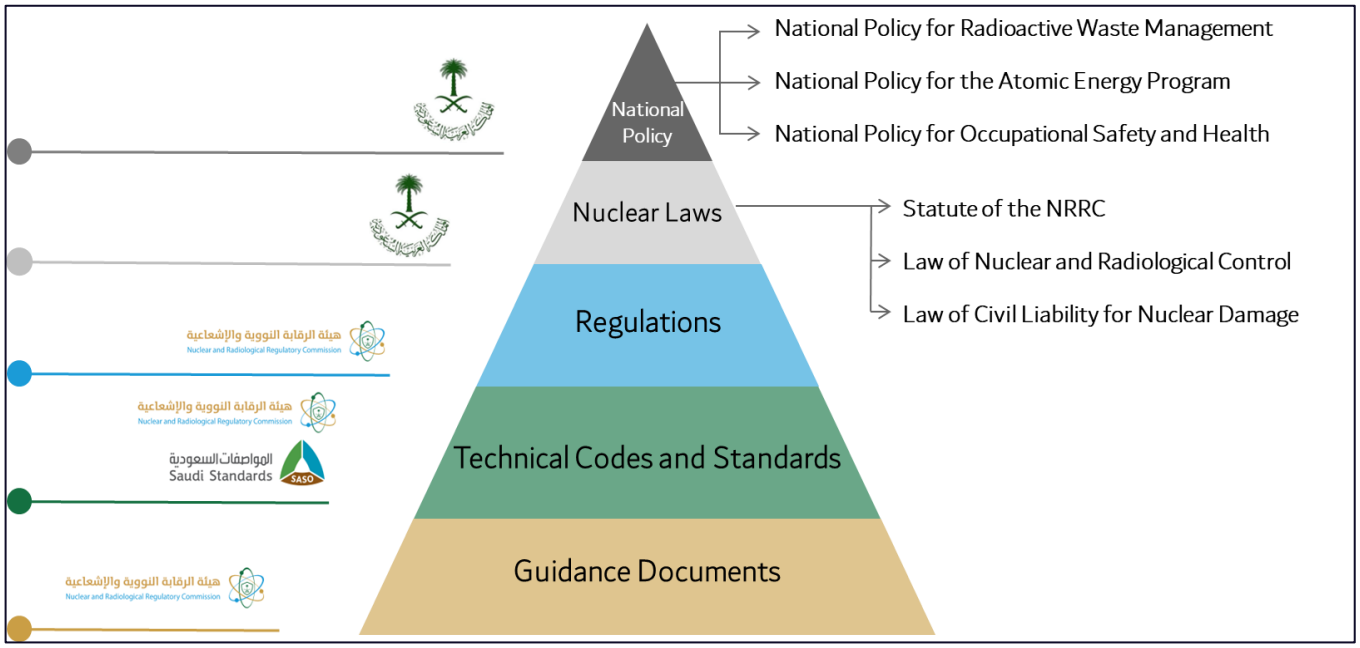

Figure 1. Hierarchy of the KSA legal and regulatory framework.

Since the previous CNS meeting, the KSA has made major legislative and regulatory framework advancements. The Cabinet of Ministers issued the National Policy for the Atomic Energy Program on March 3, 2018, and on February 16, 2022, the Cabinet of Ministers issued the National Policy for Radioactive Waste Management. In addition, the KSA enacted the following three comprehensive laws: One of these statutes is the charter for the formation of the NRRC [7] and the transfer of all regulatory responsibilities and activities from K.A.CARE to the newly formed commission. The laws were drafted following a comprehensive analysis of local and international legislation and consultation with national stakeholders, international legal firms, and other organizations. The NRRC then has utilized IAEA services to review the laws prior to its approval. Comments of the IAEA have been considered. The following are the three laws:

The Charter of the Nuclear and Radiation Safety Regulatory Commission (approved on March 13, 2018; "the Charter"). The Charter outlines the legal structure and mandates of an independent regulatory authority. Section (8) of this report provides a description of this Charter.

The Law of Nuclear and Radiological Control ("the Nuclear Law", approved on April 10, 2018). The Nuclear Law was drafted considering IAEA Safety Fundamentals SF-1 along with international best practices, then reviewed for feedback by regulatory authorities, utilities, and legal firms and the IAEA to ensure the law's inclusion as well as its alignment with the IAEA's terminology.

The Law on Civil Liability for Nuclear Damage ("the Liability Law", approved on April 10, 2018). The purpose of this law is to specify the governing compensation for nuclear damage. It contains provisions on definitions, operator's liability, liability during transport, liability amount, financial guarantee. The law is in line with the Vienna Convention on Civil Liability for Nuclear Damage and its amendments, as the KSA is a party to the Vienna Convention and Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage.

The KSA is also a party of the following international legal instruments, and these instruments have been implemented through actions at the national level, such as enacting nuclear legislation reflecting provisions and obligations under these instruments. The KSA is party of the following legal instruments:

- Treaty on the Non-Proliferation of Nuclear Weapons (1988)
- Convention on Early Notification of a Nuclear Accident (INFCIRC/335);
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (INFCIRC/336);
- Convention on Nuclear Safety (INFCIRC/449) ("CNS");
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management ("Joint Convention") (IN-/274/Rev.1/Mod.1);
- Vienna Convention on Civil Liability for Nuclear Damage (INFCIRC/500);
- Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (INFCIRC/566);
- Comprehensive Safeguards Agreement with the IAEA;
- Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA;
  Convention on the Physical Protection of Nuclear Material (INFCIRC/274);
- Amendment to the Convention on the Physical Protection of Nuclear Material (INFCIRC/274/Rev.1/Mod.1).
- International Convention for the Suppression of Acts of Nuclear Terrorism (2007) - UN
- UNSC Resolutions under chapter VII of UN Statue (such as UNSC Resolution No 1540)

The KSA government has signed many of bilateral agreements with many of neighboring countries, and nuclear countries. The scope of those agreements was specifically for the peaceful uses of the nuclear energy field. The agreements include various forms of cooperation that include transfer of knowledge and exchange of relevant experiences with these countries, and benefiting from of the experiences in the different fields, such as training and development of human resources, nuclear safety and related systems, and design, construction, operation and maintenance of nuclear power plants within the framework of safety and co-development of innovative reactor technologies in accordance with the IAEA safety standards. The list of bilateral agreements includes the following countries:

1. Arab Republic of Egypt.
2. United Arab Emirates.
3. The Republic of France.
4. The Republic of Finland.
5. The Russian Federation.
6. The People's Republic of China.

7. The Government of Hungary.
8. The Argentine Republic.
9. The Republic of Korea.
10. The Republic of Kazakhstan.
11. The Kingdom of Morocco.

The KSA also has memorandums of understanding with the following regulatory and technical support organizations for the purpose of knowledge transfer and exchange of relevant experiences:

1. National Nuclear Safety Administration (NNSA)
2. Nuclear Safety and Security (NSSC)
3. Korea Institute of Nuclear Safety (KINS)
4. Institute of Radiological Protection and Nuclear Safety (IRSN)
5. Finnish Radiation and Nuclear Safety Authority (STUK)

And there are cooperation with many other regulatory authorities like:

6. Emirates Authority for Nuclear Regulation
7. The National Nuclear Safety Office of the Czech Republic
8. Spanish Nuclear Safety Council

7.2.1 National safety requirements and regulations

The NRRC created a roadmap for developing the required set of regulations and guides with the support from its strategic partner, the Finnish regulatory authority STUK. A performance-based approach has been followed in drafting the Regulations. The regulations contain performance-based mandatory requirements complemented by other prescriptive requirements where necessary. The regulations are structured in accordance with the latest IAEA Safety Requirements, and covers all relevant areas, which includes safety, safeguards, nuclear facilities security, and other radiological areas. The IAEA Safety Requirements were updated due to the lessons learned from the TEPCO Fukushima Daiichi accident in 2011 and it have been used as a reference for drafting the regulations. The regulations approved by the NRRC board are:

1. Regulation on Radiation Safety
2. Regulation on Notification on and Authorization of Facilities and Activities with Radiation Sources
3. Regulation on Licensing and Regulatory Oversight of Nuclear Facilities
4. Regulation on Leadership and Management for Safety
5. Regulation on Site Evaluation of Nuclear Facilities
6. Regulation on the Design of Nuclear Facilities
7. Regulation on Safety Assessment of Nuclear Facilities
8. Regulation on Construction and Commissioning of Nuclear Facilities
9. Regulation on Operations of Nuclear Facilities
10. Regulation on Decommissioning of Nuclear Facilities
11. Regulation on Nuclear Security
12. Regulation on Nuclear Material Accountancy and Control

13. Regulation on Nuclear Facilities Emergency Preparedness and Response
14. Regulation on Management of Radioactive Waste
15. Regulation on Security of Radioactive Materials
16. Regulation on Authorization and Regulatory Control of Nuclear-Related Items

In the process of developing the regulations, the NRRC follows a set of action plans and procedures that can be summarized in Figure 2. Initially, a cooperation with the Finish regulatory authority STUK has been established with the purpose of drafting, reviewing, and finalizing the regulations documents. To achieve this objective, both the content of each regulation and the references to be used in the development of these regulations has been documented in a Document Preparation Profile (DPP). After the development of the first draft of the regulation, five activities and revisions were performed as follows:

- NRRC committee review
- International experts review
- National stakeholders review
- IAEA expert mission review
- Final version preparation for the board approval

At the end of each activity, NRRC discusses the feedback with STUK and recommendations were integrated into the regulation document appropriately. Before the submission of the regulations for the NRRC board approval, the regulations were shared in a Public Consultation platform to allow any organization or individual to comment on it. It worth mentioning that the development process has received positive remarks from the INIR mission that was conducted in 2017.

