United Arab Emirates

UAE NATIONAL REPORT

For the 7th Review Meeting of the CONVENTION ON NUCLEAR SAFETY

March/April 2017

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 7th Review Meeting of Contracting Parties to be held in March/April 2017

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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 Nuclear Policy) was adopted by the UAE Cabinet of Ministers in April 2008. The 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 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 web site of the UAE Permanent Mission in Vienna.

1.2 Status of the UAE Nuclear Programme

The UAE has moved forward on the commitments in the Nuclear Policy through the adoption of the relevant international instruments for nuclear safety, security and non-proliferation, through the establishment of a legal framework and governmental framework within the UAE, and through on-going support for the development of the UAE 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 third National Report of the UAE which has been prepared in accordance with Article 5 of the Convention on Nuclear Safety for review at the 7th Review Meeting of the Convention to be held in March and April 2017. 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.5, *Guidelines regarding National Reports under the Convention on Nuclear Safety*, which the

Contracting Parties adopted during the 6th Review Meeting in 2014. The report consists of three main parts. Following this introduction, Part II summarizes the significant developments in the UAE nuclear energy programme since the 6th CNS review meeting. Part III addresses an article by article review of the measures taken by the UAE to implement the provisions of Articles 6 through 19 of the Convention.

As was the case with the UAE's Second National Report submitted to the 6th Review Meeting held in April 2014, this Third National Report is a collective effort of various national organisations including the Federal Authority for Nuclear Regulation (FANR), the Emirates Nuclear Energy Corporation (ENEC), the National Emergency, Crisis and Disaster Management Authority (NCEMA) and other leading organisations.

The UAE appreciates the opportunity to participate in the 7th Review Meeting of the Parties to the Convention and looks forward to contributing to the discussion.

II. SUMMARY

2.1 Significant changes in the UAE's national nuclear energy programme

The UAE national report to the 6th Review Meeting on the Convention on Nuclear Safety described the policy decisions and the measures taken to launch the UAE's peaceful nuclear energy programme. That report described the issuance on the construction licence for the first two nuclear installations in July 2012. These units are located at the site named Barakah on the coast of the Arabian Gulf some 300 km west of Abu Dhabi. The technology at Barakah is the APR-1400 advanced pressurised water reactor supplied by a team led by the Korea Electric Power Company (KEPCO).

Since the 6th Review Meeting, FANR has granted a licence to ENEC on 15th September 2014 to construct two additional nuclear installations at the Barakah site. On 26th March 2015 ENEC submitted an application for an operating licence for Barakah Units 1 and 2. This operating licence application (OLA) is currently under review and assessment by FANR.

The manufacture of components and site construction for the installations at Barakah are currently progressing in line with the schedule milestones set by ENEC. As of June 2016 Unit 1 is now over 88% complete and has progressed into the initial stages of non-nuclear commissioning having completed Cold Hydrostatic testing in April 2016 and commenced Hot Functional Testing. FANR

has implemented a program of site construction and commissioning inspections as well as continued vendor inspections of the supply chain. As of June 2016 Unit 2 is approximately 72%, Unit 3 50%, and Unit 4 31% complete from a construction perspective.

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

The actions taken by the UAE in the light of the accident at Fukushima Daiichi were summarized in the UAE National Report to the 2nd Extraordinary Meeting on the Convention on Nuclear Safety and in the national report for the 6th review meeting.

In summary, FANR issued a request to ENEC on 4th July 2011 for an assessment of how recent experience at Fukushima and lessons learned so far may be applied to address any potential safety issues at the proposed Barakah Nuclear Power Plants. The guidance provided by FANR to ENEC for the Fukushima lessons learned evaluation considered the information developed internationally after the event, and was based mainly on the Stress Test Specifications developed by the European Nuclear Safety Regulators Group.

ENEC submitted the initial version of a report entitled "Safety Assessment Report for Barakah Nuclear Power Plants (Lessons Learned from Fukushima Accident)," on 30th December 2011. A subsequent revision was submitted in March 2015 as part of the OLA for Barakah Units 1 and 2. The report addresses the following major topics, in accordance with the FANR guidance:

- Initiating events (including, but not limited to earthquakes, flooding, fire, explosions, sandstorms, and oil spills);
- Consequential loss of safety functions (including, but not limited to the loss of electrical power, loss of ultimate heat sink, and loss of ultimate heat sink with station blackout);
- Severe accident management (including, but not limited to design features for severe accidents instrumentation and information systems, provisions for increasing plant robustness, and severe accident management guidelines);
- Proposed safety enhancements.

The Barakah Units designs already incorporated advanced features designed for coping with severe accidents. Nevertheless, a number of proposed safety improvements to enhance the ability of the plant to resist severe, low-probability events and to improve the mitigation of severe

accidents have been and will continue to be addressed during construction and the operating licence stage.

As part of the licensing for construction, FANR approved 17 proposed safety design enhancements and required ENEC to submit design details of the improvements prior to installation. The improvements generally enhanced the design against natural hazards such as seismic events and flooding and improved the plant's capability to mitigate the consequences of severe accidents. FANR has reviewed and approved the design details for all 17 of the design enhancements for all four Barakah units. As part of the OLA review, FANR is evaluating the adequacy of the proposed procedures and severe accident management guides taking into account the lessons learned from Fukushima and the approved design enhancements. Further details are discussed under Articles 17 and 18.

FANR has also studied the need for changes to its regulations in the light of the accident at Fukushima. In accordance with the UAE Policy, FANR has based many of its regulations on the corresponding IAEA safety requirements. FANR has actively participated in the IAEA Nuclear Safety Standards Committee (NUSSC) meetings and associated working groups to discuss the implications of the Fukushima findings on the IAEA Safety Standards, in particular DS 462 (Revision by amendment of GSR Part 1, NS-R-3, SSR-2/1, SSR-2/2 and GSR Part 4). FANR evaluated the information from NUSSC and the associated working groups as inputs for an assessment of FANRs regulatory framework in light of the Fukushima lessons learned.

In the light of this exercise, FANR has identified no need for immediate changes to its current regulations but has noted a number of items to be taken into account during the course of maintenance and update of its regulatory framework.

2.3 Actions taken based on the 6th CNS, the UAE Rapporteur's Report

The significant matters of interest for the UAE arising during the peer review of the 6th Review Meeting as recorded by the rapporteur were the following:

1) Maintain regulatory oversight in construction and demonstrate operational readiness
2) Conduct assessments of the emergency plans, including support for the EPREV
3) Finalize installation of full scope simulators for operator training.

Oversight of Construction and Operational Readiness

The approval of the construction licenses for all four Barakah Units included approvals of ENEC's programme for oversight of construction and non-nuclear commissioning activities. In this programme ENEC's contractors carry out a number of inspection and tests to verify the facility is constructed in accordance with design requirements, and provide documentation verifying these inspection and tests. ENEC carries out its own programme of oversight monitoring the construction and inspection activities and reports the results to FANR.

FANR conducts an independent construction inspection programme that includes ongoing daily inspections by site based resident inspectors, specialist inspection teams from headquarters and inspections of suppliers many, of whom are located in other countries. These inspections are documented in inspection reports including findings which require corrective actions of ENEC and its contractors. FANR reviews the corrective actions taken in response to its findings and monitors the closure of all findings. FANR has a structured process and set of procedures for making a decision for the issuance of an operating licence that summarizes and evaluate this programme of inspections.

In the operating license application ENEC has described to FANR the methods and processes that will be used to demonstrate operational readiness of Nawah, a wholly-owned subsidiary of ENEC that will be the operating organisation. The operational readiness process includes elements for demonstrating that implementing programmes and procedures are complete and in place and qualified staff are available and trained to implement the programmes and procedures.

FANR has developed a structured programme of inspections to review and evaluate ENECs operational readiness. These inspections will be documented in inspection reports including findings which require corrective action of ENEC. FANR has created a procedure for making findings that summarizes and evaluates ENEC's operational readiness process and FANR's independent inspection of that process to support the decision for an operating license.

Emergency Planning

An Emergency Preparedness Review (EPREV) mission was conducted by the International Atomic Energy Agency (IAEA) in the United Arab Emirates (UAE) from 21 to 31 March 2015. EPREV missions are designed to provide a peer review of emergency preparedness and response

arrangements in a country based on the IAEA Safety Standards. The specific purpose of the EPREV mission was to review emergency preparedness and response (EPR) arrangements and capabilities associated with the Barakah Nuclear Power Plant.

The EPREV mission report concluded that the nuclear emergency preparedness and response framework in the UAE is being effectively built on an existing national crisis and emergency management structure that is clear, well defined and tested. This comprehensive approach is consistent with IAEA safety standards and is a key to the future success of the emergency preparedness and response program. In addition, the EPREV identified several areas for improvement in the UAE emergency management framework.

In February 2016 the UAE conducted the first full scale exercise of the emergency plan for a nuclear accident at Barakah with demonstration of onsite and offsite emergency response capabilities. This emergency exercise was carried out well before receipt of fuel onsite as an early demonstration of the response capabilities tested in an integrated fashion. Because this exercise was conducted at an early stage some response facilities were not yet operational. For this reason, a degree of simulation was necessary. This simulation is acceptable and necessary for this exercise because the onsite emergency facilities are not fully constructed or in service and emergency implementing procedures are in an early stage of development. There will be another full scale exercise prior to fuel load, at which time all emergency response facilities will be fully operational.

There were a number of assessment teams evaluating exercise performance including teams from ENEC, FANR, various offsite responding agencies and a team from the IAEA. Action plans to address observations from these assessments are currently under way.

Full details on emergency preparedness are discussed under Article 16.

Finalize Simulator Installation for Operator Training

The Barakah nuclear plant includes two full scale simulators for the training and certification of Senior Reactor Operators (SRO) and Reactor Operators (RO). The simulators have been tested by ENEC in accordance with international standards to demonstrate the fidelity of the simulator to the plant and its suitability for use in training SROs and ROs. ENEC currently has 115 SRO and RO candidates in training in 9 cohort groups. The first cohort group has advanced through the training program including simulator training and examinations.

FANR issued a comprehensive regulation (FANR-REG-17) that governs the training and certification process for SRO and RO. The regulation requires the licensee to implement a training programme based on a systematic approach to training (SAT) for the training of SROs and ROs. The programme must be described in a written plan and submitted to FANR for approval. FANR has approved ENEC's programme as described in the plan. FANR has also conducted a number of inspections over the entire life cycle of the training programme to date to verify that ENEC is implementing the training and examination processes in accordance with requirements. REG-17 also requires an authorization (referred to as certification) from FANR before an individual can undertake the duties of an RO and SRO. FANR will base its certifications of RO and SRO on applications to be submitted by ENEC that show each candidate has successfully completed the approved training programme.

2.4 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 through hosting many missions and safety services since the 6th Review Meeting in addition to the recent EPREV mission noted above.

As previously reported in the national report for the 6th Review Meeting, FANR hosted an Integrated Regulatory Review Service (IRRS) Mission conducted by the IAEA in December 2011, covering the UAE regulatory framework for all nuclear activities regulated by FANR. This mission also took into account the lessons learned up to that time from the accident at the Fukushima Daiichi Nuclear Power Station.

At the request of the Government of the United Arab Emirates (UAE), a follow-up IRRS mission took place from 31 January to 8 February 2015. The purpose of the follow-up mission was to review the measures undertaken by the UAE to respond to the recommendations and suggestions from the initial IRRS mission conducted in 2011. In addition, the follow-up mission was extended to include a review of the transport of radioactive material.

The follow-up mission compared the UAE regulatory framework for nuclear and radiation safety against IAEA safety standards as the international benchmark for safety. The follow-up mission was also used to exchange information and experience between the IRRS follow-up Team members and the UAE counterparts in the areas covered by the IRRS.

The IRRS follow-up Team (the Team) consisted of six senior regulatory experts from six IAEA Member States and four IAEA staff members.

The Team carried out a review of the measures undertaken following the recommendations and suggestions of the 2011 IRRS mission in the following areas: responsibilities and functions of the government; the global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body related to regulation of nuclear power plants and use of radiation sources, including authorization, review and assessment, inspection, enforcement, and the development and content of regulations and guides. The additional area of the transport of radioactive material referred to above was also reviewed.

The Team concluded that FANR had systematically taken into account the recommendations and suggestions from the 2011 IRRS mission through a comprehensive action plan. Significant progress had been made in many areas and many improvements were carried out following the implementation of the action plan.

The Team concluded that FANR has further strengthened its regulatory oversight and made significant progress in addressing the findings of the 2011 IRRS mission and demonstrated commitment for an effective implementation of the IRRS programme by inviting the IRRS follow-up mission.

In addition, at the UAE's request, an Occupational Radiation Protection Appraisal Service (ORPAS) mission was conducted in November 2015 to review the regulatory framework and practical implementation of occupational radiation protection arrangements in the nation. The ORPAS team has delivered the final mission report of its review, which sets out the findings which included several good practices as well as recommendations and suggestions in the following areas:

- Approval of dosimetry services, including details of the type of dosimeters acceptable to the regulatory authority, calibration of dosimeters, performance testing and other relevant aspects;
- Establishment of a national dose registry;
- Standardization of training protocols, including the accreditation of qualified experts;

- Harmonization of health surveillance procedures;
- Strengthening procedures for over exposure investigations;
- Capacity building for radionuclide intake estimation and dose evaluation.

The UAE has requested an International Physical Protection Advisory Service (IPASS) mission to take place in late 2016. The UAE has also requested a preoperational Operational Safety Assessment Review Team (OSART) mission prior to start-up of the first unit at the Barakah nuclear facility.

The UAE continues to make extensive use of the IAEA technical cooperation (TC) programme to support the ongoing development of its nuclear safety infrastructure. The UAE Permanent Mission has successfully coordinated four TC cycles (2009-2011, 2012-2013, 2014-2015, 2016-2017), through different phases of planning, implementation, monitoring & evaluation, and closure.

