United Arab Emirates

UAE NATIONAL REPORT

For the Joint 8th and 9th Review Meetings of the CONVENTION ON NUCLEAR SAFETY

March 2023

This report has been prepared by the Government of the United Arab Emirates in fulfilment of Article 5 of the Convention on Nuclear Safety for submittal to the 8th and 9th Review Meetings of Contracting Parties to be held in March 2023

August 2022

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I. INTRODUCTION

1.1 UAE Policy on Nuclear Safety

The Policy of the United Arab Emirates (UAE) on the Evaluation and Potential Development of Peaceful Nuclear Energy (hereinafter referred to as the UAE Nuclear Policy) was adopted by the UAE Cabinet of Ministers in April 2008. The UAE Nuclear Policy outlines the role of nuclear energy in the UAE's energy programme, and states the UAE's commitment to operational transparency and to the highest standards of safety, security and non-proliferation throughout the life of the nuclear programme. The UAE Nuclear Policy also discusses the UAE's intent to develop its peaceful domestic nuclear power capability in partnership with the governments and firms of responsible nations as well as with the assistance of appropriate expert organisations including the International Atomic Energy Agency (IAEA) in a manner that best ensures long-term sustainability. The UAE Nuclear Policy is available on the website of the Federal Authority for Nuclear Regulations. .

1.2 Status of the UAE Nuclear Programme

The UAE has moved forward on its commitments in the Nuclear Policy through: the adherence to the relevant international instruments for nuclear safety, nuclear security, safeguards and non-proliferation; the establishment of a legal framework and governmental framework within the UAE; and through ongoing support for the development of the UAE's peaceful nuclear energy programme as described in subsequent sections of this report.

1.3 Purpose and Scope of this Report

Article 5 of the Convention on Nuclear Safety 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 each of the obligations of this Convention".

This is the fifth National Report of the UAE, which has been prepared in accordance with Article 5 of the Convention on Nuclear Safety for review at the joint 8th and 9th Review Meetings of the Convention to be held in March 2023. This National Report describes the legislative, regulatory and administrative measures, and other steps taken by the United Arab Emirates to fulfil its obligations as a Contracting Party to the Convention on Nuclear Safety.

The structure of the report is based on IAEA Information Circular INFCIRC/572/Rev.6, *Guidelines regarding National Reports under the Convention on Nuclear Safety*, which the Contracting Parties adopted during the 7th Review Meeting in 2017. The report is broken down into three parts: part I is the introduction, part II covers significant developments in the UAE's nuclear energy programme since the 7th Review Meeting, and part III has an article-by-article review of the measures taken by the UAE to implement the provisions of Articles 6 to 19 of the Convention.

As with the UAE's Fourth National Report submitted in 2019, this Fifth National Report is a collective effort of various national organisations including the Federal Authority for Nuclear Regulation (FANR), the Emirates Nuclear Energy Company (ENEC), a Public Joint Stock Company, Nawah Energy Company (Nawah), the National Emergency, Crisis and Disaster Management Authority (NCEMA) and other leading organisations.

The UAE appreciates the opportunity to participate in the 8th and 9th Review Meetings of the Parties to the Convention, and looks forward to contributing to the discussion.

II. SUMMARY

2.1 Significant changes in the UAE's nuclear energy programme

As of the date of submission of this National Report, the United Arab Emirates has 3 nuclear installations as defined by the Convention on Nuclear Safety. The Emirates Nuclear Energy Company (ENEC), a Public Joint Stock Company has completed the construction of three nuclear reactors at one site at Barakah in the Western Region of Abu Dhabi and one additional nuclear reactor is still under construction at the same site.

The Barakah Nuclear Power Plant is located on the coast of the Arabian Gulf some 300 km west of the city of Abu Dhabi. The Barakah reactor units are APR 1400 designs based on the Shin-Kori Units 3 & 4 facility in the Republic of Korea, which is the reference plant for the Barakah Nuclear Power Plant in the United Arab Emirates.

FANR has issued three Licences for Operation of three of the units of the Barakah Nuclear Power Plant: one issued in February 2020 for the operation of Unit 1, another issued in March 2021 for the operation of Unit 2 and recently a third issued in June 2022 for the operation of Unit 3. Unit 4 is in the final stages of construction and expected to be licensed in the near future.

The Nawah Energy Company (Nawah) is the licensee and operator of the Units 1 to 3 of the Barakah Nuclear Power Plant. To date, Nawah has completed the first refuelling outage for Unit 1 in July 2022, taken Unit 2 to commercial operation in March 2022 and completed fuel load on Unit 3 in June 2022.

2.2 Update on actions taken in light of the accident at Fukushima Daiichi in Japan

In March 2011, an enormous earthquake struck off the north eastern coast of Japan creating a tsunami over 14 metres high that swept over the Fukushima Daiichi Nuclear Power Station. The subsequent cut in electricity at the power plant and the consequent loss of reactor cooling capability caused the fuel to melt in three reactors and the uncontrolled release of radioactive materials into the surrounding area.

At that time, FANR had just begun to evaluate the first Construction License Application (CLA) it had received from the Emirates Nuclear Energy Corporation (ENEC) to build new reactors at the Barakah Nuclear Power Plant site.

To learn from the accident at Fukushima Daichi in Japan, FANR established a Fukushima Task Force to follow and engage in activities of other regulatory bodies and international organisations, such as the International Atomic Energy Agency (IAEA), the European Nuclear Safety Regulators Group (ENSREG), the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD NEA), the US Nuclear Regulatory Commission, Korea's Nuclear Safety and Security Commission, and the Korea Institute of Nuclear Safety.

FANR successfully completed assessments of the UAE's nuclear safety relevant regulations and guides and determined that they sufficiently covered the possibility of unexpected extreme events.

FANR also recommended ENEC to conduct a detailed assessment of the Barakah facility using a "stress test" methodology and submit a report on the assessment results with identification of any planned safety improvements. ENEC completed the assessment, reported the results to FANR and proposed a number of design enhancements to protect the Barakah Nuclear Power Plant from extreme events.

FANR's review of those proposed enhancements concluded that ENEC had addressed key robustness issues in its design plans. FANR granted the construction licence for Units 1 and 2 in July 2012 and for Units 3 and 4 in September 2014.

FANR have reviewed and approved all of the design enhancements for Units 1 through 4 and have conducted a rigorous inspection programme to ensure that the reactors are built in compliance with all FANR safety and security Regulations.

2.3 Lessons learned from international peer reviews, operating and construction experience, and emergency drills or exercises

The UAE has continued to cooperate extensively with the IAEA by hosting the following missions and safety services since the 7th Review Meeting of CNS: IAEA's ConvEx-3 exercise, Integrated Nuclear Infrastructure Review (INIR) mission, Pre-Operational Safety Review mission and the Education and Training Appraisal (EduTA) mission.

The 2021 UAE full scale exercise was the basis for hosting an IAEA's ConvEx-3 exercise in coordination with the International Atomic Energy Agency (IAEA), 12 international organizations and 75 IAEA Member States.

The exercise had a scenario simulating a nuclear emergency with radiological consequences of

international concern. The exercise and the rehearsal provided excellent opportunities to test UAE capabilities during 36 continuous hours (each time) and identify further areas for improvement. During the exercise and for the first time in ConvEx-3, an IAEA's Response and Assistance Network (RANET) team was deployed for real to the UAE including teams from three countries and the IAEA. Observers from 8 countries and international organizations also participated from UAE.

The UAE Barakah ConvEx-3 exercise was successfully implemented in alignment with the overall work plan prepared as agreed with the IAEA, International Organizations and Gulf Cooperation Council Countries (GCC) involved in the process. The milestones defined for the whole project were achieved as planned which was commended given all the challenges imposed by the exceptional COVID-19 circumstances.

In June 2018, an IAEA team of experts conducted an Integrated Nuclear Infrastructure Review (INIR) mission. This was INIR 3, the final stage of the INIR process which began in January 2011 at the request of the government of the UAE. The purpose of the mission was to assess the status of the UAE national infrastructure for the introduction of nuclear power. The review covered the comprehensive infrastructure required for developing a safe, secure and sustainable nuclear power programme. The team comprised nine international experts as well as IAEA experts who conducted their week-long review by interviewing officials from UAE entities, including FANR.

The review found that the UAE has adequately developed its nuclear infrastructure, including a legal and regulatory framework and has established and staffed the required organizations, in particular an independent regulatory body and an operating organization and made 9 recommendations and 8 suggestions.

In September and October 2017, upon UAE's invitation, an IAEA team comprised of 15 experts conducted a Pre-Operational Safety Review at the Barakah site. The objective of the Pre-OSART mission was to assess the operational safety performance of Nawah against IAEA's safety standards and to propose recommendations for improvements where appropriate. The areas under review by the team included leadership and management of safety, training and qualification, operations, maintenance, technical support, operating experience, radiation protection, chemistry, emergency preparedness and response, accident management, human, technology and organisational interactions and commissioning. The team identified a number of good practices

that have been shared with the nuclear industry globally and also made a number of recommendations to improve operational safety. A follow-up of pre-OSART Mission is scheduled during the month of September 2022 on Barakah NPP Units 1 and 2.

In February 2017, Education and Training Appraisal (EduTA) mission was conducted under the IAEA Technical Cooperation project RAS/9/081 "Providing Education and Training in Radiation Safety in the Asia-Pacific Region". The EduTA identified several recommendations and suggestions that could further enhance the overall national capabilities and performances for education and training in radiation protection and safety.

For full details about these international peer reviews refer to Annex 2 of this report.

2.4 Transparency and communications with the public and other national and international organisations

Both FANR and ENEC actively engage with stakeholders at the local, national and international levels. The UAE gives great importance to cooperation with international organisations such as the IAEA and foreign nuclear regulatory bodies, and other stakeholders. The UAE's interactions with these entities enable it to access information, resources, best practices and lessons learnt in addition to developing and implementing joint initiatives. Examples of stakeholder involvement and partnerships are given in Section III of this National Report in Articles 8 and 9.

2.5 Issues and topics agreed upon by contracting parties at the organisational meeting

The Officers of the Convention discussed the possibility of the Contracting Parties to report at the next Review Meeting how they have implemented the IAEA's Action Plan on Nuclear Safety at the national level. This includes reporting on how Fukushima lessons learnt are being addressed, and reporting on findings from peer review missions and progress made towards implementing action plans based on these. The UAE's progress in these areas is summarised in sections 2.2 and 2.3 above, and elaborated further in Articles 8, 16 and 18 of this National Report.

2.6 Conformance with the Vienna Declaration on Nuclear Safety

The UAE has taken note of the outcome of the Diplomatic Conference and the Vienna Declaration on Nuclear Safety in 2015.

The UAE's regulations contain requirements to address the objective of preventing accidents in the commissioning and operation of new nuclear power plants including the measures to ensure the robustness and independence of defence-in-depth.

The UAE's regulations also contain requirements to address the objective of mitigating severe accidents and to protect against the off-site impact of releases of radionuclides large enough to require long-term protective measures and actions.

The implementation of these requirements has been met through ENEC's and Nawah's safety assessments respectively contained in the applications for a Licence for Construction and Operation for the Barakah Nuclear Power Plant and FANR's regulatory review of those safety assessments. The conclusion of these safety assessments provide a technical foundation that the Barakah Nuclear Power Plant is capable of mitigating severe accidents to prevent off-site releases that could result in large scale off-site contamination or long-term protective measures and actions.

Second Principle of Vienna Declaration is addressed through a regulatory requirement in FANR Regulation on the Operational Safety including Commissioning (FANR-REG-16) which makes it obligatory on the licensee to conduct Periodic Safety Reviews every 10 years starting from the start of plant operation throughout the operating lifetime with due account taken of operating experience and significant new important to safety information from all relevant sources.

The Fukushima accident occurred during the ongoing review of the application for a Licence for Construction for Units 1 and 2 of the Barakah Nuclear Power Plant. FANR requested ENEC to follow a 'stress-test' approach to evaluate the Barakah design to a wide range of severe natural hazards and loss of electrical power and ultimate heat sink. ENEC was asked to identify any design deficiencies and identify any design enhancements that would further increase the robustness of the plant design and severe accident mitigation capability. No design deficiencies were identified and a set of enhancements were identified by ENEC and ultimately approved by FANR for installation at all four reactor units at the Barakah Nuclear Power Plant. FANR conducted dedicated inspections on Units 1, 2 and 3 of the Barakah Nuclear Power Plant prior to granting them an operating licence, to verify the implementation of identified enhancements.

Further details are provided in Articles 14, 17 and 18 of this National Report.

2.7 IAEA Generic Safety Observations Report

The UAE has taken note of the Generic Safety Observations Report as presented at the Organisational Meeting of the 7th Review Meeting of the Convention on Nuclear Safety. In line with the general progress made by other Contracting Parties, the UAE has made significant progress in several areas identified in the Generic Safety Observations Report. For example, several steps have been taken to assess and strengthen nuclear safety culture at ENEC and Nawah while the UAE has generally furthered its communication and consultation efforts with the public and other national stakeholders (as further described in Article 8 of this National Report).

The UAE response arrangements were reviewed during an EPREV Mission in 2015. Based on the mission recommendations, UAE relevant entities implemented a number of improvement actions, which were in line with an agreed action plan to address the findings of the EPREV service mission. These actions were reviewed during an EPREV follow-up mission in September 2019 and as a result all recommendations from the main mission were closed by the IAEA follow-up mission. These arrangements were also tested through the conduct of the Barakah IAEA ConvEx-3 hosted by UAE.

2.8 Future safety related activities and programmes planned for the period until the next National Report is submitted

Future UAE safety related activities over the period from the current date until the next National Report is published include the following major milestones related to the construction and operation of the Barakah Nuclear Power Plant:

- 2022 to 2023: Unit 3 Power Ascension Testing and Commercial Operation
- 2023: Unit 2 First Refuelling Outage
- 2024: Unit 1 Second Refuelling Outage and Unit 3 First Refuelling Outage.

In addition, following the completion of the construction of Unit 4 of the Barakah Nuclear Power Plant, a licence for the operation of the said unit is expected to be issued in the near future.

Other related activities include the ongoing development of plans for future management of the spent nuclear fuel and radioactive waste.

III. OBLIGATIONS OF THE CONVENTION (Articles 6-19)

Article 6: Existing Nuclear Installations

CNS Text:

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

6.0 General

The Barakah Nuclear Power Plant (BNPP) is the first nuclear power plant in the United Arab Emirates (UAE). The BNPP site is located about 300 km west of the capital city of Abu Dhabi, on the shore of the Arabian Gulf. (See Figure 1).

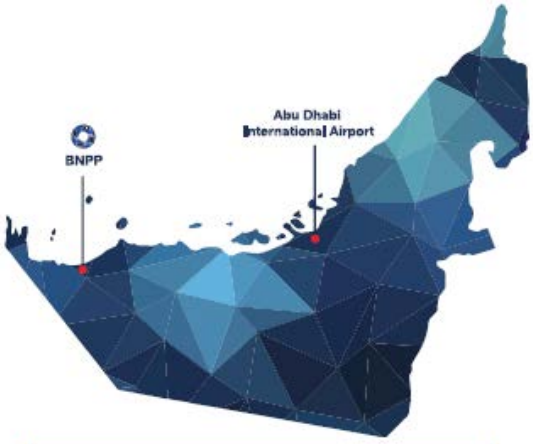


Figure 1 Map of the UAE

ENEC is responsible for the design, construction and ownership of BNPP, as well as to deliver safe, clean, reliable and efficient nuclear energy to the UAE. Nawah is the subsidiary of ENEC and the licensee that will operate and maintain the 4 units at BNPP. Barakah One is the financing arm of the BNPP Joint Venture.

BNPP has four units of pressurized water reactors rated at a nominal 1400 MWe supplied by the Korean Electric Power Company (KEPCO), model APR-1400. Two similar Nuclear Power Plants (NPPs) have been operating in South Korea, Shin Kori 3&4, which is the reference plant for BNPP units. KEPCO's APR-1400 is a Generation III+, 1400 MWe plant design that meets the highest international standards for safety and performance. APR-1400 design is an evolutionary Advanced Light Water Reactor (ALWR) design and incorporates a variety of engineering improvements and operational experience to enhance safety, economics and reliability. As a Generation III+ reactor, the APR-1400 safety system is designed to prevent or mitigate severe accidents by ensuring reactor shutdown, removing decay heat, maintaining the integrity of the containment facility, and preventing radioactive releases. By deploying a third-generation design, the UAE's fleet of nuclear reactors boasts safety levels significantly above those of existing nuclear fleets that are still dominated by second-generation designs

Furthermore, the design of the BNPP has been further enhanced based on lessons learnt from Fukushima accident.

6.1 Existing Installations

The UAE currently has two units of the BNPP in commercial operation. A third is in start-up while the fourth is in final stages of construction. Current status for the four units of BNPP is given in Table 1.

Table -1: Status of NPPs in UAE as of August 2022

Type: APR 1400

Gross Capacity: 1400 MWe

Operating Licence Owner: Nawah Energy Company

Reactor Supplier: KEPCO

Unit	Date of Start of construction First Concrete Pouring (Reactor Building)	Date of first criticality	First grid Synchronization	Date of commercial operation
1	18 July 2012	31 July 2020	19 August 2020	1 April 2021
2	15 April 2013	27 August 2021	14 September 2021	24 March 2022
3	24 September 2014	06 September 2022 (as per current milestone)	21 September 2022 (as per current milestone)	January 2023 (as per current milestone)
4	30 July 2015	TBD after obtaining the operation licence	TBD after obtaining the operation licence	TBD after obtaining the operation licence

6.2 Operational Readiness Assessments

The BNPP units have undergone reviews for obtaining the construction licences and for operating licences in a process modelled on US NRC 10CFR50. Operating licences have been granted to date for three BNPP units and the fourth and final operating licence is expected in the near future. The regulations of the UAE's Federal Authority for Nuclear Regulation (FANR) generally follow the International Atomic Energy Agency (IAEA) Safety Standards, Republic of Korea (ROK) positions, and US NRC Regulatory Guides, including General Design Criteria.

Nawah performed the operational readiness assessments and consolidated them through the Operational Readiness Report (ORR) and Operational Readiness Certifications which were submitted to FANR to convey readiness of Nawah to safely operate the BNPP Units. These documents were used by FANR to conduct the last stage of inspections called Integrated Demonstration Of Readiness (IDOR) inspections prior to granting the Operating Licence (OL). This mechanism is followed for each BNPP unit.

The ORR documents a holistic assessment of Operational Readiness for the BNPP Unit and the Nawah organization. It comprises of three sections covering the safe design, that this design has been constructed and successfully tested and finally that the operating organization is in place including the necessary processes, procedures, programs, people and tools to safely operate the

plant (See Figure 2). The assessment is based on acceptance criteria established through review of FANR Regulations and definitions, the Final Safety Analysis Report (FSAR) and Nawah's answers to FANR Request for Additional Information (RAIs).

Figure 6.2: Structure of the ORR

The ORR is divided into three discrete sections:

- Safety Assessment - The objective is to demonstrate that the safety is effectively managed at BNPP Units 1, 2 & 3. Consequently, the applicant for the licence to operate a nuclear installation shall be compliant to UAE laws and regulations and possess the licences, insurances, and other permits required for safe operation of such facility.
- Constructed per Design Assessment - The objective is to demonstrate that the BNPP Units 1, 2 & 3 have been constructed and commissioned in accordance with the approved Design as presented in the FSAR. The Design Basis is maintained under a Configuration Management program.
- Organizational Readiness Assessment - The objective is to demonstrate that Nawah is well established as an organization, with clearly defined roles and responsibilities. The organization has in place the required qualified personnel, programs, processes and procedures, and management tools to operate BNPP safely. Culture of safety and operating experience are inherent to all activities.

In addition to the ORR, the Operational Readiness Certifications are requested from Nawah for each functional unit as is supporting documentation that demonstrates the achievement of readiness for safe operation in their area of responsibility. The certifications are based on the same approach as the overall organization assessment, i.e. they are based on FANR regulations, and

represent a drill-down at each functional level. The key elements included in certifications are a verification by responsible Directors and Vice Presidents that they have clear identification of areas of responsibilities, sufficient number of trained and qualified people, and the necessary tools and equipment to perform their duties.

The ORR and the corresponding Operational Readiness Certifications correspond to the full scope required for Nawah's readiness assessment of each Unit of the BNPP and are made available to FANR at the IDOR inspections.

6.3 Ongoing Nuclear Safety Oversight

ENEC and Nawah have established several entities to perform nuclear safety oversight and operational reviews of the BNPP organization and operations. These reviewing bodies include the following:

Committee on Nuclear Power (CNP)

The Committee on Nuclear Power (CNP) is a standing advisory committee of the ENEC Board of Directors (BoD). It conducts structured visits at a defined periodicity and is responsible for overseeing and advising the BoD on issues of nuclear safety, security, reliability, regulatory, and environmental matters that relate to the construction and operation of the BNPP units.

The CNP is comprised of at least two non-employee Directors of the BoD, and at least three outside non-employee non-directors who have diverse nuclear executive experience.

The CNP Chair and Members are appointed by the BoD. Membership is periodically reviewed. The Committee assists the Board in fulfilling the Board's oversight responsibilities.

Nuclear Safety Review Board (NSRB)

Nawah established the Nuclear Safety Review Board (NSRB) to provide an independent review of the safety and effectiveness of the organization's operations in line with FANR-REG-01 Article (20) requirement for Independent Assessment by conducting periodic independent assessments on behalf of Nawah Senior Management. The NSRB does not have direct responsibility for routine plant operation but acts simply as a review board.

The NSRB meets at least twice a year; each meeting being approximately one week in length. The frequency of reviews may be modified by the CNO, based on the company performance and perceived needs.

The NSRB independently assesses and reports on operation or pre-operational readiness of the (BNPP) units with a focus on nuclear safety. The NSRB uses experienced senior-level officers and outside nuclear experts, who do not have direct responsibility for routine plant operation. The NSRB's Chairperson is appointed by CEO or CNO and the NSRB members are appointed by CNO in coordination with NSRB Chairperson.

Nuclear Oversight (NOS)

The Nuclear Oversight (NOS) Function includes programs and processes to support operational readiness and perform internal independent assessments of Nawah functions. The NOS Director reports directly to the Safety Assurance VP to ensure its independence. NOS Staff members have cross-disciplinary nuclear experience.

Nuclear Performance Improvement (NPI)

NPI is the Nawah Function responsible for management of Corrective Actions Program (CAP), Self-Assessment and Benchmarking, Operating Experience Sharing Program, Human Performance Improvement Program, and the Culture of Safety. NPI implements the systems and procedures that promote continuous improvement within Nawah and performs the associated activities.

Plant Nuclear Safety Committee (PNSC)

The Plant Nuclear Safety Committee (PNSC) is a multi-disciplinary committee established by Nawah which is responsible for review of activities that have the potential to affect nuclear safety. This committee serves in the advisory capacity to the BNPP Plant Managers to make the final decisions for the items which are defined in the scope of PNSC review.

PNSC makes written recommendation to the BNPP Plant Managers for the approval or disapproval of items referred to PNSC.

In addition, following external entities perform extensive formal activities for evaluation of BNPP performance related to nuclear safety.

International Atomic Energy Agency (IAEA)

IAEA conducted pre-OSART mission for BNPP units to assess the readiness of Nawah for safe operation of BNPP Units. A follow-up mission is scheduled by IAEA during September 2022.

World Association of Nuclear Operators (WANO)

WANO conducts Technical Support Missions (TSMs) for its members. ENEC and Nawah are members of the WANO Atlanta Center. These TSMs are voluntary for the members and initiated on an invitation only basis to assist in preparation for mandatory Crew Performance Observation (CPO) of operating crews and Pre-Start-Up Review (PSUR) conducted prior to loading fuel in an NPP. To date Nawah has successfully hosted CPO and PSUR for BNPP Units 1, 2 and 3. These pre-operational audits were conducted on-site by teams of nuclear experts from around the world. There were a few Areas For Improvement (AFIs) from these reviews but none of them was linked to start-up of the relevant Units.

6.4 Safety Enhancements Of Operating NPPs

As recently completed plants, no major enhancements have been identified to date. However, Nawah has a robust process in place to implement any identified upgrades to the BNPP units.

Nawah has placed due emphasis on learning lessons from the operating experience and utilizing it to enhance the safety of NPPs. Nawah has established an Operating Experience (OE) sharing group to address the evaluation and dissemination of OE from either internal or external sources.

Nawah actively participates with information sharing as a member of WANO, INPO, and other global industry organizations. Of special significance are the sharing agreements with the Korean reference plant operators.

Internal Operating Experience is shared via the Corrective Action Program (CAP). For significant events, Nawah Communication department generates a company-wide notification message for information to all staff. Significant events are also discussed at the Staff meetings within different Nawah Functions.

ENEC and Nawah gather external OE from the following sources:

1. WANO
2. IAEA International Reporting System (IRS) Reports
3. INPO
4. Electric Power Research Institute (EPRI)
5. United States Nuclear Regulatory Commission (US NRC)

6. Korean Electric Power Company (KEPCO) (including information from the reference plant Shin Kori 3 & 4)
7. Korean Hydro and Nuclear Power (KHNP) (including information from the reference plant Shin Kori 3 & 4)
8. Professional Journals
9. Vendors (Doosan, Westinghouse, General Electric, etc.)
10. Owner Groups (PWROG, etc.)
11. Federal Authority for Nuclear Regulation (FANR)

The operating experience items are screened by the OE group and a determination of action, if required, is made. If an OE item is determined to require evaluation by the plant, it is entered in the corrective action program for review.

The Fukushima lessons-learned have been considered and incorporated as part of the initial design after approval by FANR. An aircraft impact analysis was conducted early in the design process and resulted in structural enhancements to the plant structural design as well as system and operational modifications.

Minor corrective upgrades as identified from start-up, commissioning and operating experience, are evaluated per a safety screening and evaluation procedure to determine which, if any, upgrades require prior FANR approval before implementation.

By FANR regulation, Periodic Safety Reviews (PSR) of the nuclear installation shall be performed by the licensee, starting from the start of plant operation, every 10 years throughout the nuclear installation's operating lifetime with due account taken of operating experience and significant new important to safety information from all relevant sources. This will help in identifying necessary safety upgrades and their implementation in a timely manner.

6.5 Status

As stated above, Units 1 and 2 at Barakah are in commercial operation, Unit 3 is in start-up/commissioning, and Unit 4 is in final stages of construction. The licensee provides regular reports to the regulator of plant conditions and events. The regulator maintains a team of resident inspectors at the Barakah site with free access to all areas and all personnel. Regular inspections

are conducted by teams of regulator subject matter experts. Inspections are conducted at the licensee premises and at foreign contractors and sub-contractors in South Korea, the USA, and elsewhere.

Based on the above inspection and review activities, as well as regular communications with licensee management, FANR continually monitors plant conditions and performance.

Article 7: Legislative and Regulatory Framework

CNS Text:

Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

The legislative and regulatory framework shall provide for:

- *The establishment of applicable national safety requirements and regulations;*
- *A system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;*
- *A system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;*
- *The enforcement of applicable regulations and of the terms of licences,*
- *The enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.*

7.1 Legislative framework

The UAE legislative framework includes three types of instruments: laws and secondary legislation adopted within the UAE; multilateral instruments to which the UAE has become a party; and bilateral nuclear cooperation agreements with States that are or may be participating in the UAE nuclear programme.

7.1.1 Legislation of the United Arab Emirates

The nuclear legislative framework in the UAE is composed of the Federal Law by Decree No. (6) of 2009 Concerning the Peaceful Uses of Nuclear Energy, which came into effect on 24 September 2009, (referred to as the Nuclear Law). The Nuclear Law is a comprehensive nuclear legislation establishing the Federal Authority for Nuclear Regulation (FANR) as the nuclear regulatory

authority and addressing safety, radiation safety, security and safeguards. It is complemented by the Federal Law by Decree No 4 of 2012 Concerning Civil Liability for Nuclear Damage, which came into effect in August 2012 (referred to as the Nuclear Liability Law) and aims to establish the rules and requirements relating to civil liability and compensation for nuclear damage applicable in a situation of a nuclear accident occurring in a nuclear installation in the United Arab Emirates or during a transport of nuclear material to or from a nuclear installation located in the United Arab Emirates. The provisions of the Nuclear Liability Law are in line with UAE obligations under the 1997 Vienna Convention on Civil Liability for Nuclear Damage to which the UAE is a party and best international practices.

These two legislations are complemented by the following Cabinet Resolutions:

- Cabinet Resolution No. 8 of 2014 Concerning Licence Fees and Services Provided by the Federal Authority for Nuclear Regulation.
- Cabinet Resolution No. 27 of 2015 Concerning Administrative Penalties for Violating the Conditions of the Licences issued by the Federal Authority for Nuclear Regulation. This Cabinet Resolution is currently being revised.

In addition to these key legislative instruments, the following other legislations are also relevant:

- Abu Dhabi Law No. (8) of 2021 Establishing the Emirates Nuclear Energy Company, Public Joint Stock Company (PJSC), issued on 26 August 2021 (referred to as the ENEC Law).
- Federal Law by Decree No. (2) of 2011 Concerning the Establishment of the National Emergency, Crisis and Disasters Management Authority issued on 19 July 2011, as amended.
- Federal Law No. (24) of 1999 Concerning the Protection and Development of the Environment, issued on 17 October 1999, as amended by Federal Law No. (11) of 2006.
- Law No. (14) of 2007 Concerning the Establishment of the Critical National Infrastructure Authority and Law No. (1) of 2012 Concerning the Abolishment of the Critical National Infrastructure Authority, issued on 28 February 2012. This law transferred the functions and responsibilities of the Critical National Infrastructure Authority (CNIA) to the Critical Infrastructure and Coastal Protection Authority (CICPA) of the UAE Armed Forces.
- Federal Law No. 14 of 2016 Concerning Administrative Violations and Penalties in Federal Government.
- Federal Law No.3 of 1987 concerning the Penal Code, as amended.

- Federal Law no. 10 of 1973 Concerning the Federal Supreme Court, as amended.

7.1.2 Multilateral instruments to which the United Arab Emirates is a Party

In order to meet the UAE's commitments on transparency and international cooperation as underpinned in the Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy, the UAE has acceded to the relevant international instruments in the areas of nuclear safety, nuclear security, and non-proliferation as listed below:

- Convention on Nuclear Safety, acceded by the UAE on 31 July 2009 and entered into force for the UAE on 29 October 2009.
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, acceded by the UAE on 31 July 2009 and entered into force for the UAE on 29 October 2009.
- Convention on Early Notification of a Nuclear Accident, acceded by the UAE on 2 October 1987 and entered into force for the UAE on 02 November 1987.
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, acceded by the UAE on 2 October 1987 and entered into force for the UAE on 02 November 1987.
- Convention on the Physical Protection of Nuclear Material, acceded by the UAE on 16 October 2003 and entered into force for the UAE on 15 November 2003.
- Amendment to the Convention on the Physical Protection of Nuclear Material, accepted by the UAE on 31 July 2009 and entered into force on 08 May 2016.
- Treaty on the Non-Proliferation of Nuclear Weapons (NPT), acceded by the UAE on 26 September 1995.
- Agreement between the United Arab Emirates and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons "Safeguards Agreement", signed on 15 December 2003 and entered into force for the UAE on 09 October 2003.
- Protocol Additional to the Agreement between the United Arab Emirates and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons "Additional Protocol", signed on 08 April 2009 and entered into force for the UAE on 20 October 2010.

- Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage, acceded by the UAE on 29 May 2012 and entered into force for the UAE on 29 August 2012.
- Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, acceded by the UAE on 29 August 2012 and entered into force for the UAE on 29 November 2012.
- Convention on Supplementary Compensation for Nuclear Damage, ratified by the UAE on 07 July 2014 and entered into force for the UAE on 15 April 2015.

In addition, the UAE has expressed its political commitment to follow the guidance as contained in the Code of Conduct on the Safety and Security of Radioactive Sources and its supplementary Guidance on the Import and Export of Radioactive Sources.

7.1.3 Bilateral cooperation agreements concluded by the United Arab Emirates

The UAE has also concluded agreements with several nations to advance cooperation in the peaceful uses of nuclear energy. The national level agreements are listed below. A number of subsidiary cooperative agreements have been reached with national regulatory bodies and other entities pursuant to these high-level agreements.

- Agreement for Cooperation between the Government of the United Arab Emirates and the Government of the Republic of France in the Development of Peaceful Uses of Nuclear Energy, 15 January 2008.
- Agreement between the Government of the United Arab Emirates and the Government of the Republic of Korea for Cooperation in the Peaceful Uses of Nuclear Energy, 22 June 2009.
- Agreement for Cooperation between the Government of the United Arab Emirates and the Government of the United States of America Concerning Peaceful Uses of Nuclear Energy, 21 May 2009.
- Agreement between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the United Arab Emirates for Cooperation in the Peaceful Uses of Nuclear Energy, 2010.
- Agreement between the Government of the United Arab Emirates and the Government of Australia on Cooperation in the Peaceful Uses of Nuclear Energy, 31 July 2012.
- Agreement between the Government of the United Arab Emirates and the Government of Canada for Cooperation in the Peaceful Uses of Nuclear Energy, 18 September 2012.

- Agreement between the Government of the United Arab Emirates and the Government of the Russian Federation on Cooperation in the Field of the Use of Nuclear Energy for Peaceful Purposes, 17 December 2012.
- Agreement on Cooperation in the Peaceful Uses of Nuclear Energy between the United Arab Emirates and the Argentine Republic, 14 January 2013.
- Agreement between the Government of the United Arab Emirates and the Government of Japan for Cooperation in the Peaceful Uses of Nuclear Energy, 2 May 2013.
- Agreement for Cooperation on Peaceful Uses of Nuclear Energy between the Government of the Kingdom of Saudi Arabia and the Government of the United Arab Emirates in the Peaceful Uses of Nuclear Energy, 27 November 2019.

7.2 Regulatory framework

CNS Article 7.2 requires its Contracting Parties to ensure that the four key elements of a legislative and regulatory framework for nuclear safety are fully established. In brief, these four elements are: (i) standard-setting through regulations; (ii) authorization through licensing; (iii) inspection and monitoring of compliance; and (iv) enforcement. All four elements are set forth in UAE's Nuclear Law.

7.2.1 Regulations and regulatory guides

Articles (11), (38), and (39) of the UAE Nuclear Law empower the FANR Board of Management to issue regulations and regulatory guides, which are required for FANR's operation, "taking into consideration comments from stakeholders, information made available by experts, and internationally recognised standards and recommendations, such as IAEA standards".

FANR has established within its Integrated Management System (IMS), a process for development and review of regulations and guides that includes provisions for consultation with stakeholders and the public, and review and incorporation of their comments. This process has been recently revised to further strengthen its efficiency and the quality of the documents produced. This process is complemented by a systematic review mechanism of the existing regulations and regulatory guides following a five years cycle.

FANR has now in place a set of 23 regulations, complemented by 22 Regulatory Guides. Since the UAE's National Report to the 7th Review Meeting, 7 regulations have been revised or developed. The regulations now in place include:

- FANR REG-01, “Management Systems for Nuclear Facilities”, Version 0, 2011.
- FANR REG-02, “Siting of Nuclear Facilities”, Version 0, 2013.
- FANR REG-03, “Design of Nuclear Power Plants”, Version 0, 2013.
- FANR REG-04, “Radiation Dose Limits and Optimisation of Radiation Protection for Nuclear Facilities”, Version 1, 2018.
- FANR REG-05, “Application of Probabilistic Risk Assessment (PRA) at Nuclear Facilities”, Version 0, 2010.
- FANR REG-06, “Application for a Licence to Construct a Nuclear Facility”, Version 0, 2010.
- FANR REG-08, “Physical Protection of Nuclear Material and Nuclear Facilities”, Version 1, 2016.
- FANR REG-09, “Export and Import Control of Nuclear Material Nuclear Related Items and Nuclear Related Dual-Use Items”, Version 1, 2021.
- FANR REG-10, “System of Accounting for and Control of Nuclear Material and Application of Additional Protocol”, Version 0, 2012.
- FANR REG-11, “Radiation Protection and Predisposal Radioactive Waste Management in Nuclear Facilities”, Version 0, 2012.
- FANR REG-12, “Emergency Preparedness for Nuclear Facilities”, Version 1, 2020.
- FANR REG-13, “Safe Transport of Radioactive Materials”, Version 1, 2021.
- FANR REG-14, “Application for a License to Operate a Nuclear Facility”, Version 0, 2014.
- FANR REG-15, “Off-Site Emergency Plans for Nuclear Facilities”, Version 0, 2014.
- FANR REG-16, “Operational Safety including Commissioning”, Version 0, 2014.
- FANR REG-17, “Certification of Operating Personnel at Nuclear Facilities”, Version 0, 2013.
- FANR REG-19, “Existing Exposure Situations”, Version 0, 2015.
- FANR REG-21, “Decommissioning of Facilities”, Version 0, 2015.
- FANR REG-23, “Security of Radioactive Sources”, Version 1, 2020.
- FANR REG-24, “Basic Safety Standards for Facilities and Activities involving Ionising Radiation other than in Nuclear Facilities”, Version 1, 2015.
- FANR REG-26, “Pre-disposal Management of Radioactive Waste”, Version 0, 2014.
- FANR-REG-27, “Disposal of Spent Fuel and Radioactive Waste”, Version 0, 2019.

- FANR-REG-29, “Regulation on the Registration and Licensing of Radiation Sources”, Version 0, 2020.

The relevant IAEA safety requirements have served as the basis for many of the regulations related to nuclear installations. FANR contributes to the development of the IAEA Safety Standards through its participation in the Standards Committees. Due to such participation, FANR has also observed the actions taken by the IAEA to strengthen its safety requirements following the accident at the Fukushima-Daiichi nuclear power plant.