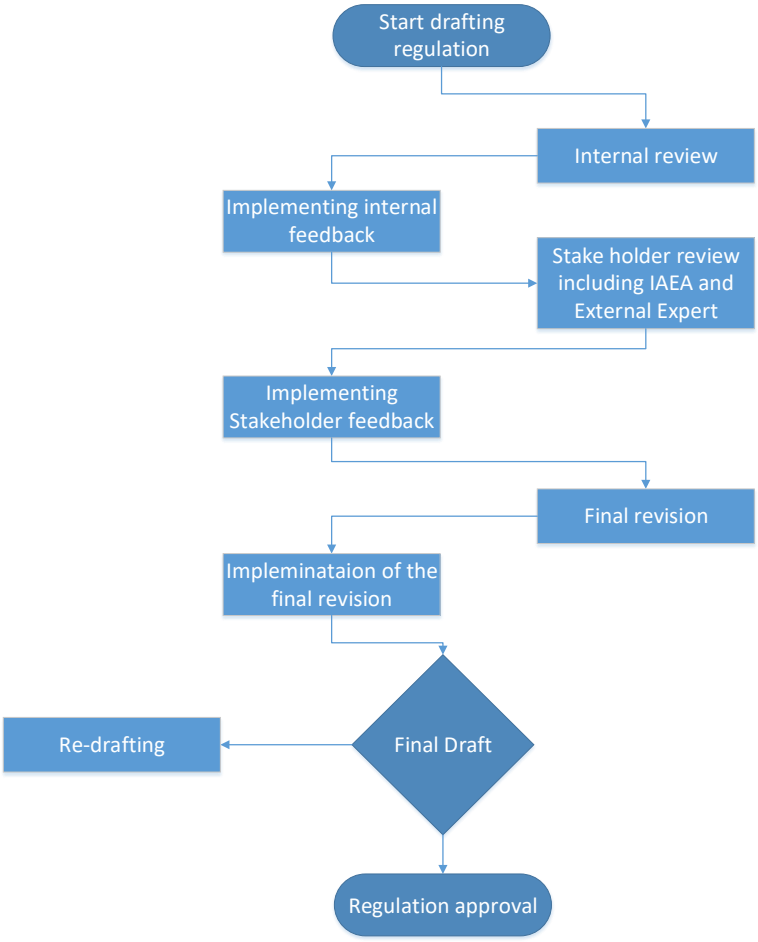

Figure 2: Regulatory process in the development of national regulations.

The NRRC is currently working on developing regulatory guides development plan. Two of these guides have been drafted and it is in the final stages for approval. In addition, KSA has supported and endorsed two codes of conducts which are Code of Conduct on the Safety and Security of Radioactive Material as well as the Code of Conduct on the Safety of Research Reactors.

7.2.2 System of licensing

The Nuclear Law empowers NRRC to set up the licensing process and develop license classifications. The responsibilities of the NRRC include the following: safety, security, and safeguards. The Nuclear Law explicitly requires applicants to inform the NRRC in advance of their intention to establish a nuclear facility. Furthermore, the Nuclear Law requires in Article 9 that the organization intending to establish and operate a nuclear facility should obtain approval from the council of ministers prior to initiating the licensing process with the NRRC. The Law is prohibiting any aspect related to starting of any nuclear or radiological activities without obtaining a license from the NRRC, as stated in Article 5 in this law.

The regulation on Licensing and Regulatory Oversight of Nuclear Facilities includes detailed information on licensing process, requirements, and information required for the license applications. Applying for

a license for a nuclear facility, as clarified in the Licensing Regulation, consists of four consecutive licensing stages. These stages are site license, construction license, operation license, and decommissioning license. The regulation describes extensively the required data in the process of applying for each license of those and the requirements criteria which need to be met before granting the license by the NRRC.

7.2.3 System of regulatory inspection and assessment

According to the Nuclear Law, NRRC is responsible for establishing an inspection program on nuclear and radiological facilities. In addition, according to Article 10 of the Nuclear Law, it empowers the regulatory authority to assign inspectors, conduct inspections, and monitor activities and facilities for the purpose of verifying compliance with authority's laws and license conditions.

The "Safety Assessment of Nuclear Facilities" regulation outlines the regulatory requirements for the safety assessment of nuclear facilities at all stages of the facility's life. Regulation requirements include both design-oriented assessments and periodic safety reviews. NRRC has already developed inspection procedures for research reactors in collaboration with STUK. These procedures are intended to aid the NRRC in conducting inspections for LPRR and will be expanded to include all nuclear activities and facilities. In addition, the NRRC intends to oversee all pertinent aspects of nuclear safety during various phases of the facilities included in this inspection program. This program includes periodic inspection procedures and technical conformity inspections focusing on manufacturing, installation, and commissioning of SSCs.

Recently, NRRC has signed contracts with several technical support organizations to support the NRRC in building capacity in the safety reviews of the Preliminary Site Evaluation Report (PSER) for the first NPP in the KSA, and the safety reviews for the commissioning and the operation stage of the LPRR. The objective of these contracts is to transfer knowledge to NRRC staff and develop necessary competencies to be able to conduct safety assessments for license applications for nuclear facilities.

7.2.4 Enforcement of applicable regulations and terms of licenses

The NRRC Charter and The Law of Nuclear and Radiological Control both explicitly mention the NRRC authority to carry out enforcement. According to Article 20 of the Law, the NRRC of is empowered to carry out inspecting and monitoring activities and facilities under its supervision, as well as to look out for infractions and to respond appropriately to them. In order to carry out this enforcement duties, Article 21 of the law states that NRRC has the right to enter any facility and compel facility operators to take corrective action. Article 22 states that NRRC has the authority to impose fines and penalties for any violations. The licensee also has the option to petition for an appeal against the charge of violating enforcement measures in a neutral court. In fact, consideration was given to the suspension, modification, and revocation of licenses when formulating the regulation on licensing and regulatory oversight of nuclear facilities. Currently, the NRRC intends to develop a comprehensive enforcement program with precise instructions on how to take enforcement action.

8. Regulatory Body

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.

8.1 Establishment of the Regulatory Body

Cabinet of Ministers resolution No. 334 enacted the transfer of all nuclear and radiological regulatory activities from K.A.CARE to NRRC on March 13, 2018, making NRRC the regulatory authority for the nuclear and radiological sector in the KSA. The NRRC is a relatively new organization, and it is in the process of being established as the national nuclear and radiological regulatory authority responsible for protecting the public and the environment of the Kingdom from ionizing radiation through the implementation of regulations and the execution of nuclear regulatory programs in safety, security, radiation protection, and safeguards. This is to be carried out in accordance with international best practices and in collaboration with the International Atomic Energy Agency (IAEA). The NRRC Charter describes its responsibilities, powers, organizational structure, governance, functions, as well as its financial resources and budget. According to the Charter of the NRRC, Article (3) states that it is the responsibility of NRRC "to regulate activities, practices, and facilities involving peaceful use of nuclear energy and ionizing radiation; to control and ensure the safety and security of such use and compliance with nuclear safeguards, to protect humans and the environment against any actual or potential exposure to radiation, including exposure to natural radiation, and to implement the Kingdom's obligations under relevant treaties and conventions". The duties and powers of the commission as defined in the Charter are:

- Setting policies and regulations to ensure the monitoring of activities, practices, and facilities;
- Setting regulations on safety, security, and nuclear safeguards, as well as ensuring implementation thereof;
- Monitoring the processes of exporting, importing and circulation of nuclear materials, nuclear-related items, and radioactive materials;
- Setting requirements for nuclear and radiological emergency preparedness;
- Controlling and inspecting activities, practices, and facilities within its jurisdiction;
- Raising awareness of the risks of ionizing radiation;
- Cooperating with relevant governmental agencies and similar authorities in other countries and international organizations;
- Representing the Kingdom in the IAEA and other relevant international organizations; and
- Any other task the Commission deems necessary to protect humans and the environment from the risks of ionizing radiation.