2.5 Transparency and communications with the public and other national and international organizations

Both ENEC and FANR have maintained active programmes of stakeholder engagement 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 learned.

Examples of stakeholder involvement and partnerships are given in Section III of this Report under Articles 8 and 9.

2.6 Issues and topics agreed upon by Contracting Parties at the Organisational Meeting

The Officers of the Convention have discussed the desirability of encouraging the Contracting Parties to report at the next Review Meeting on how they have implemented the IAEA Action Plan on Nuclear Safety at the national level. This includes reporting on how Fukushima lessons learned are being addressed and reporting on findings from peer review missions and progress made towards implementing action plans based on these. UAE progress in these areas is summarized in sections 2.2 and 2.4 above and elaborated further under Articles 8, 16, and 18.

2.7 Conformance with the Vienna Declaration on Nuclear Safety

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

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

The implementation of these requirements has been met through ENEC's safety assessments contained in the construction license applications for the Barakah Plant and FANRs regulatory review of those safety assessments. In addition, the ongoing review of the operating licenses includes updated assessments, which are under review. The conclusions of these safety assessments provide a technical foundation that the Barakah plant is robust and is capable of mitigating severe accidents to prevent offsite releases that could result in large scale offsite contamination or long term protective measures and actions.

These assessments begin with traditional robust reviews of the design basis accidents in the Safety Analysis Reports that demonstrate the integrity of the fission product barriers and defence in depth to ensure that severe core damage will not occur in response to these events. The applications for the construction licenses also included Severe Accident Analysis Reports evaluating the capabilities of the plant to prevent and mitigate severe accident conditions. FANR reviewed these assessments to ensure that the plant design and severe accident management procedures were sufficient to prevent uncontrolled releases from containment. The design basis accident and severe accident analysis evaluations are updated for the applications for the operating license and are currently under further review.

The Fukushima Accident occurred during the ongoing review of the construction license application for Barakah 1 and 2. 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 Barakah units.

Further details are provided under Articles 14, 17 and 18.

2.8 IAEA Generic Safety Observations Report

The UAE has taken note of the Generic Safety Observations Report (GSOR) as presented at the Organizational Meeting of the 7th Review Meeting of the CNS. In line with the general progress made by other Contracting Parties, the UAE has made significant progress in several areas identified in the GSOR. For example, several steps have been taken to assess and strengthen nuclear safety culture at ENEC, while the UAE has generally furthered its communication and consultation efforts with the public and other national stakeholders (as further described under Article 8). The UAE has also advanced its Emergency preparedness and response arrangements which were subjected to an EPREV mission in 2015 and tested through the conduct of a full scale exercise in February 2016 (as further described under Article 16).

Details on the progress made by the UAE that generally address the GSOR are provided under the applicable Articles of this report.

2.9 Future safety related activities and programs 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 of the Barakah nuclear facility:

- 2016 to 2017: Completion of Unit 1 commissioning and transition to operations
- 2018 to 2019: Subsequent completion of construction and commissioning of Unit 2
- 2016-2019: Infrastructure and capacity building and operations staff training;
- 2017: Application to FANR for an operating licence for Units 3 and 4;

- Units 3 and 4 follow Unit 2 at approximately one year intervals.

Other related activities include the on-going development of the UAE policy and 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

As of the date of submission of this National Report, the UAE has no nuclear installations as defined by the CNS. However, the Emirates Nuclear Energy Corporation (ENEC), a corporation responsible for the development of the peaceful nuclear energy project in the United Arab Emirates (UAE), is constructing four nuclear power plants at the Barakah site in the Western Region of Abu Dhabi. The Barakah nuclear facility is located on the coast of the Arabian Gulf some 300 km west of the city of Abu Dhabi. The Barakah units are APR 1400 designs based on the Shin-Kori Units 3&4 facility in Korea which is the reference plant for the UAE Barakah Nuclear Power Plant.

FANR has issued two construction licences, one issued in July 2012 for the construction of Units 1 and 2 and the second in September 2014 for the construction of Units 3 and 4. FANR had previously issued a Site Selection Licence, a Site Preparation Licence, and a Limited Construction Licence to ENEC. All of the above licences are available on FANR's web site.

The construction licenses authorize ENEC to conduct all regulated activities required to construct all four Barakah Units including the manufacture, possession, use, transport, storage, assembling, inspection, installation, and testing of structures, systems and components (SSCs) including supporting and auxiliary equipment and associated facilities. The licences also cover the import to the UAE of equipment and technology specified in Annex B, Paragraphs 1.1 to 1.10 of IAEA INFCIRC/254/Part 1 and IAEA INFCIRC/254/Part2 as amended. The construction licences contain several conditions, including but not limited to, approval of safety-significant modifications, reporting of unplanned events, and fulfilment of commitments made in the application.

Construction of the four units at Barakah is progressing according to ENEC's project schedule under FANR's regulatory inspection and enforcement oversight. As of June 2016 Unit 1 is now over 88% complete and has progressed into the initial stages of non-nuclear commissioning, completed the Cold Hydrostatic testing in April 2016 and has commenced the Hot Functional

Testing. As of June 2016 Unit 2 is approximately 72%, Unit 3 50% and Unit 4 31% complete from a construction perspective.

On 26th March 2015 ENEC submitted an operating licence application for Barakah 1 and 2. FANR has this application currently under review and assessment. The first operating licence is expected to be issued for Unit 1 in 2017 after completion of the review and assessment and after completion of regulatory inspections to verify the construction and preoperational testing and the readiness of the operating organisation to commence operation.

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 adopted within the UAE; multilateral instruments to which the UAE has become a party or is taking steps to join; and bilateral nuclear cooperation agreements with States that will be participating in the UAE nuclear programme. The following list of instruments (the relevant terms of which will be discussed separately) include:

7.1.1 Laws of the United Arab Emirates

- Federal Law by Decree No. (6) of 2009 Concerning the Peaceful Uses of Nuclear Energy, which came into effect on 10 September 2009, (referred to as the Nuclear Law.)
- Federal Law by Decree No 4 of 2012, Concerning Civil Liability for Nuclear Damage, which came into effect in August 2012. This Federal Law aims to regulate the provisions and determine the scope of the civil liability and compensation for Nuclear Damage that could occur as a result of a nuclear accident. The provisions of the law are in line with UAE obligations under the 1997 Vienna Convention on Civil Liability for Nuclear Damage and best international practices.
- Abu Dhabi Law No. (21) of 2009 Establishing the Emirates Nuclear Energy Corporation, issued on 20 December 2009 (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.
- 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. (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.
- Cabinet Resolution No. 27 of 2015 , empowering FANR to use compliance tools to enforce regulations.

7.1.2 Multilateral instruments adopted by the United Arab Emirates

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 on 31 July 2009.
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, acceded on 31 July 2009.
- Convention on Early Notification of a Nuclear Accident, acceded on 2 October 1987.

- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, acceded on 2 October 1987.
- Convention on the Physical Protection of Nuclear Material, acceded on 16 October 2003.
- Amendment to the Convention on the Physical Protection of Nuclear Material, accepted on 31 July 2009.
- Comprehensive Safeguards Agreement between the United Arab Emirates and the International Atomic Energy Agency ("Comprehensive Safeguards Agreement"), 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"), 2009.
- Treaty on Non-Proliferation of Nuclear Weapons (NPT), acceded on 26 September 1995.
- Vienna Convention on Civil Liability for Nuclear Damage, as amended by the 1997 Protocol, acceded on August 2012.
- Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, acceded on August 2012.
- Convention on Supplementary Compensation for Nuclear Damage, ratified in 2014.

7.1.3 Bilateral cooperation agreements

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.

- UAE-Republic of Korea Agreement for Cooperation in the Peaceful Uses of Nuclear Energy, 27 June 2009.
- UAE-United States Cooperation Agreement Concerning Peaceful Uses of Nuclear Energy, 17 December 2009.
- UAE-France Cooperation Agreement on the Development of Peaceful Uses of Nuclear Energy, 15 January 2008.
- UAE-United Kingdom Cooperation Agreement in Peaceful Uses of Nuclear Energy, 2010.
- UAE-Australia Agreement for Cooperation in Peaceful Uses of Nuclear Energy, 2 August, 2012.

- UAE–Canada Nuclear Cooperation Agreement, 19 September, 2012
- UAE-Russia Cooperation Agreement, 15 November 2012
- UAE -Argentina Cooperation Agreement on Peaceful Nuclear Energy, 15 January 2013
- UAE–Japan Cooperation Agreement, 2 May 2013

7.2 Regulatory framework

CNS Article 7.2 requires 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 guidance

Articles (11), (38), and (39) of the 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 establishing and revising regulations and guides that includes provisions for consultation with stakeholders and the public, and review and incorporation of their comments.

FANR has proceeded with issuing the regulations needed for the current phase of the nuclear power project. Since the UAE's National Report to the 6th Review Meeting, 10 regulations have been completed. The regulations now legally in place include:

- FANR REG-01, "Management Systems for Nuclear Facilities"
- FANR REG-02, "Siting of Nuclear Facilities"
- FANR REG-03, "Design of Nuclear Facilities"
- FANR REG-04, "Radiation Dose Limits and Optimisation of Radiation Protection for Nuclear Facilities"
- FANR REG-05, "Application of Probabilistic Risk Assessment at Nuclear Facilities"
- FANR REG-06, "Application for a Licence to Construct a Nuclear Facility"
- FANR REG-08, "Physical Protection for Nuclear Material and Nuclear Facilities"

- FANR REG-09 "Regulation on the Export and Import Control of Nuclear Material, Nuclear Related Items and Nuclear Related Dual-Use Items"
- FANR REG-10, "System of Accounting for and Control of Nuclear Material and Application of Additional Protocol"
- FANR REG-11, "Radiation Protection and Predisposal Radioactive Waste Management for Nuclear Facilities"
- FANR REG-12, "Emergency Preparedness for Nuclear Facilities"
- FANR REG-13, "Safe Transport of Radioactive Materials"
- FANR REG-14, "Regulation for an Application for a License to Operate a Nuclear Facility"
- FANR REG-15, "Requirements for Off-Site Emergency Plans for Nuclear Facilities"
- FANR REG-16, "Operational Safety including Commissioning"
- FANR REG-17, "Certification of Operating Personnel at Nuclear Facilities"
- FANR REG-19, "Regulation on Existing Exposure Situations"
- FANR REG-21, "Decommissioning of Facilities"
- FANR REG-23, "Security of Radioactive Sources"
- FANR REG-24, "Basic Safety Standards for Facilities and Activities involving Ionising Radiation other than in Nuclear Facilities"
- FANR REG-26, "Regulation for Pre-disposal Management of Radioactive Waste"

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 membership on the Standards Committees and the Commission on Safety Standards (CSS). Through its participation on the Committees, FANR has also observed the actions taken by the IAEA to strengthen its safety requirements following the accident at Fukushima-Daiichi.

FANR continues to develop regulations as needed with the developing UAE nuclear energy programme. The IAEA safety requirements, as well as those of other well-recognized international organisations and regulatory bodies, continue to be key references. Regulations that are currently under development include a regulation on license fees and a regulation on the Decommissioning Trust Fund. FANR REG-08, "Physical Protection for Nuclear Material and Nuclear Facilities" is presently being revised to also accommodate requirements in line with the entering into force of

the Amendments to the Convention on Physical Protection of Nuclear Material and Nuclear Facilities.

FANR regulatory guides describe methods and criteria acceptable to FANR for implementing its requirements. FANR has found it effective to adopt many of the guides issued by the regulatory body in the country of origin of the nuclear technology. FANR regulatory guides relevant to the NPP include:

- 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 Guide"
- 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 Radioactive Waste Management"
- 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"

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

7.2.2 System of licensing

Articles (23-31) of the Nuclear Law provide for requirements for granting, revoking, and suspending licences. Article (23) of the Nuclear Law prohibits any person from conducting any Regulated Activity in the UAE unless licensed to do so by FANR. "Regulated Activities" include

the siting, construction, operation, commissioning and decommissioning of Nuclear Facilities (noting that the definition of Nuclear Facilities incorporates the CNS definition of 'nuclear installation').

Article (6) of the Nuclear Law gives exclusive authority to FANR for issuing licences to practice any of the Regulated Activities in the UAE and permits FANR to impose conditions on licences. Article (28) of the 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 determines whether to issue the licence, issue the licence with conditions, or to refuse the licence and record the basis for the decision.

FANR has established in its Integrated Management System (IMS) a process consistent with the 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 Units 1 and 2 is described further in Article (14) of this National Report.

7.2.3 System of Regulatory Inspection and Assessment

Articles (32-37) of the Nuclear Law provide requirements on inspection and control of licensee activities. Article (35) of the Nuclear Law requires FANR to establish a planned and systematic inspection programme. Article (36) of the Nuclear Law requires FANR to conduct inspections covering all areas of regulatory responsibility to ensure that the operator 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 operator. Article (5) of the Nuclear Law provides FANR with the power to enter sites and facilities to carry out inspections.

FANR has established within its Integrated Management System (IMS) a process consistent with the above requirements of the 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 applied by inspectors in different areas.

Following the issuance of the construction licence Barakah Units 1 and 2 in July 2012 and 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 licence, as further discussed below in Article 14.2

7.2.4 Enforcement

Article (5.17) of the Nuclear Law gives FANR the power to take enforcement actions, 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 Nuclear Law empowers FANR to take enforcement action compelling the operator to take actions necessary to remediate any breach. Article (36.3) of the 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 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 Nuclear Law provide provisions for civil liabilities and criminal penalties for various offences related to the requirements of the Nuclear Law.