FANR continues to strengthen its regulatory framework through the development of new regulations and the revision of existing ones as needed to support the implementation of the UAE nuclear energy programme, taking into account the experience feedback gained from the implementation of the existing regulatory framework. The IAEA safety requirements, as well as those of other well-recognized international organisations and regulatory bodies, continue to be key references. The following new regulation is currently under development:

- FANR REG-30 “Regulation on the Requirements for the Provision of Radiation Safety Services”.

The existing regulations that are under revision are the following:

- FANR-REG-01 “Regulation for Management Systems for Nuclear Facilities”.
- FANR-REG-08 “Physical Protection for Nuclear Material and Nuclear Facilities”.
- FANR-REG-10 "System of Accounting for and Control of Nuclear Material and Application of Additional Protocol".
- FANR-REG-15 “Off-Site Emergency Plans for Nuclear Facilities”FANR-REG-17, "Certification of Operating Personnel at Nuclear Facilities".

FANR Regulatory Guides (RGs) describe methods and criteria acceptable to FANR for meeting and implementing the requirements contained in FANR regulations. In some cases and as appropriate, FANR has found it effective to adopt the guides issued or endorsed by the regulatory body of the country of origin, the Republic of Korea, of the nuclear reactors being constructed at the Barakah Nuclear Power Plant such as KINS RG 17.6 “Qualification for Nuclear Power Plant Personnel”. Also, FANR have used some of the US NRC Regulatory Guides such as “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants” NUREG-0800

and IAEA Safety Standards such as “Application of the Management System for Facilities and Activities, IAEA Safety Guide No. GS-G-3.1”.

FANR regulatory guides are the followings:

- FANR-RG-001, “Content of Nuclear Facility Construction and Operating Licence Applications”.
- FANR-RG-002, “Application of Management Systems for Nuclear Facilities”.
- FANR-RG-003, “Probabilistic Risk Assessment: Scope, Quality and Applications”.
- FANR-RG-004, “Evaluation Criteria for Probabilistic Safety Targets and Design Requirements”.
- FANR-RG-006, “Transportation Safety Guide”.
- FANR-RG-007, “Radiation Safety”.
- FANR-RG-010, “Development and Review of Target Sets and of Vulnerability Assessment”.
- FANR-RG-011 “Cyber Security at Nuclear Facilities”.
- FANR-RG-015, “Implementation of the Obligations and Requirements of the Additional Protocol to the UAE Comprehensive Safeguards Agreement”.
- FANR-RG-017, “Certification of Reactor Operators and Senior Reactor Operators at Nuclear Facilities”.
- FANR-RG-018, “Pre-disposal Management of Radioactive Waste”.
- FANR-RG-019, “Radiation Safety in Industrial Radiography”.
- FANR-RG-023, “Safety Significance Evaluations for Modifications for Nuclear Facilities during Construction”.
- FANR-RG-025, “Physical Protection for Transportation of Nuclear Material”.
- FANR-RG-026, “Response and Contingency Plans of Nuclear Facilities”.
- FANR-RG-027, “Near Surface Disposal of Radioactive Waste”.
- FANR-RG-029, “Screenings and Evaluations for Modifications to Operating Nuclear Facilities”.
- FANR-RG-030 “Regulatory Guide for Operational Safety for Nuclear Facilities”.
- FANR-RG-032, “Development and Modifications of Physical Protection Plan for Nuclear Power Plant”.
- FANR-RG-033 “Radiation Protection for Nuclear Power Plants”.

- FANR-RG-034 “Regulatory Guide for Preparation, Conduct, and Evaluation of Drills and Exercises for Nuclear Facilities”.
- FANR-RG-035 “Regulatory Guide for Emergency Preparedness for Nuclear Facilities”.

All approved regulations and regulatory guides are available on the FANR web site (with the exception of those marked for restricted or for official use only).

7.2.2 System of licensing

Articles (23-31) of the UAE Nuclear Law provide requirements for granting, revoking, and suspending licences. Article (23) of the UAE Nuclear Law prohibits any person from conducting any Regulated Activity in the UAE unless licensed to do so by FANR. “Regulated Activities” are listed under Article (25) and include the siting, construction, commissioning, operation and decommissioning of nuclear facilities (noting that the definition of “nuclear facilities” incorporates the CNS definition of ‘nuclear installation’).

Article (6) of the UAE Nuclear Law gives exclusive authority to FANR for issuing licences to practice any of the Regulated Activities in the UAE and to impose conditions on licences as may be required. Article (28) of the UAE Nuclear Law requires the applicant for a licence to submit detailed evidence of safety that shall be reviewed and assessed by FANR in accordance with established procedures. Following a review and assessment of a licence application, FANR, through its Board of Management, determines whether to grant the licence, grant the licence with conditions, or to refuse the licence and record the basis for these decisions.

FANR has established in its Integrated Management System (IMS) a process consistent with the UAE Nuclear Law and the relevant IAEA safety requirements for assessing applications for licences relating to a nuclear facility. Supporting procedures and instructions detail, the methods and criteria to be applied by FANR during its review of a licence application.

The safety assessment conducted as part of the licensing process for the Barakah nuclear facility is described further in Article (14) of this National Report.

7.2.3 System of Regulatory Inspection and Assessment

Articles (32-37) of the UAE Nuclear Law provide requirements for inspection and control of licensee activities. Article (35) of the UAE Nuclear Law requires FANR to establish a planned and systematic inspection programme. Article (36) of the UAE Nuclear Law requires FANR to conduct

inspections covering all areas of regulatory responsibility to ensure that the licensee is in compliance with the Nuclear Law, FANR regulations and licence conditions. When conducting inspections, FANR is required to take account of the activities of suppliers of services and products to the licensee.

Article (5.8) of the UAE Nuclear Law provides FANR with the power to enter relevant sites and facilities at any time to carry out inspections.

FANR has established within its Integrated Management System (IMS) a core process consistent with the above requirements of the UAE Nuclear Law and the relevant IAEA safety requirements for inspection of licensees' activities to verify compliance with the Nuclear Law, FANR regulations and the licence conditions. Supporting procedures and instructions detail the methods that are applied by inspectors in different areas.

Following the issuance of the licences for construction for Barakah reactor units 1 and 2 in July 2012 (the said licence was amended in 2014) and for reactor units 3 and 4 in September 2014, FANR has mobilized an inspection programme – including the deployment of resident inspectors - to verify that ENEC's construction activities comply with FANR requirements and the terms and conditions of the licences, as further discussed below in Article 14.2 of this National Report. FANR is also executing a programme of inspection to determine the readiness for operation of Barakah reactor units including the readiness of both structures, systems, and components (SSCs) and organisational aspects. FANR continues its regulatory inspections oversight relating to operating units 1 and 2, power ascension testing of unit 3 and organisational readiness of Unit 4 operation, in preparation for issuance of its operating licence.

7.2.4 Enforcement

Article (5.17) of the UAE Nuclear Law gives FANR the power to take enforcement actions in the event of violations of safety, which are defined by the Nuclear Law to include corrective actions, written warnings, revocation of a licence, and administrative penalties and fines. Article (36.2) of the UAE Nuclear Law empowers FANR to take enforcement actions compelling the operator to take actions necessary to remediate any breach. Article (36.3) of the UAE Nuclear Law empowers FANR itself to remedy a breach if the operator does not do so. In such cases, the operator would bear the necessary costs of such an intervention. Article (37) of the UAE Nuclear Law obliges the operator to comply with FANR decisions and to remedy any breach, carry out an investigation

related to the breach, and take any measures necessary to prevent a recurrence. Articles (57-64) of the UAE Nuclear Law include provisions on criminal offences and the corresponding penalties for various breaches related to the requirements of the Nuclear Law.

In August 2015, the Cabinet of the United Arab Emirates issued Resolution No. 27 of 2015 specifying the administrative penalties for violation of the conditions of the licences issued by FANR. The resolution empowers FANR to enforce safety, security and safeguards requirements under licences by applying a number of administrative penalties such as fines, suspension or revocation of FANR licences, or corrective actions against violators. Such Cabinet Resolution is currently being revised with the view to strengthen the list of violations and corresponding administrative fines applying a graded approach.

To date, no significant enforcement actions pursuant to the above authorities have been necessary with regard to the nuclear facility licences.

Article 8: Regulatory Body

CNS Text:

i. *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.*
ii. *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 organisation concerned with the promotion or utilization of nuclear energy.*

8.1 Establishment of the Regulatory Body

8.1.1 Legal foundations of the UAE regulatory body

The UAE Nuclear Law establishes the structure, responsibilities and resources of the regulatory body entrusted with implementing the legislative and regulatory framework for nuclear safety in the UAE and includes three Chapters: Chapter 2 on the establishment and objectives of the Federal Authority for Nuclear Regulation, Chapter 3 on FANR's management structure and Chapter 4 on the requirements for FANR's finances.

Chapter 2, Articles (4) to (9) of the UAE Nuclear Law

- Pursuant to Article (4)(1) of the UAE Nuclear Law, FANR was established as a public organisation with an independent balance sheet, an independent legal personality, full legal competence and financial and administrative independence. Article (4) (2) states that the aims of FANR is to ensure safety, security and radiation protection within the UAE nuclear programme through the development of the nuclear sector only for peaceful purposes.
- Article (5) gives FANR the authority to determine all matters relating to the regulation of the nuclear sector as regards safety, nuclear safety, nuclear security, radiation protection and safeguards. FANR must implement obligations under relevant international instruments entered into by the UAE. Article (5) also includes a detailed list FANR's powers.
- Article (6) gives FANR exclusive jurisdiction over the licensing of regulated activities in the UAE and other activities within the scope of the UAE Nuclear Law (e.g. activities related to the management of spent fuel or radioactive waste; the production, use, import and export of radiation sources for industrial research and medical purposes, transport of radioactive material; and the decommissioning of facilities).
- Article (7) requires FANR to co-operate with relevant government bodies on matters related to safety, security, radiation protection concerning environmental protection, public and occupational health, emergency planning and emergency preparedness, radioactive waste, liability for nuclear damage, physical protection and safeguards, water use and consumption of food, land use and planning; and safety in the transport of dangerous goods.
- Article (8) authorises FANR to investigate potential breaches of the Nuclear Law, the implementing regulations issued by FANR, its decisions or any condition of the licence issued by FANR.
- Article (9) requires FANR to maintain the highest standards of transparency in its regulatory activities and to facilitate the access of the public to all relevant information about FANR's activities while allowing it to protect confidential information.

Chapter 3, Articles (10) to (17) set forth provisions on the management of FANR

- Article (10) establishes requirements for the management of FANR by a board of management that shall be appointed by the UAE Cabinet of Ministers for a period of three years, which may

be renewed. The members of the board shall not engage whether directly or indirectly in the conduct of any regulated activity under the jurisdiction of FANR and shall not have any personal interest conflicting with FANR's interests.

- Article (11) establishes the general authorities and functions of the board including the authority to establish the general policy and strategy of FANR, to approve its budget and organisational structure, to issue the regulations and requirements needed for FANR's operations and functions, and to propose to the UAE Cabinet of Ministers the fees for FANR's licences and services amongst other authorities and functions.
- Article (12) sets forth requirements for board membership.
- Article (13) identifies the grounds on which board members may be replaced.
- Article (14) provides for the appointment of a director general by the board to carry functions assigned to the director general in the UAE Nuclear Law, implementing regulations and resolutions of the board of FANR.
- Article (15) establishes that the director general will manage FANR's business and oversee its financial, administrative and technical affairs under the board's control. It also sets out the duties of the director general such as the responsibility to review all licence applications and makes appropriate recommendations to the board as well as propose an amendment to and/ or the revocation of a licence.
- Article (16) identifies the grounds on which the director general may be replaced.
- Article (17) establishes FANR's authority to appoint its employees.

Chapter 4, Articles (18) to (22) relates to FANR's financial affairs:

- Article (18) gives FANR the authority to manage its finances. It identifies the means of funding for FANR (i.e. allocated by the government), the income generated from its functions (i.e. fees), and stipulates that gifts, grants and loans accepted by the board do not conflict with FANR's objectives.
- Article (19) establishes the dates of the fiscal year for FANR's financing.
- Article (20) makes FANR subject to UAE tender and procurement laws, and applicable financial and auditing regulations.

- Article (21) grants FANR exemption from the federal taxes of the UAE including customs duties.
- Article (22) provides that the FANR board will appoint an independent auditor to report on FANR's financial affairs.

8.1.2 Mandate, mission and tasks, authorities and responsibilities

As noted above, Article (5) of the UAE Nuclear Law gives FANR "the authority to determine all matters relating to the control and supervision of the nuclear sector in the state" in relation to safety, security and safeguards. The UAE Nuclear Law grants powers to FANR in line with Article 8 of the Convention on Nuclear Safety to implement the key regulatory functions of (i) standard-setting through regulations (UAE Nuclear Law, Chapter 5 on Licences); (ii) authorization through licensing (UAE Nuclear Law, Chapter 7, "Regulations, Guidelines, Safeguards"); (iii) inspection and monitoring of compliance (UAE Nuclear Law, Chapter 6, "Inspection and Control"; Chapter 9, "Management of Safety and Quality Assurance"); and (iv) on enforcement (UAE Nuclear Law, Chapter 10, "Civil Liabilities and Penalties").

The UAE Nuclear Law requires FANR to cooperate with other competent authorities in the areas of health and safety, environmental protection, security, emergency management and the transport of hazardous goods. FANR adopts an integrated "Three-S" approach to benefit from the coordination of its safety, security and safeguards activities.

8.1.3 Organisational structure of the regulatory body

FANR Board of Management

The Nuclear Law specifies in its Article 10.1 that FANR shall be managed by a Board of Management comprising not less than five members in addition to a Chairman, and a deputy Chairman. The Board shall be appointed by the Cabinet for a period of three years, which is renewable by the Cabinet. Article 10.2 of the Nuclear Law further provides that the Board shall be constituted entirely by qualified nationals of the UAE, who shall not engage, whether directly or indirectly, in the conduct of any activity regulated by FANR and must not have any personal interest that conflicts with the interests of FANR.

The current formation of the Board of Management of FANR was renewed by the Cabinet further three years, i.e. from January 2021 to January 2024, by way of the UAE Cabinet issued Cabinet Resolution No. (17 /1g) of 2021 on Renewal of formation of the Board of Management of FANR (issued on 24 January 2021). The composition of the Board of Management of FANR provided for in the said resolution was further revised by the Cabinet with the issuance of the following two resolutions:

– Cabinet Resolution No. (37m/2g) of 2021 Adding a member in the Federal Authority for Nuclear Regulation's Board of Management (issued on 14 February 2021); and
– Cabinet Resolution No. (57m/2g) of 2022 Adding Mr. Ahmed Salem Al Shamsi to the Board of Management of the Federal Authority for Nuclear Regulation (issued on 28 February 2022).

The current composition of the Board of Management of FANR is as follows:

- H.E. Mr Abdulla Al Suwaidi (Chairman)
- H.E. Ambassador Hamad Ali Al Kaabi, (Deputy Chairman)
- H.E. Mrs Razan Khalifa Al Mubarak (Member)
- H.E. Dr Ali Mohamed Shaheen Ahmed (Member)
- H.E. Dr Abdul Qader Ebrahim Alkhayat (Member
- H.E Mr. Yousif Ahmed Al Ali (Member)
- H.E. Eng. Mr Essa Abdul Rahman Al Hashmi (Member)
- H.E. Mr Ahmed Salem Al Shamsi (Member)

The Director General leads FANR's staff. The Legal Affairs Department and the Corporate Development Department report directly to the Director General. The Internal Audit Department, which is an independent function established to evaluate the adequacy and effectiveness of FANR controls, systems, policies, and procedures, functionally reports to the Audit and Risk Committee (ARC) of the Board of Management of FANR; administratively the Internal Audit Department reports to the Director General.

FANR's organisational structure includes two divisions: Administration Division and Operations Division. The Administration Division includes the departments of Finance and Control, Human Resources, Information and Communication Technology, Government Communications, Supply Chain and General Services. The Operations Division includes the departments of Education and Training, Nuclear Safety, Nuclear Security, Radiation Safety, and Safeguards. The management organisation chart of FANR is shown below in Figure 8.1.

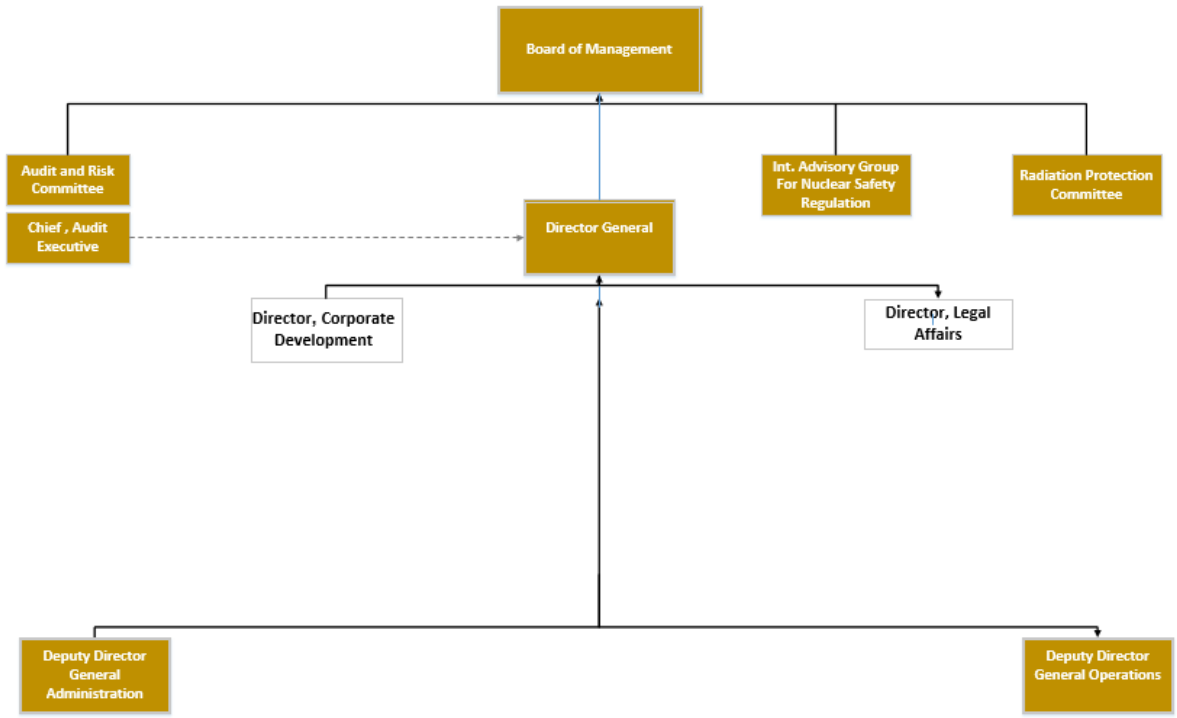


Figure 8.1 - FANR Management Organisation Chart

8.1.4 Development and maintenance of human resources

FANR has made significant progress in recruiting a qualified and capable workforce. FANR is committed to optimising the skills, processes and resources needed to excel and realise the authority's vision. FANR capacity-building efforts include steadfast support of the government's Emiratisation initiative. The main goal of all education and training activities at FANR is to ensure Emiratis are trained and developed to have the required skills and knowledge to contribute effectively to FANR's core functions.

Long-term career opportunities for Emirati employees at FANR are encouraged through focused recruitment, knowledge transfer and training and development programmes

As of the date of this report, there are 245 FANR staff members. 71% of FANR employees is Emirati. The balance of the staff includes expatriates with nuclear experience recruited from 28 countries around the world. The depth and breadth of expertise embodied within this team has been instrumental to FANR's achievements to date.

8.1.5 Measures to develop and maintain competence

Having successfully recruited a workforce to meet near-term demands, FANR's human resource strategy for long-term sustainability concentrates on developing Emiratis to take positions of increasing responsibility while retaining an appropriate cadre of non-Emirati experts. FANR complements its in-house training programmes through collaboration with ENEC, Khalifa University, the International Atomic Energy Agency and other partner institutions in a national programme of capacity-building, which offers Emiratis a range of education, training and development opportunities in the UAE and abroad. Since the last review meeting, FANR has implemented the development of the actions mentioned under section 8.1.5 of this article.

Scholarships

In order to enhance FANR's capacity building and staff competence, FANR awards scholarships to Emirati employees to complete tertiary qualifications at leading institutions such as Zayed University, Manchester University, the Korea Institute of Nuclear Safety, the Korea Advanced Institute of Science and Technology and Khalifa University. Since the 7th review meeting, the first FANR Emirati successfully graduated with a PhD degree in Nuclear Engineering, with her thesis focussing on probabilistic safety analysis and titled "Development of a Methodology for Risk

Analysis and Management in Sharing Electrical Power in Nuclear Power Plants". In 2021, two FANR employees graduated with MSc degree in Nuclear Engineering awarded by Khalifa University: one employee from the Nuclear Safety Department graduated with the thesis on "The scaling effect analysis of LSTF/ATLAS test facilities on 1% Reactor Pressure Vessel Top Head Break Loss of Coolant Accident via OECD-ATLAS project", the other employee from the Radiation Safety Department graduated with the thesis on "The Use of Global Oceanic Datasets to Support Design and Operation of Barakah Nuclear Power Plant".

Internship

The aim of the FANR internship programme is to provide university students with an exposure to the daily work of FANR and give them the opportunity to support and learn from FANR's senior staff through a structured and objective based Internship Programme Plan. Interns accompany selected career professionals and management within FANR for eight weeks. Since the inception of this programme, FANR has trained approximately ten students per year in both the administration and operations divisions. A rotation programme for technical students has also been designed to cover all departments in the Operations Division to provide them with real-life work experience in a nuclear related field. In 2020 FANR could only accommodate three interns as the programme was suspended due to the Covid-19 pandemic. A virtual internship was explored to sustain, the programme and provide support for university students. Through this virtual programme, in 2021 FANR hosted ten interns remotely, and executed by in-house subject matter experts. In 2022, FANR reinstated the physical internship programme and accommodated twenty-two interns from various engineering, science and finance academic streams. This is the largest number of interns FANR hosted since its establishment.

Employee Development Programme

The Employee Development Programme is designed to support the development of FANR's employees by equipping them with the knowledge and skills needed to perform their roles and responsibilities.

FANR has pursued the implementation of its programme for fresh graduates with its "Developee Engineers Programme". The developee programme is designed to provide fresh, Emirati engineering and physicists graduates with the fundamental knowledge, skills, and attitudes necessary to understand technical concepts applicable to nuclear engineering, radiation safety and,

specifically, nuclear regulation. This development programme runs over 53 weeks and is comprised of intensive training on nuclear and radiation fundamentals, on-the-job training in each of the departments in the Operations Division as well as soft skills training. Upon completion of the programme, Emirati nuclear engineers and physicists will be fully integrated into the departments in the Operations Division. Over the last few years, six to twelve young engineers per year have benefited from this programme.

In 2019 FANR established a new programme for fresh graduates called the "Legal Developee Programme". This programme was created to provide fresh law graduates with the knowledge necessary to understand concepts related to the laws, legislation, agreements related to the authority, and the UAE's peaceful nuclear programme in addition to other concepts related to nuclear law. The programme is broken down into four modules and offers the developees the opportunity to join a 2-week internship at a law firm in the United Kingdom.

In 2021, Education and Training Department (ETD) placed six developees on a tailored development track programme in RSD; the status of their development is as below:

- Two Developees (from RS & SSDL section) completed all components of their development programme and graduated in July & Nov 2021.
- Another two Developees has joined the Environmental Lab:
  * On March 2021 and she is preparing for her final assessment and Job Rotation Plan.
  * On September 2021 and he is attending trainings as a part of his Onboarding Program and will be doing his mid-programme assessment by the end of March 2022.
- Another Developee has joined the Radiation Sources and she is attending trainings as a part of her Onboarding Program and she will be having her mid-programme assessment by the end of March 2022.
- In December 2021, a Coordinator in Licensing Information joined FANR and will undergo a similar program as the Developee Program tailored towards technical customer service.

Another high priority for FANR is to develop the competencies of its existing and future managers and leaders to regulate the nuclear programme in the UAE. A specific development programme is implemented that includes management and leadership courses both internally at FANR and

abroad. This programme is included as a part of FANR's capacity-building approach to allow Emiratis to take on leadership roles within FANR.

Competency Development Framework

The competency development framework is the foundation for continuously ensuring a highly competent workforce at FANR. In 2021, technical and behavioural competency assessments for both divisions were conducted in an effort to highlight focused training and development needs. Following the 2020 launch of the Competency Framework Automation System; where employees and their managers conduct online competency assessments through their laptops and mobile devices; the Competency Framework was also integrated into the HR Performance Appraisal System. This provided an additional monitoring tool to ensure continuous development in maintained through performance objectives on an annual basis. In 2021 the Competency Framework System and ensure that all training & development activities are linked with the gap analysis and assessment.

Internal Training Programme

Both Emirati and expatriate employees have attended numerous in-house training courses and external courses covering technical skills, personal skills, and management and leadership topics. Expert staff members and external consultants deliver in-house training courses. In 2021, despite the pandemic, 536 internal and external training events were conducted, ranging from two hours to a few weeks, for 97% of FANR employees. This included technical and non-technical training provided by expatriate employees and Emiratis. Internal training included a variety of different training methodologies including classroom training, self-study, virtual learning, laboratory work and simulations. Although all physical training remained suspended due to the pandemic restrictions, all providers made online training opportunities available and employees were able to continue their development whilst working remotely. More than 35% of these training courses covered technical skills; the other training courses focused on soft skills or knowledge management.

Leadership and management developmen**t programme**

This programme establishes a platform for FANR employees to become more effective, efficient leaders and contributors within FANR as well as valuable contributors to FANR's broader regulatory and transparency goals.

FANR's leadership competency framework designed in 2019 serves as the base line for all leadership programmes. The first FANR leadership development centre was conducted in 2020 during which 40 of FANR's directors, managers and successors were assessed against the FANR leadership competency framework. In 2021, 90% of FANR's directors, managers attend leadership training based on their competency's assessment.

Leadership trainings 2021:

- Effective Leadership Through Emotional Intelligence.
- Team Leadership Training Course.
- Strategic Thinking Training Program.
- People & Performance Management.
- Empowerment & Delegation.

Inspector Qualification Programme

As reported at the 7th Review Meeting, FANR has implemented over the years formal inspection qualification standards for safety assessors and inspectors. The qualification follows a robust programme including initial training topics, an inspector job shadowing programme and a training course at the Ministry of Justice in order to be authorised as judicial officers. Every three years an inspector is required to participate in a re-qualification training course to renew his or her inspector card. In 2021, the FANR workforce included 81 inspectors qualified to carry out inspections at nuclear and industrial facilities in the UAE. 55 of those inspectors are Emirati.

Knowledge management

FANR has established a Knowledge Management Programme for business sustainability purposes. This programme has been designed to support its knowledge-based decisions for the safe and efficient regulation of nuclear and radiation safety activities in the UAE.

The Knowledge Management Programme also aims to support FANR management by minimizing the impact of employee mobility (e.g. transfer of personnel within or outside the organisation, retirement, promotion, etc.) and the resulting knowledge loss. It also aids the transfer of nuclear knowledge from one employee to another. In order to achieve these objectives, FANR has developed a number of methodologies and tools during the past two years.

For example, FANR has developed tools like Knowledge Loss Risk Assessment (KLRA), Knowledge Transfer Plan (KTP) which support identification of employees with critical knowledge and accordingly, transfer the targeted knowledge to the successors. Application of those methods and tools will help in mitigating the related business risks and support business continuity. Moreover, based on the lessons learned over the years; the KLRA has evolved and has been automated and integrated with competency framework which was developed in reference with IAEA Safety Report Series No. 79 Managing Regulatory Body Competences.

8.1.6 Financial resources

FANR has its budget set by its Board of Management and based on Federal Law No. (6) of 2009 regarding the peaceful uses of nuclear energy, provides a public authority called the "Federal Authority for Nuclear Regulation" shall be established, with an independent budget.

FANR's Budget is funded as per the following resources:

- With reference to Cabinet Resolution No. (8) of 2014 regarding licensing fees and services provided by FANR, FANR finances 90% of the annual budget approved by the Board of Management from the annual fees on licensees to conduct regulated activities relating to a nuclear facility. The authority also collects fees for issuance and renewal of licences to conduct any regulated activity relating to regulated material under the mandate of FANR (medical field, industrial field, etc).
- Additionally, government of Abu Dhabi contributed every year to FANR budget.

FANR manages its financial resources according to the accounting standards of the UAE federal government and the international public accounting standards. The FANR Board of Management appoints an independent auditor registered with the appropriate UAE authorities to audit annual accounts and prepare reports on the results of the audit. The overall budget provided has been adequate to enable FANR to carry out all of its significant regulatory responsibilities over the reporting period.

8.1.7 Quality management system of the regulatory body

Article (5) of the UAE Nuclear Law authorises FANR to apply the Quality Assurance principles on all procedures related to its functions. FANR implemented an integrated management system (IMS) as recommended in the relevant IAEA publications. The integrated management system

includes a set of interacting processes that address the objectives and requirements of the organisation. Elements included in the integrated management system that are tailored specifically to the regulator are the structure, resources, and processes of the core areas of nuclear regulation, licensing and inspection as well as corporate management and support functions. The establishment of the integrated management system has helped FANR to deliver its functions effectively and support the development of a strong safety culture. Figure 8.2 depicts the processes in the FANR integrated management system.

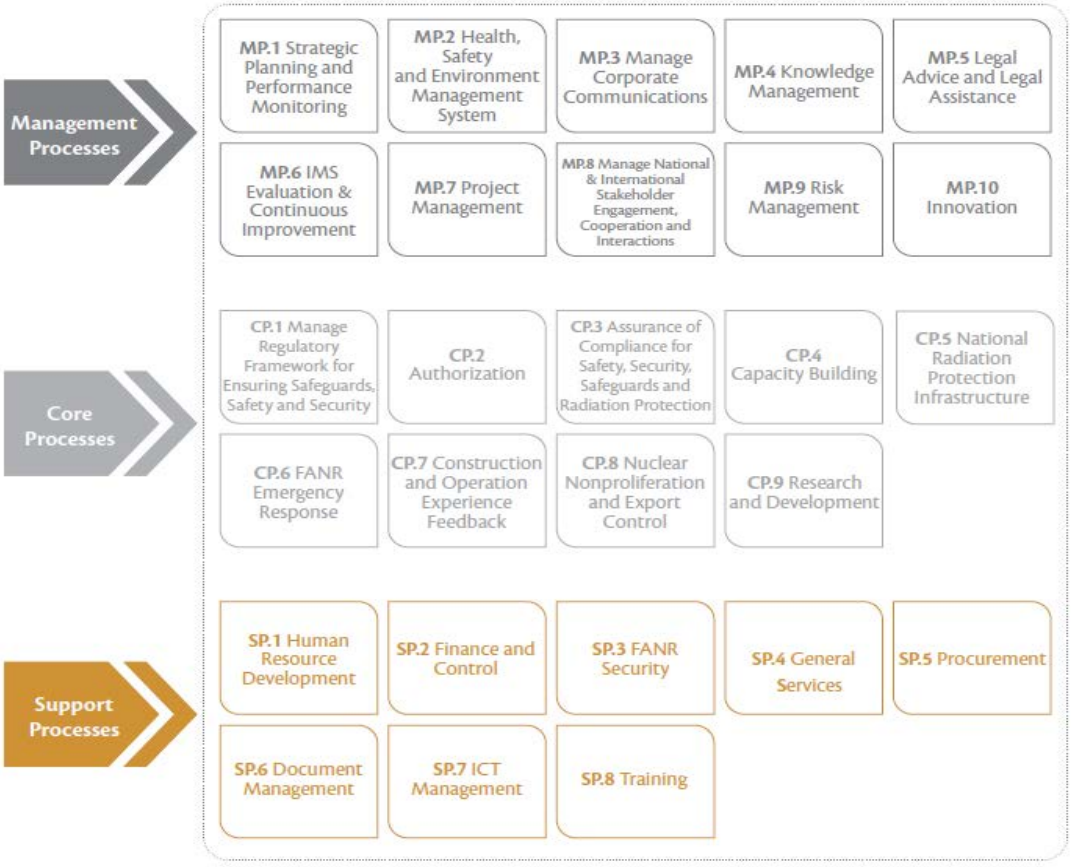


Figure 8.2: FANR Integrated Management System Processes

Architecture of Integrated Information Systems (ARIS) & Business Process-Reengineering (BPR) Project

The ARIS (Architecture of Integrated Information Systems) project development started in 2019 as an enterprise tool used to have a holistic view of process/procedure modelling and analysis.

ARIS System benefits:

1. Improve and understand processes via a modern and easy-to-use user interface.
2. Ensure consistency and reuse of models and data through a central repository.
3. Any Change on Library items will be reflected on the models where applicable.
4. Speed up the modeling process with a mini toolbar, panes, and powerful search/query capabilities which covers all procedure data such as:
   - Assigned action steps per job title/role.
   - Linked procedures lists.
   - Unified Definitions.
   - Lists of Performance Indicators / Risks

In 2021, the Business Process Reengineering (BPR) Project was launched to complement the (ARIS) system by enhancing the content of the procedures in terms of:

1. **Efficiency:** No non-value adding steps, to complete the procedure in the best way and reduce time wasted and cost.
2. **Effectiveness:** Being able to achieve its main objective and the desired output with the required quality.
3. **Governance:** Controlled to reduce operational risks and ensure correct decisions are made.
4. **Robustness:** Reducing the possibility of process failure and allow it to be easily repeated.
5. **Clarity:** All actions steps to be clear with responsibilities identified.

The project core deliverables were:

1. Reviewing the full IMS structure interrelated interactions and develop a new integrated value added chain diagram structure with the respective processes/procedures representing FANR as a whole with reference to best market practices.
2. Simplifying and reducing linked procedures within one function or spanning multiple functions in the organization.
3. Developing risks, performance and productivity indicators relative to the implementation of processes and procedures.
4. Implementing a full workflow cycle within the system to add changes to current procedures, review comments by multiple assigned parties, officially acquiring e-signatures and publishing updated document.

Internal and External Management Systems Audits

FANR conducts one full cycle of Internal Management Systems Audits each year to cover all Processes and Procedures under the integrated management systems (IMS). In addition, the certification body conducts a yearly external management system surveillance audit to ensure compliance to the applied management standards.

By end of 2021, FANR is certified for the following management systems:

1. PAS 99 Integrated Management Systems.
2. ISO 9001:2015 Quality Management Systems.
3. ISO 20000-1:2018 Information Technology - Service Management.
4. ISO 20400:2017 Sustainable Procurement.
5. ISO 56002:2019 Innovation Management Systems.
6. ISO 31000:2018 Risk Management.
7. ISO 27001:2013 Information Security Management Systems.
8. ISO 45001:2018 Occupational Health and Safety Management Systems.
9. ISO 14001:2015 Environmental Management Systems.
10. ISO 30401:2018 Knowledge Management Systems.
11. ISO 22320:2018 Guidelines for Emergency Management Systems.
12. ISO 10015:2019 Guidelines for Competence Management and People Development.
13. ISO 22301:2012 Business Continuity Management Systems.
14. ISO 17025:2017 Testing and calibration laboratories.
15. PAS 3000:2015 Smart Working.

8.1.8 Openness and transparency of regulatory activities

Article (9) of the UAE Nuclear Law requires FANR to maintain the highest standards of transparency whilst performing its functions and to facilitate the public's access to all relevant information to its activities.

In order to meet its obligations for transparency and in line with the UAE Federal Government Communication Strategy, FANR has developed and implemented it's communication strategy and programmes targeting different stakeholders including the public, Government entities, international organizations, licensees, students, media and employees. It uses different channels and tools to engage and communicate with its stakeholders such as the:

- FANR website (www.fanr.gov.ae), which includes thorough and detailed information on FANR's activities. The website presents the following:
  - All published regulations and guides with the exception of those containing sensitive information, which are restricted for nuclear security reasons.
  - Resolutions adopted by the Board of Management.
  - Summaries of the safety evaluation reports.
  - Summaries of inspection reports.
  - Peer review reports.
  - FANR Annual Reports.
  - UAE National Reports on the implementation of safety-related conventions.

The FANR website allows stakeholders and the public to interact with FANR using various communication channels including:

- Live Chat, e-Forum, Wasl (public & licensees enquiry channel), Talk to the Director General, and email queries to info@fanr.gov.ae.

Media Engagement

FANR adopts a global media strategy where it communicates with local and international media. Throughout the year, FANR conducted multiple engagement activities targeting Arabic and English media. This includes:

- Organise twice a year media briefings through which FANR Director-General presents FANR regulatory and oversight updates to the media and address the questions of the journalists.
- Organise press conferences to announce key milestones and activities.
- Issue position statement when necessary to explain a regulatory position in respect to major licensing and operational activities.
- Issue press releases with focus on major regulatory activities related to nuclear safety, security, and safeguards.
- Organise media awareness sessions.

- Conducts spokesperson-training program for its staff to be able to engage with media and answer their questions. The spokesperson-training program covers also engagement with media during an emergency that is simulated during emergency drills.
- Seeks comments from its stakeholders (including the public) on its draft regulations and guides before they are issued. FANR informs its stakeholders through correspondence, the mainstream media, social media and the FANR website that they have the opportunity to provide such comments.
- Uses its social media channels such as Facebook, Twitter, YouTube, Linked in and Instagram to provide update on its regulatory activities, raise awareness through targeted campaigns and engage with the general public and seek opinion.
- Conducts an annual stakeholders (including public, licensees, government & employees) survey to evaluate the stakeholders' awareness, perception and satisfaction and gather feedback on FANR nuclear regulatory activities. FANR receives good feedback and valuable insights from the stakeholders and adopt enhancement plans accordingly.
- Communicates with its stakeholders through its Outreach Programme where it has held awareness sessions at community centres, schools, government entities and open forum with licensees. Those public outreach activities aim to explain FANR's role in the UAE's peaceful nuclear power programme and its function in regulating and licensing radioactive materials and sources used in medicine, research, oil exploration and other industries. It also gives FANR the opportunity to answer any public concerns in relation to the peaceful nuclear programme and FANR's role in protecting the public, workers and the environment.