The NRRC is governed by a board which has a chairman appointed by a Royal Decree and five members appointed by the Cabinet of Ministers with a recommendation from the chairman. The NRRC Board of Directors appoints the Chief Executive Officer. The NRRC is now in the organization-building phase, during which numerous aspects and activities are being thoroughly evaluated. The organization structure of the NRRC is shown in Figure 3.

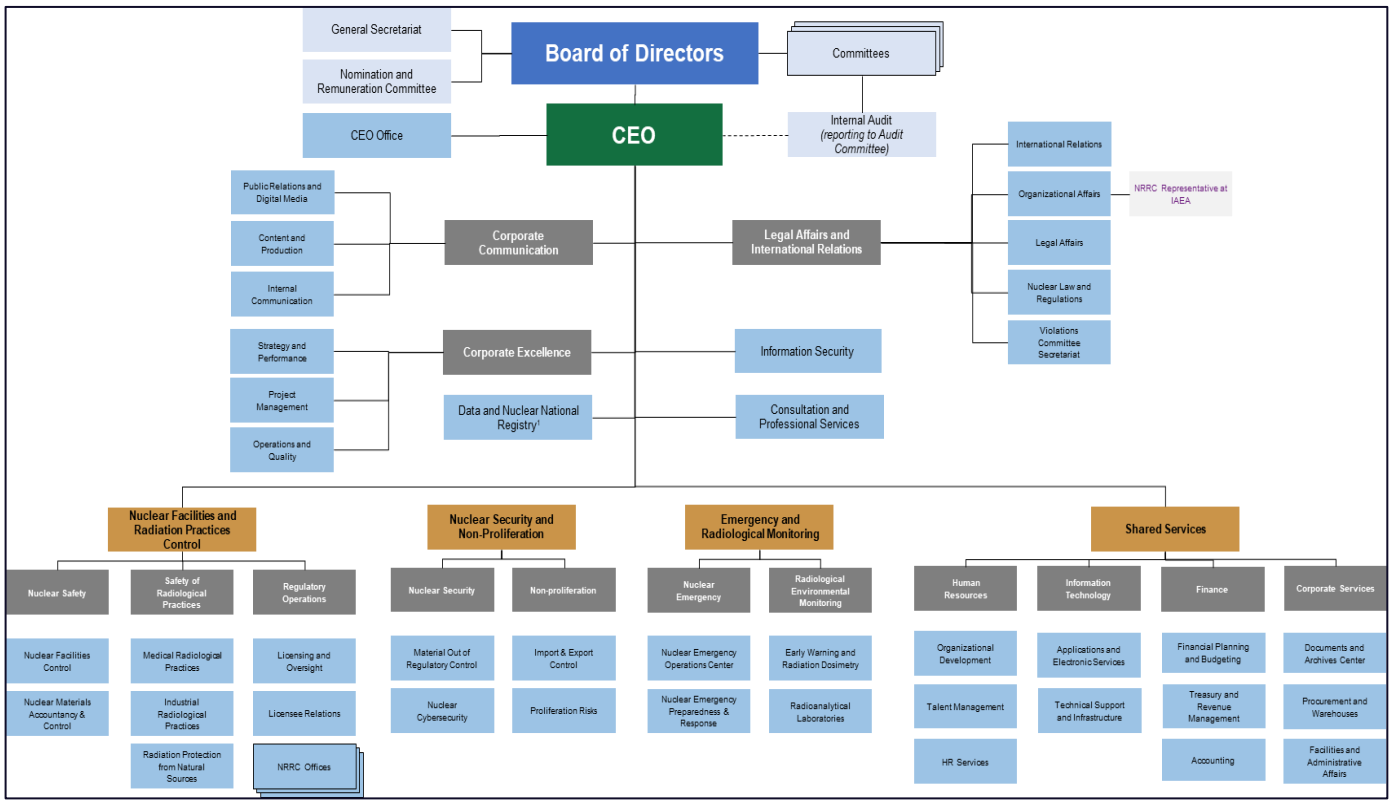

Figure 3. NRRC organizational structure.

On the basis of benchmarking studies and the quantity of present and future regulatory work, NRRC also prepared a human resource development plan to determine the human resources needed for each sector and the requisite competencies. In relation to this, NRRC is continuously working to improve the staff's competencies on a continuous basis through training and development programs. For example, an 18-month training program on nuclear safety was conducted in South Korea in collaboration with KINS for 15 NRRC staff. Additionally, the NRRC intends to use experienced international technical support organizations to assist with its regulatory activities. For example, NRRC has signed a contract with an internationally experienced organization to get technical support in reviewing the site license application for the first nuclear power plant.

NRRC has also begun to develop an integrated management system to manage all its activities. During the development of the management system, numerous references were taken into account, and the following references serve as examples:

- SF-1, Fundamental Safety Principles.
- GSR Part 1: Governmental, Legal, and Regulatory Framework for Safety, 2016.
- GSR Part 2: Leadership and Management for Safety, 2016.

- DS472: Organization, Management, and Staffing of the Regulatory Body.
- DS473: Regulatory Functions and Processes.
- Nuclear Law of the KSA.
- ISO 9000:2015, Quality Management Systems- Fundamentals and vocabulary.
- ISO 9001:2015, Quality Management Systems- Requirements.
- ISO 9004:2009, Managing for the sustained success of an organization: A quality management approach.

8.2 Status of the Regulatory Body

Article (2) of the charter of NRRC states that, to maintain the NRRC's independence and autonomy, it is linked directly to the Prime Minister: "The Commission shall enjoy a public legal personality with financial and administrative autonomy. It shall report to the Prime Minister". Effective separation is ensured between the duties and responsibilities of NRRC and any other promoting organizations, such as K.A.CARE or SNE, through the granted power NRRC by the three approved laws Section (7.1).

9. Responsibility of the License Holder

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.

According to the Law of Nuclear and Radiological Control, the authorized person holds primary responsibility for nuclear activity safety, security, and safeguards, even if the license is suspended, revoked or not renewed. In addition, the authorized person shall:

- Comply with laws as well as terms and provisions stated in the licenses issued according.
- Employ qualified staff to perform the licensed activity.
- Provide necessary means and training to prevent staff exposure to radiation hazards.
- Keep accounting and operational records of nuclear and radioactive materials and submit periodic reports to the NRRC.

Furthermore, the Regulation on Licensing and Regulatory Oversight of Nuclear Facilities states clearly that the licensee retains the responsibility for safety throughout the lifetime of facilities and for all related activities. It is also stated that this responsibility cannot be delegated.

In order to assure the licensee is fulfilling his duties and responsibilities as being the responsible for safety, there are many articles in the laws and regulations indicating these responsibilities and duties of the licensee. An additional requirement is also stated with the purpose of obligating the licensee to prove to NRRC that appropriate measures were taken, and adequate studies, analysis, and assessments were done. According to the Regulation on Licensing and Regulatory Oversight of Nuclear Facilities, it is required from the licensee to continuously and actively evaluate progress in science and technology as well as relevant information gained from the feedback of experience. The Regulation also clarifies that the licensee/a license applicant shall submit an adequate demonstration of safety in support of an application for the authorization of a facility or an activity. The licensee will not be exempted from fulfilling any other laws or regulations of the KSA.

The regulations of the NRRC require licensees to have all resources necessary for the safe operation and emergency response of a nuclear site. No license shall be issued until the NRRC is sure that the applicant has sufficient resources for the plant's safe operation. Article (5) of the Nuclear Law states that "A license applicant shall have the means, capabilities, and financial resources needed to carry out the activity subject of the license, taking into consideration the fulfillment of the requirements of nuclear safety, security, and safeguards".

10. Priority to Safety

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.

The KSA has enacted the national policy for the atomic energy program mentioned previously in Section (7) stating that "The Kingdom focuses on the principle of safety first and seeks to compel those involved in the atomic energy program to strictly comply with the applicable laws and regulations in a manner consistent with the nuclear and radiological safety culture". This national policy compels all stakeholders in the nuclear program to take all necessary measures to fulfil this principle. The NRRC has also integrated these requirements for prioritizing safety in all their regulations. Examples of these requirements are quoted from the Regulations and listed below:

Regulation on the Design of Nuclear Facilities

"A systematic design process shall be established to ensure the quality of the design of each system, structure, and component, as well as the safety of the overall design of the nuclear facility. All organizations engaged in the design of a nuclear facility shall give safety matters the highest priority".