In August 2015, the Cabinet of the United Arab Emirates published a Cabinet Resolution No. 27 of 2015 specifying the administrative penalties that UAE persons and organisations face for non-compliance with FANR regulations. The resolution empowers FANR to enforce safety, security and safeguards regulations by applying a number of administrative penalties such as fines, suspension or revocation of FANR licences, or corrective actions against violators.

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:

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.

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 and statute of the regulatory body

Three chapters of the Nuclear Law establish the structure, responsibilities and resources of the regulatory body entrusted with implementing the legislative and regulatory framework for nuclear safety in the UAE.

Chapter 2, Articles (4 to 9) of the Nuclear Law establishes the Federal Authority for Nuclear Regulation (FANR) as the regulatory body to implement the legislative and regulatory framework.

Article (4) establishes FANR as a public organisation with an independent balance sheet, an independent legal personality, full legal competence and financial and administrative independence. It states the aims of FANR as the assurance of safety, security and radiation protection within the UAE nuclear programme with the development of the nuclear sector towards only peaceful purposes.

- Article (5) gives power to FANR to determine all matters relating to the regulation of the nuclear sector in regard to safety, nuclear safety, nuclear security, radiation protection and safeguards. FANR must also implement obligations under relevant international instruments entered into by the UAE. This Article lists powers of FANR in 33 sub-articles.
- Article (6) gives FANR exclusive jurisdiction over the licensing of regulated activities in the UAE.
- Article (7) requires FANR to co-operate with relevant government bodies on matters related to the nuclear programme.
- Article (8) authorizes FANR to investigate potential breaches of the Nuclear Law.
- Article (9) requires FANR to maintain the highest standards of transparency in its regulatory activities while allowing it to protect confidential information.

- Chapter 3, Articles (10-17) set forth provisions on the management of FANR.
- Article (10) establishes the FANR Board to manage the organisation.
- Article (11) establishes the general authorities and functions of the Board including that it establishes the general policy of FANR, adopts its budget and organisational structure, and issues the range of regulations and requirements needed for FANR's operations and functions.
- Article (12) sets forth conditions of Board membership.
- Article (13) identifies the grounds on which Board members may be replaced.
- Article (14) provides for the appointment of a Director General to manage FANR and oversee its financial, administrative and technical affairs.
- Article (15) establishes that the Director General manages FANR's business and oversees its financial, administrative and technical affairs under the Board of Management control. It sets out the duties of the Director General in nine sub-articles, including that the Director General reviews all licence applications and makes appropriate recommendations to the Board.
- Article (16) identifies the grounds on which the Director General may be replaced.
- Article (17) authorizes FANR to appoint employees
- Chapter 4, Articles (18-22) deals with FANR's financial affairs.
- Article (18) gives FANR the powers to manage its finances and identifies the means of funding for FANR as: funding allocated by Government; income generated from its functions (fees); and other income that is accepted and that does not conflict with FANR's objectives.
- Article (19) establishes the dates of the fiscal year for FANR financing.
- Article (20) makes FANR subject to UAE tender and procurement laws and applicable financial and auditing regulations.
- Article (21) grants FANR exemption from UAE taxes.

- Article (22) provides that the FANR Board will appoint an independent auditor to report on the Authority's financial affairs.

8.1.2 Mandate, mission and tasks, authorities and responsibilities

As noted above, the 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 Law grants powers to FANR consistent with Article 8 of the Convention on Nuclear Safety to implement the four key regulatory functions of (i) standard-setting through regulations; (ii) authorization through licensing; (iii) inspection and monitoring of compliance; and (iv) enforcement. FANR must also set up and operate the state system of accounting and control of nuclear material (SSAC), and frameworks for the physical protection and emergency preparedness and response for nuclear facilities and activities.

The Law also requires FANR to cooperate with other competent authorities in the areas of health and safety, environmental protection, security, emergency management and transportation of hazardous materials. FANR adopts an integrated "Three-S" approach to benefit from the synergies that flow from coordination of its safety, security and safeguards activities.

8.1.3 Organisational structure of the regulatory body

The FANR Board of Management exercises FANR's legal powers. The Board comprises seven Emirati citizens, including the Chairman and Deputy Chairman, who are appointed for a term of three years by resolution of the Cabinet. The Director General leads the FANR staff organisation.

Below the Director General, FANR has created two main Divisions in the organisation to fulfil its responsibilities: Administration and Operations. The Administration Division includes the Departments of Finance and Control, Information and Communication Technology, Supply Chain and General Services, Human Resources and Government Communications; the Operations Division includes the Departments of Nuclear Safety, Radiation Safety, Nuclear Security, Safeguards and Education and Training. The organisation chart is shown in Figure 8.1.

FANR Board of Management

The UAE Cabinet has issued a Resolution in November 2014 regarding the restructure of the FANR Board of Management. The names of the Board members are as follows:

H.E. Mr. Abdulla Nasser Al Suwaidi(Chairman)

H.E. Ambassador Hamad Ali Al Kaabi, UAE's Permanent Representative to the International Atomic Energy Agency (Deputy Chairman)

H.E. Mr. Ali Khalfan Al Dhaheri, Representative of Ministry of Presidential Affairs (Member)

H.E. Mr. Sultan Abdullah Sultan Al Hebsi, Representative of Ministry of Climate Change and Environment (Member)

H.E. Mrs. Razan Khalifa Al Mubarak, Secretary General, Environment Agency – Abu Dhabi (Member)

H.E. Dr. Ali Mohamed Shaheen Ahmed, Director, Science Research Laboratory – Dubai Police (Member)

H.E. Dr. AbdulQader Ebrahim Alkhayat (Member)

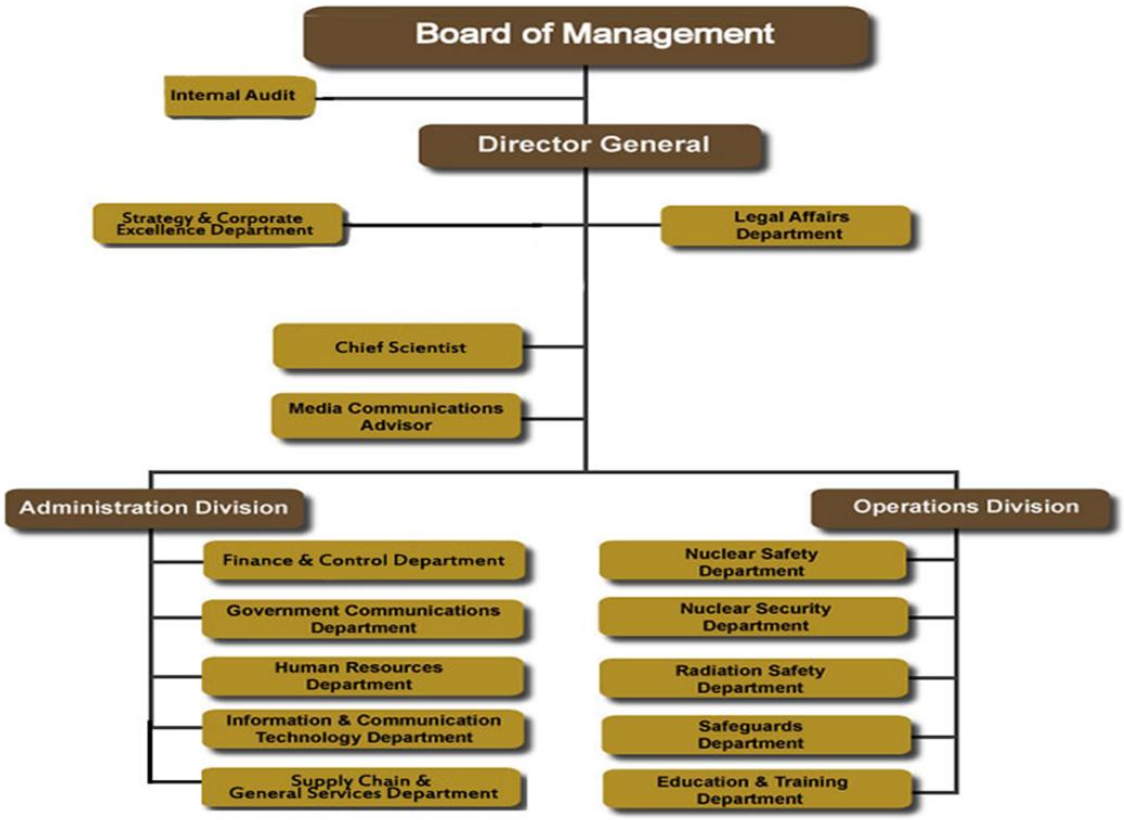

Figure 8.1 - FANR Management Organisation Chart

8.1.4 Development and maintenance of human resources

FANR has made significant progress in recruiting a qualified and capable workforce over the past three years.

The FANR staff as of the date of this report numbers approximately 200 people. Sixty-two per cent of the employees are Emirati citizens. The balance of the staff comprises expatriates with nuclear experience recruited from 25 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 Emirati nationals to take increasingly responsible positions in the regulatory body, while retaining an appropriate cadre of international experts. FANR complements its in-house training programmes through collaboration with ENEC, Khalifa University, the IAEA and other partner institutions in a national programme

of capacity building which offers to citizens a range of education, training and development opportunities in the UAE and overseas. During 2012, FANR achieved the following:

Scholarships

FANR recognises the need for scholarships, where an Emirati employee with clearly identified career potential will assume the responsibility of a higher position and may be granted a scholarship for further education if any such award will be deemed necessary to enhance his or her career potential. FANR has granted scholarships to six employees to complete their academic studies at different levels. Four FANR employees have graduated with Master's Degrees in Education Leadership, Nuclear Engineering, and Nuclear and Radiation Safety from 3 different universities in the UAE and the Republic of Korea. Other degrees employees are currently pursuing include a Bachelor's Degree in Engineering, and a PhD in Nuclear Energy at Khalifa University.

Internship

The aim of our 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 outstanding and inspiring career professionals and management within FANR for eight weeks. Moreover, they are encouraged to participate in meetings and contribute to analytical work.

Employee Development Program

The employee development programme is designed to support FANR employee's development by equipping them with the knowledge and skills needed to perform their roles and responsibilities.

FANR has established a new programme for fresh graduates called "The Developee Engineers Programme". It is designed to provide fresh UAE engineering graduates with the fundamental knowledge, skills, and attitudes necessary to understand technical concepts applicable to nuclear engineering and, specifically, nuclear regulation. This development programme runs over 53 weeks and is comprised of intensive nuclear fundamentals training, on-the-job training in each of the Operations Departments, as well as soft skills training. The programme aims to produce UAE nuclear regulatory engineers who will be fully integrated into the Operations Departments upon completion of their programme.

A high priority for FANR is to develop the competencies of its existing and future managers and leaders, who will come to regulate the nuclear programme in the UAE. A development programme has been designed that includes management and leadership courses both internally at FANR and abroad. This programme is included as a part of our capacity-building approach to allow Emiratis to be capable of taking on leadership roles within FANR.

Both Emirati and expatriate employees have attended numerous in-house trainings and external courses covering technical skills, personal skills, and management and leadership topics. In-house training courses are delivered by staff experts and external consultants are coordinated by the Education and Training Department. In 2016, FANR has also sent sixteen of its staff members to a four month long Gulf Energy Infrastructure Institute (GNEII) programme covering safety, security, and safeguards, established in collaboration with Khalifa University, Sandia National Laboratories and Texas A&M University.

FANR has developed formal qualification standards for safety assessors and inspectors. In 2015, FANR hosted their first Inspector Refresher Qualification Programme. The programme was facilitated by a consultant and also used in-house inspectors who shared their knowledge and experience of various inspection topics. This program saw twenty inspectors re-qualified for an additional three years. Currently FANR has qualified fourteen women and forty four men as inspectors.

Knowledge management

FANR has established a Knowledge Management (KM) program to assist in transfer and retention of knowledge among its staff. The objectives of the KM program include:

- Mitigate the risk of knowledge loss due to employees' mobility;
- Make available knowledge and experience that enhances the quality of collaboration and increases the effectiveness and efficiency of the regulatory body; and
- Assure sustainability of UAE nuclear program through effective nuclear knowledge transfer from one generation to another.

Several projects and initiatives have been launched under this programme. This includes, for example, formalizing the KM process within the Integrated Management System, collecting "Travel Reports" in order to share knowledge about different events that will be a reference for

future generations, "video capturing" notable presentations, and development of a technical library.

8.1.6 Financial resources

FANR has its budget set by its Board of Management and in the past receives funds made available by annual government allocation. FANR has now transitioned to having licensees pay fees in accordance with the schedule set out in a Cabinet Resolution. Licence fees constitute more than 90% of the approved budget with the balance provided by government allocation. FANR manages its financial resources according to the applicable financial and auditing regulations within the UAE. The FANR Board of Management appoints an independent auditor registered with the appropriate UAE authorities to audit annual accounts and prepare reports regarding 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 Nuclear Law authorizes FANR to "apply the Quality Assurance principles on all procedures related to its functions." Early in its existence, FANR implemented an Integrated Management System (IMS) as recommended in the relevant IAEA publications on safety requirements and guidance. The IMS includes a set of interacting processes that address the objectives and requirements of the organisation. Elements included in the IMS that are tailored specifically to the regulator are the structure, resources, and processes of the core business areas of nuclear regulation, licensing and inspection, as well as corporate management and support functions. The early 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 IMS.