Due to the pandemic, FANR has adopted multiple online engagement activities to ensure continuous interaction with the public and stakeholders including webinars, virtual workshops and exhibitions,

8.1.9 External technical support

FANR has benefited from a strong bilateral relationship with the Korea Institute of Nuclear Safety (KINS), a part of the regulatory body in the vendor country of origin, in carrying out the review and assessment of the applications for a Licence for Construction and the Licence for Operation. The cooperation agreement between FANR and KINS provides for a range of cost-free, cost-

shared and cost-recovered information exchange and technical support activities in the areas of regulations, safety assessment and licensing, inspection, operating experience and safety research.

In order to augment its resources and to assist the staff in reviewing the operating licence application, FANR contracted technical support organisations (TSOs) located in the USA and Europe. The TSOs were selected based on their organisation and staff qualifications, capability, and credentials in conducting safety evaluations of nuclear facilities for other established nuclear regulatory bodies. FANR provided direction to the TSOs to ensure consistency across the review, whilst retaining responsibility for regulatory decisions through its staff. Since 2018 FANR have conducted the remaining review work related to the operating licence application in-house without TSO support, showing its effectiveness of the knowledge transfer to FANR staff.

However, it should be noted that in 2021, FANR entered an agreement with a TSO located in USA in relation to the provision of services enhancing FANR's effectiveness in regulatory oversight of Barakah NPP operating units. These services includes provision of training to FANR staff, support to inspection program and technical assistance to FANR personnel in the review and assessment of unplanned event that may happen on site from time to time as well as Nawah's change requests. As an example of TSO's services, TSO's staff are currently assisting FANR personnel in the review and assessment of requests made by Nawah to approve new computer codes used in design and safety of Barakah NPP nuclear fuel.

8.1.10 Advisory bodies

FANR had established an International Advisory Group on Nuclear Safety (IAG-NSR) with the objective of providing independent and impartial advice to the FANR Board of Management on nuclear safety. The IAG-NSR comprised a panel of senior experts who met twice a year with the FANR Director General and senior staff and provided a direct report to the Chairman of the Board of Management with their observations and recommendations.

This Advisory group reached the term of its mandate in December 2018.

8.2 Status of the regulatory body

The UAE Nuclear Law clearly establishes FANR as the independent government body charged with the regulation and licensing of all nuclear activities within the UAE, which includes the design, siting, construction and operation of nuclear power plants as well as the regulation of

radioactive materials and radiation sources used in medical, research, oil exploration and other industries. FANR is the sole decision-maker in licensing regulated activities involving regulated material and related facilities, and its decisions are not subject to any external review. FANR is independent of the users of nuclear energy or nuclear applications such as the ENEC, Nawah and any other UAE entity charged with nuclear power and other nuclear applications promotional responsibilities.

Pursuant to the commitments set forth in the UAE Nuclear Policy and in line with the Convention on Nuclear Safety and other relevant international instruments to which the UAE is a party, FANR has committed itself to the following core values:

- Core value No. 1: Safety Culture.
- Core value No. 2: Transparency.
- Core value No. 3: Collaboration.
- Core value No. 4: Independence.
- Core value No. 5: Excellence.

The FANR Board Members described in Section 8.1.3 above are appointed for a renewable fixed term and can be removed only by a resolution of the Cabinet for defined reasons. Board Members are prohibited by the UAE Nuclear Law to engage directly or indirectly in the conduct of any regulated activity, and must not have any personal interest that conflicts with the interests of FANR.

The Chairman of the Board of Management is required by Article (11) of the UAE Nuclear Law to submit a report at the end of each financial year to the Minister of Presidential Affairs. The Board of Management is also required by law to submit a set of audited accounts to the Cabinet for endorsement.

As reflected in Chapter 4 of the UAE Nuclear Law and discussed earlier in this section, FANR has sufficient financial resources to independently fulfil its responsibilities.

The reporting structure within the UAE government, its legal and financial independence, the requirement for transparency, and its technical competence are factors that demonstrate that FANR

is effectively independent of other organisations concerned with the use or promotion of nuclear energy as required by the Convention on Nuclear Safety.

8.3 International and National Cooperation

Being an IAEA member state since 1976, the UAE has continued to have extensive cooperation with the IAEA, has participated in many missions and made use of several safety services.

FANR takes part in the technical programme of the agency and provide input to IAEA safety standards and guides. It also contributes to the IAEA training programs and workshops by hosting various IAEA activities in this regard in particular those targeting newcomers.

IAEA technical cooperation

IAEA technical support has been made available to the UAE through a large number of projects, nationally, regionally and inter-regionally; the support covers nuclear safety, security and safeguards. This cooperation has been consolidated with the establishment of the UAE Permanent Mission in 2008 acting as the official National Liaison Office to the IAEA. This collaboration is defined in an integrated work plan that is reviewed and updated by the UAE and the IAEA. The Integrated work plan provides the framework of cooperation through which the IAEA will work with all stakeholders for the development of the UAE's nuclear power infrastructure. In 2019, an updated Comprehensive Work Plan was agreed between IAEA and UAE.

Other IAEA cooperation

FANR has actively participated in peer reviews, meetings and events, and provided insight and understanding on various topics, which includes:

- Providing experts in support of IAEA technical assistance to newcomer countries.
- Hosting the IAEA Convex 3 Exercise in 2021.
- Active participation at IAEA emergency preparedness and response activities including the IAEA ConvEx exercises, and information exchange through the point of contact.
- Participation and contribution to the work of the committees under the IAEA's Commission on Safety Standards including the Radiation Safety Standards Committee, the Nuclear Safety Standards Committee, the Emergency Preparedness and Response Standards Committee, the Transport Safety Standards Committee and the Waste Safety Standards Committee.

- Contributing to the IAEA training programs and workshops by hosting various IAEA activities in this regard in particular those targeting newcomers.
- Participation at IAEA key conferences and symposiums to present its practices as a newcomer country in key areas including nuclear safety, emergency preparedness and response, knowledge management, safeguards or nuclear legal matters.

OECD NEA cooperation

In 2012 the UAE was invited to join the Multinational Design Evaluation Programme as an associate member. The Multinational Design Evaluation Programme is a multinational initiative administered by the Organisation for Economic Co-operation and Development's Nuclear Energy Agency (OECD-NEA) to leverage the resources and knowledge of the national regulatory bodies that are (or will be) tasked with the review of new reactor designs. FANR is participating in the APR1400 Design Specific Working Group on the Multinational Design Evaluation Programme (MDEP), and is an observer on the Technical Steering Committee. The APR1400 Design Specific Working Group meets on average twice a year. Since the last UAE National Report, FANR has actively contributed to the work undertaken by this Working Group. It is worthwhile noting that two technical evaluation sub-groups have been created, which report to the APR1400 Design Specific Working Group on specific technical topics: the Technical Evaluation Sub-group on Severe Accidents and the Technical Evaluation Sub-group on Transient and Accidents analysis. FANR is currently chairing the APR1400 Design Specific Working Group as well as the Technical Evaluation Sub-group on Severe Accidents. Furthermore, in November 2019 FANR has hosted the 36th meeting of the Technical Steering Committee on the Multinational Design Evaluation Programme. In 2021, the MDEP Design Specific Working Group together with its two Technical Evaluation Sub-groups has completed its working programme and issued its closure report. In 2022 UAE is participating in developing the programmes of work for the following groups: Working Group on Inspection and Oversight, Working Group on Leadership and Safety Culture and Working Group on Policy and licensing.

In 2013 the UAE joined the Halden Reactor Project. The Halden Reactor Project is a joint undertaking of organisations in 19 countries sponsoring a jointly financed programme under the auspices of the OECD-NEA. The main areas of research include fuel use, degradation of core materials, and man-machine interface systems. FANR has continuously engaged with the Halden

Reactor Project by participating in programme meetings (held twice a year), summer schools and workshops. As the chairing country for 2019, the UAE has hosted the 161st Halden Programme Group meeting in October 2019.

In 2014 the UAE joined the advanced thermal-hydraulic test loop for the accident simulation project otherwise known as “ATLAS”. The Korea Atomic Energy Research Agency in cooperation with the OECD-NEA initiated the international research programme to carry out experiments on a large-scale thermal hydraulic facility, i.e. ATLAS (Advanced Thermal-Hydraulic Test Loop for Accident Simulation). The primary objective of the programme is to address thermal-hydraulics safety issues relevant for water reactors by means of experiments. In April 2018 FANR hosted the 2nd meeting of the programme review group of the ATLAS Phase 2 and in 2022 joined ATLAS Phase 3 which is a follow up to Phase 2 and aims to enhance the nuclear safety analysis technology and improve best guidelines for accident management.

Recently, the UAE joined the Component Operational Experience, Degradation and Ageing Programme (CODAP). The programme, which is established in 2002 by OECD/NEA and sponsored by 13 countries, aims to collect and analyse data relating to degradation and failure of metallic piping and non-piping metallic passive components in commercial nuclear power plant.

Since 2016, FANR has been invited to attend the meetings of the OECD NEA Nuclear Law Committee (NLC). Further, as of March 2018, invitations have been extended to attend the meetings of the NLC Working Party on Nuclear Liability and Transport (WPNLT) and of the Working Party on the Legal Aspects of Nuclear Safety (WPLANS). Representatives of the nuclear industry of the UAE attended these meetings together with FANR, as well as the meeting of the Working Party on Deep Geological Repositories and Nuclear Liability (WPDGR) held in June 2020.

GCC cooperation

The UAE has continued regional cooperation with the Gulf Cooperation Council (GCC) in the peaceful use of nuclear energy, and has participated in coordination meetings on information-sharing in relation to emergency preparedness and response programmes.

A Cooperation arrangements between the UAE and the Kingdom of Saudi Arabia on nuclear energy entered into force in 2019 which enables FANR and the Saudi Arabia’s Nuclear and Radiological Regulatory Commission (NRRC) to work together on a technical cooperation

programme including information exchange and emergency preparedness and response related matters.

Cooperation with Foreign Regulators

FANR has established strong relationships with nuclear regulatory bodies around the world and has signed cooperation agreements with the following:

- Korea Nuclear Safety and Security Commission (2011).
- Australian Radiation Protection and Nuclear Safety Agency (2013).
- Finnish Radiation and Nuclear Safety Authority (renewed 2016).
- Canada Nuclear Safety Commission (2017).
- U.K Office for Nuclear Regulation (2017).
- French Nuclear Safety Authority (renewed 2018).
- China Nuclear Safety Administration (2018).
- Spain Nuclear Safety Council (2018).
- U.S. Nuclear Regulatory Commission (renewed 2020).

Other International Cooperation

FANR endeavours to work with the international community by supporting cooperative programmes. For example, FANR participates in meetings of experts from nations that have signed on with the U.S. Nuclear Regulatory Commission's Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP) to assess the lessons learnt from computer simulations that can guide decisions concerning nuclear power plant design, operation and safety.

FANR also participates in the Regulatory Information Conference hosted annually by the U.S. Nuclear Regulatory Commission.

UAE stakeholder cooperation

At the local level, FANR has built upon the excellent relationships it has established with its key national stakeholders. These entities represent the legal, safety, energy, health, security and environmental fields in the UAE.

FANR has agreed to memoranda of cooperation with key UAE agencies such as:

- The National Transport Authority (2012).
- The National Emergency, Crisis and Disasters Management Authority (NCEMA) (2012).
- The Abu Dhabi National Oil Company (ADNOC) (2012).
- The Environment Agency - Abu Dhabi (EAD) (2014).
- The Department of Civil of Aviation in Sharjah (2014).
- Abu Dhabi Occupational Safety and Health Center (2015).
- General Authority of Ports Border and Free Zones Security (2016).
- Insurance Authority (2016).
- The Federal Customs Authority (2016).
- National Center of Meteorology & Seismology (2016).
- An agreement with the Khalifa University of Science and Technology on the Development and Operation of the Secondary Standards Dosimeter Laboratory (2017).
- A Memorandum of Understanding with the General Command of the Armed Forces related to the Implementation of the Orphan Sources Strategy Action Plan (2017).
- Agreement on the establishment and Operation of the environmental laboratory with Zayed University (2018).
- A Memorandum of Understanding with Zayed University on establishing a framework of cooperation and exchange of information related to environmental radiological monitoring (2018).
- A Memorandum of Understanding with the Ministry of Climate Change and Environment on cooperation in certain areas (2018).

- A Memorandum of Understanding with the Department of Economic Development of Abu Dhabi in establishing a framework for cooperation and assistance with the issuance of licenses (2019).
- A Non-disclosure Agreement with the Federal Authority for Identity and Citizenship (2019).
- A Sponsored Research and Collaboration Agreement with Khalifa University (2019).
- The Telecommunications and Digital Government Regulatory Authority (TDRA) (2020).
- The Critical Infrastructure and Coastal Protection Authority (CICPA) (2020).
- The Smart Dubai Government Establishment (SGD) (2021).
- Khalifa University of Science, Technology and Research (KUSTAR) (2021).
- Project Agreement for the Implementation of the MORAD Project with Khalifa University and Institute for Radiological Protection and Nuclear Safety (IRSN) (2022).

8.4 IAEA Peer Reviews

Emergency Preparedness Review (EPREV) Service

In March 2015, at the UAE's invitation, the International Atomic Energy Agency (IAEA) assembled an Emergency Preparedness Review (EPREV) Service to examine the UAE's progress in preparing the necessary response measures to be applied in the unlikely event of a nuclear emergency at the Barakah Nuclear Power Plant now under construction in Abu Dhabi's Western Region.

After 11 days of review, the team made up of seven international and IAEA experts found that the UAE is establishing effective, nuclear emergency management arrangements that build upon the nation's existing emergency response system. For more details, see the Executive Summary in Annex 2.

A national action plan to address the IAEA's recommendations and suggestions was prepared and implemented under the coordination of FANR and in cooperation with a number of entities with responsibilities on-site and off-site.

The action plan implementation led to several improvements which were assessed during an EPREV follow-up mission in September 2019. During this follow-up mission all recommendation

made in the main mission were considered closed by the IAEA's EPREV follow-up team. The additional suggestions were considered for further improvements which were tested during the ConvEx-3 exercise (refer to Article 16).

Pre-Operational Safety Review Team (OSART) mission

In September and October 2017, at the UAE's invitation, an IAEA team made up of 15 experts conducted an 18-day pre-operational safety review (otherwise known as a pre-OSART mission) at the Barakah site. The objective of the pre-OSART mission was to assess the operational safety performance of Nawah against the IAEA's safety standards and to propose recommendations for improvements where appropriate.

The areas under review by the team included leadership and management of safety, training and qualification, operations, maintenance, technical support, operating experience, radiation protection, chemistry, emergency preparedness and response, accident management, human, technology and organisational interactions and commissioning.

The team identified a number of good practices that were shared with the nuclear industry globally, and also made a number of recommendations to improve operational safety.

Pre-Operational Safety Review Team (OSART) follow-up mission

In response to the 2017 Pre-OSART mission, ENEC has invited the IAEA to return to Barakah Nuclear Power Plant (to conduct a Pre-OSART follow-up mission, 5th September through 9th September 2022. The Pre-OSART follow-up mission will be performed following the OSART guidelines (IAEA Services Series No. 12, rev.1), with a team size of six experts following the same principles as per the Pre-OSART mission. The Nawah performed thorough reviews of the Pre-OSART findings, both suggestions and recommendations. The reviews were used to analyse the recommendations and suggestions to determine the causes and to develop action plans with the goal of closing the gaps and improving the safety and reliability of the Barakah Nuclear Power Plant.

Integrated Nuclear Infrastructure Review (INIR) mission

In June 2018 an IAEA team of experts conducted an Integrated Nuclear Infrastructure Review (INIR) mission. This was INIR 3, the final stage of the INIR process, which began in January 2011 at the request of the government of the UAE. The purpose of the mission was to assess the status

of the UAE's national infrastructure for the introduction of nuclear power. The review covered the comprehensive infrastructure required to develop a safe, secure and sustainable nuclear power programme. The team comprised nine international and IAEA experts who conducted their week-long review by interviewing officials from UAE entities including FANR.

The review found that the UAE has adequately developed its nuclear infrastructure including a legal and regulatory framework, and has established and staffed the required organisations in particular an independent regulatory body and an operating organisation. The review also provided a number of recommendations and suggestions for further strengthening the national nuclear infrastructure in the UAE, such as promoting a proactive coordination of future programme developments at a national level; continuing review and revision of the legal and regulatory framework, and establishing a national research and development programme.

Article 9: Responsibility of the Licence Holder

CNS Text:

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

9.1 Formulation in the legislation assigning the prime responsibility for safety to the licence holder

In keeping with the objectives of the government's published Nuclear Policy, the UAE Nuclear Law sets out requirements for assigning priority to safety and for the responsibility of each licence holder as shown below:

- Article (24) states "the licence issued to the licence holder shall describe the obligations of the Operator in respect of its Facility, equipment, Radiation Source(s) and personnel".
- Article (34) states "the Operator remains responsible before the Authority according to this Law by Decree, applicable regulations and the terms of its Licence even if certain activities are conducted by contractors".
- Article (43) requires that "Each Licensee shall be responsible for taking all steps necessary to reduce the risk of an Accident to a level that is as low as reasonably achievable".

- Article (57) makes the operator liable “on all matters related to Safety, Nuclear Safety, Nuclear Security and Radiation Protection”.

9.2 Description of the main means by which the licence holder discharges the prime responsibility for safety

The Emirates Nuclear Energy Corporation (the Corporation) was established by Abu Dhabi Law No (21) of 2009 Concerning the Establishment of the Emirates Nuclear Energy which was issued on 20 December 2009. In 2021, the Corporation was transformed into a Public Joint Stock Company and renamed into “Emirates Nuclear Energy Company” (hereinafter ENEC) pursuant to Abu Dhabi Law No. 8 of 2021 Concerning the Emirates Nuclear Energy Company Public Joint Stock Company (hereinafter the “ENEC new law”), which repealed Law No. 21 of 2009. Article (2) of the ENEC new Law states that:

‘The legal form of the Emirates Nuclear Energy Corporation shall be changed from a public Corporation to the Emirates Nuclear Energy Company Public Joint Stock Company and the Company shall replace the Corporation in all rights and obligations as well as in all the agreements entered into between the Corporation and others. The Company shall have an independent legal personality and enjoy full legal capacity and shall be independent financially and administratively’. The purpose of ENEC is to develop, build, finance, operate, maintain, manage and own the nuclear reactors to use them for peaceful purposes with the view of generating energy, desalination and carrying out all the other relevant necessary activities, as specified in Abu Dhabi Law no. 8 of 2021.

Nawah Energy Company Private Joint Stock Company (Nawah) operates and maintains the operating units of BNPP. FANR regulation on “Operational Safety including Commissioning”- FANR-REG-16 specifies in its Article 3 that “the prime responsibility for Safety is assigned to the Licensee of the Nuclear Facility. This prime responsibility shall cover all the activities related directly or indirectly to the Operation. It includes the responsibility for supervising the activities of all other related groups such as designers, suppliers, manufacturers and construction workers, employers and contractors as well as the responsibility for Operation of the Nuclear Facility”. In accordance with the requirements of the UAE Nuclear Law and requirements from FANR-REG-16, Nawah has the prime responsibility for safety of operating nuclear units of BNPP.

Nawah discharges its responsibility for safety through focus on the following areas:

Management for safety and a safety culture:

- Nawah has established its safety policy which prioritizes the safety and security of employees, the public and the environment at all times.
- Nawah has adopted and, through its Integrated Management System (IMS), adheres to the Institute of Nuclear Power Operations' document entitled "Traits of a Healthy Nuclear Safety Culture".
- Nawah has prioritised safety, which is reflected in its Mission statement, "Safely, reliably and efficiently generate electricity from nuclear energy to power the growth of the UAE".
- Nawah has developed a nuclear safety policy (NIMS-POL-0002), which states that nuclear safety remains its overriding priority. Although the same commitments apply to radiological safety, industrial safety, environmental safety, and security, nuclear safety is the primary value at the Barakah Nuclear Power Plant and it is never abandoned.
- Nawah achieves nuclear safety by ensuring all aspects of nuclear operations and performance minimise the probability of any event that could damage the reactor core and lead to the uncontrolled release of fission products into the environment.

Management system and organisation:

- Established a comprehensive Integrated Management System (IMS) made up of a blend of integrated components, existing in collaboration with each other in an effort to achieve the Nawah Vision and Mission.

  The principal objectives of the Nawah IMS are to:

  - Bring together in a coherent manner all requirements for managing the organization in a planned and systematic fashion,
  - Ensure no other factor, whether that be such as health, environment, quality or economics be considered outside safety requirements or impact safety in any way; and
  - Demonstrate compliance with the relevant UAE statutory laws and FANR regulations (stated in the IMS) as they apply to regulated activities.
- Numerous inspections and audits have been carried out by both nuclear and non-nuclear regulators to confirm conformance to established and required safety standards.

Human resources:

- Established a core of competent staff and is investing heavily in training and recruitment. The mixture of the staff includes both experienced staff with a nuclear background, and those that are new to the industry at different levels within the organisation. The first wave of recruitment was aimed at the competencies needed to implement the project but this has now progressed to recruiting and training staff to operate and maintain the power station.
- Adopted the Systematic Approach to Training as described by the Institute of Nuclear Power Operations.

High quality design and construction:

- ENEC awarded a contract to KEPCO, its prime contractor, for the construction of four reactor units of the advanced power reactor, the APR1400. This APR1400 design was chosen to ensure safety at the highest levels due to an enhanced design with evolutionary safety improvements including enhanced user-friendly instrumentation and controls, reduced fuel use and waste, design specifications ensuring lower vulnerability to operational disruptions, and effective, reliable safety systems to prevent accidents and mitigate their consequences.
- ENEC oversees KEPCO and its sub-contractors to ensure that the project meets it goals for safety and quality. This is achieved by a series of documentation reviews, onsite inspections and audits. These occur on-site at the Barakah Nuclear Power Plant in the Emirate of Abu Dhabi; at the premises of both KEPCO and the sub-contractor within the Republic of Korea; and elsewhere internationally.

International:

- Established membership in both the World Association of Nuclear Operators and the Institute of Nuclear Power Operations and participated in many international conferences, workshops and events.
- Experienced staff have supported peer reviews of the World Association of Nuclear Operators both for operational plants and for start-up reviews.

9.3 Description of the mechanism by which the regulatory body ensures that the licence holder discharges its prime responsibility for safety

FANR, as the national regulatory body, ensures that ENEC and Nawah discharge their prime responsibility for safety through the implementation of a comprehensive and rigorous regulatory framework under the UAE Nuclear Law. The Nuclear Law grants powers to FANR to implement the four key regulatory functions consistent with the requirements of the Convention on Nuclear Safety of (i) standard-setting through regulations; (ii) authorisation through licensing; (iii) inspection and monitoring of compliance and (iv) enforcement. FANR implements these functions through the processes and procedures defined in its integrated management system as discussed in this report under Article 8.

FANR Regulation on Operational Safety including Commissioning (FANR-REG-16) assigns the responsibility for safety to the licensee through Article (3), which states that "The prime responsibility for Safety is assigned to the Licensee of the Nuclear Facility. This prime responsibility shall cover all the activities related directly or indirectly to the Operation. It includes the responsibility for supervising the activities of all other related groups such as designers, suppliers, manufacturers and construction workers, employers and contractors as well as the responsibility for Operation of the Nuclear Facility".

9.4 Description of the mechanisms whereby the licence holder maintains open and transparent communication with the public

The establishment of ENEC and Nawah is part of the UAE's overall policy and vision to adopt nuclear power for peaceful purposes. They have established a robust programme for public communication, through workshops, open meetings, and participation in a large number of conferences and workshops both nationally and internationally. Surveys have been conducted to assess public acceptance of the project and nuclear power in general in the UAE. The survey conducted by independent market researchers found that even after a slight decrease following the Fukushima Daiichi accident, the levels of acceptance had increased above the original levels. Public acceptance for nuclear energy in the UAE is one of the highest acceptance levels in the world today. Some of the key activities conducted towards communication are as follows:

- **Outreach session (Schools, Universities and Stakeholders)**

  ENEC and its subsidiaries conduct outreach sessions for several categories in the community such as schools, Universities, and stakeholders to increase their awareness about the UAE Peaceful Nuclear Energy Program.

- **CEO outreach meetings with high level management in Government**

  CEO of ENEC conducts one to one outreach meetings with official representatives in the UAE government to share latest project updates as well as highlighting the importance of the program on a national level. In addition, they participate in national and international events and conferences and share knowledge about the Barakah Nuclear Power Plant progress and updates.

- **Public Forum**

  ENEC and its subsidiaries conduct Public Forum for the public to share the new updates on Barakah Nuclear Power Plant project and show them how far their engagements and support affect the Barakah Nuclear Power Plant project.

- **Participate in summer camps with stakeholders**

  Participate in summer camps with our strategic stakeholders and conduct awareness sessions for the community to share the Barakah Nuclear Power Plant progress and increase their awareness about the BNPP.

- **Site visits**

  ENEC arranges site visits for external stakeholders and official representatives in the UAE government entities to witness the progress at site. Periodic reports are shared with our strategic stakeholders including the Barakah power plant progress and plans updates.

- **Send periodic reports to strategic stakeholders**

  Electronic newsletter is issued to all related stakeholders to update them on the project and share some facts and figures about the nuclear energy in the UAE.

Article 10: Priority to Safety

CNS Text:

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

10.1 National safety policy and requirements

As discussed in the Introduction to this National Report, the fundamental commitment of the UAE to high standards of safety in developing its nuclear energy programme was enshrined in the Nuclear Policy. Page 4 of the Nuclear Policy contains the following statement:

"*With regard to safety of facilities, as required by the IAEA Convention on Nuclear Safety, the UAE will implement a comprehensive regime that maintains a high level of safety according to international benchmarks and ensures that all nuclear-related installations are operated in a safe, well-regulated and environmentally sound manner".*

The following additional points of the Nuclear Policy apply in a balanced way between FANR, ENEC, and Nawah and contribute to the commitment and priority to nuclear safety:

- Establishing an independent and effective regulatory authority with appropriate powers and authorities to oversee nuclear activities (FANR);
- Working with the IAEA and conforming to its standards in evaluating and establishing a safe nuclear energy programme (FANR, ENEC and Nawah);
- Establishing the licensing scope and authority, which would be in accordance with international best practices in the nuclear energy sector, and the process of issuing a licence would be characterized by thoroughness and a pervasive culture of safety (FANR);
- Selecting an advanced generation of light water reactors to enhance safety (ENEC); and
- Making extensive use of the operational safety experience gained by the most highly regarded operators of nuclear plants around the world (FANR, ENEC and Nawah).

The UAE has codified the principles and priorities established in the Nuclear Policy in its Nuclear Law. Article (1) of the Law defines "Nuclear Safety" as,

"*The achievement of proper operating conditions, prevention of Accidents or mitigation of Accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards*".

Through numerous articles, the UAE Nuclear Law affirms a strong commitment to prioritize nuclear safety. Articles (4) through (6) and (38) of the UAE Nuclear Law confirm the independence of FANR and the policy of adopting international best practice, as embodied in IAEA Safety Requirements and other internationally recognized guidance documents, into the UAE regulatory framework. Further affirmation of the priority to nuclear safety may be found in the regulations developed by FANR. Regulations have been prepared that express FANR requirements in the areas such as management systems, siting of nuclear facilities, design of nuclear facilities, radiation dose limits and optimisation of radiation protection for nuclear facilities, operational safety, the application of probabilistic risk assessment (PRA) at nuclear facilities, and training of personnel for nuclear facilities.

In the discussion of other CNS articles, this National Report documents other legislative, regulatory and institutional measures taken by the UAE to ensure that the fundamental policy of ensuring safety will be effectively and consistently implemented by all relevant bodies.

10.2 Measures taken by the Operator

ENEC is the licensee for the construction of the four reactor units at the Barakah Nuclear Power Plant. With the completion of the construction of three units, ENEC has the responsibility under the UAE Nuclear Law for managing and securing the safety of Unit 4 of the BNPP. ENEC gives the highest priority to safety throughout all activities of the nuclear project and has declared its commitment to continuously improve safety and educate staff by setting and enforcing a strong safety culture policy. ENEC's long term goals are to maintain the level of safety in accordance with the highest standards and improvements of safety culture are given top priority. To achieve the long-term goal, ENEC has prepared its "Nuclear Safety, Security and Safeguards Policy" which states that, "Emirates Nuclear Energy Corporation (ENEC) is committed to the highest standards of nuclear safety, security, and safeguards. All ENEC employees are empowered to stop work if they believe the activities and/or work conditions are unsafe. This is in line with ENEC commitment to build and maintain strong culture of safety and security, which includes continual improvement and transparency towards national and international stakeholders to protect people,

society, asset, reputation, environment and future generations from harmful effects of radiation". The stated policy is implemented through the well-defined process within the ENEC organisation. Implementation of the stated policy provides reasonable assurance that safety is given due priority and nuclear safety, security and safeguards interfaces and synergies are managed in an efficient and effective manner to protect people, society, and environment and future generations from harm.

Nawah Energy Company (Nawah) was established in 2016 for operation and maintenance of units 1 to 4 of the Barakah Nuclear Power Plant. Nawah is the licensee for the operating licence of operating units 1, 2 and 3 of the Barakah Nuclear Power Plant. Nawah commits itself to keeping safety as its overriding priority and adhere to the highest international standards in the nuclear industry by defining its Nuclear Safety Policy which states that, nuclear safety is the first value adopted at Barakah Nuclear Power Plant (BNPP) and is never abandoned and also same traits apply to radiological safety, industrial safety, environmental safety, and security. The Nawah Nuclear Safety policy ensures the synergy between safety, security and safeguards in line with the regulatory requirements, agreements and the UAE commitments under the Nuclear Non-Proliferation Treaty. The Policy is developed in such a way to ensure that all aspects of nuclear power production are performed in a safe, reliable, and efficient manner by providing a commonly understood framework of policy and principles that guide Nawah nuclear strategies, programs, processes, and implementing procedures. The leaders within Nawah organization continuously promotes safety as having a recognized value, having clear accountability, being learning driven and integrated in all activities.

In order to meet its objectives for achieving safe, reliable and efficient power, ENEC and Nawah have implemented the Integrated Management System (IMS) in compliance with FANR-REG-01, "Management Systems for Nuclear Facilities" that translate to the requirements IAEA GSR Part 2 "Leadership and Management for Safety". The management system integrates all elements of leadership and management so that requirements for safety are established and applied with other requirements, including those for human performance, operations, training, quality, safeguards and security. Safety is not compromised by other requirements or demands. The management system also supports a strong safety culture.

ENEC and Nawah reinforce safety as an overriding priority through the traits for a healthy nuclear safety culture based on recognized international standards. These traits are applicable to all four

categories of safety: nuclear, industrial, radiological, and environmental safety. ENEC and Nawah have also introduced security culture as a complementary focus area to nuclear and industrial safety culture. The introduction of security culture enables ENEC and Nawah to develop a security-minded nuclear culture, that is aligned to the IAEA recommendations on nuclear security and nuclear security culture.

The policy on culture of safety is communicated to all stakeholders, employees and contractors of ENEC and Nawah through Integrated Management policy, which is reinforced by employee training and continuous monitoring through organizational Nuclear Safety Culture Assessment. ENEC conducted a Nuclear Safety Culture Assessment of all employees in 2011, 2012, based on the questionnaires on the WANO principles for a strong nuclear safety culture and the INPO principles of excellence in nuclear project construction. Subsequently ENEC adopted the INPO document "Traits of a Healthy Nuclear Safety Culture (INPO 12-012)" in 2013 to align with the industry for maintaining and assessment of Nuclear Safety Culture within the organisation and conducted Nuclear Safety assessment in 2014. Upon forming of Nawah in 2016, the Nuclear Safety Culture Independent Assessment for the ENEC & Nawah was conducted in 2016, 2017, 2019 & 2021 based on INPO 12-012.

Two key traits of a healthy nuclear safety culture based on INPO 12-012 are:

- Nuclear safety culture is a leadership responsibility.
- Leaders must reinforce safety culture at every opportunity.

As an example of the implementation of safety culture, ENEC and Nawah line managers encourage personnel to identify known conditions adverse to quality and ensure sufficient and timely corrective and preventative actions are taken in accordance with procedures. Reports of conditions adverse to quality are analysed to identify trends. Significant conditions adverse to quality and significant adverse trends are documented and reported to appropriate levels of management. The corrective action programme in itself is the largest and most efficient tool to promote and demonstrate the ENEC and Nawah safety culture.

ENEC has undertaken a number of assessment activities. These include:

- Self-Assessments of safety culture;

- Quarterly surveys that focus on specific aspects of safety culture. For example, ENEC's Employee Concerns Programme was the subject of a recent survey to assess employee perceptions associated with the programme;
- Limited-scope reviews of selected programs, processes, and performance are periodically conducted;
- Culture of safety trends that are based on corrective action condition reports, behavioural observation data, quality assurance reports and operational experience are continuously analysed and regularly reported.

As the holder for an operating licence for Barakah NPP reactor units 1, 2 and 3, Nawah has implemented the following actions:

- Leader-led Culture of Safety employee engagement initiatives aimed at creating awareness by communicating and mobilizing employees around Culture of Safety;
- Including Culture of Safety modules in the ENARA Leadership Programme, which is aimed at developing leadership across the organization;
- Introduction of an organizational effectiveness programme in support of the organizational drivers of Culture of Safety;
- Setting nuclear standards and instilling the concept of nuclear professionalism by means of Culture of Safety induction training;
- Implementing an organizational change management process to support the rapid implementation and embedment of Culture of Safety initiatives;
- Ongoing evaluation of relevant key performance indicators to ensure achievement of culture of safety initiatives.

10.3 Regulatory processes for monitoring and oversight of arrangements used by the licence holders to prioritize safety

FANR provides monitoring and oversight of the licence holder through the powers given by the UAE Nuclear Law and the regulatory processes established in its management system.

The FANR regulations emphasize nuclear safety, starting with FANR-REG-01, "Management Systems for Nuclear Facilities". Regulation FANR REG-01 adopts the internationally accepted

definition of safety culture: "*The assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance*". This regulation specifically requires that an applicant's or licensee's management system promotes and supports a strong safety culture.

As required by the UAE Nuclear Law, FANR staff conducted a thorough review and assessment of the application documents submitted by ENEC and Nawah to verify that the relevant safety, security and safeguards requirements are met before each licence was issued by FANR.

Following the issuance of each licence, under the powers granted by the UAE Nuclear Law, FANR has followed up with inspections of the licensee's activities to verify they are being carried out safely and in compliance with the regulations and licence conditions. FANR's inspection responsibilities extend also to verifying the activities carried out by the licensee's contractors and suppliers located in the UAE and overseas. FANR formulates an annual inspection plan to manage its activities. The current inspection plan focuses on the licensee's and contractor's implementation of the management system and quality assurance programme. The specific areas to be inspected in the plan are selected based on consideration of risk significance and other qualitative factors.

Of particular significance, it is worthwhile noting that in 2021, as part of the regulatory oversight of Unit 1 in operation, FANR has undertaken two separate inspections of both ENEC's and Nawah's management systems to verify that processes, procedures and instructions are in place to reflect that safety culture is an overriding priority for all activities in place. No finding of significance was identified during these inspections.

Article 11: Financial and Human Resources

CNS Text:

Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.

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

11.1 Financial resources

In October 2016, ENEC entered into joint venture and lending arrangements in an entity known as the Barakah One Company (Barakah One), in which it shares ownership with KEPCO on an 82:18 basis. The Barakah One currently funds all plant capital related costs of the program, including the Prime Contract, which was novated from ENEC on creation of the joint venture.

At the same point, Nawah Energy Company (Nawah) was established to be the joint venture operator and licensee for the Barakah NPP. ENEC also shares ownership with KEPCO in Nawah on an 82:18 basis.

ENEC, which is 100% owned by the Government of Abu Dhabi through its holding company Abu Dhabi Development Holding Company (PJSC) (also known as "ADQ"), continues to support the construction oversight and operational readiness expenditure aspects that is required until each unit reaches its operational phase.

In October 2016 the Barakah One also agreed a power purchase agreement with the Emirates Water and Electricity Company for the purchase of electricity produced by the Barakah NPP that will ensure revenue is available to the licensed operator (via the Barakah One Company) to safely operate and maintain the facility. These revenue arrangements ensure that the operator will recover costs incurred to meet its decommissioning obligations under applicable laws, including recovery of any fees that are required to be paid into a decommissioning fund under applicable regulations, and for meeting all fuel management and storage requirements.

The Plant Services Agreement was concluded between Barakah One Company and Nawah on 20 October 2016. These revenue arrangements currently contemplate that the future operator, i.e. Nawah, will recover costs incurred to meet its decommissioning obligations under applicable law, including recovery of any fees that are required to be paid into a decommissioning trust fund under the UAE Nuclear Law (Article 42) and applicable regulations that will be issued by FANR, and for meeting all fuel management and storage requirements.

Article (42) of the UAE Nuclear Law requires the operator of a nuclear facility to pay fees into a decommissioning trust fund, which shall be established by the Cabinet of Ministers of the UAE according to a recommendation of FANR's Board of Management. FANR has developed a proposal to the Cabinet, in a form of a Cabinet resolution, and has prepared a regulation required by the UAE Nuclear Law, Article (42.3) to set out rules for the fees calculation and collection,

management of the assets of the decommissioning trust fund, and payments from the fund. While the decommissioning trust fund has yet to be established, ENEC has established a deposit interim account into which Nawah pays, via Barakah One Company, the annual contribution for Units 1, 2 and 3 of the Barakah Nuclear Power Plant as estimated in the Barakah Nuclear Power Plant Initial Decommissioning Plan for Units 1 through 4. Such account represents an interim approach for the payment of fees by Nawah pursuant to the Nuclear Law, until the decommissioning trust fund is established as foreseen by the Federal Law by Decree No. 6 of 2009.