Regulation on the Safety Assessment of Nuclear Facilities

"The operating organization and management system, and the feedback obtained and received on safety culture and leadership shall be reviewed to determine whether they are adequate and effective to prioritize safety when operating the nuclear facility".

Regulation on the Leadership and Management for Safety

"The licensee shall be responsible for establishing, implementing, sustaining, and continuously improving a management system that gives due priority to safety".

"Managers at all levels in the organization shall demonstrate leadership for safety and commitment to safety. The management shall establish, advocate, and adhere to an organizational approach to safety that stipulates that safety is an overriding priority" and "Safety shall take priority in all decisions and operations at all levels in the organization, and complacency with regard to safety shall be discouraged."

Regulation on the Construction and Commissioning of Nuclear Facilities

"The licensee is responsible for establishing and implementing an integrated management system for the construction of a nuclear facility, giving due priority to safety. Responsibilities of the organizations participating in construction activities shall be clearly defined in the management system."

"The licensee is responsible for establishing and implementing a management system for the commissioning of a nuclear facility, giving due priority to safety. Responsibilities of the organizations participating in commissioning activities shall be clearly defined in the management system."

There are many other requirements from different regulations, which are linked directly and indirectly to prioritizing safety.

As per Section (6) of this report, there are no nuclear power plant installation in the Kingdom. However, there are plans to build the first NPP (with two reactors). However, K.A.CARE has implemented a Safety Policy and a Safety Culture program in 2021, both of which emphasize the priority that should be given to safety. Further initiatives to emphasize the priority that should be given to safety will be implemented by the SNE. Moreover, it is intended that requirements to prioritize nuclear safety and to implement organizational policies and associated programs will be embedded into all contracts associated with the engineering, procurement, and construction of the first NPP project.

The NRRC is also establishing an integrated management system that puts safety in forefront of the system. All functions, processes, and procedures are driven by the concept of safety first. The NRRC is conducting all activities in accordance with prioritizing safety concept. These activities include developing the capabilities of NRRC by cooperation with technical support organizations to complete regulatory framework and regulation infrastructure and training of professionals. Furthermore, engagement in bilateral and multilateral cooperation forums with the objectives of acquiring knowledge about international best practices in nuclear safety and making extensive use of the worldwide operational experience.

11. Financial and Human Resources

1. 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.

2. 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.

11.1 Financial Resources

The government will provide the adequate financial resources required to safely build and operate the project. The detailed funding plan is under discussion and will be finalized once the final nuclear technology vendor is selected.

NRRC is fully funded by the government. NRRC is provided financial resources to be able to carry out its duties and mandate. Moreover, as per its Charter, NRRC receives fees for its licensing activities. The board of directors has lately approved financial fees for NRRC licensing activities.

11.2 Human Resources

A As stated in Section (7), the Regulation on Leadership and Management for Safety requires the licensee to demonstrate that the required skills and resources to carry out the organization's activities safely are available. In addition to ensuring that the competency requirements for key individuals at all levels are stated and training plans are submitted for regulatory approval, one of the goals of this regulation is to ensure that these requirements are met.

K.A.CARE initiated a project to develop The Human Capacity Building HCB strategy and Implementation Roadmap for the Atomic Energy Sector to identify the needed workforce requirements and to bridge the gap between the necessary and current skills of human capital in the Kingdom to support the Saudi National Atomic Energy Program (SNAEP) and to ensure the operational readiness of the sector.

The expected impact of the human capacity building Strategy is to establish an environment and infrastructure that develops and qualifies Saudi human capital in the sector. The 4 Key deliverables of the HCB Strategy and Implementation Roadmap are as follows:

1. A comprehensive HCB Strategy and Roadmap for the Atomic Energy Sector. The strategy has been completed and sent to IAEA for Technical Review which will be in March 2022.
2. Industry Placement Programs established for Saudi Nationals in coordination with one of the National Universities in the KSA and international organizations. The program has been initiated.
3. Partnerships with local and international educational institutions and training centers to build the necessary infrastructure and capabilities to support university nuclear programs.
4. A National HCB Digital Platform for building human capacities in the atomic energy sector.

For the first NPP project, it is planned that sufficient number of human resources will be transferred from K.A.CARE to the SNE. SNE will develop its plan for human resources as per the NRRC's requirements in accordance with the Licensing and Regulatory Oversight Regulation. This plan shall be created prior to applying for a site license, and it shall be updated as per progressing in the project. In addition, SNE will provide human resources needed for on-site emergency responses. Off-Site emergency will activate the national emergency plan as stated in Section (16), to ensure that the availability of all required resources.

As discussed in Section (8), NRRC prepared a human resource development plan to determine the human resources needed for each sector and the requisite competencies. The NRRC has managed to attract national and international expertise in various technical fields. NRRC has also cooperation with national and international technical support organizations to support its activities. As part of the human resource development plan, general and specialized training programs has been conducted. Training and knowledge transfer are integral components of each NRRC project with international organizations. NRRC is also utilizing IAEA training programs and services for human capacity building.

12. Human Factors

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.

NRRC places a strong emphasis on human performance throughout the lifetime of a nuclear facility. In this regard, the NRRC has incorporated number of requirements that are stated explicitly in several regulations. The main requirements for human factors are stated in the Regulation on the Leadership and Management at Nuclear Facilities, which is based on the "IAEA GSR Part 2- Leadership and Management for Safety", "IAEA GS-G-3.1 Application of the Management System for Facilities and Activities", "IAEA GS-G-3.5 The Management System for Nuclear Installations", and WENRA safety reference levels for existing reactors. This Regulation requires that safety to be achieved and maintained by utilizing an effective management system. The management system shall integrate all elements of management (e.g., safety, health, environmental, security, quality, human and organizational factors, societal and economic factors) so that requirements for safety are established and applied coherently with other requirements, and so that safety is not compromised by other conditions or demands.

Other regulations such as that on Design of Nuclear Facilities, which is based on the IAEA Safety Standard “Safety of nuclear power plants: design (SSR-2/1 (REV1)”. This Regulation states that “human factors shall be systematically considered at an early stage in the design process of a nuclear facility and shall continue to be considered throughout the entire design process, including the control room, the human-machine interfaces, the various procedures and the layout design of the facility.” The regulation also requires the licensee to assess the human factors continuously throughout the entire design process, including the control room, the human-machine interfaces, the various procedures, and the layout design of the facility. In addition, in the Regulation on the Safety Assessment of Nuclear Facilities, which is based on the IAEA Safety Standard “Safety Assessment for Facilities and Activities (GSR Part 4 (REV1)”, human factors are also emphasized. This regulation states that “human factors shall be examined to determine how they have been analyzed to affect the safe operation of the nuclear facility and to identify improvements that are reasonable and practicable.”

Moreover, the Regulation on the Operations of Nuclear Facilities, which is based on the IAEA Safety Standard Series No. SSR-2/2 “Safety of Nuclear Power Plants: Commissioning and Operation” and the WENRA reference levels for existing reactors (2014 report) emphasize human factors. In this regulation, it is required that aspects of the working environment that influence human performance factors (such as workload or fatigue) and the effectiveness and fitness of personnel for duty shall be identified and controlled. Tools for enhancing human performance shall be used appropriately to support the responses of operating personnel. The approach used for facility-specific validation and verification shall be documented. The effectiveness of incorporating human factor engineering principles in procedures and guidelines should be judged when validating them. The validation of Emergency Operating Procedures (EOPs) should be based on representative simulations using a simulator where appropriate.

The operating organization shall establish and implement a system for modification management to ensure that all modifications, either permanent or temporary, are properly identified, screened, designed, evaluated, authorized, implemented, and recorded. Safety related design modifications during the operation stage shall be approved by the NRRC.

In 2022, K.A.CARE provided NPP vendors with the Bid Invitation Specification, which includes technical requirements for human factors. The vendor bid responses will be evaluated to verify that the selected design and vendor will incorporate relevant human aspect standards, taking experience feedback into account. After the establishment of SNE, it will take on all of these tasks and build programs for human performance management and evaluation, including design, safety assessment, operations, and plant modification.

13. Quality Assurance

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.

Leadership and Management for Safety is a regulation that obliges the licensee to have a management system and adequate financial and human resources in place to assure safety. The NRRC requires the licensee to develop a management system consisting of policies, processes, and procedures that correspond to the necessary quality assurance standards and are compatible with the IAEA Safety Standard Series No. GSR Part 2. It covers the promotion of a strong safety and security culture, as well as plans for self and independent assessments and procedures to ensure that knowledge to the safe, secure, and peaceful use of nuclear energy is always maintained.