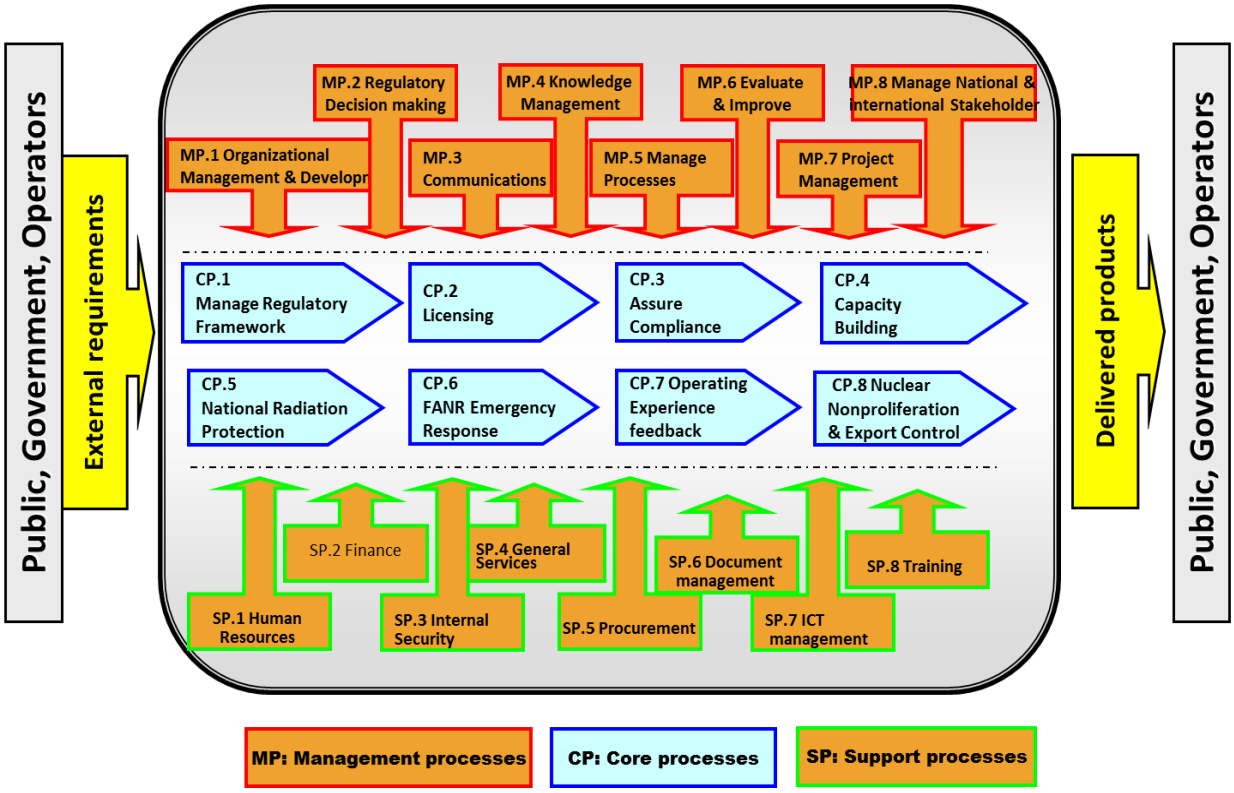

Figure 8.2: FANR Integrated Management System Processes

8.1.8 Openness and transparency of regulatory activities

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

To meet its obligations for transparency, FANR has created a programme of communication with stakeholders and the public comprising the following elements:

a) FANR web site www.fanr.gov.ae lists comprehensive information on FANR's programme. A range of documents is available, including:

- All published regulation & guides with the exception of those containing sensitive information which are restricted for nuclear security reasons.

- Resolutions of the Board of Management
- Safety Evaluation Reports summaries
- Summaries of inspection reports
- Peer review reports
- FANR annual reports
- UAE National Reports on the implementation of safety-related conventions (Convention on Nuclear Safety and Joint Convention on Spent Fuel and Radioactive Waste Management).

The website allows stakeholders and the public to interact with the Authority using a variety of communication channels, including:

- Live Chat
- E-Forum
- Talk to the Director General
- Email queries to info@fanr.gov.ae

FANR's website usage has steadily increased since its creation. In 2015, there were 284,069 page views of the FANR website, about a 15 percent increase from 2014.

b) Providing opportunities for stakeholders and the public to comment on draft regulations and guides before approval.

c) Public forums 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. In 2015, for example, FANR conducted five public forums that were attended by a total of about 1,000 people.

d) Media releases for significant events such as the passage of a new law or a Cabinet Resolution on Nuclear related matters. For instance, in September 2015, FANR issued a media release on UAE Cabinet Resolution No 27 of 2015 which empowers FANR to enforce safety, security and safeguards regulations by applying a number of administrative

penalties such as fines, suspension or revocation of FANR licences, or corrective actions against violators.

e) Social media posts, particularly featuring Twitter and Facebook, have significantly boosted public engagement in the last year.

8.1.9 External technical support

FANR has profited 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 (RBCOO), in carrying out the review and assessment of the construction licence applications as well as operating licence applications. 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.

To augment its resources, and to assist the staff in reviewing the construction licence applications and operating licence applications, FANR contracted with 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. 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.

8.1.10 Advisory bodies

FANR has established an International Advisory Group on Nuclear Safety (IAG-NSR) with the objective of providing independent and impartial advice to the FANR Board related to nuclear safety, security and non-proliferation. The IAG-NSR comprises a panel of senior experts who meet biannually with the FANR Director General (DG) and senior staff and provide a direct report to the Chairman of the Board giving their observations and recommendations.

The current IAG-NSR members are:

- David F. Torgerson, Canada, Member of INSAG, Emeritus Senior Technical Advisor to the President and CEO of AECL is the IAG/ NSR's Chairman;

- Atsuyuki Suzuki, Japan, Professor Emeritus, University of Tokyo;
- Philippe Jamet, France, Commissioner at Autorite de Surete Nucleaire (ASN);
- Younwon Park, South Korea, President of Best Engineering in Energy Solution (BEES) Inc;
- Mark Satorius, United States, Executive Director for Operations at the United States Nuclear Regulatory Commission (Formerly US NRC).

8.2 Status of the Regulatory Body

The 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 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, and its decisions are not subject to any external review. FANR is independent of ENEC and any other entity charged with promotional responsibilities.

Pursuant to the commitments set forth in UAE Nuclear Policy and consistent with the CNS 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 Awareness and Responsibility
- Core value No. 2: Independence
- Core value No. 3: Transparency
- Core value No. 4: Competency

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 forbidden by law from engaging directly or indirectly in the conduct of any Regulated Activity and must not have any personal interest that conflicts the interests of FANR.

The Chairman of the Board is required by Law to submit a report, at the end of each financial year, to the Minister of Presidential Affairs. The Board is also required by law to submit a set of audited accounts to the Cabinet for endorsement.

As reflected in Chapter 4 of the Nuclear Law discussed earlier, FANR has also been assured of having sufficient financial resources allocated by the government 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 promotion or utilisation of nuclear energy as required by the CNS.

8.3 International and National Cooperation

The UAE has continued to have extensive cooperation with the IAEA, has participated in many missions and made use of several safety services since the last National report.

IAEA technical cooperation: IAEA technical support has been made available to the UAE through more than 150 TC projects, nationally, regionally, and inter-regionally. This cooperation has been consolidated with the establishment of the UAE Permanent Mission in 2008, acting as the official National Liaison Office to IAEA. More recently, an Integrated Work Plan was signed in 2013, providing the framework of cooperation through which the IAEA will work with all stakeholders for the development of the UAE's nuclear power infrastructure. In March 2016, the UAE met with the IAEA in Vienna to review the Integrated Work Plan covering the desired IAEA safety services for the next five years. The meeting discussed safety services to be provided in 2016 and 2017. The IWP will incorporate the entire suite of IAEA safety related services and will enhance the UAE's utilization of the IAEA services.

Other IAEA cooperation: FANR has actively participated in peer reviews, meetings and events, providing insight and understanding on various topics, including:

- Contribution to the IAEA's comprehensive report, "The Fukushima Daiichi Accident," a multi-year effort culminating in the report's release in 2015.

- Participation in the international team of senior safety experts to conduct Integrated Regulatory Review Service (IRRS) missions in Korea (a follow-up mission) and Vietnam, both in 2014.
- Participation in numerous IAEA Committees, including, the Radiation Safety Standards Committee (RASSC) and the Nuclear Safety Standards Committee (NUSSC).
- Participation in the 2015 Review Meeting of Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
- Participation in meetings related to the Code of Conduct on the Safety and Security of Radioactive Sources.

OECD-NEA cooperation: In 2012, the UAE was invited to join the Multinational Design Evaluation Programme (MDEP) as an associate member. MDEP is a multinational initiative administered by the OECD Nuclear Energy Agency to leverage the resources and knowledge of the national regulatory authorities who are currently or will be tasked with the review of new reactor power plant designs. FANR is participating in the (MDEP) APR1400 Design Specific Working Group (DSWG) and as an observer on the Steering Technical Committee. The APR1400 DSWG meets on average twice a year. Since the last National Report, FANR has actively contributed to the work undertaken by this group. It is worthwhile noting that two Technical Evaluation Subgroups (TESG) have been created which report to the APR1400 DSWG on specific technical topics: the TESG on Severe Accidents and the TESG on Transient and Accidents analysis. FANR is chairing the TESG on Severe Accidents.

GCC cooperation: The UAE has continued regional cooperation with the Gulf Cooperation Council (GCC) in peaceful uses of nuclear energy and has participated in coordination meetings for sharing information on subjects such as Emergency Preparedness & Response programmes.

Cooperation with National Regulators: FANR has established strong relationships with nuclear regulatory bodies around the world, signing cooperation agreements with:

- Korea Institute of Nuclear Safety (2010)
- Finnish Radiation and Nuclear Safety Authority (2011)
- French Nuclear Safety Authority (2012)

- French Radiological Protection and Nuclear Safety Institute (2013)
- Norwegian Institute for Energy Technology (2013)
- Australian Radiation Protection and Nuclear Safety Agency (2013)
- Korea Atomic Energy Research Institute (2015)
- U.S. Nuclear Regulatory Commission (renewed 2015)

Other International Cooperation: FANR also aims to work with the international community by supporting cooperative programs. In 2016, for example, FANR hosted a meeting of experts from nations that have signed on with the U.S. Nuclear Regulatory Commission's Code Applications and Maintenance Program (CAMP) to assess the lessons learned 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, including:

- Critical National Infrastructure Authority (2011)
- Khalifa University of Science, Technology and Research (2011)
- National Transport Authority (2012)
- National Emergency Crisis and Disasters Management Authority (2012)
- Abu Dhabi National Oil Company (2012)
- Telecommunications Regulatory Authority (2013)
- Environment Agency – Abu Dhabi (2014)
- Department of Civil Aviation – Sharjah Emirates (2014)
- Abu Dhabi Occupational Safety and Health Center (2015)

- General Authority for the Security of Ports, Borders and Free Zones (2016)

FANR has hosted a variety of events to reach representatives of local and federal government entities to coordinate on safety, security, safeguards and emergency preparedness. In past year alone, these events have reached hundreds of participants.

These events included:

- A 2016 seminar for UAE stakeholders to learn about the IAEA's Report on the Fukushima Daiichi Nuclear Accident and the subsequent safety actions taken by FANR and the Emirates Nuclear Energy Corporation.
- A large number of "Meet Your Regulator" events that target licensees to build awareness of their obligations and FANR's services.

8.4 IAEA Peer Reviews

Integrated Regulatory Review Service (IRRS) mission to the UAE – Extended Follow-Up mission

As reported in the previous national report, an IRRS mission was conducted by the IAEA in December 2011, covering the UAE regulatory framework for all nuclear activities regulated by FANR. This mission also took into account the lessons learned so far from the accident at TEPCO's Fukushima Daiichi Nuclear Power Station. A highlight of the IRRS mission was that FANR requested the IAEA to assess how the newly established regulatory body aligned itself with the IAEA safety fundamentals and safety standards.

The review conducted by the IAEA compared the UAE regulatory framework for safety against IAEA safety standards as the international benchmark for safety. The mission was also used to exchange information and experience between the IRRS Review team members and their UAE counterparts in the areas covered by the IRRS.

The IRRS Review team consisted of 13 senior regulatory experts from 12 IAEA Member States, three technical staff members from the IAEA, and an IAEA administrative assistant.

The IRRS Review team identified a number of good practices and made recommendations and suggestions indicating where improvements are necessary or desirable to continue enhancing the effectiveness of regulatory functions in line with the IAEA Safety Standards.

Immediately after the mission, FANR formulated an action plan overseen by a management-level committee, to respond to and implement the suggestions and recommendations made by the IRRS team.

At the request of the Government of the United Arab Emirates (UAE), an international team of senior safety experts met representatives of the Federal Authority for Nuclear Regulation (FANR) and other organizations contributing to nuclear and radiation safety from 31 January to 8 February 2015 to conduct the IRRS follow-up mission to the UAE. The follow-up mission took place at the headquarters of FANR in Abu Dhabi. The purpose of the follow-up mission was to review the measures undertaken following the recommendations and suggestions from the initial IRRS mission conducted in 2011. In addition, the follow-up mission was extended to include a review of the transport of radioactive material.

The IRRS follow-up Team (the Team) consisted of six senior regulatory experts from six IAEA Member States and four IAEA staff members. The Team carried out a review of the measures undertaken following the recommendations and suggestions of the 2011 IRRS mission in the following areas: responsibilities and functions of the government; the global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body related to regulation of nuclear power plants and use of radiation sources, including authorization, review and assessment, inspection, enforcement, and the development and content of regulations and guides. The additional area of the transport of radioactive material referred to above was also reviewed.

The follow-up mission included a review of reference material and interviews and discussions with management and staff from FANR and other organizations.

Throughout the mission, the Team was extended full cooperation in discussing regulatory and technical issues by all parties; in particular, the staff of FANR provided the fullest practicable assistance and demonstrated extensive openness and transparency.

The Team concluded that the recommendations and suggestions from the 2011 IRRS mission have been taken into account systematically by a comprehensive action plan. Significant progress had been made in many areas and many improvements were carried out following the implementation of the action plan. Specifically, the Team determined that 13 out of 14 recommendations and 30

of 34 suggestions made at the time of the initial IRRS mission in 2011 had been effectively addressed and therefore could be considered closed.