11.2 Human resources

11.2.1 Overview of the Contracting Party's arrangements and regulatory requirements concerning staffing, qualification, training and retraining of staff for nuclear installations

The Government of the UAE has clearly recognised the importance of human resources in its Nuclear Policy. The Policy sets the basis for establishing a strategy to strengthen the human resources to regulate, manage, operate and maintain the safety of nuclear facilities.

The human resources strategy employed in the UAE nuclear energy programme comprises two tracks:

- Staffing by senior experts including international staff to address the immediate and mid-term needs.
- Development of national capacity to ensure long-term sustainability.

Sufficient numbers of staff have been hired within FANR, Nawah and ENEC to meet current requirements. These organisations continue to recruit qualified nationals and expatriates.

A national capacity building effort is being implemented by ENEC, FANR and Khalifa University. The three entities are working together across education, training, and recruitment to ensure the nuclear programme's human resource needs are met in the longer term. FANR implements and conducts extensive programmes to foster and nurture its organisation's resources, skills and processes. Detailed description of capacity building in FANR, including the training and development of the staff and inspector qualification programme is included in section 8.1.5 of this report.

Women at FANR

Women play a fundamental role in carrying out FANR's mandate of regulating the UAE's nuclear sector and ensuring the protection of the public, workers and the environment. Therefore, FANR assigned two (2) Emirati Champions to enable Gender Balance and Equality as per the government directions. Women make up over 43% of our overall workforce. They hold leadership positions and play key roles in our Nuclear Safety Department, Nuclear Security Department, Radiation Safety Department, and Education and Training Department. The percentage of Female leader is 50%.

FANR has a strong belief that Emirati women can make a significant contribution to the nuclear industry, therefore, FANR has 33% female technical employees and 15 female engineer. There are also female employees at FANR who have completed postgraduate studies in nuclear science.

International Standardisation Organisation (ISO) Certifications

FANR is implementing Smart Working and achieved PAS 3000:2015 for Smart Working. This standard shows that FANR is complying with the needed requirements for establishing good practices in the implementation of Smart Working, this includes changes in working practices, culture, working environments and associated technology.

The UAE has also signed an updated Country Programme Framework with the IAEA. The programme framework defines the short and mid-term planning of Technical Cooperation activities between the UAE and the Agency. An integrated master work plan has been prepared which defines training courses, workshops and expert assistance in relevant areas for the UAE nuclear power programme.

11.2.2 Methods used for the analysis of competence requirements and training needs for all safety related activities in nuclear installations

FANR regulation REG-01 Management Systems for Nuclear Facilities which is currently being revised, contains the following general requirements for licensees to provide adequate resources and to provide for staff training and qualification:

"The Licensee shall ensure the availability of adequate resources to carry out the activities of the organisation and to establish, plan, implement, assess and continually improve the Management System".

“The Licensee shall ensure that Senior Management determines the competency requirements for individuals at all levels and shall provide training or take other actions to achieve the required level of competence. The Licensee shall regularly evaluate the effectiveness of the actions taken ensuring suitable proficiency is achieved and maintained”.

“Senior Management shall ensure that individuals are competent to perform their assigned work and that they understand the consequences for Safety of their activities. Individuals shall have received appropriate education and training, and shall have acquired suitable skills, knowledge and experience to ensure their competence. Training shall ensure that individuals are aware of the relevance and importance of their activities and of how their activities affect Safety.”

FANR REG-16 Operational Safety including Commissioning sets out requirements regarding the structure and function of an operating organisation, staffing and resources, and qualification and training of personnel.

FANR REG-17 Certification of Operating Personnel at NPP Facilities sets out further specific requirements for training, qualification and certification of licensee staff that operate the controls of a nuclear power plant.

To comply with these requirements, ENEC and Nawah are continuing to hire their own personnel and obtain personnel from contractors. In order to support the nuclear project, ENEC continues to hire permanent staff for the continuous development of the program. A multi-lateral agreement for education and human resource development was signed by Khalifa University Science, Technology and Research (KUSTAR), Institute of Applied Technology (IAT), Korea Advanced Institute of Science and Technology (KAIST), KEPCO, Human Resources Development Service of Korea (HRD) and Korea Development Institute (KDI).

In order 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, ENEC has also established relationships with several universities and technology institutes within the UAE. ENEC is supporting KUSTAR to deliver a master degree programme in nuclear engineering aimed at developing indigenous capabilities. ENEC is working with Abu Dhabi Polytechnic (AD Poly), a secondary educational institute, whose focus is to produce the scientists, engineers, and technicians needed for the UAE to build a knowledge-based economy. By infusing the academic requirements of the nuclear technician programmes into the

AD Poly curriculum, a local source of future technicians and local equipment operators will become available to support the national nuclear energy programme.

ENEC and Nawah training programs incorporate instructional requirements to qualify personnel to operate and maintain the facility in a safe manner in all modes of operation. The programs are developed and maintained in compliance with the facility licence and applicable regulations. The training programs are periodically evaluated and revised to reflect industry experience and to incorporate changes to the facility, procedures, regulations and quality assurance requirements, and are continually reviewed by management for effectiveness.

Training of the first group of Senior Reactor Operators (SROs), Reactor Operators (ROs), Local Operators (LOs), Maintenance Engineers and Technicians began in 2013. The training program for SROs and ROs is based on a systematic approach to training. This training includes Generic Fundamentals, Basic and Integrated Systems Training taught in the classroom to establish a knowledge foundation upon which skills can be developed. The trainees then move into the Main Control Room phase of training, which uses both the classroom and "Full and Limited scope simulators" to develop the ROs and SROs operating skills.

Nawah is to be staffed with the resources necessary to operate and maintain all four reactor units of the Barakah Nuclear Power Plant. ENEC has a multi-year Operations Support Services Agreement ("OSSA") for Korea Hydro & Nuclear Power (KHNP) to provide experienced and qualified nuclear plant personnel to support Nawah. The OSSA means KHNP will provide qualified operations personnel and other services such as engineering and licensing support as supplements to the personnel and resources developed within Nawah.

11.3 Regulatory review and control activities

As noted in Section 11.2 above, FANR regulations REG-01, REG-16, and REG-17 contain requirements for adequate resourcing, training and qualification of staff for the nuclear facility.

FANR REG-14 requires applicants for an operating licence to describe the organisational arrangements and training and qualification programmes. The Final Safety Analysis Reports for Barakah reactor units 1 and 2 and reactor units 3 and 4 provide a description of the Nawah operating organisation, required staffing levels, and a description of the Nawah training and qualification programmes. FANR has reviewed these arrangements for reactor units 1, 2 and 3.

FANR-REG-17 requires the licensee to submit for FANR approval a comprehensive training plan (CTP) for reactor operating personnel. ENEC submitted its initial plan which FANR reviewed and approved in June 2012. Nawah has now assumed control of the training plan for reactor operating personnel, which was approved by FANR in 2018. Since 2013, FANR has conducted a comprehensive programme of oversight activities – reviews, assessment, and inspection - focusing on the effective implementation of the comprehensive training plan in accordance with the requirements of REG-17. In 2021, FANR completed its first inspection of the biennial requalification examination (BRE) process for certified operations personnel. Based on the results of these oversight activities and a review of application documents, FANR has granted certifications to 157 reactor operator (RO) and senior reactor operator (SRO) candidates of which 53 are UAE Nationals. FANR will continue to review certification requests of RO and SRO personnel upon receipt of applications for candidates who have completed the approved training and qualification programme.

Article 12: Human Factors

CNS Text:

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

12.1 Overview of the UAE Arrangements and Regulatory Requirements to take Human Factors and Organisational Issues into Account for the Safety of Nuclear Installations

Requirements for considering human factors can be found in FANR Regulation for the Design of Nuclear Facilities (FANR REG-03) and FANR Regulation for Operational Safety including Commissioning (FANR REG-16). These regulations address requirements on human factors and other aspects such as:

- Employing ergonomic best practices and a design objective of limiting the effects of human errors;
- Developing plant layouts and procedures (administrative, operational, maintenance, and emergency) to facilitate the interface between the operating personnel and the plant;

- Integrating human factors and the human–machine interface in a systematic design process at an early stage and continuing throughout the entire process to ensure the distinction of functions between operating personnel and the automatic systems;
- Designing the human–machine interface to provide the operators with comprehensive but easily manageable information compatible with the necessary decision and action times;
- Including verification and validation aspects of human factors at appropriate stages to confirm that the design adequately accommodates all necessary operator actions; and
- Ensuring that human and organisational factors are adequately addressed for all plant modifications, and that the consequences of plant modifications that impact human tasks and performance are analysed.

The objective of these requirements is to take into account human factors in the design and the safe operation of the plant.

12.2 Consideration of Human Factors in the Design of Nuclear Installations and Subsequent Modifications

ENEC and Nawah have committed to the implementation of a comprehensive human factors engineering programme for the Barakah Nuclear Power Plant in compliance with FANR requirements, the US Nuclear Regulatory Commission's NUREG-0711 guidance, and industry codes and standards as assurance that key elements of human factors engineering are included in the design of the main control room, remote shutdown room, and associated man-machine interfaces. The primary objective of the said programme is to apply human factors engineering principles, guidelines and criteria throughout the developmental cycle of the plant so as to reduce the task demands upon the operator, to decrease the potential for human errors, and to increase the safety and efficiency of plant operations.

The designs of the main control room, remote shutdown room, and associated man-machine interfaces are verified and validated through systematic design evaluations. These designs are integrated with consideration for plant personnel training, composition of operations' shift crews, and the development of operating procedures. The purpose of the management of the human factors engineering programme is to ensure that human factors engineering is successfully incorporated into the overall design and development activities of the Barakah Nuclear Power

Plant. There are four distinct types of verification and validation activities: (1) availability verification, (2) suitability verification, (3) integrated system validation, and (4) final plant verification. Each of the four (4) Barakah Nuclear Power Plant units follow a standard design where the verification and validation activities have been completed. Operators' performance was evaluated through situation awareness, workloads and / or team communication, to identify any errors or unacceptable criteria. The identified problems, referred to as Human Engineering Discrepancies (HED), are addressed in the man-machine interface design by changing/modifying the design or by providing appropriate operator training, and not limited to updating operation procedures. In 2020 the Human Factor Engineering (HFE) programme, including verification and validation, was effectively applied to ensure the effective implementation of a modification to the computerized procedure system used by main control room operating personnel.

Information on capabilities and limitations of human performance are also used in the ENEC and Nawah training programmes to ensure heightened attention to detail regarding construction and operational safety, security and radiation protection needs associated with nuclear plants. ENEC's and Nawah's Operating Experience Sharing Programme identify, evaluate and use lessons learnt from relevant, past and current domestic and international experience so that ENEC and Nawah can learn from and develop lessons learnt programmes. Management provides training such as human performance techniques, and tools and equipment such as properly erected and inspected scaffolds, mock-ups, and personal protective equipment to achieve and maintain a safe work environment and minimise radioactive uptakes during operation.

During plant operation, personnel performance related to important human actions are monitored. This helps to ensure the validated man-machine interface design continues to enable and support the achievement of plant operational safety goals. Identified deficiencies are fed into the corrective action programme and addressed, as appropriate, to mitigate recurrence.

The management system controls of both ENEC and Nawah ensure safety and quality in the performance of work activities. These controls are part of a "Safety Culture" that governs work in a systematic manner so that nuclear safety, worker health and safety, and the protection of the public and the environment are achieved. In order to ensure that the management system (policies, programme requirements, process descriptions and tools) will persist despite organisational changes and changes in the work scope, functional elements (areas) have been established. The functional elements allow the management system to remain stable while the organisation is

flexible. Each “functional element” is assigned a lead, who is responsible for the maintenance of policies, programmes and processes in that element. The “Functional Element Lead” is also responsible for conducting self-assessments to monitor performance and drive continuous improvement.

Requirements in FANR-REG-16 ensure that licensees consider human and organisational factors in the design and implementation of all modifications made during plant operations. FANR Regulatory Guide for Screenings and Evaluations for Modifications to Operating Nuclear Facilities (FANR-RG-029) provides guidance to licensees to assess the safety significance of modifications during plant operation. FANR Regulatory Guide for Safety Significance Evaluations for Modifications for Nuclear Facilities during Construction (FANR-RG-023) provides similar guidance for plants under construction. The scope of applicable modifications includes systems, structures and components, management system, organisational changes. The guidance in both regulatory guides assists licensees to determine if a modification requires approval by FANR prior to implementation. Modifications resulting from the execution of the human factors engineering programme are to be evaluated in accordance with the guidance set out in either FANR-RG-023 (during construction) or FANR-RG-029 (during operation).

12.3 Methods and programmes of the licence holder for analysing, preventing, detecting and correcting human errors in the operation and maintenance of nuclear installations

Nawah deploys industry benchmarked best practices identified by INPO and WANO to measure Human Performance based on established industry reset criteria. Key Performance Indicators (KPI’s) for HU is developed and used to track and trend human performance improvement through events caused by active human error or as result of a flawed defence or latent organizational weakness that meets an established reset criterion. This form part of the Nawah Human Performance (HU) Clock Reset Program, and integrated process which runs parallel to the Corrective Action Programme. Causal analysis and evaluation tools as part of the CAP Programme identifies the event causes (programmatic, organizational) and contributing causes and actions required to prevent recurrence and repeat.

A Human Performance Review Board is convened for the events that matches with significant HU Clock Reset event criterion to screen preliminary event information, determine the immediate lessons (error precursors and organizational weaknesses) and immediate actions and confirmation

of reset criteria that would also be included in the communication, noting that this is not the causal analysis, but an additional tool to share organizational learning. Within this program Nawah communicates and shares the learning from the events and reflect on improvement through sharing the days between events and longest run to the organization. Recent improvements to KPI's for HU resulted in the development and recently introduced of a Human Performance Health Index which provide an overall health of HU performance at the plant.

All individuals at Nawah including supplementary workers to support plant projects and outages are required to undergo initial training including assessment on error prevention techniques, Human Performance Tools. The Human Performance Tools deployed is categorised in two groups, Core HU Tools, that which is mandatory and required to be used by all individuals and these are Self-Check including STAR; Procedure Use and Adherence and Pre-job Briefs, with the second category being HU Conditional Tools to be identified for use to further minimise potential error, these are Take Two, Place keeping, Peer Check, Independent Verification, Concurrent Verification, Post-job debriefs, Three-way communication, use of Phonetic Alphabet, Turn Over, Flagging, Peer Review, Validate Assumptions and Do not disturb sign. Reinforcement of the Human Performance Tools are carried through functional department continuation training, assessed through on-job training and task performance assessments and through yearly refresher plant access training with additional reinforcement, coaching and correction through the leaders in the field observations.

Through leadership presence in the field, observations are performed on the execution of work and implementation of procedures. Leaders are able to observe, reinforce good work practices and detect and correct worker practices or conditions that do not meet expected Nawah standards and coach for improvement. Trends and focus areas are identified for the organization and functions such as operations and maintenance. Observation and Coaching results, the number of observations performed, the observation quality, observation findings, trends and focus areas and "What a Good Observation Looks Like" are published weekly and bi-monthly to management and staff alignment meetings to heighten error prevention awareness and learning. At Nawah, integrated risk model is followed for work activities through screening for impact, scheduling to execution and error prevention techniques such as human performance tools are integrated to ensure human error is minimised. All activities are required to have a pre-job brief, with the type of pre-job brief matched to the activity risk. Activities identified as medium to high risk are

required to have a post-job debrief which identifies any improvement from the activities to be formally captured for improvement to procedures or work instructions. For low risk activities, the requirement for post-job debriefs are optional and identified by supervisors or team members. Procedures used are human factored, have appropriate reviews built in the process for the control, compile, approval, release and for the use in the field to reduce the number of error-likely situations associated with procedure use.

At Nawah, the use of industry process control standards such as Statistical Process Control (SPC) analysis techniques is deployed for analysing Corrective Action Programme (CAP) occurrences coded as Human Performance (HU) and Pareto Analysis techniques applied for Observation & Coaching (O&C) program data to detect weakness in programs, processes and supporting worker practices to these. The data is analysed in the aggregate that allows for review against comparable periods. Through these techniques, trends are identified triggered by process thresholds established through the SPC and Pareto techniques which is further investigated for Cause and correction using recognised industry investigation causal evaluation techniques. Cognitive identification of issues impacting safe operations for further analysis through screening is applied daily on both the CAP data and Observation data that would not necessarily be triggered by a process threshold but identified by the organization's low threshold for performance shortfalls. The techniques deployed fall under the Nawah Trending Program, with reviews performed quarterly including CAP and O&C data supported by weekly and bi -monthly O&C data analysis. At Nawah the performance improvement software tool deployed is the foundation for the CAP and other performance improvement programme tools such as O&C, Self-Assessments which host and integrates the data and analysis tools SPC and ability to perform and apply Pareto analysis.

The Functions review and track performance from the KPI Reviews, CAP, HU clock reset events and Observation and Coaching data and derive actions for focussed performance improvement through Department Review Meetings and Management Review Meetings.

12.4 Self-assessment of Managerial and Organisational Issues by the Operator

Nawah has a comprehensive approach to self-assessing managerial and organizational issues in the organization, ultimately ensuring that nuclear safety enjoys an overriding consideration in all managerial and organizational programs, processes, procedures and decision-making. Nawah's self-assessment regime is based on excellence standards derived from the international nuclear

industry (IAEA Guidelines and WANO Performance Objectives & Criteria). Functional areas such as Nuclear Performance Improvement, Organizational Effectiveness, Nuclear Oversight, Quality Assurance and Internal Audit conduct self-assessments on various aspects of managerial and organizational factors. Additionally, cross-functional teams are assembled from time to time to conduct self-assessments on a broad range of managerial and organizational issues, in preparation for external reviews from WANO, Nuclear Safety Review Boards and the Committee of Nuclear Power, quality assurance, programme self-assessments, internal audits and external audits were carried out on the Korea Electric Power Corporation (KEPCO) and sub-contractors. The effectiveness of the management processes used is assessed to confirm their ability to achieve the intended results and to identify opportunities for improvement.

12.5 Arrangements for the Feedback of Experience in Relation to Human Factors and Organisational Issues

Analyses of human factors engineering such as operating experience reviews and functional requirement analysis are fed back to the designers for resolution of any issues into the design. The feedback is arranged through the Human Factors Engineering Process, which ensures that human factors engineering principles and guidelines are adequately considered during the design phase and applied to all design activities. Design reviews, and reviews of experience are conducted through review meetings with each member in the design team and by independent reviewers who are extensively used for interdisciplinary review. This practice has been used during the construction and commissioning of the Barakah Nuclear Power Plant, and continues into the operations phase to address plant design changes and modifications.

12.6 Regulatory Review and Control Activities

As noted in section 12.1 above, FANR regulations FANR-REG-03 and FANR-REG-16 contain requirements for the consideration of human factors in the design and operation of a nuclear facility.

FANR Regulation on the Application for a Licence to Construct a Nuclear Facility (FANR REG-06) requires applicants for a Licence for Construction to describe how they will apply human factors in the design of the facility. FANR Regulation on the Application for a Licence to Operate a Nuclear Facility (FANR REG-14) requires applicants for a Licence for Operation to also provide facility design information related to human factors. The Preliminary Safety Analysis Report and

Final Safety Analysis Report for Units 1 and 2 , and Units 3 and 4 of the Barakah Nuclear Power Plant, includes a chapter describing its human factors engineering programme, and the application of that programme for the design of the main control room, remote shutdown room, and man-machine interfaces.

FANR staff reviewed the relevant chapter of the Preliminary Safety Analysis Report as part of its review and assessment of the application for the licence for construction and found that the information provided by ENEC was adequate to give reasonable assurance that the requirements will be met. FANR also reviewed the relevant chapter of the Final Safety Analysis Report supporting the application for a Licence for Operation for Units 1, 2 and 3 and similarly found that the information contained therein meets regulatory requirements.

FANR has conducted inspections of ENEC's integrated system validation activities to verify that this element of the human factors programme has been carried out in accordance with FANR requirements and the applicable regulatory guidance. These inspections resulted in no adverse findings. As part of FANR's operational readiness decision process for Units 1, 2 and 3 of the Barakah Nuclear Power Plant, FANR has completed inspections of Nawah's management system elements to determine whether Nawah's human factors programme for operations will address the aspects of design implementation and human performance monitoring. There were no adverse findings in these inspections.

All reportable events submitted by licensees, in accordance with conditions of the licence, are reviewed by FANR to ensure that investigations are appropriately carried out to determine whether human factors and human performance elements contributed to the cause of the event. Through reviews and inspections, FANR also ensures that licensees plan and execute effective corrective actions to mitigate recurrence of events.

Article 13: Quality Assurance and Integrated Management Systems

CNS Text:

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes 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.

13.1 Overview of the UAE's arrangements and regulatory requirements for quality assurance programmes, quality management systems, or management systems of the licence holders

Article 43 of the UAE Nuclear Law states that "The Licensee shall ensure that there is a Management System in place and adequate financial and human resources to ensure Nuclear Safety". Article 44 of the UAE Nuclear Law states that "As part of its Management System for Safety, the Licensee shall set up [a] management Safety system and adopt policies and procedures to define and adhere to appropriate Quality Assurance requirements…".

FANR Regulation for Management Systems for Nuclear Facilities (FANR-REG-01) sets out general requirements for the management system of the licensee. FANR-REG-01 is based on the International Atomic Energy Agency (IAEA) Safety Standards on The Management System for Facilities and Activities (Safety Requirements No. GS-R-3). FANR has also adopted the IAEA's guidance on management systems and determined that the Nuclear Quality Assurance (ASME NQA-1) standard is an acceptable approach to the definition of a Quality Assurance Programme.

13.1.1 Management systems of the Licence Holders

In the UAE, Nawah is the licence holder for operation of Barakah Nuclear Power Plant (BNPP). Currently three out of four nuclear reactors are operational at Barakah. In accordance with FANR Regulation (FANR-REG-1), Nawah has developed Nawah Integrated Management System (NIMS) with the objective to achieve and enhance safety for continual improvement.

Nawah has also implemented Nawah Quality Assurance Program (NQAP) which is an integral part of the Nawah Integrated Management System (NIMS). Through the introduction and implementation of quality assurance requirements, Nawah integrates quality into the performance of all activities that have the potential to adversely impact the safe operation of BNPP. The Nawah Quality Assurance Manual (NQAM) along with the implementing documents forms the NQAP which ensures meeting the requirements of ASME NQA-1-1994 with 1995 Addenda, with Part 1, II & III applied in graded manner. The NQAP is applied to those quality related activities that involve the function of safety-related Structures, Systems & Components (SSCs) associated with the design, fabrication, construction & testing of the SSCs of the plant. It applies also to the managerial and administrative controls to assure safe operations of BNPP reactors. For the non-safety related SSCs NQAP is applied in a graded manner. The NQAP includes consideration of

the technical aspects of the activities affecting quality and provides control over activities to an extent consistent with their importance to safety.

Nawah has described the details of these management systems in the Final Safety Analysis Report (FSAR).

13.2 Status with regard to the implementation of integrated management systems at nuclear installations

ENEC's management system for siting, design, procurement and construction

ENEC has established a comprehensive management system designed to meet its goals and objectives. The purpose of the management system is to provide the framework for managing and governing the company in such a way as to achieve and improve safety, security and quality continually in ENEC's activities by:

- Identifying and integrating the statutory and regulatory requirements that apply to the company's activities and facilities;
- Describing the planned and systematic processes, functions and activities necessary to satisfying those requirements; and
- Ensuring that security, quality, environment and business requirements are not considered separately from safety requirements to prevent their possible negative impact on safety.

ENEC's Management System integrates processes considered essential to manage ENEC's business and technical functions, and includes the organisational framework for developing policies, manuals, processes, procedures and other tools for approval.

ENEC's Quality Assurance Programme

The quality assurance programme as described in the ENEC Quality Assurance Manual focuses on nuclear quality assurance. The Quality Assurance Programme is part of the management system and covers ENEC's scope as the owner and licence holder for the UAE Civil Nuclear Energy Programme. The ENEC Quality Assurance Manual covers the quality assurance programme for ENEC and its activities including programme management and oversight of the prime contractor, sub-contractors and others as required.

The ENEC Quality Assurance Manual focuses on nuclear safety and presents ENEC's overall approach for quality and safety and also establishes the means by which quality and safety is to be

achieved. The programme related to implementing documents and procedures define more detailed responsibilities and requirements, and define the organisational interfaces involved in conducting activities within the scope of the ENEC Quality Assurance Programme. The Quality Assurance Programme focuses on ensuring that the nuclear safety and quality requirements are met.

The scope of the ENEC Quality Assurance Programme addresses the owner's activities for the licence for construction covering site selection, design, procurement and construction. The detailed work activities for the delivery of Units 1 to 4 of the Barakah Nuclear Power Plant are carried out under the prime contractor's Quality Assurance Programme, which has been reviewed and approved by ENEC in compliance with the ENEC Quality Assurance Programme, and applicable codes and standards as per the contract.

As the prime contractor of the Barakah Nuclear Power Plant, the Korea Electric Power Corporation (KEPCO) has developed a quality assurance programme that complies with the ENEC Quality Assurance Programme.

The KEPCO quality assurance programme applies to its activities defined in the contract with ENEC, and requires oversight of KEPCO's contractors and suppliers for the supply of the Barakah Nuclear Power Plant.

ENEC provides oversight of KEPCO and its contractors. This covers technical and commercial oversight. The quality assurance oversight is carried out through the review and acceptance of KEPCO's quality assurance programme, audit plans and other related documents, and through ongoing surveillance activities and audits.

The audit programme for ENEC, the contractors and suppliers are supported by audit plans to ensure audits are implemented at a frequency that meet the requirements of ongoing project implementation activities, and the applicable standards. ENEC conducts audits on the prime contractor and its major sub-contractors and suppliers as required to verify compliance with applicable standards and all aspects of the quality assurance programme.

Nawah's Management System for Operations

As part of its application to operate Units 1, 2 and 3 of the Barakah Nuclear Power Plant, Nawah has described its integrated management system in Chapter 17 of the final safety analysis report. The main objectives of Nawah's integrated management system are:

- To ensure safety is paramount within the management system overriding all other demands;
- To bring together (in a coherent manner) all requirements for managing the organisation;
- To describe planned and systematic actions necessary to provide adequate assurance that all requirements are satisfied; and
- To demonstrate compliance with the relevant UAE statutory laws and regulations.

Nawah's integrated management system is based on the IAEA Safety Standards on the Application of the Management System for Facilities and Activities (Safety Guide No. GS-G-3.1); it is broken down as follows:

- Level 1: High level policy for leadership and management.
- Level 2: Programmes and processes.
- Level 3: Implementing procedures.

The scope of the management of the integrated management system encompasses all safety related activities at the Barakah Nuclear Power Plant and Nawah's offices as well as all phases of the nuclear power plant lifecycle.

Nawah's Quality Assurance Programme

As part of its application for a Licence for Operation for Units 1, 2 and 3 of the Barakah Nuclear Power Plant, Nawah described its quality assurance programme in Chapter 17 of the final safety analysis report and the Nawah Quality Assurance Manual. The Nawah Quality Assurance Manual addresses the licensee's activities for plant operations, which includes Barakah Nuclear Power Plant commissioning, operations, engineering and maintenance activities.

Nawah has implemented Nawah Integrated Management System (NIMS) for Operations of Nuclear Power Plants which is made up of a blend of integrated components, existing in collaboration with each other in an effort to achieve the Nawah vision and mission. Nawah brings these elements together in a systematic and coherent manner in accordance with applicable regulations and standards while engaging the stakeholders and enforcing the right standards. With the objective to achieve and enhance safety, Nawah senior management have committed to the establishment, implementation and continuous improvement of an Integrated Management System (IMS). The principal objectives of the Nawah IMS are to:

a) Bring together in a coherent manner all requirements for managing the organization in a planned and systematic fashion,

b) Ensure no other factor, whether that be such as health, environment, quality or economics be considered outside safety requirements or impact safety in any way; and

c) Demonstrate compliance with the relevant UAE statutory laws and FANR Regulations (stated in the IMS) as they apply to regulated activities.

The NIMS is based on 5P (Plant, Program, Process, Procedure & People) Operating Model which defines the five focus areas on how Nawah operate across process, organization, and functional departments, integrating a disciplined application of controls to enhance safety into everything. Using the qualified people, Nawah safely operates the plant through established programs, processes and procedures and engage, qualify and further develop the people to sustain excellent performance in all aspects.

Nawah manages 5P Operating Model is through Governance, Oversight, Support and Perform (GOSP) activities. This enables everyone working for Nawah to clearly understand their role and level of accountability in ensuring performance excellence.

Nawah ensures this working model through demonstration of its corporate values of Accountability, Teamwork, Safety, Integrity, Trust and Excellence (or AT SITE). These values are shared by everyone at Nawah in the work is performed and guide internal conduct (i.e. behaviours) of individual as well as healthy relationship with stakeholders.

13.3 Main elements of the quality assurance programme covering all aspects of safety throughout the lifetime of the nuclear installation including delivery of safety related work by contractors

The ENEC Quality Assurance Manual has been developed in accordance with ASME NQA-1.

The current scope of the quality assurance programme, as documented in the Quality Assurance Manual, addresses the owner's activities for the Licence for Construction covering site-selection, design, procurement and construction activities. In accordance with the prime contract, the detailed work activities and associated quality assurance programmes for the delivery of the Barakah Nuclear Power Plant are carried out under the KEPCO quality assurance programme for the

Barakah Nuclear Power Plant, which has been reviewed by ENEC for compliance with the ENEC Quality Assurance Programme, and applicable codes and standards.

The Nawah quality assurance programme for the operations phase for Units 1, 2 and 3 of the Barakah Nuclear Power Plant is described in Chapter 17 of the final safety analysis report and is implemented through the NQAM.

NQAM is the top-tier QA document for implementation of NQAP. It is focused on nuclear safety and presents Nawah's overall philosophy for quality and safety, and establishes the requirements by which quality and safety are to be achieved. The QA Program-related implementing documents and procedures define more detailed responsibilities and requirements, and define the organizational interfaces involved in conducting operational activities within the scope of the Nawah QA Program. The QA Program and its role in the IMS are focused on ensuring that nuclear safety and quality requirements and commitments are met. Compliance with the NQAM and associated implementing documents, including programs, processes, and procedures, is mandatory. The main elements of the Quality Assurance Program are briefly explained as follows:

13.3.1 Organisation & Responsibilities

The NQAM describes the Nawah organizational structure, functional responsibilities, levels of authority and interfaces for establishing, executing, and verifying the implementation of the Nawah QA Program. Nawah management demonstrates commitment to the establishment, implementation, assessment and continuous improvement of the Nawah QA Program and allocates adequate resources to carry out the required activities.

13.3.2 Quality Assurance in Design

Nawah and the Operations and Maintenance supporting contractor (KHNP) have implemented an integrated, systematic Configuration Management Program to maintain the configuration of the Barakah NPP Units 1&2 and Units 3&4 in accordance with its design and licensing basis, throughout the life of the NPP.

13.3.3 Quality Assurance in Procurement Document

Applicable regulatory requirements, design basis, and other requirements necessary to ensure adequate quality are included and/or referenced in the documents for procurement of material, equipment, and services, whether purchased by Nawah, contractors or sub-contractors. Nawah

contract documents require contractors and sub-contractors to provide a quality assurance program or quality management system, consistent with the provisions of the NQAM.

13.3.4 Quality Assurance in Instructions, Procedures & Drawing

The NQAM assures that the necessary measures and controls are in place such that all activities affecting quality are properly performed in accordance with controlled implementing instructions, procedures and/or drawings. These documents are of a type appropriate to the circumstances where applicable and include quantitative and/or qualitative acceptance criteria as necessary to implement the NQAM requirements. Adherence to procedures related to implementation of the NQAM is mandatory (controls for emergency situations, and for the reporting of deviations, have also been established). Procedures are also in place to ensure that information related to security is protected from public disclosure

13.3.5 Document Control

Nawah has established the measures and governing procedures to control the preparation, reviewing, screening, approving, coordinating, issuance, and changes to documents and drawings that specify quality requirements or prescribe how activities affecting quality, including organizational interfaces, are controlled to ensure the correct documents are being employed.

13.3.6 Control of Purchased Items, Material, and Services

The NQAM assures that activities affecting quality of materials, equipment and services purchased by Nawah, contractors and sub-contractors are executed in a controlled manner. Such quality related activities are performed in accordance with prescribed procedures and instructions as required and utilize a graded approach consistent with the importance to safety, complexity and frequency of procurement of the item or service.

13.3.7 Identification, Control and Traceability of Items

The NQAM ensures that the necessary measures and controls are in place to control activities for the identification and control of materials, parts and components by Nawah, contractors and sub-contractors. This includes the controls for consumable materials and items with a limited shelf life.

13.3.8 Control of Special Processes

The NQAM describes how Nawah ensures that special processes affecting the quality of items or services are controlled. Special processes that control or verify quality such as welding, heat

treating and non-destructive examination, are performed by qualified personnel using qualified procedures in accordance with applicable codes and standards, specifications criteria and other specified requirements, when applicable.

13.3.9 Inspection

The NQAM describes how Nawah ensures through oversight and quality surveillance that necessary measures and controls are in place to assure quality requirements are met, detect and prevent CFSI, and cover activities for inspection done by contractors and suppliers. Such activities ensure that items, services, and activities affecting safety, meet established requirements and conform to applicable documented specifications, instructions, procedures, and design documents.

13.3.10 Test Control

The NQAM ensures that necessary test requirements and procedures are in place in order to verify conformance to specified requirements or demonstrate that items perform satisfactorily in service. Test results are documented and their conformance with test requirements and acceptance criteria is evaluated. Tests are carried out by properly qualified personnel.

13.3.11 Control of Measuring and Test Equipment

The NQAM states that tools, gauges, instruments and other measuring and test equipment (M&TE) used for activities affecting quality are controlled and at specified periods calibrated and adjusted to maintain accuracy within necessary limits.

13.3.12 Handling, Storage, Shipping and Housekeeping

Handling, storage, and shipping activities are performed in accordance with approved procedures and instructions to control the handling, storage, packaging, shipping, cleaning, and preservation of items to prevent inadvertent damage or loss, and to minimize deterioration.

13.3.13 Inspection, Test and Operating Status

The NQAM states that the status of inspection and test activities are identified either on the items or in documents traceable to the items where it is necessary to ensure that required inspections and tests are performed, and to ensure that items which have not passed the required inspections and tests are not inadvertently installed, used or operated, and to ensure notification to affected organizations.

13.3.14 Control of Nonconforming Items

The NQAM states that items that do not conform to specified requirements are controlled to prevent inadvertent installation or use. Controls are established for the identification, documentation, evaluation, segregation when practical, disposition of non-conforming items, and for notification to affected organizations.

13.3.15 Corrective Action

The NQAM states that conditions adverse to quality, such as, but not limited to, failures, malfunctions, deficiencies, deviations, defective material and equipment, and non-conformances are identified promptly and corrected as soon as practicable. In the case of significant conditions adverse to quality, the cause of the condition is determined, and corrective action taken to preclude recurrence. The identification, cause and corrective action for significant conditions adverse to quality are documented and reported to appropriate levels of management. Appropriate follow-up actions are taken to verify implementation of this corrective action.

13.3.16 Quality Assurance Records

Nawah has established necessary QA measures and governing procedures to ensure that sufficient QA records of items and activities affecting quality are developed, reviewed, approved, issued, used, and if required, corrected to reflect the activities undertaken at Barakah NPP. QA records furnish documentary evidence that items or activities meet specified quality requirements.

13.4 Audit programmes of the licence holder

Nawah has established an audit program to assess the effectiveness of Nawah Quality Assurance Program (NQAP) for its internal functions as well as for contractors and suppliers.

13.4.1 Audit of Nawah's internal functions

Nawah plans and carries out internal audits of Nawah's function at a frequency to verify the compliance with all aspects of the NQAP and to determine its effectiveness. These audits are performed per written procedures / checklists by personnel who do not have direct responsibilities

for performing the activities being audited. Audit results are documented, reported to and reviewed by responsible management. Follow up action (if any) are taken as per requirement.

13.4.2 Audit of Contractors and suppliers

ENEC provides technical and commercial oversight of KEPCO and its contractors. This oversight is done through the review and acceptance of KEPCO's quality assurance programmes, audit plans and other related documents, and through ongoing surveillance activities and audits. As the licence holder for operation, Nawah has established an audit programme to assess the implementation of its quality assurance programme and management system. The audit programme is supported by project audit plans to ensure audits are conducted at a frequency to meet the requirements and applicable standards. The Nawah Quality Assurance Programme includes the audit of Nawah's functions of programmes and processes and also of Nawah's quality assurance programmes of suppliers and contractors.

Nawah also perform external audits to assess compliance of the QA programs implemented by contractors and suppliers with the Nawah requirements. The audit of contractors and suppliers are supported by audit plans to ensure audits are conducted at a frequency to meet the requirements of the applicable standard. Nawah auditors are cognizant of potential counterfeit, fraudulent and suspect items (CFSIs) and conduct CFSI audits utilizing a CFSI checklist to such depths as to assure the legitimacy of the product or service being offered or procured from the supplier

13.5 Regulatory review and control activities

As noted in Section 13.1 above, FANR-REG-01 sets out general requirements for the licensee's management systems. FANR-REG-01 is based on IAEA Safety Standards on The Management System for Facilities and Activities (Safety Requirements No. GS-R-3). FANR has also adopted the IAEA's guidance on management systems and has determined that ASME NQA-1 is an acceptable approach to the definition of a quality assurance programme.