K.A.CARE has implemented appropriate and targeted quality assurance arrangements for the work it has completed on the LNPP project to-date. This has included the site characterisation activities, the Bid Invitation Specification and the Site Licence application. The operating company will develop an integrated management system will include arrangements to assure lifetime quality of the plant and its maintenance and operation.
K.A.CARE issued the Bid Invitation Specification to NPP vendors in 2022 and this includes requirements for quality assurance. The production process for the BIS included reviews and comments by experts from IAEA. The vendor bid responses will be evaluated to ensure that the selected vendor will include appropriate quality assurance arrangements. After the Engineering Procurement Construction (EPC) contract is in place, SNE will perform audits to assure that appropriate quality arrangements are being implemented.

14. Assessment and Verification of Safety

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.

14.1 Assessment of Safety

The Nuclear Law stipulates that the regulatory body must evaluate licensing applications to confirm the facility's safety. In addition, the regulatory body has the authority to deny, condition, suspend, or revoke any license based on the results of its evaluations.

In this regard, the NRRC fulfills its regulatory responsibilities regarding the evaluation of safety with the assistance of highly regarded organizations. The NRRC has developed a regulation on safety assessment based on the IAEA's GSR Part 4 (Rev. 1). The regulation focuses on the design of a nuclear facility and the periodic safety reviews performed at regular intervals during the life cycle of the facility. This regulation is related to the Regulation on the Design of a Nuclear Facility where requirements are detailed pertaining to the safety objectives, design basis, design features, and management of safety in the design of a nuclear facility. The safety assessments are performed against the safety objectives and criteria of the Regulation on the Design of a Nuclear Facility.

The results of the periodic safety review of a nuclear facility will be used in:

- creating an integrated view of the facility safety status and necessary improvements;
- steering the allocation of resources on issues and actions of safety significance; and
- supporting proactively the safe use of the facility throughout its lifetime.

According to Safety Assessment of Nuclear Facilities regulation, The periodic safety reviews shall be performed with a maximum interval of 10 years to follow the development of the nuclear facility, the operating organization, and the nuclear field in general. A safety assessment is not only performed for the purpose of granting licenses and periodic assessments but is also conducted whenever the NRRC sees regulatory concerns.

14.2 Verification of Safety

The NRRC, as part of the verification of safety, requires the licensee to conduct a periodic safety assessment. The results shall be validated by independent verification. Analyses or review exercises covering the full assessment or specific parts with safety significance should also be conducted. The NRRC require the licensee to verify and validate the evaluation using proper experimental data, calculation methods, and computer codes utilized for the safety study. Uncertainty and sensitivity

analyses must also be done and accounted for in the application of the results. In addition, the licensee is required to ensure that the design of safety-related objects is assessed to establish whether they are sturdy, of proven design, and appropriate for their intended use. The licensee must also conduct exhaustive analyses and evaluations of systems, structures, and components that have safety relevance, design complexity, technical novelty, or potential exposure to challenging conditions.

The Aging Management Program is part of the requirements included in the regulations. Therefore, the operating organization shall have an Aging Management Program to identify all aging mechanisms relevant to structures, systems, and components that are important to safety. The operating organization should also determine their possible consequences and the necessary activities to maintain the operability and reliability of these SSCs over the entire operating life of the facility.

An important aspect of the NPP project that has been performed is the site characterization study. Assessment and verification of the analyses in these studies was undertaken, including using independent verification on key topics. Demonstration of compliance with IAEA safety standards related to site evaluation was an integral part of this work. These studies have now been completed and form part of the site license application which was submitted for NRRC assessment in May 2022. The SNE will establish safety verification programs, inspection surveillance, aging effects on items relevant to safety, and an effective aging management program to ensure safety in function performance throughout the planned lifetime of the facility. Besides that, the BIS includes requirements for assessment and verification of safety. The vendors bid responses will be evaluated to ensure that the selected vendor will include appropriate safety assessment and verification arrangements.

15. Radiation Protection

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.

The national regulation on Radiation Safety sets out the general safety requirements in ensuring the protection of people and the environment against the harmful effects of ionizing radiation and the safety of radiation sources. It applies to all activities and facilities, including nuclear installations. This regulation harmonizes the requirements applicable in the Kingdom with international best practices to achieve the highest standards of safety.

As established in the regulatory framework and implemented through processes such as authorization, review, assessment, and inspections, the NRRC requires license holders to develop a comprehensive radiation protection program. Among others, the program shall include provisions on dose limit observation and environmental monitoring with constraints on radioactive material releases, operational control measures, and requirements to ensure that radiation exposures are optimized for all operational and maintenance activities. The principle of optimization of radiation protection (ALARA) is continuously interpreted and integrated into this regulation based on the world's best

practices. It reflects the requirements for the optimization of protection and safety. The concept of optimization shall be applied throughout the lifetime of any nuclear facility.

In this regard, K.A.CARE issued the BIS with a consideration of including the requirements for radiation protection in line with the regulatory framework. It will ultimately ensure that relevant programs will be established in compliance with regulatory expectations.

With respect to the public and environmental impacts of the nuclear facilities, radiological baseline studies have been completed at the proposed NPP sites and submitted as part of the site characterization studies for regulatory review. The objectives of this work included the following:

- understanding the ambient radioactivity of the atmosphere, hydrosphere, lithosphere, and biota in the NPP site and its surroundings;
- constructing a network of sampling locations and defining a sampling methodology;
- monitoring and assessing the surroundings to determine the current radiological baseline; and
- initial considerations for establishing a radiological environmental monitoring program for the power plant site.

The results of these baseline studies have been incorporated into the Preliminary Site Evaluation report and Preliminary Environmental Impact Assessment report. These have been submitted to NRRC for assessment as part of the Site Licence application made in May 2022.

16. Emergency Preparedness

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

16.1 Emergency Plans and Programs

According to the National Policy for the Atomic Energy Program of the Kingdom of Saudi Arabia, the Kingdom is committed to the highest standards of nuclear safety and the protection measures against radiation hazards at all nuclear facilities and at all stages of disposal of spent fuel and radioactive waste, with appropriate emergency plans in place.

In September 2008, the “National Response Plan for Radiological and Nuclear Emergencies” was officially approved by the Prime Minister. After the approval of the Nuclear Law, a revision of this national plan was conducted. The main objectives of this revision were: (1) to ensure the consistency between the Nuclear Law and the national emergency preparedness and response plan, (2) to ensure the appropriate coordination of roles and responsibilities, (3) to assure the availability of adequate resources, and (4) to confirm the activation of a fluent communication with international level for notification and assistance in the case of nuclear accidents.

The Directorate-General of Civil Defence (DGCD), pertaining to the Ministry of Interior is the responsible national agency for leading Saudi Arabia’s efforts to respond to any hazards and disasters, including nuclear and radiological emergencies. Other governmental entities shall support the Civil Defense as per the national plan. For emergency preparedness, all national authorities involved in the national emergency response were involved in the development of the national plan and the roles and responsibilities of each organization has been specified. NRRC leads the efforts in the revision of the National Response Plan for Radiological and Nuclear Emergencies. Also, NRRC is the point of contact for the Convention on Early Notification and Assistance.

The Nuclear Law empowers the NRRC to establish the requirements for nuclear and radiological emergency plans for nuclear and radiological facilities. The NRRC has issued the Regulation on “Nuclear Facilities Emergency Preparedness and Response”, NRRC-R-14, which is based on IAEA GSR Part 7 “Preparedness and Response for a Nuclear or Radiological Emergency”. This Regulations establishes the requirements for an adequate level of preparedness and response to a nuclear or radiological emergency at nuclear facilities that shall mitigate the consequences of a nuclear or radiological emergency if such an emergency arises despite all efforts made to prevent it. This Regulation requires the licensee to establish and maintain arrangements for on-site preparedness and response to a nuclear or radiological emergency for facilities or activities under its responsibility, to prepare an emergency plan and establish the necessary organizational structure for the clear allocation of responsibilities, authorities, and arrangements for coordinating facility activities and co-operating with response organizations in a timely manner and throughout all phases of an emergency, and to have a management system and organization in place to ensure a timely response in an emergency situation. The on-site emergency plan shall be based upon an assessment of reasonably foreseeable events and situations that may require protective measures on- or off-site.