In conclusion, the Team found that FANR has further strengthened its regulatory oversight and has demonstrated commitment for an effective implementation of the IRRS programme. For more details see the Executive Summary in Annex 2.

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 comprising seven international and IAEA experts 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.

The team found that the UAE is establishing effective nuclear emergency management arrangements that build upon the nation's existing emergency response system, according to a team of international safety experts that today completed an 11-day review of the UAE's planning efforts. For more details, see the Executive Summary in Annex 2.

Occupational Radiation Protection Appraisal Service (ORPAS)

In November 2015, an IAEA team of occupational safety experts conducted an Occupational Radiation Protection Appraisal Service (ORPAS) mission to review the regulatory and practical implementation of occupational radiation protection arrangements in the country. The IAEA team comprised six international and IAEA experts who conducted their week-long review by interviewing officials from UAE government entities, including FANR, and visiting several companies in Abu Dhabi and Dubai that use radiation or provide technical radiation services in the course of their work, such as medical and industrial facilities.

The review found that a system to regulate radiation in the workplace is being effectively implemented by FANR.

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 policy on peaceful uses of nuclear energy, the UAE Nuclear Law sets out requirements for assigning priority to safety and for the responsibility of each licence holder, including:

- Article (2) of the Nuclear Law states that "…The development and regulation of the Nuclear Sector in the State will afford priority to Safety, Nuclear Safety, Nuclear Security, Radiation Protection and safeguards."
- 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 was established by Abu Dhabi Law No. (21) of 2009, *Establishing the Emirates Nuclear Energy Corporation*, issued on 20 December 2009 (referred to as the ENEC Law). Article (2) of the ENEC Law, states,

"[t]here shall be an establishment pursuant to this Law a corporation called Emirates Nuclear Energy Corporation which shall have an independent legal personality and full legal capacity to conduct its activities, achieve its objectives and shall have a financial and administrative independence to manage its affairs, wholly owned by the government."

In accordance with the requirements of the UAE Nuclear Law and as a FANR licensee the Emirates Nuclear Energy Corporation (ENEC) currently has the prime responsibility for safety. ENEC's

operating subsidiary, Nawah Energy Company, will accede this responsibility once the Operating License is granted.

ENEC discharges its responsibility for safety during the construction phase through focus on the following areas:

- Management for safety and safety culture: ENEC has established its safety policy and has made the following statement: "We prioritize the safety and security of ENEC employees, the public and the environment at all times." In addition, ENEC has adopted the Institute of Nuclear Power Operators (INPO) "Traits of a Healthy Nuclear Safety Culture" and has to date conducted three safety culture assessments. To supplement these values, ENEC has also adopted the Institute of Nuclear Power Operations (INPO) 'Principles for Excellence in Nuclear Project Construction'. It also promotes these values to its prime contractor, KEPCO, and its subcontractors by supporting safety culture workshops.
- Management system and organization: ENEC has established a comprehensive Management System for its corporate governance 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 through an integrated management system. ENEC has achieved ISO 9001:2008 certification for its management system. ENEC has had numerous inspections/audits performed by regulators, both nuclear and non-nuclear, to confirm ENEC's conformance to safety standards that have been established by them.
- Human resources: ENEC is establishing a core of competent staff and is investing heavily in training and recruitment. The mixture of the staff includes both experienced staff with nuclear background and those that are new to the industry at different levels within the organization. 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. ENEC has adopted the Systematic Approach to Training as described by INPO and is working closely with KEPCO to ensure that the expectations of FANR are met.
- High Quality Design and Construction: ENEC has awarded a contract to KEPCO, its prime contractor, for the construction of four units of the APR1400 (Advanced Power Reactor).

This APR-1400 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.

- Project Oversight: ENEC provides oversight on KEPCO and its subcontractors to ensure that the project meets it goals for safety and quality. This is achieved by a series of documentation reviews, on-site inspections and audits. These occur on site at Barakah, in Abu Dhabi, at KEPCO premises and subcontractors premises within Korea and internationally. To support this, ENEC has staff based in Korea, Barakah and Abu Dhabi.
- International: ENEC is establishing itself within the international nuclear arena. It has membership with both WANO and INPO. It has affiliated itself to both the WANO Atlanta and Tokyo centres and the ENEC CEO is currently a Board member of WANO's Atlanta centre. To assist in both establishing relations and strengthening UAE's understanding of the processes, ENEC will have two liaison engineers at WANO Atlanta centre. ENEC has participated in many international conferences, workshops and events and has had a number of senior managers participate in INPO training programs in the USA as well as having WANO led workshops and training on an annual basis in Abu Dhabi. The focus of these workshops for the last two years has been on safety culture and leadership expectations within the nuclear industry. ENEC has sent experienced staff to support WANO peer reviews both for operational plants and for start-up reviews, in preparation for the WANO start-up peer review process scheduled for 2016 before the first unit is taken critical for the first time. ENEC also receives operating and construction experience from WANO, INPO and the IAEA and reviews that for applicability to the project, to either address immediately or to perform an assessment at a more appropriate time in the project timeline. In some cases these require formal responses directly to WANO. In addition, ENEC will host an IAEA pre-OSART mission in 2017.

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 discharges its prime responsibility for safety through the implementation of a comprehensive and rigorous regulatory framework under the UAE nuclear law. The 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) authorization 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.

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

The establishment of ENEC is part of the UAE overall policy and vision to adopt nuclear power for peaceful purposes and as such ENEC has a role to play in the communication of the goals of the project and nuclear power in general. ENEC has a robust program for public communication and holds various workshops and open meetings as well as participating in a large number of conferences and workshops, both nationally and internationally. ENEC has also conducted surveys 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 that the levels of acceptance had increased above the original levels. Public acceptance for nuclear energy in the UAE is currently around 80% - one of the highest acceptance levels in the world today.

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 and ENEC 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);
- 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, ENEC);
- 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).

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 Nuclear Law affirms a strong commitment to prioritize nuclear safety. Nuclear Law Articles (4) through (6) and (38) 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, 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.

The UAE has also established a high level International Advisory Board (IAB) to advise the Government in the progress the UAE is making in achieving and maintaining the highest standards of safety, security, non-proliferation, transparency and sustainability. The IAB comprises independent experts with broad experience in nuclear affairs, including safety. The members are:

- Dr. Hans Blix (Chair) - former IAEA Director General
- Dr. Kun Mo Chung - former South Korean Minister of Science and Technology
- Ambassador Thomas Graham - former US Ambassador for Non-Proliferation
- Mr. Takuya Hattori - President of Japan Atomic Industrial Forum, Inc.
- Lady Barbara Judge – Former Chair, United Kingdom Atomic Energy Authority
- Mr. Jukka Laaksonen – Former Director General of Finland's Radiation and Nuclear Safety Authority
- Sir John Rose -- Rolls-Royce Chief Executive

The IAB meets twice a year and issues reports on its findings and recommendations which are made available publicly on its web site at www.uaeiab.ae.

10.2 Measures taken by the Operator

As the licensee for the construction of the four Barakah NPPs, ENEC has the overall responsibility under the UAE Nuclear Law for managing and securing the safety of the plant. 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.

In order to meet its objectives for achieving safe, reliable and efficient power in 2017, ENEC has implemented an integrated management system in compliance with FANR Regulations that translate to the requirements of IAEA GS-R-3 "Management Systems for Facilities and Activities". The ENEC management system integrates all elements of 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 ENEC management system also supports a strong safety culture.

ENEC reinforces safety as an overriding priority through the traits for a healthy safety culture based on recognized international standards. These principles reinforce core requirements establishing, for example, that decision making reflects safety first, a questioning attitude is cultivated, nuclear technology is special and unique, and that everyone is personally responsible for safety. These core traits are applicable to all four categories of safety: nuclear, industrial, radiological, and environmental safety. More recently ENEC introduced security culture as a complementary focus area to nuclear and industrial safety culture. The introduction of security culture enables ENEC to develop a security-minded nuclear culture, that is aligned to the IAEA directives on nuclear security and nuclear security culture.

The culture of safety is communicated through management policy, reinforced through employee training and monitored through organizational assessments.

ENEC conducted a culture of safety assessment of all employees in 2011, 2012, 2014 and will conduct a follow up assessment at the end of 2016. The assessment questionnaire in 2011 and 2012 was based on the WANO principles for a strong nuclear safety culture and the INPO principles of excellence in nuclear project construction. The assessment consisted of 69 questions covering 8 safety culture principles. ENEC then changed its standards to align with the industry changes to "Traits of a Healthy Nuclear Safety Culture" in 2013 and hence its assessments were based on the new adopted standards. 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 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 safety culture.

Since the Culture of Safety assessment in 2014, 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 applicant for an operating licence for Barakah NPP Units 1 and 2, Nawah has started to implement the following future 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 ENEC's 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;
- Formally utilising ENEC's Project Management Office to manage and coordinate the successful implementation of Culture of Safety initiatives;
- Ongoing evaluation of relevant KPIs 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 applicant's or licensee's management system promotes and supports a strong safety culture.

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

Following the issuance of each licence, under the powers granted by the 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.

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

The Government of Abu Dhabi, through ENEC, currently funds the costs of constructing the Barakah Nuclear Power Project and associated activities such as capacity building and planning. ENEC may enter into a joint venture and lending arrangements for the construction and development of the Barakah nuclear power project and has developed a detailed proposal for the same working with its Government of Abu Dhabi stakeholders, KEPCO and a consortium of international lenders. In the absence of any such arrangements, the Government of Abu Dhabi will continue to fund ENEC's activities during the construction and development of the project.

ENEC is currently working with its Government of Abu Dhabi stakeholders to structure a power purchase agreement with the Abu Dhabi Water and Electricity Company (ADWEA) for the purchase of electricity produced by the Barakah NPP that will ensure revenue is available to the licensed operator to safely operate and maintain the facility. These revenue arrangements currently contemplate 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.

Article (42) of the Nuclear Law requires the operator of a nuclear facility to pay fees into a decommissioning trust fund. FANR is drafting the Cabinet resolutions and a regulation required by the Law to set out rules for the fee calculation and the administration of the decommissioning trust fund, and plans to have these regulations in place before the operations phase.

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 both FANR and ENEC to meet current requirements. Both 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.

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 (IWP) 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 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-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 is continuing to hire its 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. Under the prime contract between ENEC and KEPCO, 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 bachelor degree programme in mechanical engineering and a master degree programme in nuclear engineering aimed at developing indigenous capabilities. ENEC is working with the Institute of Applied Technology (IAT), 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 IAT curriculum, a local source of future technicians will become available to support the national nuclear energy programme.

Selected candidates from the UAE have been enrolled in nuclear, mechanical, and electrical engineering programmes in the United States and partnerships with local educational institutions have strengthened the potential pipeline for talented employees.

ENEC's 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), and Maintenance 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 class room 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 two full scale simulators to develop the ROs and SROs operating skills. There are currently 115 Emiratis in the RO and SRO training program. The first group has advanced through the entire training program and have completed the written and simulator examinations required for Certification by FANR.

Nawah Energy Company is under formation as a subsidiary of ENEC and is the applicant for the Operating License for Barakah Unit 1. ENEC is developing Nawah into a fully staffed and qualified nuclear operator with the resources necessary to operate and maintain all four units of the Barakah Nuclear Energy Plant. ENEC recently entered into 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 and REG-17 contain requirements for adequate resourcing, training and qualification of staff for the nuclear facility.

FANR REG-6 requires applicants for a construction licence to describe the organisational arrangements and training. ENEC provided in the PSAR for Barakah 1 and 2 a description of its current organisation and staffing. FANR has reviewed this part of the PSAR as part of its review and assessment of the complete application and found that the information provided by ENEC was adequate to give reasonable assurance that the requirements will be met.

FANR-REG-17 requires the licensee to submit for FANR approval a comprehensive training plan for reactor operating personnel. ENEC has submitted its plan which FANR reviewed and approved in June 2012. FANR has also inspected the preparation and delivery of the initial fundamentals examination for reactor operator trainees in accordance the requirements of REG-17. FANR plans to review certification requests of RO and SRO personnel upon application by ENEC on behalf of candidates who have completed the training 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 organizational issues into account for the safety of nuclear installations

A requirement for taking human factors into account can be found in FANR regulation FANR REG-03, "Design of Nuclear Facilities". This regulation addresses human factors requirements including considerations such as:

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

- integrating systematic consideration of human factors and the human–machine interface in the design process at an early stage and continuing throughout the entire process, to ensure 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

The objective of these requirements is to ensure consideration of 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 has committed to the implementation of a comprehensive Human Factors Engineering (HFE) program for Barakah in compliance with FANR regulatory requirements, NUREG-0711, and industry codes and standards to assure that key HFE elements are included in the design of the Main Control Room (MCR) and Man-Machine Interface (MMI). The primary objective of this program is to apply HFE 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 efficiency of plant operations.

The MCR design is verified and validated through systematic design evaluations. Plant personnel training, composition of operations shift crew, and the development of operating procedures are correlated closely with the MCR design. The purpose of the Human Factors Engineering program management is to ensure that HFE is successfully incorporated into the overall design and development activities of Barakah NPP. The Man Machine Interface (MMI) evaluations are on-going and are being tested in the simulator for the Barakah NPP. 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. The verification activities have been completed for Unit 1. Through these tests, situations of unacceptable operator performance such as high workloads and/or high operation errors are identified. The problems identified are addressed in the MMI design by changing the design or by providing operator assistance. This

evaluation activity addresses the usability of the MMI resources and allows for deficiencies to be identified and addressed early in the design process.

Information on capabilities and limitations of human performance are also used in the ENEC training programme to ensure heightened attention to details regarding construction and operational safety, security and radiation protection needs associated with nuclear plants. ENEC's Operating Experience Program process identifies, evaluates and employs lessons-learned studies from relevant past and current domestic and international experience in order for ENEC to learn from and develop its own lessons-learned programme. 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 minimize radioactive uptakes during operation.