FANR-REG-06 and FANR-REG-14 require the applicant for a licence for construction and a licence for operation respectively to describe how they will manage safety including the management system to ensure that all requirements for safety, security and safeguards will be satisfied.

ENEC described its management system and quality assurance programme in the preliminary safety analysis reports for Units 1 to 4 of the Barakah Nuclear Power Plant. FANR reviewed the relevant chapter of the preliminary safety analysis reports as part of its review and assessment of the complete applications, and found that the information provided by ENEC was adequate to give reasonable assurance that the requirements will be met. The information related to quality assurance provided by ENEC and Nawah in the final safety analysis report in support of the application for a licence for operation of Units 1 to 3 has been reviewed by FANR.

The UAE Nuclear Law authorises FANR to conduct inspections of the licensee and its suppliers, which focus on the implementation of the management system and quality assurance programme. Since 2012, FANR has been conducting team inspections to verify the work of ENEC, its prime contractor KEPCO, and major suppliers located in the Republic of Korea and the United States of America. Findings from these inspections are communicated to the licensee for corrective action. Both FANR's resident inspectors at the Barakah site and teams of inspectors based at FANR's Headquarters conduct monthly inspections of the construction and commissioning activities at the Barakah Nuclear Power Plant.

From the beginning of 2018 to the end of February 2022, there have been 182 findings from the inspections. Although the scope of these inspections is broader than quality assurance and management systems, the areas where the inspectors most frequently made findings in this period were related to process management (i.e. design control), test control, and the management of quality assurance records. With Unit 1 and 2 in commercial operation and Unit 3 completing start-up and commissioning tests, the inspection programme has begun to shift towards verifying the readiness of organisational aspects for plant operation of Unit 4.

Article 14: Assessment and Verification of Safety

CNS Text:

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

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;

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

14.1.1 Overview of the UAE's arrangements and regulatory requirements to perform comprehensive and systematic safety assessments

Article (5) of the UAE Nuclear Law gives powers to FANR to establish the requirements for systematic safety assessments and periodic safety reviews. Article (28) of the UAE Nuclear Law makes it clear that detailed evidence of safety is required at all relevant stages of licensing of a nuclear installation. Articles (29) and (43) require the licensee to perform safety assessments over the lifetime of the nuclear facility, to address any deficiencies, and to provide FANR with any information relevant to the FANR's regulatory responsibilities. Article (32) requires review and assessment of the licensee or applicant at every stage of the regulatory process.

Regulation FANR REG-06, Application for a Licence to Construct a Nuclear Facility, and regulation FANR REG-14, Application for a Licence to Operate a Nuclear Facility, define an Independent Safety Verification (ISV) as, "A written verification performed by suitably qualified and experienced individuals, who did not participate in the original Safety Assessment, to determine whether the approach taken in conducting such Safety Assessment was reasonable and in accordance with international best practice". Each of these regulations requires that an ISV report be provided as part of the licence application request describing all proposed departures from or changes to the reference design.

14.1.2 Assessment of safety through the licensing process

Article (25) of the UAE Nuclear Law requires that a licence be obtained prior to engaging in any "Regulated Activity" which include selection of a site for, preparation of a site for, construction, commissioning and operation of a nuclear facility.

Each licence application is required to meet all applicable legal and regulatory requirements. FANR is required by law to conduct a thorough review and assessment of licence applications to verify that the relevant objectives, principles and criteria are met, and to satisfy itself that the available information demonstrates the safety of the facility or activity. Following its review and

assessment, FANR is empowered to grant a licence, grant a conditional licence, or refuse a licence request. Article (28) of the Nuclear Law stipulates that the FANR formally records the basis for its licensing decisions.

FANR has established in its management system a process consistent with the UAE Nuclear Law and the relevant IAEA safety requirements for assessing applications for licences relating to the construction and operation of a nuclear facility. The main steps in the process comprise the receipt and acknowledgement of the application; review and assessment of the application; issuing requests for additional information from the applicant where necessary; preparation of a safety evaluation report; and a decision on licensing by the Board of Management. Supporting procedures and instructions detail the methods and criteria to be applied by reviewers.

14.1.2.1 Construction licence for the Barakah nuclear installation

The process of review and assessment of the application and granting the licence for construction of the four reactor units at the Barakah Nuclear Power Plant are described in full in the UAE national reports to the 6th and 7th Review Meetings. As reported at the previous Review Meeting, FANR completed its review of ENEC's construction licence applications for all Barakah reactor units and documented its findings in two Safety Evaluation Reports (SER). The SER summaries for Barakah Units 1 and 2 and Barakah Units 3 and 4 construction licence applications are available on FANR's website. Formal approval from FANR's Board of Management for these construction licences was granted in July 2012 and September 2014 respectively. The construction licences are also available on FANR's web site.

Construction and commissioning of the four reactor units have progressed according to the schedule set by ENEC and Nawah with construction and commissioning having been completed on Barakah Units 1, 2 and 3. Construction completion for Unit 4 is forecast for 2023-2024.

14.1.2.2 Operating licence for the Barakah nuclear installation

Nawah was established in 2016 as a subsidiary of ENEC to operate and maintain reactor Units 1 to 4 at the Barakah Nuclear Power Plant. As reported in the previous UAE national report, ENEC submitted an application on behalf of Nawah to FANR on 26 March 2015 for the operation of the first two reactor units at the Barakah Nuclear Power Plant (Barakah Units 1 and 2). A further application was submitted on 27 March 2017 for operation of Barakah Units 3 and 4.

The applications requested authorisation to conduct Regulated Activities involving Barakah Units 1 through 4, as per Article (25) of the UAE Nuclear Law, including nuclear commissioning, operations, modifications, and import, possession, storage, handling, and use of regulated material. As discussed in the submissions, while the applications were for both Barakah Units 1 and 2, for the first application and for both Units 3 and 4 for the second application, the construction schedule for all units was different (i.e. one year behind between units). Accordingly, ENEC requested separate operating licences for each unit.

ENEC's comprehensive applications package was composed of the following elements in accordance with FANR regulations:

- Application Letter.
- Final Safety Analysis Report (FSAR) (21 chapters, supplements and addenda covering Safety, Security, and Safeguards).
- Technical Specifications.
- Independent Safety Verification (ISV) and Independent Design Review (IDR).
- Nawah Quality Assurance Manual (NQAM).
- Safety Assessment Report for Barakah Nuclear Power Plants (Lessons Learned from Fukushima Accident).
- Severe Accident Analysis Report (SAAR).
- Differences from Early Versions of Chapters 13 and 17 of FSAR.
- Commitments Associated with OLA.

The following documents were submitted separately:

- Physical Protection Plan (PPP) for Operations.
- On-Site and Off-Site Emergency Plans.
- Facility Safeguards Plan.
- Probabilistic Risk Assessment (PRA) Summary Report.
- Delivery of the Initial Decommissioning Plan & Associated Funding Arrangement Plan.

FANR's requirements and guidance on the content of the FSAR followed IAEA and USNRC guidelines. Before beginning its review and assessment activities, FANR concluded through a completeness review that the FSAR submitted by ENEC included the required safety, safeguards and security information, consistent with the integrated "Three-S" approach.

Review and assessment

FANR has conducted a thorough review and assessment of the applications for operation of Barakah reactor units in accordance with its established process as outlined above.

FANR used a graded approach to focus resources on the most risk significant areas of the licence application and used information from the Licensing Basis (LB) reviews carried out previously by FANR to maximise the effectiveness and efficiency of its review process. FANR staff reviewed the information provided in the operating licence application to verify consistency with information previously supplied in the construction licence applications for the Barakah reactor units 1, 2, 3 and 4. Where differences exist for example due to updated information, or, information not previously submitted, FANR staff is reviewing the information in accordance with its established process.

FANR used the information gained during the implementation of the inspection programme, carried out during the construction of the units, to provide input into the operating licence decision.

Technical Support Organisations (TSOs)

To augment its resources, and to assist the staff in reviewing the operating licence application, FANR contracted with three Technical Support Organizations (TSOs) located in the USA and Europe. The TSOs were selected on the basis of their organization and staff qualifications, capability, and credentials in conducting safety evaluations of nuclear facilities for other established nuclear regulatory bodies. Contracts were awarded for work packages comprising different areas of the FSAR for example, siting, design, safety analysis, and radiation protection. FANR provided alignment and direction to the TSOs, thereby ensuring consistency across the review and retaining responsibility for regulatory decisions through its in-house team of seasoned staff. Since 2018 all remaining review work related to the operating licence application has been conducted in-house without TSO support.

Current licensing status

At the time of this report, the applications for a licence to operate Barakah reactor units 1, 2 and 3 are complete and Operating Licences were issued for BNPP Units 1, 2 and 3 on 16 February 2020, 08 March 2021 and 17 June 2022, respectively. The Operating License Application for BNPP Unit 4 is expected to be submitted for review in the near future.

14.2 Verification and Management of Safety

14.2.1 Overview of the UAE's arrangements and regulatory requirements for the verification of safety

Article (43) of the UAE Nuclear Law requires the operator to perform comprehensive and systematic safety assessments and take steps to address any deficiencies that are identified during design, construction and operation of a nuclear facility. This article also requires the operator to issue a procedures guide concerning the performance of its activities especially for the operation, maintenance, surveillance and testing of selected equipment in line with the approved limits and conditions for safe operation and with the approved quality assurance programmes.

FANR-REG-06 Application for a Licence to Construct a Nuclear Facility requires the applicant to describe the inspection, tests and analysis that provide reasonable assurance that the structures, systems and components of a nuclear facility meet the design objectives.

FANR-REG-14 Regulation for an Application for a Licence to Operate a Nuclear Facility requires the applicant to provide information on the commissioning programme that will be used to provide assurance that the as-built nuclear facility satisfies the regulatory requirements and can be operated safely, including:

- a summary of the results of the non-nuclear commissioning tests carried out; and
- a commitment to a nuclear commissioning test programme to be conducted.

Articles (35) and (36) of the UAE Nuclear Law empower FANR to conduct regulatory inspection programmes to ensure that the operator is in compliance with the Nuclear Law, the applicable regulations and the conditions set out in the licence.

14.2.2 Main elements of programmes for continued verification of safety

During the period covered by this present UAE national report, the principal safety verification objective for activities conducted under the construction licences is to confirm that the systems, structures and components of the nuclear facility have been constructed in accordance with the design and can be operated safely. As required by FANR-REG-06, ENEC has described in the PSARs the construction inspection and test programme that it will carry out to achieve the above objective.

The overall hierarchy and principal concepts for the inspections and tests that ENEC and its contractors will carry out to verify the design requirements during construction and following completion of construction are based on the reference plant's Preoperational Inspection System.

The Barakah NPP Preoperational Inspection System consists of five stages of inspections and tests for verifying design requirements of structures, systems, and components (SSCs). A summary description for each stage of the Barakah NPP Preoperational Inspection System is as follows:

Stage I: Structure Inspection of Nuclear Facilities

Verifying that the Seismic Category I and II structures are constructed to perform the required functions and conform to the applicable codes and standards, design data and corresponding PSAR requirements.

Stage II: Installation Inspections of Equipment

Verification of installation, welding, Non-Destructive Test (NDT) and pressure tests for nuclear components, including reactor pressure vessel, to ensure compliance with the related design requirements.

Stage III: Cold Functional Tests (CFT)

Verification of system performance, including pumps, motors, heat exchangers and valves at ambient temperature, following installation of the systems and equipment.

Stage IV: Hydro-static and Hot Functional Tests

Hydro-static test of the Reactor Coolant System (RCS) and the secondary side of the Steam Generator (S/G), and Hot Functional Test (HFT) of systems including the RCS to verify the system's integral performance.

Stage V: Initial Start-up Test

Initial Start-up Test for performance verification of test items including Post-fuel load HFT, Initial Criticality, Low-power Physics tests, Power Ascension test.

The above construction inspections and tests are divided into two major areas of jurisdiction:

- Stages I and II: Work is performed by construction subcontractors and this area includes construction inspections and construction installation checks.

- Stages III and IV: Work is performed under the direction of the Commissioning Group and this area includes construction acceptance test, system flushing, CFT, and Pre-core HFT.

In addition to the inspections and tests carried out by the licensee and its contractors, manufacture and installation of certain safety-related components is also subject to conformity verification by "third-party" authorized nuclear inspectors in accordance with the Korean KEPIC Code.

14.2.3 Regulatory review and control activities

FANR has reviewed and accepted the description of the construction inspection and test programme given in the PSAR during its review of ENEC's application for a construction licence, as noted above in section 14.2.1.

Following the issuance of the construction licence, FANR mobilised its inspection team to verify that ENEC's construction activities comply with FANR requirements and the terms and conditions of the licence. The UAE Nuclear Law gives FANR powers to inspect the activities of licensees and their contractors. According to Article (34) of the UAE Nuclear Law the licensee remains responsible before FANR even if certain activities are carried out by contractors. FANR has established within its Integrated Management System (IMS) a process consistent with the requirements of the Nuclear Law and the relevant IAEA safety requirements for inspection of licensees' activities. Supporting procedures and instructions detail the methods that are to be applied by inspectors.

In order to effectively deliver its inspection programme, FANR has set a formal qualification standard for its inspectors. The inspector qualifications include theoretical (classroom) and practical (on-the-job) training in basic and applied nuclear technology, management systems, quality assurance and safety culture, inspection and enforcement procedures, and training in legal procedure by the UAE Ministry of Justice.

As of the date of this report, the number of qualified inspectors at FANR has increased from 81 in 2021 to 88. They are involved in regulatory activities, supported by other FANR subject matter experts and contractors. FANR has now deployed 8 resident inspectors to a permanent site office at Barakah Nuclear Power Plant to assist in overseeing the construction, commissioning and operation activities taking place at the site. Inspectors and specialists from headquarters are used to supplement the resident inspector compliment in specialised areas, e.g. certification of Reactor and Senior Reactor operators, when required.

FANR has formulated annual inspection programmes covering the activities of Nawah, ENEC and its prime contractor and major suppliers related to engineering, procurement and site construction. The annual inspection programmes focused on the requirements for the management system and quality assurance programme to verify that the controls specified by the licensee comply with the requirements and are implemented in the supply chain. The specific inspection areas are selected based on ranking criteria which include measures of risk significance and feedback from previous inspections.

From 2019 until the end of 2021, FANR has conducted over 90 nuclear safety, security and safeguards inspections in relation to the Barakah NPP licences. These inspections were covering the regulatory oversight four units under construction or operating regimes. With respect to nuclear safety, the objective of the inspections is to verify the work of Nawah, ENEC, its prime contractor KEPCO, and major suppliers located in Korea and the USA.

In addition to inspections overseas, FANR inspectors carried out inspections on site to directly verify construction, commissioning and operation activities on all four reactor units. Inspected SSCs included Reactor Coolant and Safety Injection system piping, class 1E electrical equipment, and safety related pumps among many others. The findings from each inspection were communicated to the licensee for corrective action. In general, findings were judged to be of low safety significance.

FANR has also performed inspections on the programs, processes and procedures prepared by Nawah for operating and supporting safe operation on the BNPP Units 1 to 3. Owing to a large volume of the documents prepared by different functions of Nawah, these inspections were carried out by FANR in different phases, which were called as “wave” inspections. The findings from these inspections were issued through inspection reports and are being addressed by Nawah for appropriate closure.

Of particular significance in the decision-making process to grant an operating licence on each unit, FANR conducted a series of inspections specifically designed to evaluate the readiness of Nawah – as an operating organisation - to operate safely the plants. This type of inspections entitled Integrated Operational Readiness (IDOR) inspections were covering elements such as sufficiency and competences of the operator’s staffing, including English proficiency, closure of any actions

plans and remaining open items and follow up on actions arising from external assessments (e.g. WANO).

Notwithstanding the above, the overall assessment of inspection findings from the FANR inspection programme concludes that ENEC's and Nawah's overall effectiveness in managing safety is generally acceptable.

As described in previous UAE national reports, Licence Condition 6 (LC 6) of Barakah construction licence requires ENEC to notify FANR of any unplanned event that occurred during construction. Unplanned events are categorised in the licence condition as any event that has the potential to affect safety, security and safeguards. Following initial notification, ENEC is also required to undertake and then provide to FANR for review analysis of the event, a determination of the extent of the condition as well as a corrective action plan that provides reasonable assurance that the event will not re-occur.

During the construction of Barakah Units 1 through 4, there were 43 events reported by ENEC to FANR. While the event reported may have occurred on one particular unit, its root cause may have affected several units and consequently in this cause the corrective action plan submitted by ENEC had to be implemented on all potentially affected units. Closure of all LC6 events raised during construction was a pre-requisite for granting a construction licence.

It is noteworthy that when granting an operating licence to Nawah for Barakah Units 1, 2 and 3, FANR included the same Licence Condition 6. As of the time of this report, there have been 17 unplanned events reported by Nawah to FANR. All of them have been evaluated by FANR that concluded that appropriate corrective actions have been taken by Nawah or are currently under evaluation.

Article 15: Radiation Protection

CNS Text:

Each Contracting Party shall take the appropriate steps to ensure that, in all operational states, the radiation exposure to the workers and to 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 the prescribed national dose limits.

15.1 Overview of the UAE's radiation protection principles

The UAE Nuclear Law gives FANR the authority to regulate radiation protection in the nuclear sector in the UAE. Article (38) of the UAE Nuclear Law specifies that FANR Board of Management shall issue the regulations specifying the requirements that all operators must comply with and follow.

FANR has developed regulations on radiation protection in order to implement the requirements of the UAE Nuclear Law. FANR's regulations are based on the best international practices and acknowledge the fundamental principles of radiation protection, the justification of practices, dose limits and the optimisation of safety and protection.

15.1.1 Justification

The UAE government established a national policy and strategy for safety in its Nuclear Policy published in April 2008. The Nuclear Policy which provides a concise summary of the analysis (including consideration of other energy sources such as gas, oil and solar) behind opting for a nuclear power programme. The analysis provided estimates of future demand for electricity for the country, categorized in "low", "likely" and "high" projections for the future. The peak demand for electricity is likely to rise to about 40 GW by the year 2020, following a succession of years with close to 9% annual increase.

As mentioned in the Nuclear Policy, "Evaluation of different options revealed that a heavy future reliance on burnable liquids would entail extremely high economic costs, as well as a significant degradation in the environmental performance of the UAE's electricity sector. Evaluation of alternative energies, including solar and wind suggested that, while these options could be deployed within the UAE, even aggressive development could only supply 6-7% of peak electricity demand by 2020".

Nuclear power-generation emerged as a proven, environmentally promising and commercially competitive option which could make a significant base-load contribution to the UAE's economy and future energy security.

The Government of the UAE desires to make clear its peaceful and unambiguous objectives in respect both of its current evaluation of a peaceful nuclear energy program as well as the potential future deployment of actual nuclear power generation facilities. Further, the Government of the

UAE also emphasized that nuclear energy represents only one of several options being evaluated, as the UAE seeks to meet future energy needs and develop a diversified and secure portfolio of power-generation assets.

Through the licensing of the Barakah Nuclear Power Plant and the monitoring and assessment of the overall performance of ENEC and Nawah, as licensees, the continued justification of the nuclear power programme is demonstrated.

15.1.2 Limits

FANR-REG-04 sets out dose limits for occupational exposure and for members of the public, and requires licensees to establish a dose constraint in line with international best practices.

The licensee shall ensure that occupational exposures and public exposures to ionising radiation, and all discharges of radioactive materials to the environment are kept below the prescribed limits during all operational states and activities. The licensee shall keep records of measured and estimated doses and release data, and report them to the authority as specified in the applicable regulations.

15.1.3 Optimisation

FANR-REG-04 describes requirements for the optimisation of protection for workers, the public and the environment so that the number of people exposed (and the magnitude of the individual radiation doses) are “as low as reasonably achievable” with the consideration of social and economic factors.

15.2 Regulatory Requirements Concerning Radiation Protection at Nuclear Installations

FANR has developed the following regulations and key provisions relating to radiation protection:

- FANR-REG-04 establishes occupational and public dose limits and the requirements for optimisation of radiation protection that are relevant to a nuclear facility during its design, construction, operation and decommissioning. FANR-REG-04 was revised in 2018 to reflect the new ICRP 2007 recommendations in ICRP Publication 103.

  The limit for the effective dose to a worker who is occupationally exposed during the normal operation of a nuclear facility is an average of 20 millisieverts (mSv) per year averaged over a period of five years (100 mSv in 5 years), and with no single year exceeding 50 mSv. The annual equivalent dose limit to the lens of the eye of a worker is to be an average of 20

millisieverts (mSv) per year averaged over a period of five years (100 mSv in 5 years) with no single year exceeding 50 mSv. The annual equivalent dose limit at any point on the hands, feet or skin is 500 mSv.

In addition to the limits stated above, the revised regulation stipulates the dose limits for persons aged 16 to 18 years who are being trained for employment involving occupational exposure to ionising radiation. These limits are as follows:

- Effective dose limit is 6 mSv per year.
- Equivalent dose limit for the lens of the eye is 20 mSv per year.
- Equivalent dose limit for the extremities and to the skin is 150 mSv per year.

The revised regulation stipulates that the licensee shall arrange the work of a female worker who has declared that she is pregnant so that the equivalent dose to the foetus is optimised and shall not exceed 1 mSv for the remainder of the pregnancy. If a female worker has informed the licensee that she is breastfeeding an infant, the licensee shall ensure that the said female worker is not employed in work involving risk of internal exposure.

The limit for the annual effective dose to a member of the public (this includes persons working in the nuclear facility other than those categorised under the "Worker' definition") is 1 mSv. The annual equivalent dose in the lens of the eye shall not exceed 15 mSv nor shall the annual equivalent dose at any point on the skin exceed 50 mSv.

In FANR-REG-04 the "average member of the critical group" to the "representative person" has been revised while keeping the calculation of doses to members of the public unchanged.

- The Regulation for Radiation Protection and Predisposal Radioactive Waste Management in Nuclear Facilities (FANR-REG-11) complements FANR-REG-04. It addresses the licensee's responsibility to establish a radiation protection programme as part of its management system covering the elements of organisational responsibilities, the classification of working areas and access control, local rules and supervision of work, work planning and work permits, protective clothing and equipment, workers' health surveillance, workplace monitoring and assessment of occupational exposures, training, and records.

  FANR REG-11 requires the licensee to identify and establish controls over all radioactive waste and keep radioactive waste generation to the minimum practicable. This regulation also

sets criteria for clearance from regulatory control and discharge of radioactive waste, and for an environmental monitoring programme.

The clearance levels and limits for discharges of radioactive material are specified in Article 22 and Article 23 of FANR-REG-11 respectively. Article 22 states that the safety case for materials and objects planned to be cleared from further regulatory control shall comply with the following provisions:

- In all reasonably foreseeable situations, the effective dose expected to be incurred by any member of the public due to the cleared material is of the order of 10μSv or less in a year and the effective dose due to low probability events does not exceed 1mSv in one year; or
- The activity concentration of an individual radionuclide does not exceed the relevant level in Tables 1 and 2 of IAEA Safety Standard RS-G-1.7 on the Application of the Concepts of Exclusion, Exemption and Clearance.

Article 23 of FANR-REG-11 states that the licensee shall ensure that the doses arising from discharges meet the requirements of FANR-REG-04. The safety case for all radioactive discharges (gaseous and liquid effluents) specifies the discharge limits that must comply with FANR-REG-04 dose requirements.

Article 24 of FANR-REG-11 obligates the licensee to establish and implement an environmental monitoring programme to ensure that public exposure is adequately assessed, and sufficient to demonstrate compliance with the regulations. The licensee reports the results of the environmental monitoring programme to FANR every six months including recorded data from the source monitoring programme, dose rates at the site boundary and in premises open to members of the public to verify compliance with discharge limits set in the approved safety case.

Regulation for an Application for a Licence to Construct a Nuclear Facility (FANR-REG-06) and Regulation for an Application for a Licence to Operate a Nuclear Facility (FANR-REG-14) require the licensee to develop a radiation protection programme, which includes a description of all onsite radiation sources, the application of the ALARA principle for the optimisation of protection and design features for radiation protection.

15.3 Radiation protection activities

Radiation protection activities apply to occupational workers, members of the public and the environment.

15.3.1 Control of radiation exposure of occupational workers

Radiation protection staff members comprise Managers, Supervisors, Specialists, and Technicians whose primary aim is the effective implementation of the Radiation Protection Programme.

- The Plant Manager is responsible for the safe operation of the plant, and for public and occupational radiation safety.
- The Plant Radiation Safety Director is responsible for ensuring the adequate protection of the health and safety of personnel working at the plant during all aspects of activities covered within the scope and extent of the license. The Radiation Safety Director reports to the Plant Manager and exercises supervisory control over the Radiation Protection Team. The Radiation Safety Director is responsible and accountable for implementing the Barakah Nuclear Power Plant Radiation Protection Programme. The Radiation Safety Director has direct access to the highest level of plant management to resolve issues and to deal with concerns related to radiation protection.
- Radiation protection staff is responsible for implementing the Radiation Protection Programme and is responsible for ensuring that radiation protection procedures and policies are implemented.

Implementation of ALARA (As Low As Reasonable Achievable) in the Design and Construction of Nuclear Installations

Nawah has established an ALARA Committee consisting of senior members of the plant management team experienced in nuclear plant operations and maintenance; the Plant Manager or the Radiation Safety Director chairs the ALARA Committee. The ALARA Committee reviews the principles of radiation protection, annual collective doses, long-term initiatives, and the radiation protection control plan. The purpose of the Radiation Protection ALARA program is to establish the requirements and responsibilities for the effective implementation of the ALARA program. The objective of the ALARA program is to ensure that occupational radiation exposure, individually and collectively, is maintained ALARA. The ALARA program consists of five

ALARA program procedures. These procedures cover On-line and Outage Exposure evaluations. The ALARA program ensures radiation exposure controls are in place to ensure adequate dose reduction methods are incorporated into the work activities.

The design of the Barakah Nuclear Power Plant incorporates radiation protection measures to ensure that occupational radiation exposures in future operation will be as low as reasonably achievable. These measures include:

- separation of radioactive components into separately shielded compartments;
- use of shielding designed to adequately attenuate radiation emanating from pipes and equipment that are sources of significant ionising radiation;
- use of remotely operated equipment;
- ventilation of equipment areas that have the potential for creating airborne radiation;
- installation of permanent radiation monitoring systems;
- training of personnel in radiation protection; and
- development and implementation of administrative policies and procedures to keep exposures as low as reasonably achievable.

Radiation Protection Training

Radiation protection training and development programme has been established by Nawah to provide all employees with knowledge of the fundamentals of radiation protection. Nawah is a learning organisation that values and embraces feedback, training, self-assessments and the timely review and response to industry operating experience. Nawah has hired diverse staff that provides the correct balance of education and experience with a special focus on Emirati staff development. Nawah continues to engage in industry benchmarking and working groups to identify and adopt radiation protection best practices. The training program provides Radiation Protection Supervisors and Technicians a systematic approach to training to ensure staff initial and continuing training supports staff development.

Dose Reduction

The collective effective dose is part of the safety assessment presented by the applicant for FANR review. The collective effective dose is compared with similar facilities that are currently in

operation around the world. The expected collective occupational exposure at units of the Barakah Nuclear Power Plant compares favourably with the criteria of less than 1 person-Sv/yr as stated in the Electric Power Research Institute (EPRI) Utility Requirements Document. It also compares favourably with the current pressurized water reactor occupational performance in the United States of America referenced in the document entitled Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2009, Forty-Second Annual Report (NUREG-0713, Volume 31). This supports the conclusion that the occupational exposures at the Barakah Nuclear Power Plant have been optimised. Remedial actions in the event of the overexposure of a worker (or workers) must be described in the licensee's radiation protection programme.

In the event of a violation of the dose limits, FANR has the authority to impose administrative fines and penalties for breaching any term or condition of a licence pursuant to the regulations issued by FANR and the Cabinet Resolution No. 27 of 2015 Concerning Administrative Penalties on Violating the Conditions of the Licences issued by the Federal Authority for Nuclear Regulation.

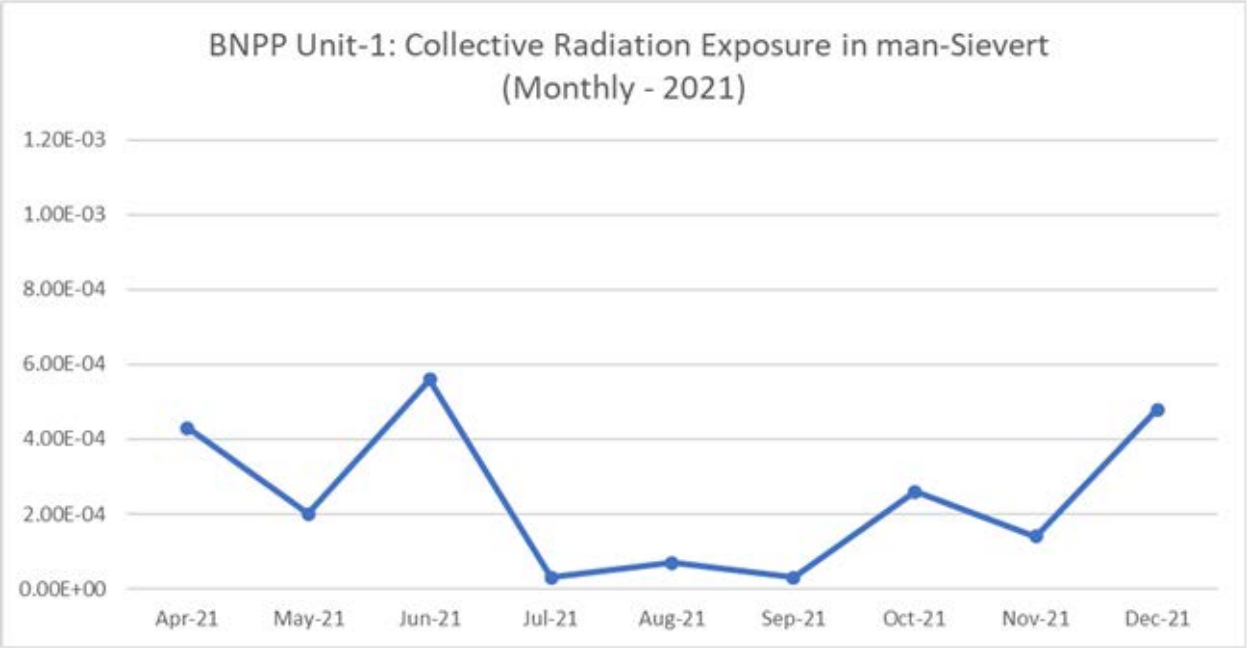
- Improvement of the Radiation Protection Programme – Nawah has enhanced its radiation protection programme based on FANR's inspections and feedback, recommendations from the World Association of Nuclear Operators (WANO), self-assessments, benchmarking and input from industry experts, feedback from Nawah's organisation, and management strategic objectives to adopt international radiation protection standards. Enhancements may be characterised as follows:
  - Dose reduction: the ALARA management and radiation worker incentives, temporary shielding evaluation and implementation, radiological risk management, and radiological posting and labelling;
  - Contamination control: unencumbered access to the radiologically controlled area, use and control of vacuums and high efficiency particulate air (HEPA) filters, alpha contamination controls, discrete radioactive particle detection and management; and
  - Minimisation of radioactive waste: degradable protective clothing, and a focus on radiation worker education.

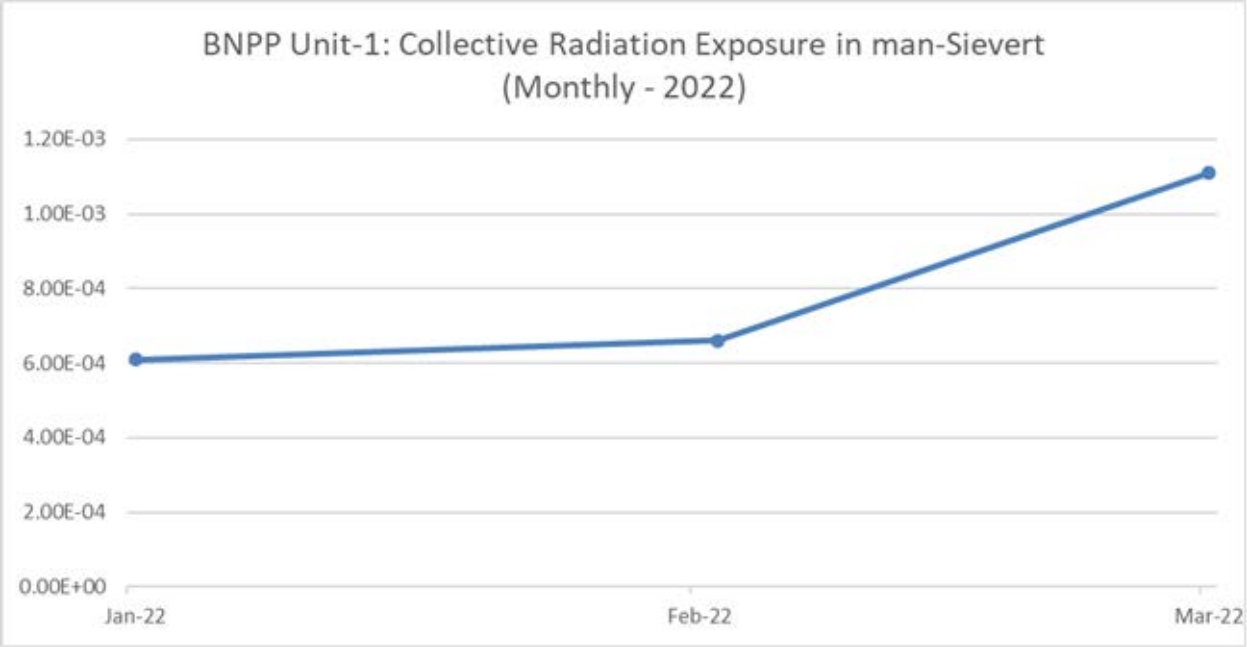
- Nawah has incorporated enhancements into station procedures, and conducted training impact analyses for all enhancements. Early field implementation has been scheduled to provide time to practice before required. FANR published its third annual report on the Radiological Environmental Monitoring Programme in the United Arab Emirates to document the level of baseline radiation in the UAE environment prior and after the start of the operation of the Barakah Nuclear Power Plant.

Regular reports to FANR (Rad Worker Dose)

The UAE Nuclear Law gives FANR the authority to establish and operate a register of occupational doses arising from a regulated activity. In 2018 FANR initiated the plan to establish the UAE National Dose Register. The National Dose Register is a centralised system for the collection and maintenance of personal dose records for workers receiving occupational exposure in the UAE. FANR hosted an IAEA Expert Mission in February 2018 with participating members from Australia and Canada. The structure of both the Australian and Canadian national dose registers was provided to FANR as a guide for the development of the UAE National Dose Register. FANR has drafted a white paper on the establishment of the national dose register with input from various missions, international guidance and practices. The UAE National Dose Register is currently under development and will be integrated into the FANR E-Licensing system. Individual dose records are provided to FANR twice each year.

BNPP Unit-1 started commercial operation from 01 April 2021. The collective radiation exposures for the year 2021 and 2022 are given below.





15.3.2 Control of radiation exposure of members of the public and the environment

FANR-REG-04 includes the requirements for optimisation of public exposure due to radioactive effluents. In response to the requirements for optimising public exposure (and as part of the regulatory process), Nawah (i.e. the licensee) has established public dose constraints and concentration constraints for radioactive material. The dose constraints and concentration

constraints are contained in (and implemented through) the Barakah Offsite Dose Calculation Manual in accordance with FANR-REG-04.

FANR has conducted a thorough review and assessment of the Barakah Offsite Dose Calculation Manual, which contains the Radiological Environmental Monitoring Programme and the Radioactive Effluent Control Programme. FANR has also conducted an operational readiness inspection to review applicable implementing procedures associated with the Barakah Offsite Dose Calculation Manual and verify that the implementing procedures are technically sufficient to implement the objectives of the Barakah Offsite Dose Calculation Manual and meet applicable FANR requirements. Nawah continues to develop the Radiological Environmental Monitoring Programme and to submit successive Semi-annual Radiological Environmental Operational Reports as required by FANR regulations.

FANR's Radiological Environmental Laboratory publishes series of annual reports on the Radiological Environmental Monitoring Programme in the United Arab Emirates. These reports are comprehensive and independent assessment of the radioactivity level in the general environment of the United Arab Emirates including the areas around nuclear facilities. The first report was published in 2018, and continued with series of annual reports that document each year Radiological Environmental Monitoring Programme results. All these reports, document the baseline of radioactivity in the United Arab Emirates' environment prior the operation of the Barakah Nuclear Power Plant. In parallel, FANR Radiological Environmental Monitoring Programme is continuously expanding and collecting routine sample every year. FANR reviews and assesses Barakah's environmental monitoring programme and compares it with its independent monitoring data. FANR also ensures compliance of the licensee through the continuous inspection of Barakah's radiological environmental monitoring programme.

Discharge of Radioactive Material

Radiation Environment activities apply to member of the public and Environment.

At BNPP, the Plant Environment Director is responsible for ensuring the adequate protection of the health and safety of the members of the public, also responsible and accountable for implementing the Barakah Nuclear Power Plant Offsite Dose Calculation Manual Programme. Environmental Staff is responsible for implementing Environment Radiation Programme as described in the ODCM and other applicable procedures.

Nawah Environment manuals and procedures established conservative dose constraints for liquid and gaseous releases to the environment, these dose constraints constitute a small fraction of the dose limit. Additionally, a dose projection has been established to limit the releases of gaseous and Liquid effluent to only 2% of the constraint values.

An Assessment of Radiation Doses to the Population around Nuclear Installations

Nawah Environment Department submits operational Effluent and Environmental Monitoring Semi-annual reports to FANR. Baseline reports were submitted for more than two years prior to operation of unit 1.