In its efforts to build its capabilities and infrastructure to respond to nuclear and radiological emergencies, NRRC has established its Emergency Operations Center (EOC) within its headquarter to respond to radiological and nuclear emergencies. The EOC operates 24/7 for the prompt activation of national radiological and nuclear emergencies. The EOC in its operation, implements programs for the identification, analysis and evaluation of nuclear risks imposed on the region. It also has a communication team that is responsible for sending and receiving reports of radiological nuclear accidents with the IAEA in the context of early reporting of nuclear accidents through IAEA Unified System for Information Exchange in Incidents and Emergencies (USIE). NRRC also has joined IAEA's Response and Assistance Network (RANET) to provide its assistance internationally with its expertise and equipment.

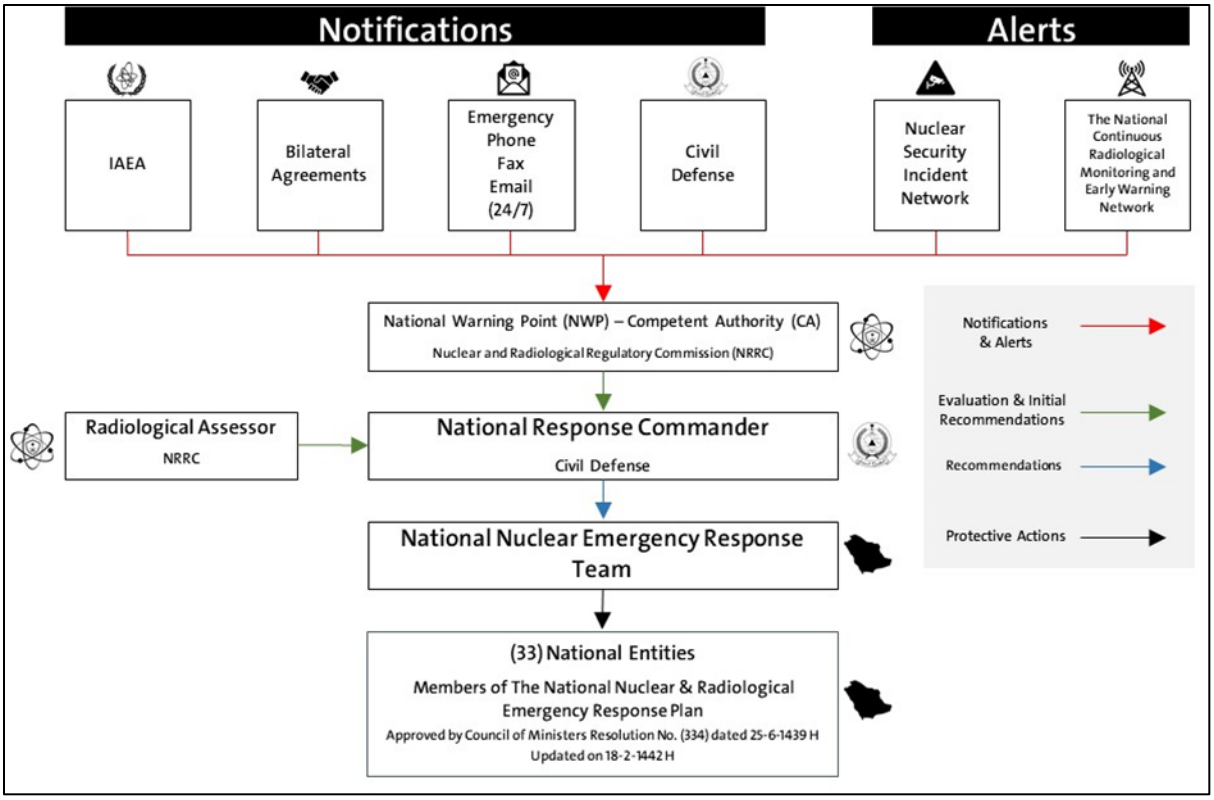

Figure 4. Operational procedure for an emergency notification/alert.

As stated earlier in section (1.0), currently there are no operating nuclear power plants in the Kingdom, hence there are no NPP emergency plans. For the first NPP in the KSA, appropriate emergency arrangements will be implemented before operation of the NPP. As part of the site characterization studies of the Preferred Site of the first NPP, K.A.CARE has performed studies to demonstrate the feasibility of implementing an emergency plan. These feasibility studies were submitted to NRRC in support of the Site License application. The emergency plan will be initiated, developed and implemented per the NRRC requirements.

16.2 Information of the Public and Neighboring States

As per the requirements in the Regulation on "Nuclear Facilities Emergency Preparedness and Response", The licensee shall supply the NRRC and the response organizations with advance instructions for the public in the emergency planning zone on preparing for an emergency situation. In the event of an emergency situation, the licensee shall coordinate with the relevant authorities in warning the public within the precautionary action zone.

The "National Response Plan for Radiological and Nuclear Emergencies" has declared arrangements for informing the public in the event of a nuclear emergency, whether it is inside the Kingdom or outside. This arrangement is being coordinated between the Saudi National Nuclear and Radiological Emergency Response Team, the Ministry of the Interior, and the Ministry of Media.

The Kingdom has signed bilateral agreements with some of its neighbouring countries. The scope of these bilateral agreements covers emergency preparedness and response. The Kingdom is also working

with the other Gulf Cooperation Council (GCC) countries on the development of the GCC Radiological/Nuclear Emergency Response Plan. The arrangements for informing competent authorities in neighbouring states are coordinated by the Ministry of Foreign Affairs in consultation with NRRC. The Kingdom is party of the Convention on Early Notification of a Nuclear Accident.

16.3 Emergency Preparedness for Contracting Parties Without Nuclear Installations

As mentioned in Section (16.2), the Kingdom is party of the Early Notification Convention. NRRC started its National Program for Environmental Radiological Monitoring (NPERM) which includes a network of radiation monitoring stations. There are currently 140 radiation monitoring stations distributed across the country. Initiatives have been taken by the Kingdom to connect its network to the International Radiation Monitoring Information System (IRMIS). In addition, work on progress to expand the coverage of the network by increasing the number of monitoring stations to reach 240 by the end of 2022.

The EOC is equipped with a Decision Support System (DSS) that contains simulation codes capable of performing prognostic studies on a local and global scale to aid the evaluation of the short- and long-term radiological consequences of nuclear incidents. The EOC, via its simulation codes, proactively issues periodic reports and assists in developing risk assessment studies. During nuclear emergencies, reports issued by the EOC are provided to the permanent national committee for response to radiological or nuclear emergencies to execute its plans. The system is also used in drills and trainings. It was used in the recent Level 3 Convention Exercises ConvEx-3 which was hosted by UAE.

17.Siting

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.

17.1 Evaluation of Site-Related Factors

The SNAEP is planned to have two PWR units with capacities ranging from 1.0 GWe to 1.7 GWe. Each unit has storage for spent fuel and related nuclear waste management facilities. The Regulation on “Site Evaluation of Nuclear Facilities”, NRRC-R-05, has been developed based on the IAEA Safety Requirements SSR-1 "Site Evaluation for Nuclear Installation". Furthermore, the developed regulation

considers special conditions related to the Kingdom of Saudi Arabia, such as the effect of sandstorms, high temperature, and salted sediment layers at the site. The regulation encompasses site-related factors and site facility interaction factors related to plant operational states and accident conditions.

The Regulation on "Licensing and Regulatory Oversight of Nuclear Facilities", NRRC-R-03, sets the licensing requirements of nuclear facilities and identifies the stages of licensing. One of the licensing steps is the site license, which is required by the NRRC to ensure nuclear safety and protection against site-specific phenomena, as well as to protecting people and the environment from possible harmful radiation effects that could arise from a nuclear facility on the selected. During site investigation, an appropriate management system must be implemented. Obtaining a license for a nuclear plant site necessitates the submission of a thorough Preliminary Site Evaluation Report (PSER) that addresses all aspects listed in Regulation NRRC-R-05, as well as an Environmental Impact Assessment (EIA) report.

The PSER must include at least the following topics:

- General geographic information of the site and the surrounding region.
- Geological, geotechnical, and seismic conditions and the related design basis.
- Meteorological and hydrological conditions (including seawater, precipitation, groundwater, etc.) and the relevant design basis.
- Vegetation and animal life in the area.
- Human activities in the vicinity of the site with potential to affect the facility (industry, storage, transport) or which could be affected by the plant.
- The radiological effects of the facility on the population and environment in the vicinity of the site during regular operation and accident conditions.
- Description of the population (density, distribution, evolution) in the region.
- Schools, hospitals, and any other installations which would be difficult to evacuate or protect in case of an accident.
- The land use plans in the region.
- The potential for heat dissipation (including the ultimate heat sink).
- Other site-related factors with the potential to affect the safety or design requirements of the facility and the related design basis where relevant.
- Evaluation of the site in terms of security and emergency arrangements.
- For the site of a disposal facility, consideration of effects of local conditions on post-closure safety.