During plant operation, personnel performance related to important human actions will be monitored. This will help to ensure the validated MMI design continues to enable and support the achievement of plant operational safety goals. Identified deficiencies will be fed into the corrective action program and corrected as appropriate to mitigate recurrence.

ENEC's Management System controls ensure safety and quality in the performance of work activities. These controls are part of ENEC's "Culture of Safety" that governs work in a systematic manner so that nuclear safety, worker health and safety, protection of the public and protection of the environment are achieved. To ensure that the Management System (policies, programme requirements, process descriptions and tools) will persist through the organisational and work scope changes that occur over time, 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 for monitoring performance and driving continuous improvement.

FANR RG-023 provides guidance to licensees for assessing the safety significance of modifications during plant construction. The scope of applicable modifications includes both systems, structures, and components (SSCs) and organisational changes. The guidance in RG-023 assists licensees in determining if a modification requires approval by FANR prior to

implementation. Modifications resulting from the execution of the human factors engineering program during construction are to be evaluated in accordance with the RG-023 guidance.

12.3 Self-assessment of managerial and organizational issues by the operator

As part of ENEC Quality Assurance, program self-assessments, internal audits as well as external audits of KEPCO and subcontractors are conducted. The effectiveness of the management processes used is assessed to confirm their ability to achieve the intended results and to identify opportunities for improvement.

12.4 Arrangements for the feedback of experience in relation to human factors and organizational issues

Human Factors Engineering analyses, 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 fed through the organization 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 Barakah and will continue into the operations phase to address plant design changes and modifications.

12.5 Regulatory review and control activities.

As noted in Section 12.1 above, FANR regulation REG-03 contains requirements for consideration of human factors in design and operation of a nuclear facility.

FANR REG-06 requires applicants for a construction licence to describe how they will apply human factors in the design of the facility. FANR REG-14 requires applicants for an operating licence to also provide facility design information related to human factors. FANR REG-16 requires operating licence holders to consider human and organisational factors in the design and implementation of plant modifications and systematically analyse potential consequences of modifications on human performance. ENEC provided in the PSAR and FSAR for Barakah Units 1 and 2 a chapter describing its Human Factors Engineering programme.

FANR staff reviewed the relevant chapter of the PSAR as part of its review and assessment of the application for the construction licence and found that the information provided by ENEC was adequate to give reasonable assurance that the requirements will be met. FANR staff review of the relevant chapter of the FSAR supporting the operating licence application is on-going.

FANR has conducted an inspection of ENEC's integrated system validation activities to verify that this element of the human factors programme is being carried out in accordance with FANR requirements and the applicable regulatory guidance. This inspection resulted in no adverse findings. As part of FANR's operational readiness decision process for Barakah Unit 1, there are plans to conduct further inspections to assess ENEC's human factors programme for operations.

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" and "As part of its Management System for safety, the Licensee shall set up management safety system and adopt policies and procedures to define and adhere to appropriate Quality Assurance requirements…"

FANR regulation REG-01 *Management Systems for Nuclear Facilities* sets out general requirements for licensees management systems. REG-01 is based on and closely follows IAEA Safety Requirement GS-R-3. FANR has also adopted the IAEA guidance on management systems and has specified ASME NQA-1 as an acceptable approach to the definition of a Quality Assurance programme.

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

ENEC Management system for siting, design, procurement and construction

The Emirates Nuclear Energy Corporation has established a comprehensive Management System for its corporate governance 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:

a) Identifying and integrating the statutory and regulatory requirements which apply to the Company's activities and facilities;

b) Describing the planned and systematic processes, functions and activities necessary to satisfying those requirements;

c) Ensuring that security, quality, environment and business requirements are not considered separately from safety requirements, so as to prevent their possible negative impact on safety.

The Management System encompasses all phases of the nuclear plant lifecycle and activities as applicable, including but not limited to those at ENEC's headquarters, as well as siting, design, procurement, fabrication, construction, commissioning, operation, decommissioning, and any subsequent period of institutional control.

The Management System integrates processes considered essential to manage ENEC's business and technical functions, and includes the organizational structure and framework for developing policies, manuals, processes, procedures, and other tools for approval through the Management System Integration Committee (MSIC).

ENEC's Quality Assurance programme

The Quality Assurance Program as described in the ENEC Quality Assurance Manual (EQAM) is focused on nuclear quality. The Quality Assurance (QA) program is an integral part of the Management System and covers ENEC's scope as the Owner and Licence Holder for the UAE Civil Nuclear Energy Program. The EQAM is based on the requirements of ASME NQA-1:1994

(Ref. 3) and covers quality assurance program for ENEC and its activities including program management and oversight of the Prime Contractor (PC), sub-contractors, and others as required.

The EQAM, the top-tier QA document, is focused on nuclear safety and presents ENEC's overall philosophy for quality and safety, and also establishes the means by which quality and safety is to be achieved. The program related implementing documents and procedures define more detailed responsibilities and requirements and define the organizational interfaces involved in conducting activities within the scope of the ENEC QA program. The QA program is focused on assuring the nuclear safety and quality requirements are met.

The current scope of the QA program addresses the Owner activities for the construction licence covering site-selection, design, procurement and construction activities. The detailed work activities and associated QA programs for the delivery of the Barakah NPP Units 1-4 are performed under the Prime Contractor's QA program, which has been reviewed and released by ENEC for compliance with the ENEC QA program and applicable codes and standards as per the Contract.

The Korea Electric Power Corporation (KEPCO), as the Prime Contractor of the Barakah NPP Units 1-4 project, has developed a QA program that complies with the requirements of ASME NQA-1:1994 and the ENEC QA program.

The KEPCO QA program applies to its activities defined in the contract with ENEC and requires oversight of the contractors and suppliers pertaining to KEPCO's role for the supply of Barakah NPP Units 1-4 as per the contract with ENEC.

ENEC provides oversight of KEPCO and its contractors. This covers technical and commercial oversight. The QA oversight is done through review and acceptance of the KEPCO QA programs, audit plans, other related documents, and through on-going surveillance activities and audits.

The audit programs for ENEC, the contractors and suppliers are supported by audit plans to ensure audits are implemented at a frequency which meets the requirements of on-going project implementation activities and the applicable standards. ENEC QA conducts audits on the Prime Contractor, major Prime Contractor subcontractors and suppliers as required to verify compliance with applicable standards and all aspects of the quality assurance program and to determine its effectiveness.

Nawah's Management System for operations

As part of its application to operate Barakah Units 1 and 2, Nawah has described its integrated management system in Chapter 17 of the FSAR. The principal objectives of the Nawah IMS are to a) bring together in a coherent manner all requirements for managing the organisation in a planned and systematic fashion; b) ensure no other factor be considered outside safety requirements or impact safety in any way; and c) demonstrate compliance with the relevant UAE statutory laws and FANR regulations as they apply to regulated activities. The Nawah IMS describes three levels of structure for IMS documentation based on IAEA GS-G-3.1, Applications of the Management System for Facilities and Activities:

- Level 1: High level overview of Leadership and Management
- Level 2: Programs and Processes
- Level 3: Implementing Procedures

The scope of IMS management encompasses all safety related activities at Barakah NPP and Nawah offices, as well as all phases of the nuclear plant lifecycle. At the time of writing this report, the Nawah IMS remains under review by FANR staff as part of the operating licence application review and assessment process.

Nawah's Quality Assurance Program

As part of its application for a licence to operate Barakah Units 1 and 2, Nawah has described its quality assurance program in Chapter 17 of the FSAR and the Nawah Quality Assurance Manual (NQAM). The NQAM is the top-tier QA document, 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 NQAM addresses the licensee's activities for plant operations which includes Barakah NPP commissioning, operations, engineering, and maintenance activities. The NQA Program complies with ASME NQA-1:1994, Quality Assurance Requirements for Nuclear Facility Applications, with 1995 Addenda, Part I and II with Part III applied in a graded manner. At the time of writing this report, the Nawah QA program and NQAM remain under review by FANR staff as part of the operating licence application review and assessment process.

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 Program (EQAM) has been developed in accordance with ASME NQA-1 "Quality Assurance Requirements for Nuclear Facility Applications".

The current scope of the QA program addresses the Owner activities for the construction licence covering site-selection, design, procurement and construction activities. The detailed work activities and associated QA programs for the delivery of the Barakah NPP units 1-4 project are performed under the KEPCO "QA program for Barakah NPP"; reviewed and released by ENEC for compliance with the ENEC QA program and applicable codes and standards as per the Prime Contract (PC).

The QA program for the operations phase for Barakah Units 1 & 2 is described in Chapter 17 of the FSAR and documented in the Nawah QA Manual. The NQAM has been developed in accordance with ASME NQA-1, portions of ANSI/ANS-3.2, and ASME NCA-4000 and covers the QA program for Nawah and its activities, including program management and oversight of contractors, sub-contractors, and others, as required. At the time of writing this report, the Nawah QA program and NQAM remain under review by FANR staff as part of the operating licence application review and assessment process.

13.4 Audit programmes of the licence holder

ENEC provides technical and commercial oversight of KEPCO and its contractors. This oversight is done through review and acceptance of KEPCO QA programs, audit plans, other related documents, and through on-going surveillance activities and audits.

13.5 Regulatory review and control activities

As noted in Section 13.1 above, FANR regulation REG-01 Management Systems for Nuclear Facilities sets out general requirements for licensees management systems. REG-01 is based on and closely follows IAEA Safety Requirement GS-R-3. FANR has also adopted the IAEA guidance on management systems and has specified ASME NQA-1 as an acceptable approach to the definition of a Quality Assurance programme.

FANR REG-06 requires applicants for a construction licence to describe the arrangements that they will implement to manage Safety, including its management structure, the Management System that will be implemented to assure that all requirements for Safety, Security and Safeguards will be satisfied during the proposed activity, and its strategy for the development, maintenance and enhancement of a strong safety culture. ENEC provided in the PSARs for Barakah Units 1-4 a chapter describing its Management System and Quality Assurance programme.

FANR staff reviewed the relevant chapter of the PSAR as part of its review and assessment of the complete application and found that the information provided by ENEC was adequate to give reasonable assurance that the requirements will be met.

Under the powers granted by the UAE Nuclear Law FANR conducts inspections of the licensee and its suppliers following a systematic plan, focusing 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 Korea and the USA. Findings from these inspections are communicated to the licensee for corrective action. In 2016 to the end of June, FANR has conducted 6 inspections of the Barakah NPP site and 4 inspections of major suppliers. The inspections have resulted in a total of 44 findings, all judged to be of low safety significance. Although the scope of these inspections is broader than quality assurance and management systems, the areas where the inspectors most frequently made findings in 2016 were process management (design control), management of the corrective action program, and product control, including documentation, receipt, handling, and acceptance of products. With Barakah Unit 1 nearing operation, the inspection programme has begun to shift towards verifying the readiness of organizational aspects for plant operation.

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 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 Authority'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 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 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 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 first two units at the Barakah facility are described in full in the UAE national report to the 6th Review Meeting. Since the 6th Review meeting FANR completed its review of ENEC's construction licence application for Barakah Units 3 and 4 and documented its findings in a Safety Evaluation Report (SER). ENEC's application for Unit 3 and 4 construction was identical in all essential technical aspects to the previous application for Units 1 and 2. FANR's review process followed the similar steps as for the first two units, re-using the previous safety assessments where applicable and focusing on departures from the original application. The SER summary is available on FANR's web site. On 15 September 2014, the FANR Board of Management accepted the findings and recommendations of the staff and decided to issue the construction licence for Barakah Units 3 and 4. The Construction Licence is also available on FANR's web site.

Construction of the four units is progressing according to the schedule set by ENEC.

14.1.2.2 Operating licence for the Barakah nuclear installation

ENEC submitted an application on behalf of Nawah Energy Company (Nawah) to FANR on 26 March 2015 for the operation of the first two units of the nuclear facility at the Barakah site (Barakah Units 1 and 2). Nawah is to be fully incorporated as a wholly owned subsidiary of ENEC.

The application requested authorisation to conduct Regulated Activities involving Barakah Units 1 and 2, 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 submission, while the application was for both Barakah Units 1 and 2, the construction schedule for Unit 2 is approximately one year behind Unit 1. Accordingly, ENEC requested separate operating licenses for each unit, to be issued as construction progresses.

ENEC's comprehensive application 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 US recommendations. The FSAR submitted by ENEC included the required safety, safeguards and security information, consistent with the integrated "Three-S" approach.

Review and assessment

FANR is conducting a thorough review and assessment of the application in accordance with its established process as outlined above.

FANR is using a graded approach to focus resources on the most risk significant areas of the licence Application and is using 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 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 intends to use 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.

Current licensing status

The application for a licence to operate Barakah Units 1 and 2 is currently under review by FANR.

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) a summary of the results of the non-nuclear Commissioning tests carried out; and

(b) a commitment to a nuclear Commissioning test programme to be conducted.

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

14.2.2 Main elements of programmes for continued verification of safety

In the current phase of the nuclear facility in the UAE, the principal safety verification objective for activities conducted under the current 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 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 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:

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

2. Stages III and IV: Work is performed under the direction of the Commissioning Group and this area includes construction acceptance test (CAT), 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 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.

FANR currently has approximately 60 qualified inspectors involved in regulatory activities, supported by other FANR subject matter experts and contractors. FANR has deployed 5 resident inspectors to a permanent site office at Barakah to assist in overseeing the construction and commissioning 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 also engaged a specialist TSO to provide support for inspection programme planning and for conduct of field inspection

FANR has formulated annual inspection programmes covering the activities of 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.