Nawah performs monthly and quarterly reports to ensure timely monitoring of releases although FANR limits are annually.

All effluent release pathways are monitored using Radiation Monitoring System with alarm setpoint as 0.25% for the gaseous and 0.75% of the liquid limits to provide assurance of high protection for the member of the public.

Nawah ODCM is revised to adopt “representative person concept” in lieu of “average member of the critical group”, additionally, the dose to the member of the public is calculated based on conservative assumptions of using all direct, inhalation, ingestion pathways.

The total effective dose to the maximum exposed representative person from the Barakah site in 2021 was 0.003 mSv, which is a small fraction of the site wide dose constraint of 0.25 mSv/yr.

15.4 Regulatory Review and Control Activities

FANR staff has conducted a thorough review and assessment of the radiation protection design features provided in the final safety assessment report for Units 1, 2 and 3 of the Barakah Nuclear Power Plant and issued the safety evaluation reports that supported the facilities licensing process.

FANR staff has also conducted the operational readiness inspections on the implementation of the Radiation Protection Programme including radiation protection training, process control programme, instrument calibration and the Barakah Off-site Dose Calculation Manual to verify that the required elements of the Radiation Protection Programme are developed and implemented for Units 1, 2 and 3 of the Barakah Nuclear Power Plant.

FANR staff conducted a radiation protection inspection on the receipt, unloading and storage of unirradiated nuclear fuel for Barakah Nuclear Power Plant. The inspection assessed the

implementation of the Radiation Protection Programme and the implementation of procedures required for the receipt, inspection, handling and storage of unirradiated nuclear fuel at Barakah Nuclear Power Plant.

For the units that are under construction, FANR staff conducted a thorough review of the preliminary safety assessment report for Unit 4 of the Barakah Nuclear Power Plant to ensure that the ALARA principle is implemented and consistent with the applicable design criteria. This includes performing confirmatory calculations to provide a basis for assessing the reasonableness of the source terms, shielding design, storage capacity for wastes, effluent discharge concentrations, and associated public dose.

FANR staff also conducted the as-built verification inspections to verify that the drawings and equipment specifications are consistent with the as-built conditions at the plant.

Article 16: Emergency preparedness

CNS Text:

i. *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.

ii. *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.*

iii. *Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.*

16.1 Emergency plans and programmes

The UAE Nuclear Law establishes FANR as the regulator of the nuclear sector in the UAE. This law specifies the roles and responsibilities of FANR in relation to emergency preparedness and

response including the development, review, approval and oversight of the on-site and the off-site emergency plans; the licensee; and the competent authorities.

The Federal Law No (23) of 2006 Concerning Civil Defence in the UAE specifies the roles and responsibilities of the UAE Civil Defence to ensure the protection of personnel, property and national resources both during times of stability and instability.

The Federal Law by Decree No (2) of 2011 establishes the National Emergency, Crisis and Disasters Management Authority (NCEMA) as the national competent authority for developing national emergency preparedness, the response and recovery framework, standards and national plans, coordinating response, supporting capacity-building and the capacities of different entities, and conducting exercises. This law outlines the main functions and responsibilities assigned to NCEMA on the management and coordination of emergencies, crises and disasters.

The UAE's emergency management system is documented in the National Response Framework with NCEMA as the lead. This framework describes the functions of all response organisations for emergencies, crisis and disasters in the UAE. It provides a framework to coordinate efforts at the national level and to adopt a strategy at both local and federal government levels.

For nuclear and radiological emergencies, NCEMA has developed the General Framework for Nuclear and Radiological Emergency Response in cooperation and coordination with FANR and other concerned entities. This framework describes the emergency management system for such emergencies. It also describes the planning basis for radiological or nuclear events, identifies the roles and responsibilities of each concerned entity, describes in general the notification process, activation, concept of operation, planning zones, operations management, termination and recovery, and defines a classification scheme for nuclear and radiological emergencies.

FANR and NCEMA completed a memorandum of understanding (MOU) on 15 July 2012 on Cooperation in the Field of Nuclear and Radiological Emergency Preparedness and Response. This MOU outlines the responsibilities of both FANR and NCEMA for emergency plans and programmes. There are regular meetings of the steering committee to oversee cooperation under the MOU.

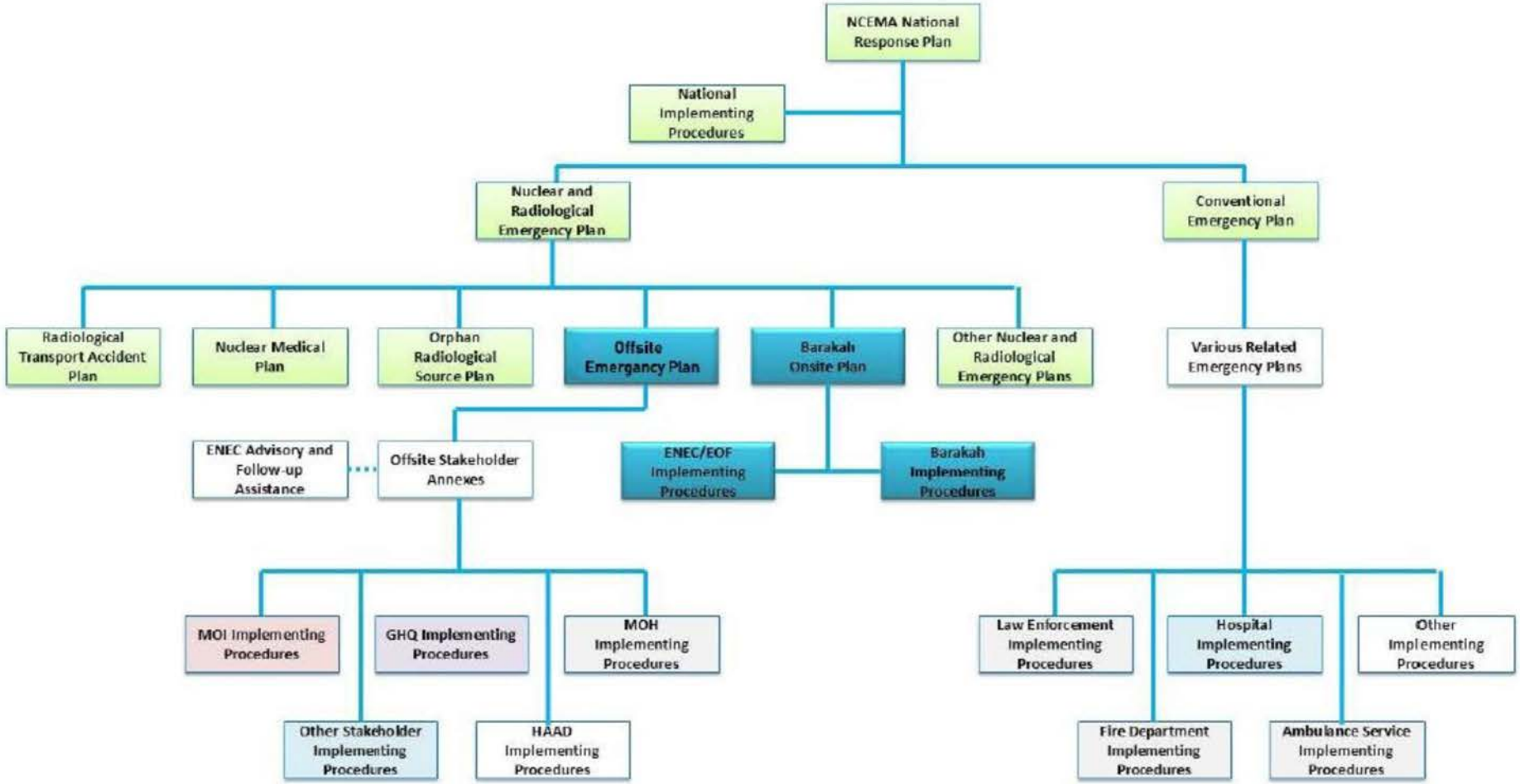
FANR is part of two committees in relation to the Barakah Nuclear Power Plant: the National Emergency Preparedness Coordination Committee and the Barakah Exercise Preparation Committee, which were established by NCEMA.

NCEMA and other concerned entities contributed to the National Risk Register, which provides an analysis and assessment of potential risks and threats the country faces including all internal and external radiological and nuclear risks and hazards. NCEMA manages and maintains the National Risk Register.

In February 2019 NCEMA developed the National Recovery Framework. This framework describes the recovery functions of all organisations in the UAE. It allows efforts to be coordinated at a national level so that a strategy can be adopted at a local, federal and national level in order to stabilise the situation after an emergency, crisis or disaster.

In 2021 the Ministry of Interior, in cooperation with the concerned entities, issued the fifth version of the Off-site Nuclear and Radiological Emergency Response Plan for the Barakah Nuclear Power Plant (hereafter referred to as the Off-site Plan), which describes and details the concept of operations and specific roles and responsibilities of each national response entity, and the support organisations.

Figure 16.1 Emergency Preparedness Program Hierarchy



IAEA missions

The UAE hosted an IAEA Emergency Preparedness Review (EPREV) service mission in March 2015. The main purpose of the EPREV Mission was to conduct a review of the UAE's emergency preparedness and response arrangements and capabilities associated with the Barakah Nuclear Power Plant. The review was carried out by comparing existing arrangements in the UAE with the international safety standards and good practices on emergency preparedness and response.

FANR is cooperating with the National Emergency, Crisis and Disasters Management Authority (NCEMA), the Ministry of Interior, the Emirates Nuclear Energy Corporation (ENEC) and other concerned entities addressed all recommendations and suggestions from the EPREV service mission. The UAE entities implemented a number of improvement actions, which were in line with an agreed action plan to address the findings of the EPREV service mission. The EPREV mission findings related to the on-site arrangements were also considered during FANR pre-operation inspections. These actions were reviewed during an EPREV follow-up mission in September 2019 and as a result all recommendations from the main mission were closed by the IAEA follow-up mission.

16.1.1 On-site emergency planning

The FANR Regulation for Emergency Preparedness and Response for Nuclear Facilities (FANR-REG-12) specifies the FANR's requirements for the licensee's preparation and response to an emergency at a nuclear facility. Its purpose is to ensure that the licensee has an organisation that is capable of coping with emergencies and mitigating their consequences, and that the licensee can carry out assessment actions and implement notification procedures. It also requires the licensee to demonstrate that it has adequate emergency facilities and equipment, provides appropriate training, maintains emergency preparedness, and is capable of recovery after an emergency. The licensee's arrangements must be described in the emergency plan including the authorities, responsibilities and duties of individuals assigned to it, and the means for notification of such individuals in the event of an emergency. This regulation was revised based on the lessons learned from its implementation, IAEA newest standards, lessons learned from Fukushima Daiichi accident and best practices around the world. The revision also considered the feedback from all applicable stakeholders. The new version was published in 2021.

FANR issued regulatory guide FANR-RG-035 entitled Regulatory Guide for Emergency

Preparedness for Nuclear Facilities, which provides methods and/or criteria acceptable to the Authority for meeting FANR requirements for the licensee's preparation, planning and response to an emergency at a nuclear facility.

The Barakah Nuclear Power Plant units 1 to 4 On-site Emergency Plan (hereafter referred to as 'on-site emergency plan') was developed in accordance with FANR-REG-12, and is supported by implementing procedures. The assessment by Nawah Energy Company (Nawah) of the potential emergencies associated with the nuclear facility is included in its on-site emergency plan.

ENEC submitted Revision 06 of the on-site emergency plan to FANR in March 2020. FANR reviewed the on-site emergency plan as part of the Final Safety Analysis Report, Chapter 13.3, emergency planning review.

Nawah has implemented an emergency classification scheme to group normal events or states according to their nature and severity. This classification scheme has been aligned with the off-site national response plan, which is maintained by the Ministry of Interior. The on-site emergency plan provides for four classes of emergencies listed in ascending order of severity: (1) Notification of Unusual Event (NOUE), (2) Alert, (3) Site Area Emergency (SAE), and (4) General Emergency (GE).

Nawah has emergency preparedness implementing procedures that includes specific pre-determined emergency action levels, which correspond to a given emergency classification level. The emergency action levels are based on the abnormal conditions for the nuclear facility, security related concerns, releases of radioactive material, environmental measurements, and other observable indicators.

Nawah has developed a comprehensive, integrated project schedule for the development and implementation of the Barakah Emergency Preparedness Programme (On-site and Off-site).

On-site emergency response will be provided from the following facilities:

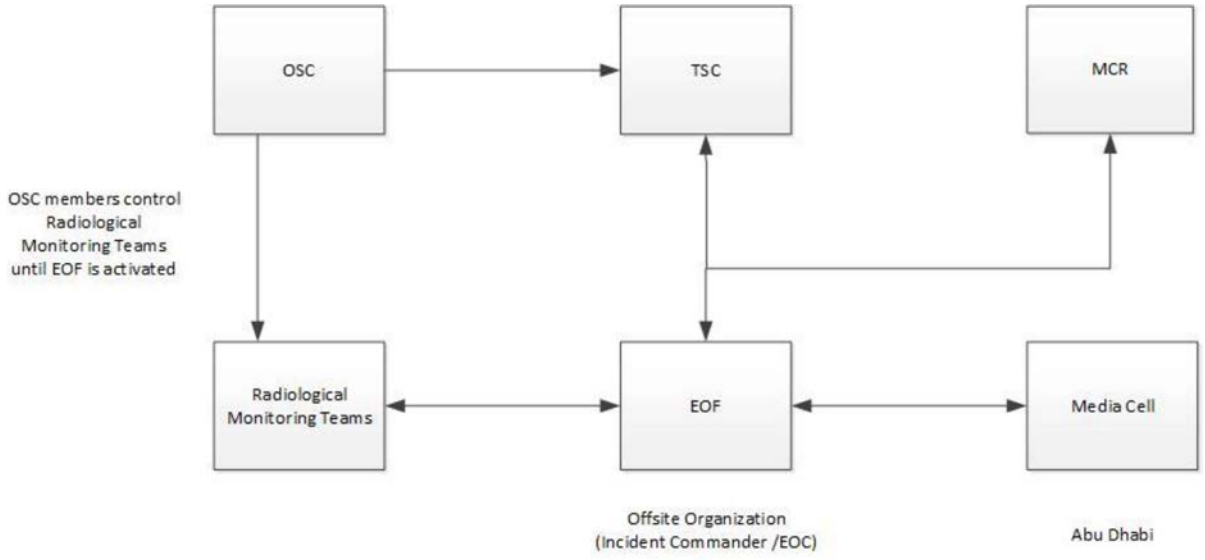
- Main Control Room (MCR) – the Main Control Room is not considered an emergency response facility, however, it is the initial location for command and control of the emergency response effort, and it is also the location where the initial assessment and coordination of corrective actions take place.
- Technical Support Centre (TSC) – the Technical Support Centre is the on-site emergency

response facility that is located close to the Main Control Room. It has no direct plant control functions and is designed to provide operations personnel with the necessary technical support to respond to an emergency. Once operational, the Technical Support Centre will serve as the primary communications centre during an emergency situation.

- Operational Support Centre (OSC) – the Operational Support Centre is an on-site assembly area separate from the Main Control Room and Technical Support Centre where operations support personnel report to (and are deployed from) during the response to an emergency situation.
- Emergency Operations Facility (EOF) – the Emergency Operations Facility complements the on-site facilities and is located approximately 50 km away from the Barakah Nuclear Power Plant. Members of the Emergency Operations Facility are responsible for the command and control of the overall emergency response effort, and the coordination of the on-site and off-site response.

Figure 16.2 – Onsite Emergency Response Organization Interrelationships, illustrates how the members of the Emergency Response Facilities (ERFs) are connected when all ERFs are activated.

Figure 16.2 - Onsite Emergency Response Organization Interrelationships



The on-site plan takes into account a precautionary action zone, and an urgent protective action planning zone, which are consistent with IAEA safety standards.

FANR has conducted emergency preparedness inspections on the Nawah emergency planning programme and emergency facilities as part of FANR's Operational Inspection Programme for the Barakah Nuclear Power Plant. An operational inspection for Unit 1 of the Barakah Nuclear Power Plant was conducted from 25-29 April 2021.

Actions undertaken by Nawah following the Fukushima Daiichi accident in 2011 include provisions to store and maintain portable equipment, which include portable pumps, hoses, auxiliary equipment as well as a mobile diesel generator. The Barakah Nuclear Power Plant Accident Management Programme includes provisions for deploying mitigation strategies to restore reactor core cooling, containment integrity control, and spent fuel pool cooling capabilities using flexible equipment. As required by Article (19) of FANR Regulation on Operational Safety including Commissioning (FANR-REG-16), such equipment is stored in a warehouse located in a safe area to ensure its availability.

16.1.2 Off-site emergency planning

FANR Regulation on the Requirements for Off-site Emergency Plans for Nuclear Facilities (FANR-REG-15) provides the requirements for the off-site emergency plan. This regulation defines the responsibilities and duties for implementation, measures for mitigation and remediation of consequences, arrangements for warning of the public, and measures for testing emergency preparedness.

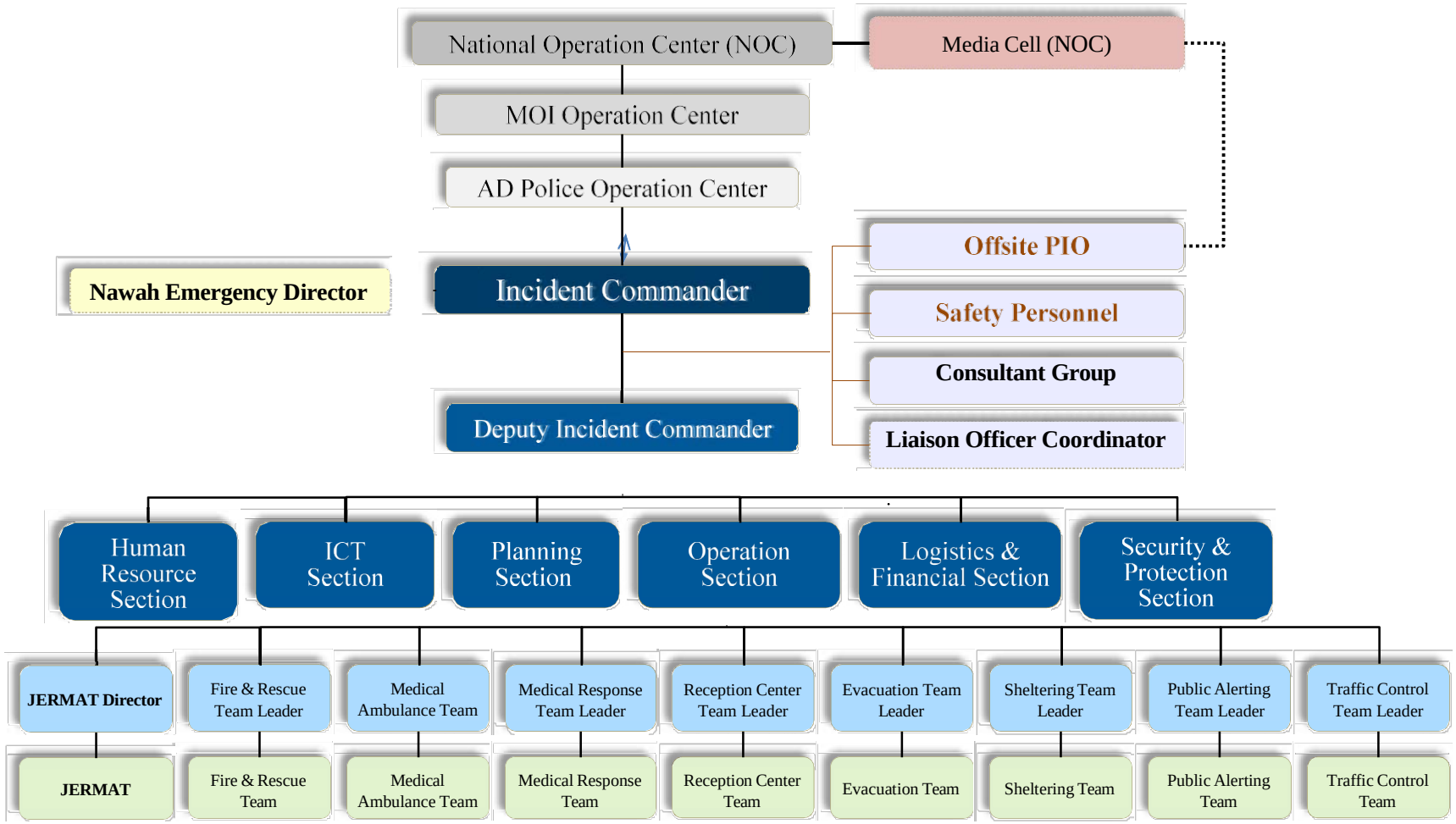
The Ministry of Interior in coordination with the concerned entities have developed the off-site plan in accordance with FANR-REG-15. The off-site plan includes annexes addressing roles and responsibilities of external stakeholders; each supported by implementing procedures.

The main stakeholders that form part of the off-site response organisation include the following:

- Abu Dhabi Quality and Conformity Council (QCC).
- Abu Dhabi Agriculture and Food Safety Authority (ADAFSA).
- Emirates Nuclear Energy Company PJSC (ENEC).
- Environment Agency – Abu Dhabi (EAD).
- Federal Authority of Nuclear Regulations (FANR).
- General Headquarters of the Armed Forces (GHQ).

- Department of Health Abu Dhabi (DOH).
- Ministry of Interior (MOI).
- National Emergency Crisis and Disasters Management Authority (NCEMA).

Twenty-three other stakeholders provide support to the off-site plan.



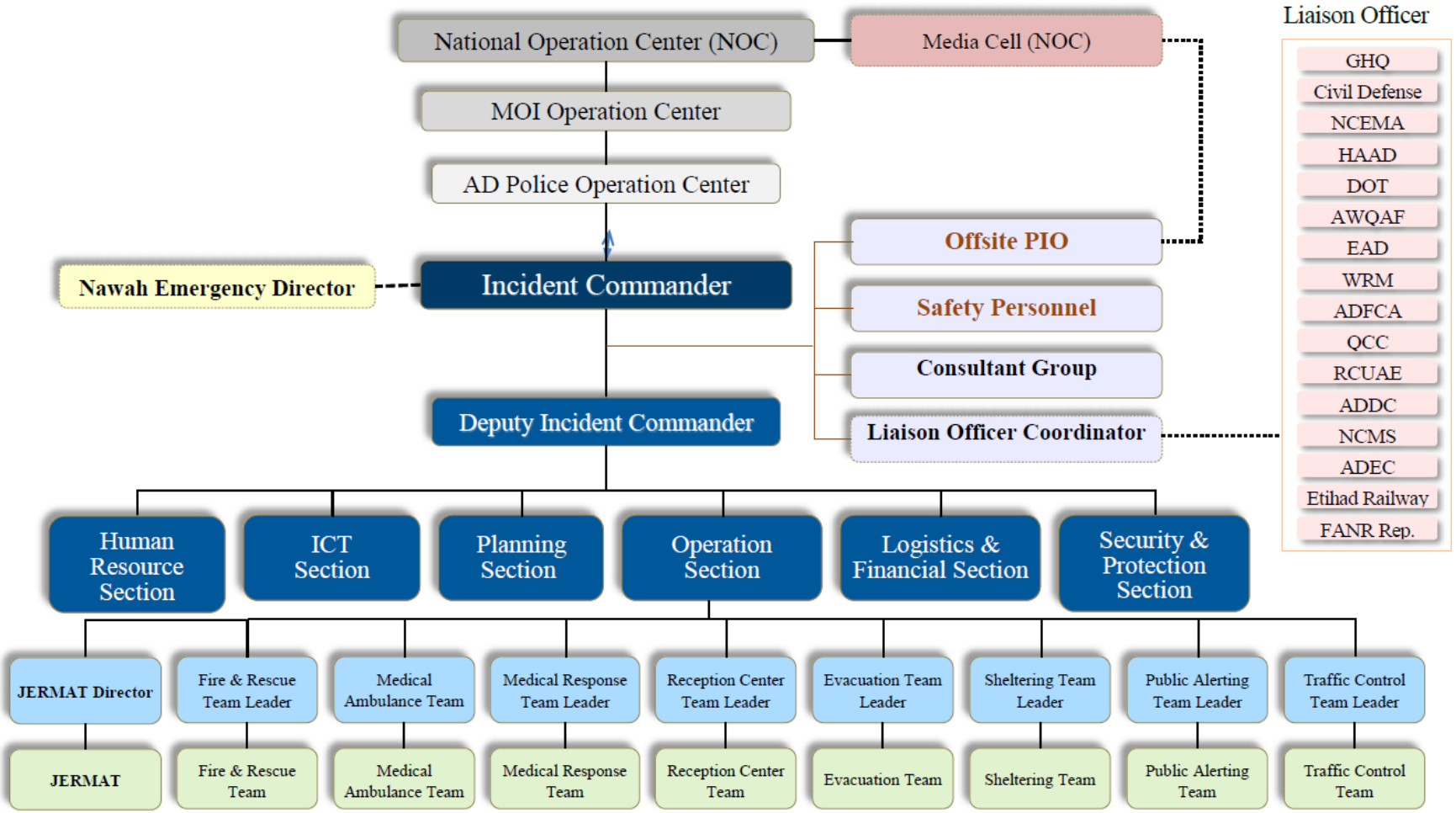


Figure 16.3 Offsite Response Organizational Chart

The off-site response will be handled from an emergency facility in Al Ruwais Emergency Operations Centre where the off-site response is handled under the leadership of the Incident Commander. This emergency centre is in the same building as the licensee's Emergency Operations Facility. The co-location of the Emergency Operations Facility and the Emergency Operations Centre is expected to significantly contribute to the effectiveness of the coordination arrangements. Major change has been made in the area of the off-site plan in which the Extended Planning Distance (EPD) and the Ingestion and Commodities Planning Distance (ICPD) were extended in the Off-Site Emergency Plan – Revision 5 to 100 km and 300 km respectively which is aligned with IAEA suggested approach. These distances are set for planning purposes, whereas the actual areas will be determined on the basis of the prevailing conditions in an emergency.

The Regional Radiological and Nuclear Emergency Preparedness and Response Plan (RNEPR) is also in place to address the preparedness and response to an actual or perceived radiation hazard that could affect more than one Gulf Council Cooperation (GCC) States. This RNEPR covers the response at the regional level for the purpose of coordination between the response organisations of the Gulf Council Cooperation States. It also considers the provision of regional support when needed during such emergencies. This plan defines an extended planned distance and an ingestion and commodities planning distance, which are in line with IAEA's guidance.

FANR inaugurated its Emergency Operations Centre in March 2019 to ensure the effective response to a nuclear and radiological emergency and keeps its operation with state of the art tools since then. The FANR Emergency Response Organisation (FERO) has staff qualified to perform duties on-call and during eventual emergencies or exercises and drills. The qualified FERO members have expertise and competences to support their teams on areas like nuclear safety, radiological assessment, nuclear security, emergency communication and other subject matter experts available when needed. .

16.1.3 Exercises & drills for emergency preparedness and response

Article (4) of FANR-REG-12 requires the licensee to maintain an emergency plan, and Article

(7) 2.b of FANR-REG-15 requires the conduct of drills and exercises at regular intervals for the functions to be carried out under the off-site emergency plan.

FANR has issued FANR-RG-034 entitled Regulatory Guide for Preparation, Conduct, and Evaluation of Drills and Exercises for Nuclear Facilities, which will be used to provide methods

and/or criteria acceptable to the Authority for meeting FANR requirements for drills and exercises performed at Nuclear Facilities.

Training, drills and exercises is an area where UAE counterparts have invested significant effort to test, identify areas for improvement and enhance their arrangements.

Nawah has established implementing procedures for the systematic approach to training, and objectives and demonstration criteria for exercises. In line with these criteria four drills and the UAE Barakah ConvEx-3 exercise were conducted in 2021.

FANR has organised its own training, drill and exercise activities, and also participates in Nawah's drill to test the arrangements of its own emergency response organisation. FANR, as the UAE's "Competent Authority" under the international emergency conventions, has coordinated the UAE's participation in all applicable IAEA's exercises during the last five years (i.e. five in 2017, three in 2018, five for 2019, four in 2020 and five in 2021).

The health sector has a specific standard on exercises for chemical, biological, radiological, nuclear and explosive materials. Based on this standard, UAE reference hospitals have been implementing quarterly drills since 2017 in case of a nuclear or radiological emergency.

All other entities also improved their arrangements based on the participation in national and international scale exercises as well as internal, strategic drills and training activities.

FANR and NCEMA prepared and carried out a series of full-scale emergency exercises in coordination with various stakeholders; the last full-scale emergency exercise was carried out on 26 October 2021. This exercise was conducted to demonstrate the on-site and off-site capabilities to protect the health and safety of the public and environment in the event of a nuclear emergency. The exercise allowed the demonstration and performance of the emergency response capabilities including the associated emergency plans, facilities, equipment, implementing procedures and the emergency response organisation. FANR evaluated on-site arrangements and supported NCEMA on its off-site evaluation.

IAEA's ConvEx-3 Exercise

The 2021 full scale exercise was also the basis for hosting an IAEA's ConvEx-3 exercise in coordination with the International Atomic Energy Agency (IAEA), international organizations and other IAEA Member States. The exercise had a scenario with radiological consequences of

international concern. The exercise and the rehearsal provided excellent opportunities to test UAE capabilities during 36 continuous hours (each time). During the exercise and for the first time in ConvEx-3, an IAEA's Response and Assistance Network (RANET) team was deployed for real to the accident state. The UAE Barakah ConvEx-3 exercise was successfully implemented in alignment with the Overall Work Plan prepared as agreed with the IAEA, International Organizations and Gulf Cooperation Council countries involved in the process. The milestones defined for the whole project were achieved as planned which is to be commended given all the challenges imposed by the exceptional COVID-19 circumstances.

Programme and performance areas for improvement were identified during the exercise assessment by both FANR assessors and Nawah evaluators. The most notable area for improvement in performance was in the area of the performance of staff in the main control room, and dose assessment. These and all the other areas for improvement were included in Nawah's Corrective Action Programme.

Image: Field activities during Barakah UAE ConvEx-3 exercise

Information of the public and neighbouring states

Communications with the public

Article 6 on Arrangements for Warning of the Public of FANR-REG-15 states:
'The Off-site Emergency Plan shall include arrangements for:

- Coordinating the release of information during an Emergency including identifying the Competent Authority to be the source of official information;
- Providing the public with prompt information on risks and any protective actions required or that may be required including information to the public outside the Emergency Zones;
- Responding to any misleading, inaccurate or confusing information appearing in the media; and
- Ongoing education of the public in the vicinity of the Nuclear Facility about Protective actions.

The off-site emergency plan describes the activation of a 'Media Cell' in the National Operations Centre led by NCEMA. The Media Cell consists of the National Media Council, Abu Dhabi Police Security Media Department, the FANR Communication Liaison Officer, and other supporting organisations to implement the media and public information plan. This plan aims to issue warnings and instructions to the public, and to keep the public and media informed through press conferences or other approved media channels within two hours of receiving notification of a site area emergency or a general emergency.

Communication with neighbouring states

The roles and responsibilities in relation to communication with other States are described in the off-site emergency plan, and in the media and public communication plan on responding to emergencies at the Barakah Nuclear Power Plant.

The UAE has arrangements to inform the IAEA and affected States as needed and in line with the Convention on Early Notification of a Nuclear Accident. The notifications are made through FANR as competent authority under the said Convention.

NCEMA and the Ministry of Foreign Affairs and International Cooperation have arrangements in place to inform neighbouring countries within a period of time that does not exceed two hours

from the receipt of an emergency notification of a site area emergency or a general emergency.

At the regional level, the UAE is working with other Gulf Cooperation Council countries through the Gulf Cooperation Council Emergency Management Centre (GCC EMC) that is located in Kuwait. All communications to Gulf Cooperation Council countries go through the GCC EMC as per the Regional Radiological and Nuclear Emergency Preparedness and Response Plan.

16.2 Emergency preparedness for contracting parties without nuclear installations

The UAE's emergency preparedness for nuclear events from other countries is covered within the GCC EMC's Regional Radiological and Nuclear Emergency Preparedness and Response Plan. In parallel to notifications from the IAEA, NCEMA will establish communication channels with neighbouring countries in cooperation and coordination with the Ministry of Foreign Affairs and International Cooperation. This communication will include the GCC EMC in Kuwait.

Article 17: Siting

CNS Text:

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

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

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

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

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

17.1 Overview of the UAE's arrangements and regulatory requirements relating to the siting and evaluation of sites of nuclear installations

The Nuclear Law gives FANR authority to regulate the 'Nuclear Sector' of the UAE. Article (25) describes selection of a site, preparation of a site and construction of nuclear facility as regulated activities for which a licence is required from FANR.

FANR now has several regulations describing the regulatory requirements related to site selection, site preparation and site construction.

FANR REG-02 "Siting of Nuclear Facilities" describes the requirements for the evaluation of a proposed site and defines the extent of information relating to a proposed site to be presented by the applicant. This information includes, but is not limited to, the following:

a) evaluating a proposed site to ensure that the site-related phenomena and characteristics are adequately taken into account;

b) analysing the characteristics of the population of the region and the capability of implementing an Emergency Plan over the projected lifetime of the plant;

c) defining site-related hazards; and

d) quantifying the input parameters related to seismic, meteorological, hydraulic, geotechnical areas and human induced conditions used in the Design of the Nuclear Facility SSCs.

FANR-REG-03, "Regulation for the Design of Nuclear Power Plants," specifies that natural external events shall be considered in the design process including those which have been identified in site characterization, such as earthquakes, dust storms/sandstorms, cyclones, floods, high winds, tornadoes, tsunami (tidal waves), and extreme meteorological conditions.

FANR REG-06, "Application for a Licence to Construct a Nuclear Facility", requires an applicant for a licence to construct a nuclear facility to submit in the PSAR comprehensive information on the evaluation of the proposed site.

FANR-REG-14, "Regulation for an Application for a Licence to Operate a Nuclear Facility", specifies the requirements for an application to FANR for a licence for the operation of a nuclear facility; including the submission in FSAR of an updated evaluation of the site and the nuclear commissioning tests.

17.2 Evaluation of site related factors

On 17th July 2012, based on a thorough review and assessment of ENEC's construction licence application, FANR issued a licence to ENEC authorizing the construction of Units 1 and 2 at Barakah. FANR conducted a thorough review of the Construction Licence Application for Barakah NPP Units 1 and 2 including Chapter 2 of the PSAR. FANR concluded that Chapter 2 of the PSAR along with supplemental application materials demonstrated a sufficient safety basis for issuing a construction licence and complies with relevant regulatory requirements, contained primarily in FANR-REG-02. FANR concluded that the site has been properly characterized for the environment of the United Arab Emirates at the location of the Barakah NPP and that the site is suitable for use as a location for operation of a multi-unit nuclear power facility as described in the Barakah PSAR Units 1&2 supplied by ENEC.

Construction of Units 1 and 2 at Barakah has been completed according to ENEC's project schedule under FANR's regulatory inspection and enforcement oversight.

On 28th February 2013, FANR received from ENEC a Construction Licence Application (CLA) for Barakah Units 3 and 4. FANR carried out the review and assessment of the CLA submitted by ENEC. Barakah Units 3 and 4 are similar in design to Barakah Units 1 and 2. Also, the designs for all four units utilize the same reference design which is the Shin-Kori Units 3 and 4 currently operating in the Republic of Korea. FANR conducted a thorough review of the Construction Licence Application for Barakah NPP Units 3 and 4 including Chapter 2 of the PSAR. FANR concluded that Chapter 2 of the PSAR along with supplemental application materials demonstrated a sufficient safety basis for issuing a construction licence and complies with relevant regulatory requirements, contained primarily in FANR-REG-02. FANR concluded that the site has been properly characterized for the environment of the United Arab Emirates at the location of the Barakah NPP and that the site is suitable for use as a location for operation of a multi-unit nuclear power facility as described in the Barakah PSAR Units 3&4 supplied by ENEC. On 15th September 2014 FANR issued a Construction Licence for Barakah Units 3 and 4.

On March 20th 2015, ENEC submitted to FANR an Operating Licence Application (OLA) for Barakah Units 1 and 2. The OLA for Units 1 and 2 included the Final Safety Analysis Report (FSAR) and other supporting documents required by FANR for review and approval. The OLA for Barakah Units 1&2 incorporated the pertinent information developed since the submittal of the

Construction Licence Application, including the information that ENEC committed to provide as a condition of the Construction Licence. The FSAR included complete information on the final design, facility operation, including the organizational structure, responsibilities and authorities, managerial and administrative controls to be used to assure safe operation, plans for start-up testing and initial operations, plans for conduct of normal operations, including maintenance, surveillance, and periodic testing of SSCs, plans for coping with emergencies.

With the OLA for Units 1&2 of the Barakah nuclear power plant, ENEC submitted a comprehensive characterization of the Barakah Nuclear Power Plant (BNPP) site. Chapter 2 of the FSAR updated the characterization of the site in terms of geography and demography, nearby industrial, transportation, and military facilities, meteorology, hydrologic engineering, geology, seismology, and geotechnical engineering. The updated site characterization showed no abnormal trends.

In March 2017, Nawah submitted to FANR an Operating Licence Application (OLA) for Barakah Units 3 and 4. The OLA for Units 3 and 4 include the Final Safety Analysis Report (FSAR) and other supporting documents required by FANR for review and approval.

FANR reviewed the Unit 3 OLA and the pertinent information from the review of the FSAR from Units 1 and 2, inspections at Barakah NPP, both international and domestic operating experience, and operation of Units 1 and 2. On June 17th 2022, FANR issued an operating licence to Nawah for Barakah Unit 3.