The National Environment Authority must authorize the non-radiological aspects of the Environmental Impact Assessment prior to issuing a site license.

In order to address all regulatory aspects related to choosing the site of the NPP, NRRC engages in open, formal dialogues with K.A.CARE. These regulatory matters include reviewing methodologies of conducting site characterization studies, authorization required, applicable IAEA requirements, and the emergency and security requirements. The objective of this ongoing engagement is to ensure regulatory requirements and give advanced feedback.

17.2 Impact of the Installation on Individuals, Society, and the Environment

KA.CARE has conducted several studies in accordance with IAEA standards and national regulations to guarantee that the impact of the facility on the environment and vice versa is assessed properly. In 2012, K.A.CARE concluded an NPP site evaluation survey in cooperation with an international expert organization. The Kingdom used an evaluation method based on IAEA Safety Guide 50-SG-S9 "Site Survey for Nuclear Power Plants", and IAEA Safety Guide SSG-35 "Site Survey and Site Selection for Nuclear Installations". Following these standards, as well as other references, the siting process has been developed through three phases in order to nominate the best location to build the first NPP. In 2017, two locations were selected as candidate sites for the last phase of the siting process, one as a Preferred Site and the other as an Alternative Site.

In the last phase, a comprehensive and detailed site characterization and evaluation study for the two candidate sites was conducted in cooperation with specialized consultancy services as well as the Environmental Impact Assessment study. The comprehensive and detailed site characterization studies have been completed in 2021 for the preferred site. The PSER includes 25 site characterization studies. In the first quarter of 2022, as a part of engagement activities between NRRC and K.A.CARE, K.A.CARE shared the siting reports with NRRC including the PSER and the EIA reports to check the completeness of the studies before the official SLA submission.

Recently, the responsibility of the National Atomic Energy Project to build the first NPP in the Kingdom of Saudi Arabia was transferred to the SNE. By the end of May 2022, SNE formally submitted the SLA to NRRC. The regulatory review process of the SLA has started. NRRC is utilizing the expertise of an international technical support organization to support licensing activities. In addition, NRRC is verifying the analysis of certain critical studies independently.

17.3 Re-evaluation of Site-Related Factors

As mentioned in the above sections, K.A.CARE has submitted the PSER and the EIA recently, so at this moment there are no re-evaluation activities. However, as per the requirements in the NRRC-R-05, it is required to continue monitoring the site during operation and the updated information shall be presented in relation to the periodic safety reviews. A review after a shorter interval shall be done in the event of evidence of potentially significant changes in hazards. Also, the suitability of the site shall be re-assessed if the nuclear capacity at the site is planned to be expanded significantly. All these activities shall be carried out by the licensee during the NPP's lifetime. Examples of these requirements are quoted from the Regulations and listed below:

<u>Regulation on the Site Evaluation of Nuclear Facilities</u>

"The site evaluation provides input to both the preliminary safety analysis report and the final safety analysis report. Site evaluation continues throughout the operational stage of the nuclear facility, and includes monitoring, periodic safety reviews, and other activities to confirm the site-specific design parameters as well as safety re-evaluations based on the outcome of periodic safety reviews."

"The monitoring of external hazards and site conditions shall be commenced as soon as practically possible but no later than the start of construction and shall be continued until decommissioning. The

monitoring plan shall be developed as part of the objectives and scope of the site evaluation"
"Following the issuance of the site license, the site's detailed investigations and evaluation shall be continued. The results shall be presented in a final site evaluation report. The report shall include site related design parameters of the planned facility. The report shall be submitted to the NRRC for approval"

17.4 Consultation with other Contracting Parties Likely to be Affected by the Installation

The Kingdom of Saudi Arabia is a party to the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency, and Vienna Convention on Civil Liability for Nuclear Damage, as mentioned in Section (7).

The Kingdom has signed bilateral agreements with some of its neighbouring countries. The scope of these bilateral agreements covers wide range of activities including; cooperation between regulatory authorities, emergency preparedness and response, technical cooperation, and sharing relevant information for nuclear facilities. Similar agreements are under discussion with other concerned neighbouring countries.

18. Design and Construction

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.

18.1 Implementation of Defense in Depth

NRRC has issued Regulation NRRC-R-06 "Design of Nuclear Facilities" as well as NRRC-R-07 "Safety Assessment of Nuclear Facilities". These two Regulations describe the main concept of defense in depth. These two Regulations were developed based on the IAEA Safety Standard SSR-2/1, Rev. 1 "Safety of Nuclear Power Plants: Design" and GSR Part 4 (Rev. 1) "Safety Assessment for Facilities and Activities". Other guides, such as IAEA Safety Standards Series No. SSG-25 "Periodic Safety Review for Nuclear Power Plants", has been taken into consideration while developing these two regulations. Some of the examples of the implementation defense in depth concept as stated in the developed Regulation are the following:

Regulation on the Design of Nuclear Facilities

"The design of a nuclear facility shall incorporate the principle of defense in depth in both the structural and functional characteristics of the facility. The defense in depth principle shall be applied structurally to physical barriers preventing radioactive releases and functionally to safety functions protecting the

integrity and leak tightness of the physical release barriers. The primary objective shall be to prevent accidents, and if not successful, to manage accidents and mitigate their consequences."

"The necessary number of defense levels for a nuclear facility, in a specific mode of operation, shall be justified based on the number of radioactive materials involved, the consequences of the potentially most severe release scenario, and the effectiveness of physical release barriers and protective safety features incorporated in the design. For the justification, five levels of defense shall be considered as the general design principle:

a. The purpose of the first level of defense is to prevent deviations from nominal operational conditions and failures of items relevant to safety.
b. The purpose of the second level of defense is to detect and control deviations from regular operations to prevent such an anticipated operational occurrence from escalating to accident conditions.
c. The purpose of the third level of defense is to prevent fuel, reactor core, or other radiologically significant facility damage in an accident that develops due to the above-mentioned levels, although very unlikely, not being effective.
d. The purpose of the fourth level of defense is to mitigate the consequences of severe accidents that result, which are extremely unlikely to occur, from a failure of the third level leading to severe damage and a subsequent release of radioactive materials to the reactor containment or other confinement areas.
e. The purpose of the fifth and final level of defense is to further mitigate the radiological consequences of environmental radioactive releases with the provision of emergency response measures."

"The levels of defense in a nuclear facility shall be independent as far as practicable to prevent a coincidental or consequential loss of several defense levels in or following any facility state resulting from the loss of one defense level. Facility states that could lead to high radiation doses or an early or large radioactive release shall be shown to be extremely unlikely with such a high level of confidence that they can be considered eliminated by design."

Safety Assessment of Nuclear Facilities

"Based on initiating event identification, accident sequence modelling, and detailed reliability analyses, the probabilistic risk assessment shall present the quantitative results in the form of different facility damage states and their frequencies. The total frequency of damage states involving severe damage, with appropriate uncertainty considerations, shall be viewed as a quantitative estimate of the effectiveness of the defense in depth levels and the safety functions in preventing severe accidents. The results shall be used to identify the most significant contributors to the severe damage frequency and the subsequent opportunities for safety improvements and a more balanced design."

"The defense in depth features of the nuclear facility shall be reviewed, analyzed, and assessed to determine whether adequate provisions have been made at each level of defense in depth, whether there exist such dependencies between the levels that several levels of defense could be coincidentally

or consequentially lost, and whether the final design can be considered compliant with the defense in depth principle."

"The safety functions shall be reviewed, analyzed, and assessed to determine whether their failure tolerance and reliability are at a level commensurate with their importance for the defense in depth and the fundamental safety function objectives of the nuclear facility. The reviews, analyses, and assessments performed for a specific safety function shall cover the relevant operational states and the accident, design extension, and hazard conditions."

NRRC has issued Regulation NRRC-R-08 which describes the regulatory requirement for the "Construction and Commissioning of Nuclear Facilities". This Regulation applies to the construction and commissioning stages of new nuclear facilities and to major modifications and refurbishments of an existing nuclear facility. The requirements of this developed Regulation apply as such to a holder of a construction license (licensee) of a nuclear facility and, to an appropriate extent, to an applicant of a construction license, supplier of the facility or its major parts (vendor), contractors, and suppliers of safety-related products and their subcontractors. This regulation also presents the responsibilities of the licensee and suppliers and the prerequisites and as well as management principles of construction and commissioning stages. Transference of responsibilities from the construction stage to the commissioning and from the commissioning stage to the operation is detailed in the Regulation. The Regulation also details all requirements concerning safety culture for both construction and commissioning stages.