In 2015, for example, FANR conducted twenty-two team inspections to verify the work of ENEC, its prime contractor KEPCO, and major suppliers located in Korea and the USA. For example, in October 2015, a design verification inspection was carried out at KEPCO for the Auxiliary Feedwater System. In addition, FANR inspectors carried out inspections on site to directly verify construction and commissioning activities on all four units. Inspected SSCs included Reactor Coolant and Safety Injection system piping, class 1E electrical equipment, and safety related pumps among others. The findings from each inspection were communicated to the licensee for corrective action. All of the findings for 2015 were judged to be of low safety significance. The FANR assessment of inspection findings concludes that ENEC's overall effectiveness in managing safety was generally acceptable.

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 Nuclear Law gives FANR the authority to regulate radiation protection in the overall nuclear sector of the UAE. Article (38) of the UAE Nuclear Law specifies that FANR Board of

Management shall issue the regulations specifying the requirements which all operators must comply with and follow.

FANR developed radiation protection related regulations to implement the Nuclear Law requirements. FANR regulations are based on the best international practices and acknowledge the fundamental principles of radiation protection; justification of practices, dose limitation and optimization of protection and safety.

15.1.1 Justification

The UAE government conducted an analysis of the future energy demand for the country. The analysis concluded that national annual peak demand for electricity is likely to rise to more than 40,000 MW by 2020, reflecting a cumulative annual growth rate of approximately 9% from 2007 onward. The UAE has taken steps to evaluate viable options to meet future demand. 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.

Through the licensing process the Barakah nuclear power plants have demonstrated a low radiological impact on workers, the public and the environment, supporting the conclusion that the nuclear power plants provide a net benefit to society, which is outweighed by the risk of radiation exposure associated with commercial nuclear power.

15.1.2 Limitation

FANR-REG-04 *Regulation for Radiation Dose Limits and Optimisation of Radiation Protection for Nuclear Facilities* 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, which serves as a design constraint for new facilities.

The licensee shall ensure that occupational exposures and public exposures to ionizing radiation and all discharges of radioactive material 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 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 (ALARA), taking account of social and economic factors.

15.2 Regulatory Requirements Concerning Radiation Protection at Nuclear Installations

FANR has developed the following regulations and key provisions dealing directly with 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.

> *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 50 mSv in any one year. The annual Equivalent Dose in the lens of the eye of a Worker shall not exceed 150 mSv, nor shall the annual Equivalent Dose exceed 500 mSv at any point on the hands, feet or skin.*
>
> *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.*

The dose limits established in FANR-REG-04 are consistent with International Commission on Radiological Protection (ICRP) recommendations and are based on the tissue weighting factors published in the 1990 ICRP Recommendations (ICRP Publication 60). FANR is in the process of revising FANR-REG-04 to reflect the new ICRP 2007 recommendations (ICRP Publication 103) so that the annual equivalent dose in the lens of the eye of a worker shall not exceed 20 mSv in a year, averaged over a period of 5 years (100 mSv in 5 years), with no single year exceeding 50 mSv.

FANR-REG-11 *Regulation for Radiation Protection and Predisposal Radioactive Waste Management in Nuclear Facilities* compliments 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 following provisions:

a) 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

b) 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 "Application of the Concepts of Exclusion, Exemption and Clearance".

Article 23 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.

FANR-REG-06 *Regulation for an Application for a Licence to Construct a Nuclear Facility* and FANR-REG-14 *Regulation for an Application for a Licence to Operate a Nuclear Facility* require the licensee to develop a radiation protection programme including 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

The design of the Barakah NPP incorporates radiation protection measures to ensure that occupational radiation exposures in future operation will be ALARA. 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 ionizing 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 maintain exposures ALARA.

Radiation protection training and development are currently in progress within ENEC, and an employee training programme has been established to provide all employees with knowledge of the fundamentals of radiation protection. Future training for radiation workers that will require access to areas of potential radiation or contamination will begin in Q3 2016.

The collective effective dose is part of the safety assessment presented by the applicant for FANR review. The collective effective dose is compared with currently operating, similar facilities throughout the world. The expected collective occupational exposure at Barakah Units 1 and 2 compares favourably with both the Electric Power Research Institute (EPRI) Utility Requirements Document criteria of less than 1 person-Sv/yr, as well as current PWR occupational performance in the United States as referenced in "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 Barakah Units 1 and 2 have been optimised. Remedial actions in the event of an overexposure of a worker or workers are required to 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. Accordingly, the Cabinet of Ministers approved the Cabinet Resolution No. 72

of 2015 “Concerning Administrative Penalties on Violating the Conditions of the Licences” issued by FANR.

15.3.2 Control of Radiation Exposure of Members of the Public and the Environment

ENEC submitted the pre-operational Radiological Environmental Monitoring Programme (REMP) to FANR and committed to collect background radiological data for two years prior to plant operation.

FANR will publish a report on the baseline radiation levels and radioactive materials in the environment of the UAE, prior to the operation of the Barakah NPP Unit 1. The objective of this report is to determine a reference point prior to the start of UAE commercial nuclear power to be used to assess the impact of routine environmental discharges, and also in the event of a nuclear incident.

FANR’s environmental laboratory is established and continuing to develop its capabilities to analyse environmental samples for radionuclides discharged from nuclear power plants. FANR’s results will be compared with those from the Licensee’s REMP. A detailed radiological environmental monitoring report will be published by FANR for public information.

Other FANR radiological environmental monitoring capabilities also include gamma monitoring stations. They provide a continuous gross gamma measurement for UAE and around Barakah Nuclear Power Plants in order to continuously assess the impacts of nuclear activities on the environment.

15.4 Regulatory Review and Control Activities

FANR staff are conducting a thorough review and assessment of the radiation protection design features provided in the Final Safety Assessment Report (FSAR) to assure that the ALARA philosophy is implemented and consistent with the applicable ALARA 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 conducts inspections on key systems, structures and components related to radiation protection and the ALARA principle at various fabricators. As-built inspections are performed to verify that the drawings and equipment specifications are consistent with the as-built conditions at

the plant. As applicable radiation protection program elements are developed, FANR plans to perform inspection on these documents and their implementation.

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 Federal Law by Decree No 6 of 2009 on the Peaceful Uses of Nuclear Energy specifies the roles and responsibilities of the licensee, the competent government authorities and FANR regarding Emergency Preparedness and Response including the development, review, approval, and oversight of the Licensee's on site and the off-site emergency plans.

Federal Law by Decree No 2 of 2011 establishes the National Emergency, Crises and Disasters Management Authority (NCEMA) as the national competent authority for developing national emergency response plans, coordinating response, and conducting exercises. This Law outlines the main functions and responsibilities assigned to NCEMA to carry out the UAE policy regarding necessary procedures to be used for managing and coordinating emergencies, crises and disasters.

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

Moreover, FANR is part of two committees for the Barakah NPP project, National Emergency Preparedness Coordination Committee (NEPCC) and Barakah Exercise Preparation Committee, which have been established by the coordinating authority NCEMA.

FANR cooperates with NCEMA and other concerned entities, in preparing the General Framework for National Nuclear and Radiological Emergency Response, which describes the roles and responsibilities of each national-level concerned entity.

FANR and other national-level concerned entities participated in developing a National Risk Register (NRR), based on analysis and assessment of potential risks and threats the country faces, which included all internal and external radiological and nuclear risks and hazards. The National Risk Register is managed and maintained by NCEMA.

In February 2016, the Ministry of Interior (MOI), in cooperation with the concerned entities, developed and approved the third version of the Off-site Nuclear and Radiological Emergency Response Plan for Barakah Nuclear Power Plant (hereafter referred to as the Off-site Plan) which describes the roles and responsibilities of each national and local response entity, and the support organisations.

IAEA missions

The UAE hosted an IAEA IRRS mission in December 2011 with a follow-up mission taking place in February 2015. For the follow-up mission it was agreed that the Emergency Preparedness and Response area would be reviewed during an EPREV peer review mission which took place in March 2015.

The purpose of the EPREV Mission was to conduct a review of the United Arab Emirates (UAE) emergency preparedness and response (EPR) arrangements and capabilities associated with the Barakah NPP. The EPREV Mission also assessed progress with the previous finding of the 2011 IRRS Mission to the UAE in this area. The review was carried out by comparing existing

arrangements with the current international safety standards and good practices. FANR in cooperation with NCEMA, MOI, ENEC and other concerned entities were involved in the EPREV Mission peer review. The EPREV mission identified six recommendations, five suggestions and two good practices. FANR in cooperation with NCEMA, MOI, ENEC and other concerned entities prepared an action plan to address the EPREV Mission's recommendations and suggestions. The action plan was submitted to the IAEA for future follow up by an EPREV Mission. The UAE is planning to have a follow-up mission in the near future.

For more information, please click on the link below:

https://fanr.gov.ae/En/Documents/2015EPREV-UAE-Final%20(2).pdf

16.1.1 On-site Emergency Planning

FANR-REG-12, "Regulation for Emergency Preparedness for Nuclear Facilities," specifies the Authority's requirements for the Licensee's preparation and planning for and response to Emergencies at Nuclear Facilities. 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 perform 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 arrangements shall be described in the Emergency Plan, including definition of authorities, responsibilities, and duties of individuals assigned to it and the means for notification of such individuals in the event of an emergency.

The Barakah Units 1 and 2 On-site Emergency Plan (hereafter referred to as On-site Emergency Plan) has been developed in accordance with FANR-REG-12, and is supported by On-site implementing procedures. ENEC assessment of the potential emergencies associated with the Nuclear Facility is included this assessment in its On-site Emergency Plan.

Following the Fukushima event, ENEC undertook actions to enhance emergency preparedness with respect to communications and staffing given a multi-unit event.

ENEC is implementing an emergency classification scheme based on system and effluent parameters which offsite response organizations use for offsite protective action decisions. This classification scheme is aligned to the National Response plan, maintained by NCEMA. The On-

site Emergency Plan provides for four classes of emergencies: (1) General Emergency, (2) Site Area Emergency, (3) Alert and (4) Notification of Unusual Event.

The On-site Emergency Plan includes predefined Emergency Action Levels (EALs) based on the abnormal conditions for the Nuclear Facility, security related concerns, releases of radioactive material, environmental measurements and other observable indicators. The Onsite Emergency Plan includes EALs for all abnormal conditions that correspond to each of these classes of emergency. The emergency plan developed by ENEC will be implemented by emergency procedures in the form of documents and instructions that will detail the implementation actions and methods required to achieve the objectives of the requirements in the FANR-REG-12.

ENEC 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 MCR is not considered an emergency response facility; however, it is the location from which emergency response operations and activities will be initiated.
- Technical Support Centre (TSC) – the TSC is the On-site emergency response facility that is located close to the MCR, and which will provide plant management and technical support to the MCR during an emergency situation. Once operational, the TSC serves as the primary communications centre during an emergency situation.

  Operational Support Centre (OSC) – the OSC is an On-site assembly area separate from the MCR and TSC where operations support personnel report to, and are deployed from, during the response to an emergency situation.

ENEC submitted the On-site Emergency Plan to FANR in November 2014. FANR reviewed the On-site Emergency Plan as part of the Final Safety Analysis Report (FSAR) Chapter 13.3 Emergency Planning review.

FANR is currently conducting Emergency Preparedness (EP) inspections on the ENEC emergency planning programme and emergency facilities as part of FANR operational readiness inspection programme for Barakah NPP Unit 1.

To better estimate source terms from a multi-unit nuclear accident, FANR uses an updated version of RASCAL (Radiological Assessment System for Consequence Analysis) software which is provided for multi-unit assessment capability by the United States Nuclear Regulatory Commission (U.S. NRC).

16.1.2 Off-site Emergency Planning

FANR-REG-15, "Requirements for Off-site Emergency Plans for Nuclear Facilities" provides the requirements for the Off-site emergency plan. This regulation defines:

a) Terms and procedures for preparation of Off-site Emergency Plans;

b) Responsibilities and duties for implementation;

c) Measures for mitigation and remediation of consequences;

d) Arrangements for warning of the public; and

e) Measures for testing Emergency Preparedness.

The Ministry of Interior (MOI) in coordination with the concerned entities has developed the Off-site Plan. This plan has been developed in accordance with the FANR-REG-15, and includes annexes addressing responsibilities of external stakeholders; each annex is supported by implementing procedures. FANR has drafted FANR Regulatory Guide 024: "Criteria for Protective Actions in Response to a Nuclear or Radiological Emergency". This Regulatory Guide addresses the Generic Criteria, Operational Criteria and the Emergency Action Levels (EALs), which will be utilised for recommending and advising protective actions and other actions aimed at enabling the termination of a nuclear or radiological emergency through transition to an existing exposure situation.

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 under the full Off-site Emergency Plan, together with the On-site Emergency Plan, prior to receipt of nuclear fuel.

NCEMA, FANR, ENEC and other concerned entities conducted five table-top drills, eight Integrated Facility Drills, and two drills with offsite participation to enhance the coordination between the On-site and Off-site activities for Barakah NPP before the Fuel Receipt Exercise.

ENEC and other concerned entities in coordination with FANR and NCEMA successfully conducted a Full Scale Fuel Receipt Exercise on 23rd February 2016. The purpose of the Barakah exercise was to meet FANR's requirements for a pre-fuel receipt exercise, and to evaluate Onsite and Off-site plans and response entities' capabilities. ENEC has committed to conduct a full scale exercise prior to fuel load to fully demonstrate the full response capabilities of the onsite response organisation. ENEC is coordinating with FANR and NCEMA on the development of the Fuel Load Exercise objectives, extent of plan and scenario

Prior to the pre-fuel receipt Barakah exercise FANR developed On-site and Off-site assessment plans that described pre-exercise review elements, processes for evaluating exercise conduct, and a post-exercise evaluation summary. Prior to the exercise, FANR reviewed ENEC's proposed Exercise Objectives and Extent of Play submittal including the scenario. FANR verified that all critical elements were addressed and aligned with objectives. Subsequently, FANR developed Exercise Evaluation Criteria based on IAEA EPR-Exercise 2005, "Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency," and trained Assessors in the use of the evaluation criteria. ENEC developed its own evaluation criteria based on NUREG 0654, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants and included them in their process for self-critique to improve the EPR programme.