17.3 External extreme events

As part of the review of the Construction Licence Application (CLA) for Barakah Units 3 and 4, FANR requested that ENEC provide a separate submittal addressing lessons learned from the Fukushima Daiichi tsunami-induced nuclear accident. Part of that submittal required further consideration of extreme natural and man-made events. FANR conducted a detailed review of the ENEC Fukushima report and completed the safety evaluation, making findings regarding extreme natural events.

For extreme seismic events beyond the design basis, FANR concluded that further information was needed with regard to the seismic margin or capacity for the Barakah units. This included situations where non-seismically designed structures, systems, and components could be challenged and have adverse consequences on the operation of structures or equipment that is

relied upon for coping with extreme events at the multiple-unit Barakah site. Two seismic related safety improvements were identified: (1) seismic capacity of a main control room display; and (2) seismic capacity of the Alternate AC (AAC) diesel generator building. ENEC has performed a seismic PRA as part of its safety assessment for Barakah to address a number of Fukushima-related issues and provided acceptable verification that margin exists to accommodate extreme events.

For extreme flooding events beyond the design basis, FANR concluded that the design changes proposed by ENEC, including water-tight doors and relocated penetrations, would provide protection against flooding well above the flooding level that would result from a design-basis tsunami. FANR concluded that a further evaluation of a beyond-design-basis tsunami and the combination of storm surge and tsunami was warranted in order to understand the increase that this could cause in run-up at and inundation of the Barakah NPP site. ENEC evaluated the extent of flooding caused by a tsunami generated by a beyond-design basis earthquake at the Makran Subduction Zone on the northern coast of the Gulf of Oman. The evaluation indicated that no threat would result to the Barakah NPP site from such postulated initiating events.

FANR also reviewed ENEC's evaluation of external events more severe than those postulated for the design basis including dust-sandstorm, oil spill, flammable and explosive mixtures, fires and toxic gas releases. FANR has in addition reviewed ENECs assessment of the impact of explosions and large fires that may result from the impact of a large aircraft.

In summary, FANR found that ENEC had conducted an adequate assessment of other extreme natural and man-made initiating events beyond the design-basis that could affect the Barakah site. This includes margins that are available and measures that can be taken to cope with and mitigate such extreme events. FANR also found that the plant safety improvements that were proposed for addressing Fukushima lessons learned are acceptable and appropriate for improving the capability to cope with and mitigate extreme events of this type.

17.4 Regulatory review and control

FANR has reviewed and assessed the information on the site evaluation presented by ENEC in the FSAR Units 1 and 2. FANR also reviewed the quality assurance programmes that ENEC submitted in support of its Operating Licence Application for Barakah Units 1 and 2. In June 2017, Nawah submitted to FANR an Operating Licence Application (OLA) for Barakah Units 3 and 4. The OLA documents for Units 3 and 4 include the Final Safety Analysis Report (FSAR) and other supporting

documents required by FANR for review and approval. FANR reviewed the Unit 3 OLA and the pertinent information from the review of the FSAR from Units 1 and 2, inspections at Barakah NPP, both international and domestic operating experience, and operation of Units 1 and 2. On June 17th 2022, FANR issued an operating licence to Nawah for Barakah Unit 3.

FANR maintains a close liaison with the UAE competent authorities in the fields of the environment and emergency management. For example, the impact of natural and human-induced external hazards on the safety of the nuclear installation shall be evaluated over its lifetime. Long-term monitoring programs should include data gathering from site-specific instrumentation and data from specialized institutions. The data should be used in comparisons to detect significant changes from the design basis, for example changes due to the possible effects of climate change. Consultation with neighbouring counties has continued bilaterally and in the context and framework of the Gulf Cooperation Council forums.

Article 18: Design and Construction

CNS Text:

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

i. *The design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence 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 human factors and the man-machine interface.*

18.1 Implementation of defence in depth

18.1.1 Overview of the UAE's arrangements and regulatory requirements concerning the design and construction of nuclear installations

The UAE Nuclear Law gives FANR authority to regulate the "Nuclear Sector" of the UAE. Article (25) establishes selection of a site and construction of a nuclear facility as regulated activities for which a licence is required from FANR.

FANR REG-02, Regulation for the Siting of Nuclear Facilities, sets out requirements to follow when evaluating sites for Nuclear Facilities. The main purpose of the site evaluation is to protect the public and environment from the radiological consequences of radioactive releases due to normal operation and accidents. In the evaluation of the suitability of a site for a Nuclear Facility, effects of external events (natural in origin or human induced) occurring in the region of the particular site shall be considered.

FANR REG-03, Regulation for the Design of Nuclear Power Plants, sets out requirements for design. FANR-REG-03 covers general requirements, the principal technical requirements including maintenance of fundamental safety functions, defence-in-depth, safety classification, the general design basis, and specific requirements for systems and components.

FANR REG-03 also includes a requirement to include in the design reasonable and practicable measures to prevent and mitigate severe accidents and certain severe accident precursors including Station Blackout and Anticipated Transient without Scram.

FANR REG-03 also includes a requirement to perform a design-specific assessment of the potential effects of the impact of a large, commercial aircraft and to demonstrate that for a reactor accident either the reactor core remains cooled or the containment remains intact or demonstrate how the risk compares against probabilistic target of core damage frequency and large release frequency. The regulation also includes requirements that for spent fuel storage accidents, either spent fuel cooling or spent fuel integrity is maintained or demonstrate how the risk compares against the probabilistic targets such that public health and safety and the environment are protected.

FANR REG-05, “Regulation for the Application of Probabilistic Risk Assessment (PRA) at Nuclear Facilities”, requires the licensee constructing or operating a nuclear facility to conduct a Probabilistic Risk Assessment (PRA) to complement the Nuclear Facility Design, Construction, Operation and Safety analysis.

FANR REG-06, “Application for a Licence to Construct a Nuclear Facility, requires an applicant for a licence to construct a nuclear facility” to submit in the Preliminary Safety Analysis Report (PSAR) a description of the general design of the proposed nuclear facility, a description of the systems structures and components of the facility, and a summary of the results of the safety analyses performed to assess the safety of the Nuclear Facility.

FANR REG-14, “Application for a Licence to Operate a Nuclear Facility, requires an applicant for a licence to operate a nuclear facility” to submit in the Final Safety Analysis Report (FSAR) a description of the general design of the proposed nuclear facility, a description of the systems structures and components of the facility, and a summary of the results of the safety analyses performed to assess the safety of the Nuclear Facility.

18.1.2 Status of the application of the defence in depth concept in the UAE’s nuclear installations

FANR REG-03, Regulation for the Design of Nuclear Power Plants, Article (7) provides regulatory requirements for the application of the Defence-In-Depth principle. The Article requires that Defence-in-Depth shall be incorporated in the design process and provide:

- multiple physical barriers to the uncontrolled release of Radioactive Materials to the environment;
- Safety margin, and the Construction shall be of high quality, so as to provide confidence that plant failures and deviations from Normal Operations are minimised and accidents prevented;
- for control of the Nuclear Facility behaviour during and following events, using inherent and engineered features;
- for supplementing control of the Nuclear Facility, by the use of automatic activation of Safety Systems to minimise operating personnel actions in the early phase of Postulated Initiating Events (PIEs);
- for equipment and procedures to control the course, and limit the consequences, of accidents; and,
- multiple means for ensuring that each of the fundamental Safety Functions, i.e. control of reactivity, heat removal, and confinement of Radioactive Materials is performed, thereby ensuring the effectiveness of the barriers and mitigating the consequences of any PIEs.

The regulation requires that the design shall prevent challenges to the integrity of physical barriers, the failure of a barrier when challenged; and failure of a barrier as a consequence of failure of another barrier, as far as is practicable. The regulation requires that the design takes into account the fact that the existence of multiple levels of defence is not a sufficient basis for continued power operation in the absence of one level of defence and that all levels of defence are to be available

at all times. The regulation allows that some relaxation of the availability of certain defence-in-depth provisions may be specified for various operational modes other than power operation. The objectives of the approach taken as specified by the regulation shall be to:

- provide adequate means to maintain the Nuclear Facility in a normal operational state;
- ensure the proper short term response immediately following a PIE; and
- facilitate the management of the Nuclear Facility in and following any Design Basis Accident (DBA), and in those selected Accident Conditions beyond the DBAs.

FANR-RG-004, Evaluation Criteria for Probabilistic Safety targets and Design Requirements, provides further guidance to applicants and licensees the objectives and criteria associated with the various levels of defence-in depth.

ENEC has performed both a deterministic and probabilistic safety analysis. The probabilistic analysis includes the analysis of internal and external events and all modes of plant operation. The deterministic analysis is performed on a number of event categories using conservative assumptions, assuming the worst case single failure and bounding initial conditions. The results of the safety analyses are used to verify assumptions made in the original design process.

ENEC's evaluation of the external hazards that may affect the Barakah facility is presented in Chapter 2, Site Characteristics, of the FSAR, submitted in support of the operating licence applications. The evaluation included the identification and assessment of hazards associated with:

- Nearby Industrial, Transportation, and Military Facilities.
- Meteorology.
- Hydrologic Engineering.
- Geology, Seismology, and Geotechnical Engineering.

The evaluation concluded that events from nearby industrial, transportation, and military facilities do not pose a risk to the facility and no special provisions are required to prevent or mitigate such events.

The assessment of the meteorological conditions confirms the environmental conditions that must be taken into account in the design of various SSCs. The particular climatic conditions at the

Barakah facility are taken into account in the design of numerous SSCs including, but not limited to, enhanced HVAC capacity, increased system cooling capacity, sand intrusion prevention, etc.

The Barakah facility site elevation is designed to ensure that the site remains “dry” i.e. free from accumulated water. The hydrological engineering assessment of the site confirms that the site elevation selected for construction of the Barakah facility is adequate to protect against all postulated conditions including precipitation, floods, surges, seiches, wave action and tsunamis.

The peak ground acceleration used in the design of Barakah “important to safety” SSCs is 0.3 g. The geological, seismological, and geotechnical engineering assessment of the site demonstrates that the maximum Ground Motion Response Spectra (GMRS) expected at the Barakah site results in a peak ground acceleration of 0.177 g, and is less than the design criteria used for the Barakah “important to safety” SSCs.

18.1.3 Extent of use of design principles for Defence in Depth in the UAE’s nuclear installations

The majority of the essential systems and components of the Barakah units, required for plant safe shutdown and accident mitigation, are located in the auxiliary building (AB). The auxiliary building surrounding the reactor containment building is divided into two 100% redundant safety divisions in the west and east direction by a robust structural wall serving as a principal separation barrier between the redundant trains of essential systems. In addition, each safety division in the auxiliary building is further divided into two quadrants in the south and north direction by a quadrant separation wall resulting in a total of four quadrants (Quadrant A and C in Division I, Quadrant B and D in Division II) inside the auxiliary building. The plant arrangement provides separation to the extent practical between redundant safety systems in order to prevent loss of safety function as a result of hazards different from those for which the system is required to function, as well as for the specific event for which the system is required to be functional. Separation between redundant safety systems with their related auxiliary supporting features is a basic protective measure.

In general, the two division concept provides 100% redundancy of all safety related equipment.

Functional diversity in the reactor protection system is incorporated into the system design to prevent loss of the protective function. Whenever a reactor protection system trip function is required it is frequently complemented by other trip functions. The engineered safety features

actuation system signals are used to actuate two or four independent essential safety feature trains. Where it is practical, an engineered safety features actuation system can be generated by more than one parameter.

A diverse protection system augments reactor trip and auxiliary feedwater actuation by using separate and diverse Non class-1E trip logic from that used by the primary protection system.

Passive features of the design include; fire protection offered by fire rated structural barriers; passive flood protection is applied to the flooding analysis which excludes any operator action to isolate the flooding source; passive autocatalytic re-combiners for both design basis accident and beyond design basis accident hydrogen control; passive means (gravity) for inserting control element assemblies.

Fail safe provisions have been incorporated into the design of the plant protection system and in the extensive use of air operated valves.

ENEC has identified US NRC RG 1.53 - Application of the Single-Failure Criterion to Safety Systems, to be applicable to the design of the Barakah units. FANR staff have evaluated the information provided in the construction licence applications for the Barakah units to ensure that regulatory requirements are met. The review of information contained in the operating licence applications submitted for Barakah Units 1, 2 and 3 have confirmed the results of the original evaluation.

18.1.4 Implementation of design measures to prevent beyond design basis accidents, or should they occur, mitigating radiological releases in UAE's nuclear installations

Within the construction and operations licence applications for the Barakah units, ENEC proposed provisions in the design to address beyond design basis events. These provisions include provisions for the prevention and mitigation of these events. Examples of these provisions include:

- A Diverse Protection System to prevent Anticipated Transient Without Scram events.
- A non-safety related Alternative AC diesel generator capable of supplying the essential loads of a single division of one unit is provided for the Barakah units. This diesel generator provides diversity and independence from the offsite power and onsite power systems and sources.
- For mitigation of beyond design basis events, containment systems and design provisions include:

- A large dry containment that is configured to promote retention of, and heat removal from, the postulated core debris during a severe accident,
- Corium retention in the core debris chamber virtually eliminates the potential for significant Direct Containment Heating induced containment loadings,
- The large cavity volume provides for a convoluted gas vent escape pathway from the core debris chamber,
- The core debris chamber is designed with a large area for the spreading of molten material released from the reactor pressure vessel and is provided with a Cavity Flooding System to promote cooling and stabilisation of molten material,
- The design includes an Emergency Containment Spray Backup System, with dedicated piping, spray nozzles and external make-up provisions, to cater for events when the safety related containment spray system is unavailable,

In line with FANR REG-03 Article (41), ENEC has completed a detailed assessment of the impact of commercial aircraft on the Barakah NPP design as required by FANR regulation. The aircraft impact assessment, based on NEI-07-13 concluded that the design provides adequate protection of public health and safety in the event of an impact of a large commercial aircraft. The impact would not inhibit core cooling capability or spent fuel pool integrity. The assessment resulted in the identification of the key design features and functional capabilities and these have been described in the licensee application documents.

Following the Fukushima event, and in response to a FANR requirement, ENEC provided a safety assessment of the impact of the event which included a reassessment of its proposed severe accident management strategy. While this reassessment demonstrated that the APR-1400 design incorporates features for coping with severe accidents, a number of measures were proposed to increase the plant robustness, including:

- Implementation of an electrical cross tie which would allow any unit essential diesel generator to supply any unit essential switchboard.
- Implementation of an external make-up water injection line for the steam generators,
- Implementation of an external water injection line for the Reactor Coolant System,
- Implementation of an external water injection line for the Spent Fuel Pool,

- Implementation of battery duty capacity extension from 8 to 16 hours for 2 battery safety channels,
- Provisions for quick connection of a mobile diesel generator to one of two electrical divisions with sufficient capacity to power essential equipment,
- Implementation of AAC DG fuel storage supply from 8 hours to 24 hours.
- Installation of Passive Autocatalytic Recombiners (PARs) in the Spent Fuel Pool area,
- Spent fuel pool instrumentation upgrade,
- Toxic gas monitor in Main Control Room.
- Implementation of a dedicated Accident Management Program Warehouse for storing and maintaining portable equipment and components that are prescribed by the accident management program.

Implementation of all these design enhancements was approved under specific conditions of the construction licences for the Barakah units. Certain operational aspects of these enhancements and other procedural and equipment enhancements to support the operators' severe accident management actions have been assessed under the review of the operating licence application for the Barakah units. The review confirmed that the design and procedural enhancements proposed by ENEC have been properly implemented and provide adequate support to its severe accident management strategy.

18.1.5 Implementation of measures to maintain the integrity of the containment to avoid long term off-site contamination in the UAE's nuclear installations

The reactor cavity structure in the Barakah units is equipped with an offset core debris chamber designed to de-entrain and trap the debris ejected during a reactor vessel breach and prevent subsequent debris dispersal into the upper compartment of the containment.

The reactor cavity has been designed to maximize the unobstructed floor area available for the core debris to flow and spread. Uniform distribution of the core debris within the reactor cavity results in a relatively shallow debris bed with a large surface area for heat dissipation. The containment steel liner is embedded in 0.914 m (3 feet) of concrete in the reactor cavity area to preclude direct contact of core debris with the containment basemat.

The Barakah units are fitted with a cavity flooding system (CFS) which, during a severe accident, is manually actuated before a reactor vessel breach to cool the core debris in the reactor cavity and scrub fission product releases to the containment atmosphere. The water delivery of borated water from the Inside containment Refuelling Water Storage Tank (IRWST) source to the reactor cavity occurs passively due to the natural hydraulic driving heads of the system since the IRWST is at a higher elevation than the reactor cavity. Once actuated, flooding of the reactor cavity progresses until the water levels in the IRWST and the reactor cavity equalize at 6.4 m (21 feet) above the reactor cavity floor. The cavity flooding valves remain open during the accident to provide a continuous supply of water to quench any core debris.

Analyses have been provided that demonstrate that flooding of the reactor cavity prior to breach of the reactor vessel provides for effective heat removal of any core debris that may be relocated into the reactor cavity. The analyses also assess the effects of Molten Core Concrete Interaction that occurs when molten core debris is in contact with the concrete floor and walls of the reactor cavity. The results of this analysis provides the assurance that the 0.914 m (3 feet) of concrete above the containment steel liner, provides an adequate protective barrier that prevents a challenge to containment integrity in the event of a severe accident.

As a means to control any build-up of hydrogen generated as a result of a beyond deign basis event, the Barakah units are provided with a Hydrogen Mitigation System which consists of passive autocatalytic recombiners (PARs) supplemented by hydrogen igniters. The PARs are effective for accident sequences in which mild or slow hydrogen release rates are expected, and are provided at locations in the containment where the hydrogen concentrations are predicted by analysis to be significant. The igniters supplement PARs for accidents of very low probability where rapid release rates of hydrogen are expected. There are eighteen PARs dedicated to beyond deign basis event mitigation, which are in addition to the twelve PARs provided to mitigate the effects of hydrogen generation contemplated during a design basis event. There are ten igniters which are located based on the analysis of the most probable hydrogen sources. The igniters are powered from Class 1E buses. In the event of a loss of off-site power, the igniters can be powered from either of the essential diesel generators. On loss of off-site power and failure of the EDGs to start or run, the igniters can be powered from the alternate AC (AAC) diesel generator.

The Barakah design includes an Emergency Containment Spray Backup System (ECSBS), with dedicated piping, spray nozzles and external make-up provisions, to cater for events when the

safety related containment spray system is unavailable. The ECSBS is designed to protect the containment integrity and prevent uncontrollable releases of radioactive materials into the environment due to the containment overpressure. The emergency containment spray flow path can be provided by one of a number of external water sources (e.g. the reactor makeup water reservoir, demineralized water storage tank, fresh water storage tank, or the raw water tank, etc.), through the fire protection system via a diesel driven fire pump or mobile pump, to the ECSBS line emergency connection outside of containment located at ground level near the auxiliary building.

18.1.6 Implementation of design improvements as a result of deterministic and probabilistic risk assessments in the UAE's nuclear installations made after the previous National Report

The two of the four Barakah units are currently in commercial service, with the first refuelling outage of Unit 1 completed. For Unit 3, an operating licence was granted on 17 June 2022. Fuel load commissioning is complete, with fuel load and initial start-up test program are expected to be completed starting in mid-2022 on Unit 3. Unit 4 is currently in pre-fuel load commissioning and construction. All these activities are performed in accordance with the provisions of the construction and operating licences issued for the units. The design enhancements identified as a result of the post-Fukushima review, as identified in section 18.1.3 above, are the only main design improvements identified as a result of updated deterministic or probabilistic risk assessments thus far during the construction and initial commissioning activities.

18.1.7 Regulatory review and control of the implementation of defence in depth concept

FANR is required by the Nuclear Law to conduct a thorough review and assessment of licence applications to verify that the relevant objectives, principles and criteria are met, and to satisfy itself that the available information demonstrates the safety of the facility or activity. FANR conducted a thorough review and assessment of the construction licence applications in accordance with its established process as described in section 14. FANR satisfied itself that the information provided by ENEC was adequate to demonstrate that the relevant objectives, principles and criteria were met and construction licences were granted for all four units as discussed in section 14.1.2.1. These licences contain conditions which include, but are not limited to, items related to regular reporting on activities undertaken under the licence, the reporting of unplanned events, and control

of safety significant modifications. The licence conditions supplemented by the FANR inspection programme, are considered adequate to maintain the oversight of activities during construction and commissioning.

FANR staff have concluded their review of information supplied in support of the operating license application for Barakah Units 1, 2 and 3 and operating licences have been granted for those units.

For provisions related to the continued review and assessment of the safety case after an operating licence, FANR-REG-16, "Operational Safety including Commissioning", includes an article on Periodic Safety Review. The article requires the licensee to provide an updated safety assessment at ten yearly intervals. This periodic safety assessment report will be subject to review by FANR.

18.2 Overview of the UAE's arrangements and regulatory requirements concerning the incorporation of proven technologies

Article (32) of the UAE Nuclear Law requires review and assessment of the licensee or applicant at every stage of the regulatory process. The article includes a requirement for FANR to satisfy itself that: "the technical solutions, and in particular any novel ones, have been proven or qualified either by competent authorities, experience or testing, and are capable of achieving the required level of safety".

FANR-REG-03 requires that SSCs important to safety shall be designed according to internationally recognised codes and standards and shall be of a design proven by experience analysis and test and shall be selected to be consistent with the plant reliability goals necessary for Safety. Codes and standards shall be identified, and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to ensure that the final quality is commensurate with the necessary Safety Function. The regulation also requires that where an unproven design or feature is introduced or there is a departure from an established engineering practice, safety shall be demonstrated to be adequate by means of appropriate supporting research programmes, performance tests with specific acceptance criteria, and the examination of operational experience from other relevant applications. New designs or features shall be adequately tested before being brought into service and shall be monitored in service, to verify that the expected behaviour is achieved.

18.2.1 Implementation of proven technologies

ENEC's strategy for procurement of nuclear technology sought a proven design, previously licensed based on internationally recognized standards and with a demonstrated history of safe operation. This strategy was aimed at achieving high standards of safety and minimising project risks.

The APR-1400 is an evolution of technology developed and licensed in the United States. The Republic of Korea has accumulated significant operating experience with its fleet of domestic plants. The APR-1400 builds on this experience and includes several improvements in safety technology. The Korean regulatory authority has issued construction permits for six APR-1400 units at Shin-Kori and Shin-Hanul in Korea. Shin-Kori Units 3&4 are the reference plants for the Barakah Nuclear Power Plant and both have been issued operating licences. Shin-Kori Unit 3 is in its fourth cycle of commercial operation. Shin-Kori 4 is in its second cycle of commercial service. Shin-Kori 5&6 are about mid-way through stages of construction. Shin-Hanul unit 1 has completed initial core load and has just begun post-core functional tests and the start of the pre-service operational test program. Shin-Hanel Unit 2 is construction and commissioning completed and awaits an operating license.

18.2.2 Qualification of new technologies

The software that drives the digital platform that provides for the control and protection of plant systems and functions has been designed specifically for the Barakah units. The processes for developing and implementing this software comply with the regulatory requirements and industry standards governing those activities. The software design throughout the software life cycle is implemented in accordance with software development plan documents. These plans include software verification and validation (V&V) and identify how the test activities are implemented. During the test phase the components of the software are evaluated, and integrated into the hardware, and the software is evaluated to determine whether the requirements have been satisfied. Testing is accomplished by the method that hierarchically assembles the software units, and performs an integration test, and subsequently, performs a validation test. Factory Acceptance Testing is performed at the manufacturers premises prior to shipment of the equipment to the facility. Once the equipment is installed in the facility, Site Acceptance Testing is performed to

provide final confirmation that the equipment has been correctly implemented into the plant and performs in accordance with requirements.

18.2.3 Regulatory review and control of the Implementation of proven technologies

FANR-REG-06 requires any applicant for a Construction Licence to identify any reference Nuclear Facility, evidence of approval of the reference Nuclear Facility by the authorised regulatory authority in the country of origin, a list of proposed departures or changes between the proposed design and the reference design, an Independent Safety Verification report on all proposed departures from or changes to the reference design, and a list of all country-of-origin safety information incorporated by reference in the application.

FANR-REG-06 also requires that the application contains a description of the SSCs of the Nuclear Facility including a discussion of their safety objectives, design bases, safety classification, design and construction codes and the inspection, tests and analysis that provide reasonable assurance that the system will meet its design objectives.

ENEC noted in its application for construction of Barakah units 1 and 2 that the reference plant is Shin Kori 3 and 4 and provided evidence of construction approval by the Korean authorities. ENEC provided a Supplement 1 to the PSAR that contains (1) a description of the departures from the reference design and (2) a summary of the independent safety verification (ISV) that ENEC conducted to confirm that the application represents a thorough, well documented and technically sound safety analysis for Barakah Units 1 and 2. The departure description provided in Supplement 1 of the PSAR identified those items associated with Barakah Units 1 and 2 that differ from the reference plant, including the reasons for and a description of the differences.

ENEC also described the ISV review of the construction licence application indicating that ENEC and other specialist consultants contributed to its preparation. The guidelines used in the ISV were those contained in IAEA Safety Requirements and Guides. The results of the ISV are described in a supplemental report which identified a number of items that were candidates for improvement. ENEC evaluated each of these items and concluded that no substantial safety issues were identified.

FANR concluded that Supplement 1 of the PSAR, along with supplemental application materials, demonstrates the compliance with relevant regulatory requirements, contained primarily in FANR-REG-03 and FANR-REG-06.

Furthermore, FANR-REG-06 requires the applicant to provide a description of how recent lessons learned and experience from other similar Facilities, scientific and technical developments, as well as the results of any relevant research on protection and safety have been applied to resolve potential safety issues.

As required by FANR-REG-06, ENEC submitted information on test and analysis of the structures, systems and components of the facility in the relevant PSAR sections. FANR found this information generally satisfactory to give reasonable assurance that the SSCs will meet their design objectives.

ENEC also submitted Supplement 2 of the PSAR which describes safety issues and lessons learned from operating experience applicable to the Barakah NPP Units 1-4 design and operation that have been identified subsequent to KINS approval of the APR-1400 design in 2002. Supplement 2 of the PSAR also summarizes how the issues / lessons learned have been resolved for Barakah Units 1-4 and where in the PSAR their resolution is discussed.

Supplement 2 of the PSAR also identifies action items resulting from the Three-Mile Island (TMI) accident, as well as the U.S. NRC evolutionary and advanced LWR design issues which are applicable to Barakah Units 1-4 as discussed in the PSAR. Supplement 2 serves as a roadmap that identifies the safety and operating experience issues applicable to Barakah Units 1-4 and where in the PSAR their resolution is discussed.

FANR concluded that the information in the PSAR provides reasonable assurance that all significant generic safety issues, operating and research experiences have been considered in the design for the Barakah facility.

18.3 Overview of the UAE's arrangements and regulatory requirements concerning the design for reliable, stable and manageable operation

FANR-REG-03 establishes requirements for the design of structures, systems, and components (SSCs) important to safety. It also provides requirements for a comprehensive safety assessment to include deterministic analysis and probabilistic risk assessment. As a general requirement, FANR-REG-03 requires that SSCs important to safety be designed in accordance with internationally recognized codes and standards and that designs be proven by experience or testing. Lessons learned from other facilities, as well as research results, must be taken into account in the design of SSCs.

Articles (25) through (30) of this regulation specifically relate to reliability as they pertain to design consideration of common cause failures, single failure criterion, fail safe design, reliability of auxiliary services, testing and equipment outages, and the consideration of reliability for harsh environmental conditions.

FANR-REG-03 also requires that the facility be designed to operate within a defined range of acceptable plant parameters with a minimum set of plant support systems operational, and that deterministic analyses be performed to confirm adequacy of such defined operational limits and equipment availabilities. FANR-REG-03 also requires the applicant to assess the plant capabilities for design basis accidents and accidents more severe than the design basis accidents and to identify measures to prevent them from occurring or mitigate their consequences should one occur.

FANR-REG-03 Article (35), Human Factors - Design for Optimal Operating Personnel Performance, contains requirements to ensure that human factors, including those associated with the man-machine interface, are considered in the design process.

18.3.1 Implementation of approaches to ensure reliable, stable and manageable operation

The advanced control room (ACR) of the APR-1400 has a fully computerized man machine interface (MMI), features include redundant compact operator consoles, a large display panel (LDP), computerized procedure system (CPS), soft controls, and a safety console with a minimum number of fixed position displays and controls. These integrated design features are intended to reduce operator error and enhance safe operation of the plant.

Human factor engineering (HFE) principles are incorporated into (1) the planning and management of HFE activities; (2) the plant design process; (3) the characteristics, features, and functions of the MMI, procedures, and training; (4) the implementation of the design; and (5) monitoring of performance at the site.

The main purpose of HFE is to enhance the plant safety and operability for the unit’s design life by minimizing human errors in the MMI design.

The HFE program plan was developed to attain the following:

- The operating crew is able to accomplish all assigned tasks necessary for plant safety and operation.

- The MMI system and function allocation are designed to provide the operating crew with acceptable workload levels to assure vigilance.
- The MMI system is designed to support a high degree of situation awareness for the plant operators.
- Signal detection and event recognition principles are kept within the operator information processing limits.
- The MMI is designed to minimize operator memory load.
- The MMIs are designed to minimize operator error and provide for error detection and recovery capability.

The HFE program activities and process is composed of four (4) phases (i.e., planning, analysis, design, and evaluation) which contain nine HFE program activities:

- Operating experience review (OER).
- Functional requirements analysis (FRA) and function allocation (FA).
- Task analysis (TA).
- Staffing.
- Human reliability analysis (HRA).
- MMI design.
- Procedure development.
- Training program development.
- HFE verification and validation (HFE V&V).

The HFE activities are a repetitive activity throughout the design cycle to ensure that HFE principles have been implemented into the MMI design. The MMI design approach is as follows:

- The design process is iterative.
- HFE analyses such as OER, FRA/FA and TA are provided to the designers for incorporation into the design.

- Design reviews and design review meetings by each member in the design team and by independent reviewers are used for interdisciplinary review.
- Final MMI design is validated using a simulator.

18.3.2 Regulatory review and control of the approaches to ensure reliable, stable and manageable operation

Preliminary information on design and reliability of SSCs important to safety in the Barakah Units was described in the relevant sections of the PSARs which ENEC submitted with its applications for construction licences. This information was assessed by FANR to ensure conformance to FANR-REG-03 requirements. Information reviewed included considerations related to:

- The design shall be aimed at limiting the effects of human errors.
- Consideration of human factors and the man–machine interface shall be included in the initial design process and shall continue throughout the entire process.
- The man–machine interface shall be designed to provide the operating personnel with comprehensive but easily manageable information in both the main control room and the remote shutdown room.
- Verification and validation of the human factors engineering.
- The time available for action, the physical environment to be expected and the psychological demands to be made on the operating personnel.
- Equipment necessary in manual response and recovery processes shall be located to ensure its ready availability at the time of need and to allow human access in the anticipated environmental conditions.

From its review FANR found this preliminary information provided reasonable assurance that the Barakah units can be operated in a reliable, stable and manageable manner and considered adequate to support the authorisation of a construction licence.

The information provided in support of the construction licence applications has been updated and supplemented in the operating licence application for Barakah units 1, 2 and 3. This information was reviewed by FANR and found to be adequate to support the authorization of the operating licence for Barakah units 1, 2 and 3.

Article 19: Operation

CNS Text:

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

i. *the initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and reliability of SSCs 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.*

19.0 General:

The UAE Nuclear Law specifies that the operation of a nuclear reactor is a regulated activity that requires a licence issued by FANR. FANR issued FANR-REG-16 “Operational Safety including

Commissioning" which establishes various requirements to be met during the operation of the nuclear facility. FANR also issued several regulatory guides incorporating the methods to support the applicant and the licensee to implement the specific regulations. In line with the requirements, ENEC submitted to FANR an application for a licence for the operation for Units 1 & 2 and Units 3&4 of the Barakah Nuclear Power Plant on behalf of its subsidiary Nawah. Subsequently, FANR issued to Nawah a licence for operation of Unit-1 of the in February 2020, Unit-2 in March 2021 and Unit 3 in June 2022 after successful completion of review process. Currently Unit-1 in commercial operation, Unit-2 declared commercial operation in March 2022, Unit 3 in start-up phase with fuel loaded and Unit 4 is ongoing for construction with 92% of completion to construction activities.

19.1 Initial authorisation

On 26 March 2015, ENEC submitted to FANR an application for a licence to operate Units 1 and 2 of the Barakah Nuclear Power Plant on behalf of its subsidiary Nawah. FANR reviewed and assessed the applications and issued the Operating Licence for Unit 1 in February 2020 and Unit 2 in March 2021.

The UAE Nuclear Law specifies that the operation of a nuclear facility is a regulated activity that requires a licence issued by FANR. The construction and fuel receipt, handling, and storage licences issued by FANR to ENEC authorise the licensee to conduct cold and hot functional testing of the systems of the as-built facility and to possess special nuclear material but they do not authorise nuclear fuel loading or initial testing or operation of the reactor.

FANR issued Regulation for an Application for a Licence to Operate a Nuclear Facility (FANR-REG-14), which specifies requirements for the content of the application for a licence for operation. FANR has also issued Regulation on Operational Safety including Commissioning (FANR-REG-16) with comprehensive requirements for safety in operation and commissioning. The development of these regulations takes into consideration the relevant IAEA safety requirements for operation of a nuclear facility.

FANR-REG-16 includes the relevant requirements associated with the operational phase. For example, Article 8 on operational limits and conditions requires that the facility be operated in accordance with the operational limits and conditions to prevent accidents and events, and ensure

the ability to mitigate such events if they occur. The operational limits and conditions are derived from the safety analysis and are reviewed for operating experience insights.

Article 25 of FANR-REG-16 requires that all activities that are important to safety be controlled with approved detailed procedures, instructions and drawings. This article also requires that procedures are established for use in the event of anticipated operational occurrences and design basis accidents as well as for beyond design basis accidents.

Articles 5, 6 and 9 of FANR-REG-16 include necessary requirements to ensure adequately qualified and trained staff for all functions that are important to safety including adequate training facilities for all technical and maintenance disciplines.

Article 23 of FANR-REG-16 requires an operating experience programme to address events from the facility as well as events in the nuclear industry worldwide to learn from such events.

These requirements along with other articles in areas such as safety policy, control of nuclear facility configuration, equipment qualification, chemistry programme and many others establish a comprehensive basis for the initial and ongoing regulation of operations.

Nawah's application for a licence for operation is based on the submissions for the reference plant that have been previously reviewed and have resulted in an operating licence decision by the Korean authorities. The application for a licence for operation included the Final Safety Analysis Report and other supporting documents required for review by FANR-REG-14. The Final Safety Analysis Report includes information concerning facility operation including the organisational structure, responsibilities and authorities, managerial and administrative controls to be used to ensure safe operation, plans for start-up testing and initial operations, plans for the conduct of normal operations including maintenance, surveillance and periodic testing, plans for coping with emergencies, and proposed technical specifications. The Final Safety Analysis Report is the principal document upon which FANR is basing its review and assessment to support the decision for issuance of BNPP Unit 1, Unit 2 and Unit 3 licences for operation.

As construction of each unit is completed, the focus shifted to commissioning, start-up and operation of the facility. Using qualified staff, ENEC and Nawah ensured a smooth transition from construction to commissioning and operation under the responsibility of the Chief Nuclear Officer. The prime contractor, the Korea Electric Power Corporation, is responsible for conducting the commissioning activities while ENEC conducts oversight. Under the licence for construction,

ENEC is ultimately responsible for the safe execution of activities for the construction and commissioning of the nuclear power plant.

Stages III, IV and V of the Pre-operational Inspection System are being carried out under the direction of the Commissioning Group including the construction acceptance test, the cold functional test, and pre-core hot functional test. Stage V of the Pre-operational Inspection System comprising the initial start-up test and initial criticality, low-power physics tests, and power ascension tests will be conducted once the Licence for Operation is granted by FANR in February 2020 for Unit-1, March 2021 for Unit-2 and 17 June 2022 for Unit-3.

ENEC and Nawah have developed an operational readiness process to introduce the capability to safely and reliably operate the Barakah Nuclear Power Plant with due regard for the safety of people and the environment, and compliance with regulatory requirements and international obligations. This process has been described in application documents for the licence for operation, and includes the performance objectives and criteria of the World Association of Nuclear Operators (WANO) for each of the 17 functional and cross-functional areas, and 14 support areas. In 2017, the International Atomic Energy Agency (IAEA) conducted a pre-operational Operational Safety Review Team (OSART) Mission to review the operational safety performance of Unit 1 of the Barakah Nuclear Power Plant against the IAEA's safety standards. The Mission noted several areas of good performance along with several issues recommended for resolution prior to plant operations.

FANR established Regulation 17 'Regulation for the Certification of Operating Personnel at Nuclear Facilities' that dictates requirements for training, qualifications, and certification for Senior Reactor Operators (SRO) and Reactor Operators (RO) to ensure their competence to safely operate the Barakah nuclear power plant. FANR had conducted several inspections to ensure training and qualification programs for operating personnel were based on a systematic approach and were being implemented to meet FANR requirements. FANR has applied an exhaustive and comprehensive oversight approach for the development and administration of operator certification examinations. FANR engaged Emirati staff in these activities, laying a foundation for Emirati staff to take ownership of this regulatory process and lead reviews and inspections going forward. FANR conducted rigorous and timely reviews of certification applications through remote and on-site activities and challenged the licensee to continually improve the quality of the application process. FANR has issued 157 certifications for Unit 1 – 4 to date for licensee operating

personnel, which helps to ensure the safe operations of Barakah NPP and continued safety of the public.