18.2 Incorporation of Proven Technologies

The NRRC's regulations would require any applicant for a Construction License to identify any reference Nuclear Facility, declare evidence of approval of the reference Nuclear Facility by the authorized regulatory authority in the country of origin, and identify a list of proposed departures or changes between the proposed design and the reference design, conduct an Independent Safety Verification on all proposed departures from or changes to the reference design, and present a list of all country-of-origin safety information.

It is also stated in the developed Regulation that it is a requirement for designing nuclear facilities to designate items important to safety. This requirement is deemed necessary to:

a. sustain a single failure if the item is required to perform a correct action to meet the acceptance criteria in safety analysis;
b. comprise fail-safe features and prevention of harmful interactions with other items as appropriate from the safety function and system design standpoints;
c. comply with the relevant codes, standards, and engineering practices as relevant to the design of a nuclear facility;
d. be manufactured, constructed, assembled, installed, and erected in accordance with well-defined processes and design specifications; and
e. be calibrated, tested, maintained, repaired or replaced, inspected, and monitored as required to ensure their functionality, capability, integrity, and reliability in all specified conditions.

It is the Kingdom's approach to seek nuclear technologies that:

- are of proven design;
- are previously licensed;
- consider in the design the lessons learned from the Fukushima Daiichi accident;
- are based on internationally recognized standards; and
- with a demonstrated history of safe operation.

18.3 Design for Reliable, Stable, and Manageable operation

NRRC developed requirements for assuring the reliability and stability and manageability of operating nuclear installations with the consideration of different aspects required for operation including I&C system, automatic safety actions, and determining operation procedure, limits, and conditions as well as operating organization assessment. Issues related to the human factor and human-machine interface are also taken into consideration in NRRC regulations as mentioned in Article [12] of the convention.

In March 2022, K.A.CARE issued the Bid Invitation Specification (BIS) to NPP vendors, including those identified in this article (Article 18) for the safety of the design, defense in depth, safety in construction, and stable and reliable operation. The requirements include that all relevant IAEA safety standards shall be complied with as well as the regulations of the country of origin. The BIS requires that the proposed plant for KSA be based on a reference plant that has been licensed in the country of origin and has a successful operating history. The vendor bid responses will be evaluated to ensure that the selected vendor will include appropriate arrangements in the design for all these aspects.

19. Operation

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 program 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.

19.1 Initial Authorization

The Regulation on "Licensing and Regulatory Oversight of Nuclear Facilities", NRRC-R-03, sets the licensing requirements of nuclear facilities and identifies the stages of licensing. An Operating license is required before commencing the operation of a nuclear facility. The Regulation states that the operating license for a Nuclear Power Plant can only be granted if the nuclear facility as-built meets the radiation and nuclear safety requirements laid down in national regulations and the nuclear facility as-built meets conditions given in the construction license. The Regulation states all required information and documentation need to be submitted to support the Operation License Application.

The Regulation on "construction and commissioning of Nuclear Facilities", NRRC-R-08, require the licensee to establish and implement a commissioning program in the framework of the management system for commissioning. This program shall specify the responsibilities for implementing and reporting the various parts of the program. The commissioning stages, test objectives, and acceptance criteria of the tests shall also be specified in an auditable way. The commissioning program shall be approved by NRRC and shall include all the tests necessary to demonstrate that the facility, as-built, meets the safety requirements, including regulatory requirements, as specified in the Safety Analysis Report and detailed design requirements. The commissioning program shall demonstrate that the facility can be safely operated in accordance with the operational limits and conditions (OLCs) of the facility. The licensee shall review the OLCs on the basis of the results of the commissioning tests.

19.2 Operational Limits and Conditions

The Regulation on "Operations of Nuclear Facilities", NRRC-R-09, prescribes the general requirements for the safe operations of nuclear facilities. It addresses the direct operational activities of nuclear facilities as well as closely related functions and procedures. The Regulation is based on the 1) IAEA Safety Standard SSR-2/2 (Rev. 1) "Safety of Nuclear Power Plants: Commissioning and Operation", 2) IAEA SSR-3 "Safety of Research Reactors", and 3) IAEA SSR-4 "Safety on Nuclear Fuel Cycle Facilities".

This Regulation states that the operating organization shall ensure that the plant should be operated in accordance with the set of OLCs. Moreover, those OLCs shall be developed for ensuring that the facility is being operated in accordance with the design assumptions and intent as documented in the Safety Analysis Report. The regulation requires that the OLCs should be reviewed with consideration of experience, developments in technology and approaches to safety, and changes in the facility. It is also a requirement that the process for making modifications or departing from the OLCs shall be defined.

19.3 Procedures for Operation, Maintenance, Inspection, and Testing

The Regulation on "Operations of Nuclear Facilities", NRRC-R-09, requires the licensee to develop operating procedures to be applied comprehensively for nuclear testing, normal operation, anticipated operational occurrences, and accidents. The regulation also states that the operating organization shall prepare and implement documented programs of maintenance, testing, surveillance, inspection, and maintaining required equipment qualification of SSCs important to safety to ensure that their availability, reliability, and functionality remain in accordance with the design over the lifetime of the facility.

The Regulation also states that all activities important to safety shall be carried out in accordance with documented procedures. The procedures and instructions described in the management system, and safety culture, shall be followed in the operation of a facility. Also, it is required to update the procedures to ensure that they remain fit for their purpose.

19.4 Procedures for Responding to Operational Occurrences and Accidents

According to the Regulation on "Operations of Nuclear Facilities", the operating procedures shall be developed in a way that applied comprehensively for normal operation and anticipated operational occurrences and accidents. Emergency operating procedures, with other specific procedures or guidelines when applicable, shall be provided to cover design extension conditions. The aim shall be to re-establish or compensate for lost safety functions and, for nuclear reactors and facilities hosting spent fuel, to set out actions to prevent severe fuel damage.

19.5 Engineering and Technical Support

The availability of the necessary engineering and technical support in all safety-related fields will be assured throughout all stakeholder organizations. Furthermore, K.A.CARE specified in their requirement from technology vendors that experts should be located in the Kingdom of Saudi Arabia in order to plan for the centralization of necessary resources to ensure sufficient engineering and technical assistance.

All the stated regulatory requirements for operational safety have been included within K.A.CARE requirements in the BIS for engineering, maintenance and operational support. Vendor bid proposals will be evaluated to ensure the selected vendor/design will comply with these requirements. Additional technical support contracts have been prepared and will be implemented in the near future to provide SNE and the future owner/operator with additional competent experts and the required resilience in engineering and technical support.

19.6 Reporting of Incidents Significant to Safety

The Regulation on "Operations of Nuclear Facilities", requires that the operating organization to establish procedures and criteria for reporting events relevant to safety. NRRC also requires incident significant to safety to be reported.

19.7 Operational Experience Feedback

The Regulation on “Operations of Nuclear Facilities”, requires the operating organization to establish an operating experience program to learn from events at the facility and events in the nuclear industry and other industries worldwide.

All the stated regulatory requirements for operational safety have been included within the BIS for engineering, maintenance, and operational support.

19.8 Management of Spent Fuel and Radioactive Waste on the Site

The Kingdom of Saudi Arabia issued the Radioactive Waste Management Policy as described in Section (7.1). The KSA is part of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management Joint Convention. The Kingdom has necessary has established the regulatory infrastructure for the safe management of the radioactive waste. Currently, there are no spent fuel in the Kingdom as there are no operating NPP.

The Regulation on “Management of Radioactive Waste”, NRRC-R-16, sets out the safety objectives, criteria, and requirements for the protection of human health and the environment that shall be applied to the activities and to the facilities for the predisposal management of radioactive waste, and the requirements that shall be met to ensure the safety of such activities and facilities. The Regulation is based on the IAEA Safety Standard Publication “Predisposal Management of Radioactive Waste” General Safety Requirement GSR Part 5 of 2009.

20.Annex 1: List of Acronyms

NRRC	Nuclear and Radiological Regulatory Commission
K.A.CARE	King Abdullah City for Atomic and Renewable Energy
KACST	King Abdulaziz City for Science and Technology
SNAEP	Saudi Nuclear Atomic Energy Program
NEPIO	Nuclear Energy Program Implementing Organization
SNE	Saudi Nuclear Energy Holding Company
RFP	Request for Proposal
NPP	Nuclear Power Plant

LPRR	Low-Power Research Reactor
TSO	Technical Support Organization
EIA	Environmental Impact Assessment
SER	Site Evaluation Report
EOC	Emergency Operating Centre
PSAR	Preliminary Safety Analysis Report
FSAR	Final Safety Analysis Report
PMO	Project Management Office
BIS	Bid Invitation Specification
NPRNER	National Plan for Radiological & Nuclear Emergency Response