FANR continued activities for regulation during the operating phase through the development of internal processes and procedures to govern regulatory oversight of an operating nuclear facility as well as preparedness for events and accidents that may occur during operations. FANR has also instituted specific training and qualification programmes for its staff to ensure the effective execution of its oversight activities during operation. In 2020, FANR introduced the operational safety simulator to train and develop FANR regulatory staff to enhance their effectiveness in overseeing the Licensee's operational standards including crew resource management, human performance and response to upset and postulated accident conditions.

FANR has established a baseline inspection programme to evaluate the commissioning activities as well as a series of inspections to evaluate operational readiness. FANR's inspections covered a full range of activities during the construction period as well as during the commissioning activities to examine ENEC's basis to establish that the facility has been constructed in accordance with the design. Inspection procedures cover for example: procurement, design verification, structural concrete, containment liner and penetrations, and important-to-safety piping and welding. There are specific inspection activities for commissioning tests where FANR's inspectors review the testing procedures and witness actual testing in the field.

FANR also has a series of written inspection procedures for reviewing the operational readiness of the licence for operation applicant, Nawah. For example, there are inspection procedures for organisational readiness, management systems, safety culture, surveillance testing, the fire protection programme, personnel training and qualification, contamination control and the conduct of operations.

FANR issues written inspection reports for each inspection including any findings that require corrective action of the licensee or the licence for operation applicant. When ENEC or Nawah determine that sufficient corrective actions have been taken to resolve the finding, they provide a package of information for FANR inspectors to review during a follow-up inspection. FANR tracks the status of all findings for construction, commissioning and operational readiness to ensure that all findings are closed before granting the licence for operation or will evaluate any open

findings to determine whether it is appropriate to grant the Licence for Operation with the finding still open.

ENEC's programme of oversight of commissioning and Nawah's programme to determine operational readiness provide evidence that the written submissions for facility design and operational readiness in the application for a licence for operation have been implemented and are in place. Results of FANR's independent programme of inspection in these areas verify that implementation has been completed and will be used an input for the decision to grant a licence for operation.

This programme of inspections along with the issuance of all necessary regulatory requirements for operations, the submission of a comprehensive application for operations by Nawah, FANR's review and assessment of this application and regulatory inspection of construction, commissioning, and readiness of the organisation for operation provide thorough assurance that the appropriate steps have been taken to ensure safety in the initial authorisation of operations.

19.2 Operational Limits and Conditions (OL&C)

Operational Limits and Conditions (OL&C) are a set of rules which set forth parameter limits, the functional capability and the performance levels of equipment and personnel approved by FANR for safe operation of the BNPP units. Nawah prepared the Technical Specification (TS) based on the design inputs and approved Final Safety Analysis Report (FSAR) to comply with FANR Regulation FANR-REG-16 "Operational Safety including Commissioning". The Technical Specification contains all the OL&Cs, within which the plant should be operated to prevent situations arising that could lead to Anticipated Operational Occurrences (AOO) or Accident conditions. The TS is prepared in two parts as TS LCO (Limiting Condition for Operation) and TS Bases. The TS LCO part contains all the OL&C which includes the following:

a) Safety Limits.

b) Limiting Safety System Setting (LSSS).

c) Limiting Condition for Normal Operation (LCO).

d) Surveillance and testing requirements.

e) Action Statement for deviations from Normal Operation.

TS Bases part contains the detailed technical justification of the various stipulations laid in the TS LCO part. The Technical Specification prepared by Nawah is approved by FANR before the issuance of operating licence. During operation, FANR periodically verifies compliance of the Technical Specification conditions through regulatory inspections and review of submissions made by Nawah.

Any change in the Technical Specification needs approval from FANR. Nawah submits the proposal for approval to FANR with a justification of modification request. Meetings are held between Nawah and FANR as necessary. Nawah has configuration management process to ensure that relevant documentation including Technical Specifications, FSAR, impacted procedures are updated and training requirements as necessary are taken care of.

FANR established Evaluation and Approval of Licensee Change Requests process and procedure. Licensee Change Requests (LCRs) may be submitted by licensees to request approval for a variety of changes related to operating Nuclear Facilities. This procedure provides direction and guidance for the evaluation and approval of a Licensee Change Request (LCR).

19.3 Procedures for Operation, Maintenance, Inspection & Testing:

FANR has established a requirement in FANR-REG-16 "Operational Safety including Commissioning" for Nawah to develop procedures which control all activities that are important-to-safety in all modes of reactor operation at BNPP. Nawah has developed a suite of procedures in compliance with the regulatory requirement. These are reviewed and validated by individual/group other than the preparer before approval following a systematic process. Wherever applicable these procedures are also validated on the plant simulator.

The Plant Nuclear Safety Committee (PNSC) reviews and approves the procedures which are developed to comply with the Technical Specifications. Any modification based on operating experiences or plant conditions to these approved procedures goes through the approval by PNSC in accordance with FSAR.

Nawah has developed following suite of procedures for Operation, Maintenance, Inspection & Testing:

- System Operating Procedures,
- General Operating procedures,
- Normal Operating Procedures,
- Abnormal Operating Procedures,

- Emergency Operating Procedures,
- Alarm or Annunciator Response Procedures,
- Maintenance Procedures,
- Plant radiation protection procedures,
- Emergency preparedness procedures,
- Instrument calibration and test procedures,
- Chemical-radiochemical control procedures,
- Radioactive waste management procedures and
- Maintenance and modification procedures.

19.4 Procedure for responding to operational occurrences & Accidents

FANR has established a requirement in FANR-REG-16 "Operational Safety including Commissioning" for Nawah to develop the procedures for responding to Anticipated Operational Occurrences (AOO), Design Basis Accidents (DBA) and Severe Accidents (SA). Nawah has developed these procedures in compliance with the regulatory requirement.

The Annunciation Response Procedure (ARP) and Abnormal Operating Procedures (AOP) have been prepared mainly to handle AOO. These procedures guide the Main Control Room (MCR) Staff on the actions required to be taken to correct any off-normal conditions as per alarm annunciation or as observed by the Operator. Nawah has also developed Emergency Operating Procedures (EOP) and Severe Accident Management Guidelines (SAMG) for mitigating and handling the DBAs and SAs respectively.

For effective utilisation of required procedures by the MCR staff, Nawah has installed a Computerized Procedure System (CPS) in MCR. CPS covers Emergency Operating Procedures (EOPs) and Abnormal Operating Procedures (AOPs) and guides the operator effectively to the right steps as needed. CPS procedures are controlled documents and are approved using the same review and approval processes as other operating procedures.

At Nawah, a well-developed program for Severe Accident Management is established through Accident Management Program (AMP). The scope of AMP extends beyond at-power single reactor accidents to Spent Fuel Pool Accidents, Shutdown Plant State Accidents and Multi-unit Accidents. The AMP is having Accident Management Manual which provides guidance for mitigating and handling the severe accidents. The Manual covers the transition criteria from the EOP to Severe Accident Management Guidelines.

19.5 Engineering and Technical Support

Nawah has established an Engineering Function within its organisation for providing engineering and technical support to ensure nuclear safety in all modes of reactor operation. The Engineering Function has required staffing levels and a robust training and development program to ensure the required skills and knowledge capabilities are maintained within the organisation to support the plant through its lifetime. Nawah has also entered into a number of key third party contracts to further ensure availability of necessary engineering and technical support. These are as follows:

- Long Term Engineering Agreement: Through this agreement, engineering & technical support is available from KEPCO E&C and KEPCO SD who are the architect engineer and authorized designers of Nuclear Steam Supply System (NSSS) for the nuclear power plant at BNPP. Also, through this contract Nawah has ensured support to operational & design changes along with other engineering services.
- Engineering of Choice: Nawah has signed third-party contract with multiple global industry leaders for expert engineering & technical support who have proven track knowledge in providing engineering & technical support to nuclear power plants.
- Framework contracts: Nawah has entered into framework contracts and ensured access to experienced nuclear support companies and Original Equipment Manufacturers (OEMs) for long time engineering and technical support. These frameworks contracts are established in such a way that Nawah will get different required services such as maintenance services across the organization along with specific engineering and technical support services.

In addition, Nawah has established close working relationships with KHNP to adopt a fleet approach to the BNPP reactor (APR-1400) design ensuring sharing of information and experience to assist in improving performance and ensure safe and reliable operation throughout the life of the plant.

19.6 Reporting of Incidents Significant to Safety

Operating Licence (OL) for BNPP Units 1, 2 and 3 includes a specific licence condition for reporting of events significant to safety. In compliance with this licence condition, Nawah has established a reporting process which includes reportability determination and different templates for the reports required to be submitted to FANR. These are developed in accordance with the regulatory guidance provided by FANR through FANR-RG-30 “Regulatory Guide for Operational Safety for Nuclear Facilities” and IAEA guidance through IAEA-SSG-050.

The events/conditions are confirmed to be reportable to FANR or not by reviewing them against the available guidance which is straightforward for most of them. But on certain occasions the available information of the event/condition and the guidance for reportability determination do not lead to a direct conclusion on the reportability. For such cases, Nawah has a process of Potentially Reportable Occurrence Evaluation (PROE) to determine the reportability.

Sometimes it may happen that the information revealed on an event/condition after making a notification to FANR could lead to a conclusion that the event does not meet the reportability criteria. Nawah has included a provision in its reporting process an option to retract these event notifications/ reports subsequently with a justification of a change in the decision.

The reporting of any event significant to safety, security or safeguards is done by Nawah to FANR through following process:

i. Immediate notification: for information on emergency condition.
ii. Prompt Notification: for reporting of safety, security and safeguards related events.
iii. Follow up reporting: for submission of subsequent detailed report on events.

FANR established procedure to review Events, also identifies the steps to identify and implement the actions to be taken as part of the regulatory response to the Event. This procedure is a part of FANR Construction and Operating Experience Feedback process (CP.7).

19.7 Operating Experience Feedback System:

FANR-REG-16 (Operational Safety including Commissioning), requires that "The Licensee (Nawah) shall establish an operating experience program to learn from events at the Nuclear Facility and events in the nuclear industry and other industries worldwide". In compliance to this regulatory requirement, Nawah has an established Operating Experience Sharing Program which is in accordance with the industry guidelines set forth by INPO and WANO. The program set by Nawah comprises two processes as per the Nawah Procedure on Operating Experience Program.

The first process starts with collecting all the event reports identified as "Significant" by WANO and INPO such as Significant Operating Experience Reports (SOERs), Significant Event Reports (SERs), INPO Event Reports (IERs) level 1 and 2. These documents are evaluated by the Nawah for applicability. If found applicable for BNPP Units, these are reviewed to identify if some gaps exist and corrective actions are required. Nawah has a well-established Corrective Action Program (CAP) which captures the responses to these reports along with corrective actions required to be taken (if any). Subsequently, the response to SOERs, IER Level 1 and 2 are reviewed by the Significant Operating Experience Review Board in accordance with the established procedures. In

addition, WANO operating experience reports from the reference plant of Shin Kori, US NRC Information Notices (Nuclear Power Reactor issues only), INPO and WANO Guidelines having an action assigned for review and determination of actions are also reviewed by Nawah. These documents, along with SERs are reviewed by the central OE group to check the completeness of the response and actions taken by the individual reviewer within the organisation.

The second process involves collecting all the INPO and WANO operating experience reports classified by INPO/WANO as “Noteworthy” and IAEA Incident Reports (IRS). These documents are screened on weekly basis by the Operating Experience Screening Committee (OESC) for review and action determination. The OESC is a collegial group composed of technical experts from the major departments of the Nawah organisation such as Operations, Maintenance, Engineering, RP, Chemistry, Safety, Training, HU, etc. The OESC reviews the OE documents in the weekly meeting. Based on the outcome of the review process the documents are assigned in CAP for appropriate action to the different functions within the organisation.

Since start of the year 2020, Nawah has evaluated 159 OE related documents for applicability to BNPP.

An example of the success of the Nawah Process for Operating Experience Sharing, is the installation of oxygen monitors following an event at the reference plant where three workers were exposed to nitrogen and died. The Shin Kori event was due to a leaking nitrogen valve. A similar issue occurred at BNPP later. But since Nawah had installed Oxygen monitors/alarms at those locations based on the OE of Shin Kori, personnel were quickly evacuated, and no injuries/fatalities occurred.

Also, Nawah has an established process for the reporting of BNPP events to the other nuclear industry as part of Operating Experience (OPEX) Sharing Program. Nawah is having a specific procedure containing the WANO OE reporting criteria. This guidance provides the details and requirements for the reporting of station events to the other nuclear industry as per the established OPEX program within the organisation. Through the various available reporting channels since start of construction, Nawah has shared a large database of OE (150 numbers of events since start of construction) with the global nuclear industry. Nawah has reported even minor incidents which didn’t pose any concern to safety to the plant or personnel. This was done in line with the essence of OE program in supporting the other new nuclear plants across the globe, especially the new countries which are embarking on their journey towards being nuclear, to avoid similar events at

their place. This large numbers of events shared by Nawah has placed it in the top quartile of industry reporting and helped it being recognised by WANO as a good reporting station.

FANR established Construction and Operating Experience Feedback process (CP.7). The purpose of this process is to provide recommendations for establishing, implementing, assessing and continuously improving the operating experience programme in the UAE, in order to prevent or minimize the risk of future events at Licensees by learning from events that have already occurred in the UAE or elsewhere. There were 10 Nawah Event reports screened by FANR in 2021 with 2 UAE Events being shared to the IAEA IRS. In addition; 31 international Events were received and reviewed. As an outcome of these reviews, two reactive inspections were performed by FANR in 2021.

In 2021, the FANR IRS coordinator was selected to be on the IRS Advisory Committee for the first time, to help contribute to the international community by improving the IRS.

FANR also supports nuclear safety related improvements globally by sharing information on Events with other international nuclear organisations. Currently reports are exchanged with KINS monthly, on a secured platform between KINS and FANR that contain information on plant status, major plant activities and Events.

19.8 Management of Radioactive Waste and storage of spent fuel on the Site:

FANR-REG-16 “Operational Safety including Commissioning” includes a requirement on the licensee to establish and implement a programme for the management of radioactive waste. Nawah has established and implemented the Radioactive Waste Management Program in compliance with the regulatory requirement for:

a) The safe management and storage of radioactive waste from its generation until its delivery to the entity for the purpose of disposal,
b) Identifying and controlling all radioactive waste
c) Keeping radioactive waste to the minimum practicable.

The above objectives are met by Nawah in compliance with the FANR-REG-11 “Regulation for Radiation Protection and Predisposal Radioactive Waste Management in Nuclear Facilities” and “FANR Regulatory Guide on Pre-disposal Management of Radioactive Waste (FANR-RG-018)”. Nawah keeps the generation of radioactive waste to a practicable minimum in terms of volume of waste generated from Barakah NPPs through effective operations and the use of proven technology by means of:

i. Careful planning and performance of maintenance work.
ii. Avoiding the generation of secondary radioactive waste, for example, by placing restrictions on taking packaging and other material into the radiologically controlled area.
iii. Procedures for the control of contamination and implementation of effective decontamination methods.
iv. Good segregation practices, including clearance of materials as per approved procedures at points of waste generation.
v. Implementation of volume reduction processes.
vi. Reuse and recycle of materials wherever possible.

Under the Radioactive Waste Management program, Nawah has implemented systems for handling of liquid, gaseous and solid radioactive waste. These systems ensure compliance with the dose optimization (ALARA) goal specified in FANR-REG-04 (Radiation Dose Limits and Optimization of Radiation Protection for Nuclear Facilities). The brief description of the systems is as follows:

i. Liquid Waste Management System (LWMS):

   The LWMS is designed to collect, segregate, store, process, sample, and monitor radioactive liquid waste generated during the operation of the plant. Liquid wastes are segregated according to waste types to minimize the potential for mixing and contamination of non-radioactive flow streams. The liquid radioactive waste generated from the plant is treated by filtration, reverse osmosis, and ion exchange to keep the concentrations of radioactive material in the processed liquid as low as possible. The processed liquid radioactive waste is sampled and analyzed to verify that the required concentration after dilution is obtained prior to discharge from monitor tanks. Radiation monitors are installed in the discharge line for a controlled and monitored release.

ii. Gaseous Waste Management System (GWMS):

   The GWMS is designed to ensure that gaseous radioactive waste generated from primary system of plant is adequately decayed in the gaseous radwaste system and then released to the atmosphere through the plant ventilation system which is monitored continuously by radiation monitoring system.

iii. Solid Waste Management System (SWMS):

   The SWMS processes both wet solid active waste and dry active waste (DAW) for on-site interim storage or delivery to the entity designated according to UAE Nuclear Law. The solid

waste generated during operation or maintenance activities consisting of contaminated or potentially contaminated material is collected and sorted. The sorted radioactive waste is kept in solid waste containers for processing by waste compaction, solidification or drying before transporting to the on-site radwaste storage facility. The packaging of processed solid waste is done in accordance with requirements set forth in FANR-REG-13 Regulation for the Safe Transport of Radioactive Material.. The packaged solid radwaste container is labelled with container number, waste type, dose rate, and packaging date for easy recognition before keeping inside radwaste storage facility. The other high active solid waste such as used filter cartridges from primary systems are handled by radiation shielded filter handling cask and stored in Radwaste storage facility.

Disposal of Clearance Level Waste

FANR-REG-11 “Radiation Protection and Predisposal Radioactive Waste Management in Nuclear Facilities” includes a requirement on the licensee on the clearance of radioactive waste. The requirement states, “The Licensee shall consider the authorized Discharge of effluent and the Clearance of material from Regulatory Control, after some appropriate processing and/or a sufficiently long period of Storage, in accordance with Articles 21 and 22 of this regulation, together with reuse and recycling of material provided that protection objectives are met, in order to reduce the amount of Radioactive Waste that needs further processing or Storage”.

Nawah has developed a procedure to obtain clearance of radioactive waste from regulatory control in compliance with the requirement set forth in FANR-REG-11. As per the procedure, Nawah conducts the assessment of radioactive waste based on the set assessment criteria and clearance level for the specific radioactive waste. The clearance level activity concentration followed by Nawah is in compliance with IAEA Safety Standard RS-G-1.7- “Application of the Concepts of Exclusion, Exemption and Clearance”. If the assessed radioactive waste meets the clearance level criteria, then appropriate process is followed for disposal of the same. If the radioactive waste does not meet the clearance level criteria, then it is segregated from the other clearance materials and stored in the designated storage area for radioactive waste.

Storage of Spent Fuel:

The BNPP reactor is designed to store its spent fuel in the on-site Spent Fuel Pool (SFP) which maintains specified water level. The pool water is cleaned up to maintain the spent fuel pool surface dose rate as per design value. The SFP is designed to accommodate spent fuel assemblies generated for 20 years of operation.

BNPP unit 1 has undergone first refuelling outage during April-June, 2022 and at present there are 92 numbers of spent fuel assemblies stored in the SFP.

IV. CONCLUSION

The discussion in this Fifth National Report by the UAE as a Contracting Party to the Convention of Nuclear Safety confirms a conscientious and systematic effort by the UAE government and the relevant bodies in the UAE to implement fully the obligations of the Convention to develop the programme for the peaceful uses of nuclear energy. The UAE government has supported the establishment of the required infrastructure and necessary legislative, regulatory, and organisational framework to ensure the safety, security and non-proliferation of the technology being used. The UAE programme has made significant progress and recently entered into the operation phase, with the operating licence granted by FANR to Nawah for the first, second and third Units of the Barakah Nuclear Power Plant in 2020, 2021 and 2022 respectively. Relevant UAE organisations are fully committed to meeting the obligations of the Convention on Nuclear Safety and to continuing participation in the peer review process established under the Convention. The UAE has adopted a policy of transparency regarding its nuclear programme and will continue to make available a full range of information on how it is meeting its responsibilities in the future. The UAE looks forward to receiving the questions and comments of other Contracting Parties to the Convention on Nuclear Safety on this National Report, and is committed to clarifying any issues raised during the 8th and 9th Review Meetings on the Convention on Nuclear Safety.

ANNEX 1 – List of Acronyms

AAC	Alternate AC
AB	Auxiliary Building
ACR	Advanced Control Room
ADAFSA	Abu Dhabi Agriculture and Food Safety Authority
ADNOC	Abu Dhabi National Oil Company
AFI	Areas for Improvement
ALARA	As Low As Reasonably Achievable
ALWR	Advanced Light Water Reactor
AMP	Accident Management Program
AOO	Anticipated Operational Occurrences
AOP	Abnormal Operating Procedures
APR	Advanced Pressurized Reactor
ARIS	Architecture of Integrated Information Systems
ARP	Annunciation Response Procedure
ASME	American Society of Mechanical Engineers
AT SITE	Accountability, Teamwork, Safety, Integrity, Trust and Excellence
ATLAS	Advanced Thermal-Hydraulic Test Loop for Accident Simulation
ATWS	Anticipated Transient Without Scram

BNPP	Barakah Nuclear Power Plant
BoD	Board of Directors
BPR	Business Process Reengineering
CAMP	Code Applications and Maintenance Program
CAP	Corrective Action Programme
CEO	Chief Executive Officer
CEP	Construction Environmental Permit
CFS	Cavity Flooding System
CFT	Cold Functional Test
CICPA	Critical Infrastructure and Coastal Protection Authority
CLA	Construction Licence Application
CNIA	Critical National Infrastructure Authority
CNO	Chief Nuclear Officer
CNS	Convention on Nuclear Safety
CNP	Committee on Nuclear Power
CODAP	Component Operational Experience, Degradation and Ageing Programme
ConvEx	Convention Exercise
CPO	Crew Performance Observation
CPS	Computerised Procedure System
CSARP	Cooperative Severe Accident Research Program

CSS	Commission on Safety Standards
DBA	Design Basis Accidents
DOH	Department of Health - Abu Dhabi
DSWG	Design Specific Working Group
EAL	Emergency Action Level
EAD	Environmental Agency of Abu Dhabi
ECSBS	Emergency Containment Spray Backup System
EduTA	Education Training and Appraisal
EIA	Environmental Impact Assessment
EMC	Emergency Management Centre
ENEC	Emirates Nuclear Energy Company PJSC
ENSREG	European Nuclear Safety Regulators Group
EOF	Emergency Operations Facility
EOP	Emergency Operating Procedures
EPR	Emergency Preparedness and Response
EPREV	Emergency Preparedness Review Service
EPRI	Electric Power Research Institute
EQAM	ENEC Quality Assurance Manual
ERF	Emergency Response Facility
EPREV	Emergency Preparedness Review

ETD	Education and Training Department
FA	Function Allocation
FANR	Federal Authority for Nuclear Regulation
FERO	FANR Emergency Response Organisation
FRA	Functional Requirements Analysis
FSAR	Final Safety Analysis Report
GCC	Gulf Cooperation Council
GE	General Emergency
GHQ	General Headquarters of the Armed Forces
GMRS	Ground Motion Response Spectra
GNEII	Gulf Nuclear Energy Infrastructure Institute
GSOR	Generic Safety Observations Report
HEPA	High Efficiency Particulate Air
HFE	Human Factors Engineering
HFT	Hot Functional Test
HRA	Human Reliability Analysis
HRD	Human Resources Development Service of Korea
HMI	Human-Machine Interface
HU	Human Performance
IAB	International Advisory Board

IAEA	International Atomic Energy Agency
IAG-NSR	International Advisory Group on Nuclear Safety
IAT	Institute of Applied Technology
ICRP	International Commission on Radiological Protection
IDP	Individual Development Programme
IDR	Independent Design Review
IDOR	Integrated Demonstration of Readiness
IMS	Integrated Management System
INIR	Integrated Nuclear Infrastructure Review
INPO	Institute of Nuclear Power Operators
IPASS	International Physical Protection Advisory Service
IRS	IAEA Incident Reports
IRRS	Integrated Regulatory Review Service
IRWST	In containment Refuelling Water Storage Tank
ISO	International Organisation for Standardisation
ISV	Independent Safety Verification
IWP	Integrated master Work Plan
KAIST	Korea Advanced Institute of Science and Technology
KDI	Korea Development Institute
KEPCO	Korea Electric Power Corporation

KHNP	Korean Hydro and Nuclear Power
KINS	Korea Institute of Nuclear Safety
KM	Knowledge Management
KPI	Key Performance Indicator
KUSTAR	Khalifa University of Science, Technology and Research
LDP	Large Display Panel
LWR	Light Water Reactor
MCR	Main Control Room
MDEP	Multinational Design Evaluation Programme
MMI	Man Machine Interface
MOI	Ministry of Interior
MOU	Memorandum of Understanding
MSIC	Management System Integration Committee
MW	Megawatt
Nawah	Nawah Energy Company
NCEMA	National Emergency, Crisis and Disaster Management Authority
NEA	Nuclear Energy Agency of the OECD
N-EIA	Nuclear Environmental Impact Assessment
NEPCC	National Emergency Preparedness Coordination Committee
NIMS	Nawah Integrated Management System

NOS	Nuclear Oversight
NOUE	Notification of Unusual Event
NPI	Nuclear Performance Improvement
NPP	Nuclear Power Plant
NPT	Treaty on Non-Proliferation of Nuclear Weapons
NRR	National Risk Register
NQA	Nuclear Quality Assurance
NQAM	Nawah Quality Assurance Manual
NQAP	Nawah Quality Assurance Program
NRC	US Nuclear Regulatory Commission
NRRC	Nuclear and Radiological Regulatory Commission
NUSSC	Nuclear Safety Standards Committee
NSGC	Nuclear Security Guidance Committee
NSBR	Nuclear Safety Review Board
OE	Operating Experience
OECD	Organisation for Economic Co-operation and Development
OLA	Operating Licence Application
OLC	Operational Limits and Conditions
ORR	Operational Readiness Report
ORPAS	Occupational Radiation Protection Appraisal Service

OSART	Operational Safety Assessment Review Team
OSC	Operations Support Centre
PARS	Passive Autocatalytic Recombiners
PC	Prime Contract
PNSC	Plant Nuclear Safety Committee
PPP	Physical Protection Plan
PRA	Probabilistic Risk Assessment
PSAR	Preliminary Safety Analysis Report
PSUR	Pre-Start Up Review
QA	Quality Assurance
QCC	Abu Dhabi Council for Quality and Conformity
RANET	Response and Assistance Network
RASCAL	Radiological Assessment System for Consequence Analysis
RASSC	Radiation Safety Standards Committee
RBCOO	Regulatory Body Country of Origin
RCS	Reactor Coolant System
REG	Regulation
REMP	Radiological Environmental Monitoring Programme
RG	Regulatory Guide
RNEPR	Radiological and Nuclear Emergency Preparedness and Response Plan

RO	Reactor Operator
ROK	Republic of Korea
RSD	Radiation Safety Department
SA	Sever Accident
SAAR	Severe Accident Analysis Report
SAE	Site Area Emergency
SAT	Systematic Approach to Training
SER	Safety Evaluation Report
SGD	Smart Dubai Government Establishment
SPC	Statistical Process Control
SRO	Senior Reactor Operator
SSAC	State System of Accounting and Control
SSDL	Stander Secondary Dosimetry Lab
SSC	Structure, Systems, and Component
TA	Task Analysis
TC	Technical Cooperation
TDRA	Telecommunications and Digital Government Regulatory Authority
TESG	Technical Evaluation Subgroup
TSC	Technical Support Centre
TSM	Technical Support Missions

TMI	Three Mile Island
TSO	Technical Support Organisations
WANO	World Association of Nuclear Operators

ANNEX 2 – Executive Summaries of IAEA Peer Reviews

EPREV follow-up mission EXECUTIVE SUMMARY (full report here)

At the request of the Government of the United Arab Emirates (UAE), an international team of experts conducted an EPREV follow-up mission on 8-12 September 2019. The purpose of the EPREV follow-up mission was to review the actions undertaken to address the recommendations and suggestions made during the EPREV mission fielded in the UAE in 2015. The review compared UAE emergency arrangements related to the findings of the 2015 EPREV mission against the IAEA safety standards for preparedness and response for a nuclear or radiological emergency.

The mission focused on preparedness for emergencies at facilities in Emergency Preparedness Category I (EPC I), as defined in IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency, which includes emergencies taking place at nuclear power plants (NPPs).

The team for the EPREV follow-up mission consisted of international EPR experts from five IAEA Member States as well as a team coordinator and deputy team coordinator from the IAEA Secretariat. The EPREV follow-up mission consisted of a review of reference materials provided by UAE and a number of site visits and interviews. During the follow-up mission, the EPREV team interacted with government officials and response organizations at all levels as well as with staff of the Barakah NPP.

The review team noted that UAE has made significant progress in developing and revising emergency arrangements for an emergency at Barakah NPP since the 2015 EPREV mission.

The national commitment to emergency preparedness is evident in the ongoing efforts among response organizations in the country. In particular, the creation of the Joint Emergency Radiological Monitoring and Assessment Team (JERMAT), including the related drills and exercises, significantly improves the ability to conduct monitoring, sampling and assessment during an emergency response by coordinating the operation of technical resources and teams.

The team noted a number of good practices related to the EPR arrangements in the country. The ongoing commitment of all response organizations is apparent in the documentation of the frequent

meetings held and the regular revision of plans and procedures through a formal quality management process. The team also noted the comprehensive drill and exercise programme to test the arrangements and the clear link between the evaluation reports and the revision of plans and procedures.

Additionally, the completion of a number of facilities and related logistical supplies and equipment since the 2015 EPREV mission helps to ensure that emergency response functions can be performed. The co-located off-site emergency operations centre and Barakah NPP emergency operating facility allow for close coordination between the on-site and off-site officials during an emergency while maintaining their unique responsibilities. The state-of-the art facilities at the Abu Dhabi National Oil Company (ADNOC) Ruwais Hospital provide for the prompt treatment of injured or contaminated persons during an emergency.

The review team also noted some areas that could benefit from further improvements. In particular, The IAEA team noted that the UAE should continue its ongoing efforts to formally document and approve a national protection strategy for a nuclear or radiological emergency. The document was prepared by FANR and revised and approved by all members of the UAE's Radiation Protection Committee. Further steps to finalize the document are under process. Additionally, the arrangements for protection of emergency workers and helpers, for managing radioactive waste in an emergency and for terminating an emergency should all be completed in line with the IAEA safety standards.

EduTA EXECUTIVE SUMMARY (full report here)

The EduTA mission was conducted on 16-23 February 2017 under the IAEA Technical Cooperation project RAS/9/081 "Providing Education and Training in Radiation Safety in the Asia-Pacific Region".

The mission was conducted after a preparatory mission held on August 2016 aimed at: providing an overview on the scope and objective of the EduTA; explaining how to complete the questionnaire providing the appropriate supporting documents; drafting with the national counterpart the agenda for the full mission; providing advice on the establishment of the national strategy for education and training in radiation, transport and waste safety.

Following the preparatory mission, the questionnaire was sent out to Federal Authority for Nuclear Regulation (FANR) with the request to fill out the core modules (Modules A on the legal and

regulatory framework for education and training, Module B on the national strategy for education and training).

At the conclusion of the mission, the EduTA team identified several recommendations and suggestions that could further enhance the overall national capabilities and performances for education and training in radiation protection and safety.

In order to bring the education and training provisions in line with the IAEA safety standards the EduTA team recommends that:

- R.1 A formal system of recognition for the qualified expert should be established in line with the IAEA Safety Standards. This system should specify the required functions, duties and qualifications of a qualified expert.
- R.2 Criteria for the designation/appointment of the radiation protection officer should be established, in line with the IAEA Safety Standards, with provisions for radiation protection officer's functions, duties, and qualifications.
- R.3 Once the formal system of recognition of the qualified expert is established, the FANR licensing and inspection procedures should reflect the application of the related requirements.
- R.4 Consideration should be given to establish requirements for training in radiation protection for personnel in existing exposure situations.
- R.5 A national policy and strategy for education and training in radiation, transport and waste safety should be developed.

The EduTA team also identified how process and procedures can be improved and therefore suggest that:

- S.1 In association with R.1 and R.2: When establishing the functions, duties and qualifications of the qualified expert (R1) and those of the radiation protection adviser (R2), care should be taken to differentiate between the advisory role of the qualitied expert and the supervisory role of the radiation protection officer.
- S.2 In association with R.1 and R.2: Consideration should be given to using the national qualification framework for developing a system for the formal recognition of the qualified expert. If appropriate, the same approach should be used for the designation of the radiation protection officer.

- S.3 In association with R.1 and R.2: Once the role, functions and qualification requirements of the qualified expert and radiation protection officer have been established, current provisions for the training (e.g. training programmes) should be revised and updated.
- S.4 A survey should be carried out to identify existing potential qualified experts that could form a pool of expertise for a transition period until the recognition scheme is operational.
- S.5 Consideration should be given to the development of further guidance on the content of radiation protection training courses for the workers in all practices. The existing guidance and any new guidance should be disseminated to training organisations.
- S.6 In the process of developing the training programme for the emergency preparedness and response personnel, consideration should be given to providing training in radiation protection in accordance with the actual and predicted needs. This training should be focused on the job functions.
- S.7 In association with R.5: Consideration should be given to the draft white paper outlining the content of the policy and identifying the main steps and actions to establish the national strategy. While the policy is expected to be submitted to Government, the strategy could be endorsed by all the relevant national stakeholders concurring to its implementation (e.g. Radiation Protection Committee in the State).

Pre-OSART EXECUTIVE SUMMARY (full report here)

The Pre-Operational Safety Review (Pre-OSART) mission was conducted by the International Atomic Energy Agency at the Barakah Nuclear Power Plant in the United Arab Emirates from 16 September to 3 October 2017.

This OSART mission reviewed twelve areas: Leadership and Management for Safety; Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience Feedback; Radiation Protection; Chemistry; Emergency Preparedness and Response; Accident Management; Human Technology Organization Interaction; and Commissioning.

The mission was coordinated by an IAEA Team Leader and Deputy Team Leader and the team was composed of experts from Finland, France, Hungary, the Russian Federation, Slovakia, Slovenia, Spain, the United Kingdom, Ukraine and four IAEA staff members. The collective nuclear power experience of the team was approximately 430 years.

Unit 1 will be the first of the four units to be commissioned. The review team made plant observations on this unit and reviewed the programmes and processes that apply to the whole site. As a result of the review the team identified 21 issues resulting in 10 recommendations and 11 suggestions. 4 good practices were also identified.

Several areas of good performance were noted:

- The plant has established a leadership development programme adapted to the multicultural, multi-national nature of the organization, to ensure that cultural diversity is addressed, maintained and leveraged to build strong teams with a focus on safe operation.
- The plant is leading the development of the qualification for nuclear positions administered by Nawah, and their recognition by the UAE National Qualification Authority (NQA). This allows the plant to take credit for prior learning and qualification from another NQA accredited organization, thereby reducing the amount of training and time required to produce qualified employees.
- The plant has established a good relationship with Off-site Organizations and other interested parties. This allows for rapid communications should an event occur at the plant, a forward planning function that can advise incident controllers and extensive facilities for the reception of people affected by an incident.

The most significant issues identified were:

- Plant should reinforce the effectiveness of the managers in the field programme.
- The plant should improve the execution of its oversight of maintenance activities performed by contractors in order to ensure equipment safety and reliability.
- The plant should ensure timely development, validation and approval of a comprehensive surveillance programme and implementation procedures.

INIR PHASE 3 EXECUTIVE SUMMARY (full report here)

A Pre-INIR mission was conducted in April 2018 and the final self-evaluation report (SER) was submitted to the International Atomic Energy Agency (IAEA) on 25 May 2018.

The INIR mission team was led by Mr Milko Kovachev, Section Head of the Nuclear Infrastructure Development Section, and consisted of staff from the IAEA Departments of Nuclear Energy, Nuclear Safety and Security and the Office of Legal Affairs as well as international experts recruited by the IAEA.

The INIR mission and associated activities were funded through a combination of a cost-sharing contribution from the Government of the United Arab Emirates and an extra budgetary contribution through a Peaceful Uses Initiative (PUI) Project entitled Strengthening Nuclear Power Infrastructure Development in Member States.

The INIR mission was conducted from 24 June to 1 July 2018. The meetings were held in Abu Dhabi. The main interviews were conducted over five days. The UAE counterparts were well prepared for the mission and managed its participation in the review effectively. During the interviews, the UAE counterparts provided an update on the status of issues where progress had been made since the SER was finalized, and provided additional supporting documentation requested by the INIR team.

The INIR team concluded that the UAE is close to completing the required nuclear power infrastructure for starting the operation of its first nuclear power plant (NPP). It has established competent organizations and the legal and regulatory framework, and has plans for achieving operational readiness.

In order to assist the UAE in completing and maintaining its infrastructure development, the INIR team made 9 recommendations and 8 suggestions. The INIR team also identified 7 good practices that may benefit other countries implementing a nuclear power programme.

Based on the recommendations and suggestions, the key areas for further action are summarized below:

- The UAE needs to approve and implement all the appropriate arrangements for radioactive waste management.

  In December 2016 the UAE prepared its draft Policy on the Long-term Management and Disposal of Spent Nuclear Fuel and Radioactive Waste which reinforced its 2008 commitment to manage its radioactive waste and spent nuclear fuel in a responsible manner, and in accordance with its international obligations.

  The UAE needs to approve its draft 2016 Policy to enshrine its commitment to responsible radioactive waste and spent fuel management. This, together with approval of the Cabinet Resolution to establish the Decommissioning Trust Fund, would allow the finalization of regulations, the creation of the relevant bodies, and the development of strategies and plans to implement the policy.

- The UAE needs to continue to implement the arrangements required to ensure the long-term sustainability of the nuclear power programme.

  The UAE has developed its nuclear infrastructure, including a legal and regulatory framework. It has established and staffed the required organizations, in particular an independent regulatory body and an operating organization. Reaching this point for such a major programme is a significant achievement for the country. The UAE recognizes that the nuclear power programme entails a long-term commitment lasting at least one hundred years. It is important that the UAE strengthens arrangements and processes to ensure the long-term sustainability of the programme. Areas to be considered include: the proactive coordination of future programme developments at a national level; the continuing review and revision of the legal and regulatory framework as necessary; and the establishment of a research and development programme to enhance national capabilities.