ENEC submitted to FANR, the Barakah NPP Fuel Receipt Exercise Scenario Package, which identified forty eight objectives for the exercise, of which twenty-four covered elements to test the capabilities of ENEC to mobilize and perform required On-site emergency response actions.

At the request of FANR, the IAEA sent an expert mission of three emergency planning counterparts to observe the preparation, conduct and evaluation of the Barakah NPP Emergency Exercise. The team participated in meetings and training sessions conducted before the exercise and observed pre-exercise planning discussions among the different On-site and Off-site organizations involved in the exercise.

16.2 Information of the public and neighbouring states

Communications with the Public

FANR Regulation 15 Article 6, "Arrangements for Warning of the Public" states:

"The Off-site Emergency Plan shall include arrangements for:

a. *Coordinating the release of information during an Emergency, including identifying the Competent Authority to be the source of official information;*

b. *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;*

c. *Responding to any misleading, inaccurate or confusing information appearing in the media; and*

d. *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 Operation Centre, led by NCEMA, and consisting of the National Media Council, Abu Dhabi Police Security Media department and other supporting organisations to implement the media and public information plan in order to issue warnings and instructions to the public and to handle the media through press conferences or other approved media channels within two hours of receiving notification of Site Area Emergency (SAE) or General Emergency (GE).

Communication with Neighbouring States

The UAE is working with the other GCC countries on revising the GCC Radiological/Nuclear Emergency Response Plan through a Technical Cooperation (TC) project with the IAEA. The arrangements for informing competent authorities in neighbouring states are coordinated by the Ministry of Foreign Affairs in consultation with NCEMA and FANR.

FANR participates in the IAEA's Unified System for Information Exchange (USIE) for Incidents and Events as the method for rapidly sharing nuclear or radiological event information with IAEA and its member countries. Since 2012, FANR has participated in a number of Convention

Exercises (ConvEx) conducted by the Incident and Emergency System in the IAEA using the USIE program.

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 Federal Law by Decree No. 6 of 2009 (or simply 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, and 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. Construction of the first two units at Barakah is progressing 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 being constructed 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. In September 2014 FANR issued a Construction Licence for Barakah Units 3 and 4.

In March 2015, ENEC submitted to FANR an Operating Licence Application (OLA) for Barakah Units 1 and 2. The OLA for Units 1 and 2 includes the Final Safety Analysis Report (FSAR) and other supporting documents required by FANR for review and approval. The OLA for Barakah Units 1&2 incorporates 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 includes 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 updates 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.

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 is needed with regard to the seismic margin or capacity for the Barakah units. This includes 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 such as 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 are 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 is also reviewing the quality assurance programmes that ENEC submitted in support of its Operating Licence Application for Barakah Units 1 and 2. FANR maintains a close liaison with the UAE competent authorities in the fields of the environment and emergency management. 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 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-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 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 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 PSAR. 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 south and north 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 east and west 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 essential safety features actuation system signals are used to actuate two or four independent essential safety feature trains. Where it is practical, an essential 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 class1E 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 recombiners 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 updated information in the operating licence application is currently under review.

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 licence application 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.

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,
- 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 all these design enhancements has been 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 are being assessed under the review of the operating licence application for the Barakah units.

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, 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 first of the four Barakah units is currently in the final phases of construction and in the early phases of system commissioning. The other three units are currently under construction. All these activities are performed in accordance with the provisions of the construction 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 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 are currently reviewing the information supplied in support of the operating licence application for the first of the Barakah 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

The APR-1400 is developed from technology developed and licensed in the United States. 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 four APR-1400 units at Shin-Kori and Shin-Hanul in Korea. Shin-Kori Units 3&4, which are now nearing completion, are the reference plants for the UAE facility.

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.

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:

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

b) The MMI system and function allocation are designed to provide the operating crew with acceptable workload levels to assure vigilance.

c) The MMI system is designed to support a high degree of situation awareness for the plant operators.

d) Signal detection and event recognition principles are kept within the operator information processing limits.

e) The MMI is designed to minimize operator memory load.

f) 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:

a) Operating experience review (OER)

b) Functional requirements analysis (FRA) and function allocation (FA)

c) Task analysis (TA)

d) Staffing

e) Human reliability analysis (HRA)

f) MMI design

g) Procedure development

h) Training program development

i) 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:

a) The design process is iterative.

b) HFE analyses such as OER, FRA/FA and TA are provided to the designers for incorporation into the design.

c) Design reviews and design review meetings by each member in the design team and by independent reviewers are used for interdisciplinary review.

d) 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:

1. The design shall be aimed at limiting the effects of human errors.
2. Consideration of human factors and the man–machine interface shall be included in the initial design process and shall continue throughout the entire process.
3. 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.
4. Verification and validation of the human factors engineering.
5. The time available for action, the physical environment to be expected and the psychological demands to be made on the operating personnel.
6. 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 construction licence applications.

The information provided in support of the construction licence applications has been updated and supplemented in the operating licence application for Barakah units 1 and 2. This information is currently under review by FANR staff.

Article 19: Operation

CNS Text:

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

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

19.1 Initial authorisation

The UAE nuclear power project is currently at the construction stage. However, the provisions of CNS Article (19) are being implemented at the current time. On 26th March 2015 ENEC submitted an operating licence application for Barakah 1 and 2 to FANR. This application is currently under review and assessment by FANR.

The Nuclear Law specifies that operation of a nuclear facility is a regulated activity that requires a licence issued by FANR. The current construction licence issued by FANR authorises the licensee to conduct cold and hot functional testing of the systems of the as-built facility but does not authorise possession of special nuclear material or loading of nuclear fuel or initial testing or operation of the reactor.

FANR issued regulation REG-14 which specifies requirements for the content of the operating licence application. In addition FANR has REG-16 with comprehensive requirements for safety in operation. The development of these regulations takes into consideration the relevant IAEA safety requirements for operation of a nuclear facility.

FANR REG-16 "Operational Safety Including Commissioning" includes the remaining relevant requirements associated with the operational phase. For example, Article 8 "Operational Limits and Conditions" requires that the facility be operated in accordance with the OLCs to prevent accidents and events and ensure the ability to mitigate such events if they occur. The OLCs are derived from the safety analysis and are reviewed for operating experience insights.

Article 25 "Procedures" requires that all important to safety activities shall 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 "Structure and Functions of the Organization", Article 6 "Staffing and resources of the Organization" and Article 9 "Qualification and Training of Personnel include necessary requirements to ensure sufficiently qualified and trained staff for all important to safety functions including adequate training facilities for all technical and maintenance disciplines.

Article 23 “Feedback on Operating Experience” requires an operating experience programme to address events from the facility as well as events in the nuclear industry worldwide to learn from all such events.

These requirements along with many other Articles in areas such as Safety Policy, Control of Nuclear Facility Configuration, Equipment Qualification, Chemistry Programme and many others in coordination with FANRs existing regulations establish a comprehensive basis for initial and ongoing regulation of operations.

The ENEC operating licence application is based on the submissions for the reference plant that will have been previously reviewed and have resulted in an operating licence decision by the Korean authorities. The operating licence application included the Final Safety Analysis Report (FSAR) and other supporting documents required by FANR for review. The FSAR will includes information concerning 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, plans for coping with emergencies, and proposed technical specifications. The FSAR is the principal document upon FANR is basing its review and assessment to support a future decision to issue an operating licence.

As construction of each unit is completed, the focus is shifting to commissioning, start-up and operation of the facility. ENEC will train staff and oversee the operating organization to ensure a smooth transition from construction to commissioning and operation under the responsibility of the Chief Nuclear Officer (CNO). The prime contractor, KEPCO is responsible for conducting the commissioning activities while ENEC conducts oversight. ENEC is ultimately responsible for the safe execution of activities for the nuclear power plant- project.

Stages III, IV and V of the Preoperational Inspection System are being performed under the direction of the Commissioning Group including the construction acceptance test (CAT), Cold Functional Test, and pre-core Hot Functional Test. Stage V of the Preoperational Inspection System, comprising Initial Start-up Test including Initial Criticality, Low-power Physics tests, and Power Ascension tests will be conducted after the operating licence has been granted by FANR.

ENEC has developed an operational readiness process to introduce the capability to safely and reliably operate the Barakah Nuclear Power plant with due regard for safety of people and the

environment and compliance with regulatory requirements and international obligations. This process has been described in application documents for the operating license application and includes WANO performance objectives and criteria for each of the 17 functional and cross functional areas and 14 support areas. The UAE has requested the IAEA to conduct a pre-operational Operational Safety Review Team mission prior to commissioning of the first unit at the Barakah nuclear facility to provide additional assurance of readiness for operations

FANR has established a baseline inspection program to evaluate the commissioning activities as well as a series of inspections to evaluate operational readiness. FANR inspections cover a full range of activities during the construction period as well as during the commissioning activities to examine ENECs basis to establish that the facility has been constructed in accordance with design. Inspection procedures cover for example: procurement, design verification, structural concrete, containment liner and penetrations, important to safety piping and welding. There are specific inspection activities for commissioning tests where FANR 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 future operating company. For example, there are inspection procedures for surveillance testing, fire protection programme, personnel training and qualification, contamination control and conduct of operations as examples.

FANR issues written inspection reports for each inspection including any findings that require corrective action of the licensee. When ENEC determines 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 an operating license or will evaluate any open findings to determine whether it is appropriate to grant the operating license with the finding still open.

ENECs programme of oversight of commissioning and operational readiness in combination with FANR's independent inspection program supplement provide a basis to conclude that the written submittals in the operating license for facility design and operator readiness have been implemented and are in place.

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

IV. CONCLUSION

The discussion contained in this third National Report by the UAE as a Contracting Party to the CNS confirms a conscientious and systematic effort by the government and the relevant bodies in the UAE to implement fully the obligations of the Convention in developing the programme for the peaceful uses of nuclear energy. The government has supported the establishment of the necessary legislative, regulatory, and organizational framework to ensure the safety, security and non-proliferation of the technology being used. The UAE programme has made significant progress in the construction license phase and has entered into the advanced stages of preparation for the transition to operations for the first reactor in the near future, followed by the remaining three units. Relevant UAE organizations are fully committed to meeting the obligations of the CNS 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 CNS Contracting Parties on this National Report and is committed to clarifying any issues raised during the 7th Review Meeting on the Convention on Nuclear Safety.

ANNEX 1 – List of Acronyms

AAC	Alternate AC
AB	Auxiliary Building
ACR	Advanced Control Room
ALARA	As Low As Reasonably Achievable
APR	Advanced Pressurized Reactor
ASME	American Society of Mechanical Engineers
CAMP	Code Applications and Maintenance Program
CEP	Construction Environmental Permit
CFS	Cavity Flooding System
CFT	Cold Functional Test
CICPA	Critical Infrastructure and Coastal Protection Authority
CLA	Construction Licence Application
CNS	Convention on Nuclear Safety
CPS	Computerised Procedure System
CSS	Commission on Safety Standards
DSWG	Design Specific Working Group
EAL	Emergency Action Level
EAD	Environmental Agency of Abu Dhabi
ECSBS	Emergency Containment Spray Backup System
EIA	Environmental Impact Assessment
ENEC	Emirates Nuclear Energy Corporation
EPR	Emergency Preparedness and Response
EPRI	Electric Power Research Institute

EQAM	ENEC Quality Assurance Manual
ERF	Emergency Response Facility
EPREV	Emergency Preparedness Review
FANR	Federal Authority for Nuclear Regulation
FSAR	Final Safety Analysis Report
GCC	Gulf Cooperation Council
GE	General Emergency
GMRS	Ground Motion Response Spectra
GNEII	Gulf Nuclear Energy Infrastructure Institute
GSOR	Generic Safety Observations Report
HFE	Human Factors Engineering
HFT	Hot Functional Test
HRD	Human Resources Development Service of Korea
HMI	Human-Machine Interface
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
IMS	Integrated Management System
INPO	Institute of Nuclear Power Operators
IPASS	International Physical Protection Advisory Service

IRRS	Integrated Regulatory Review Service
IRWST	In containment Refuelling Water Storage Tank
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
KINS	Korea Institute of Nuclear Safety
KM	Knowledge Management
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
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
NPP	Nuclear Power Plant

NPT	Treaty on Non-Proliferation of Nuclear Weapons
NRR	National Risk Register
NQAM	Nawah Quality Assurance Manual
NRC	US Nuclear Regulatory Commission
NUSSC	Nuclear Safety Standards Committee
NSGC	Nuclear Security Guidance Committee
OLA	Operating Licence Application
OLC	Operational Limits and Conditions
ORPAS	Occupational Radiation Protection Appraisal Service
OSART	Operational Safety Assessment Review Team
OSC	Operations Support Centre
PARS	Passive Autocatalytic Recombiners
PC	Prime Contract
PPP	Physical Protection Plan
PRA	Probabilistic Risk Assessment
PSAR	Preliminary Safety Analysis Report
QA	Quality Assurance
RASCAL	Radiological Assessment System for Consequence Analysis
RASSC	Radiation Safety Standards Committee
RBCOO	Regulatory Body Country of Origin
REMP	Radiological Environmental Monitoring Programme
RO	Reactor Operator
SAAR	Severe Accident Analysis Report
SAE	Site Area Emergency

SAT	Systematic Approach to Training
SER	Safety Evaluation Report
SRO	Senior Reactor Operator
SSAC	State System of Accounting and Control
SSC	Structure, Systems, and Component
TC	Technical Cooperation
TESG	Technical Evaluation Subgroup
TSC	Technical Support Centre
TSO	Technical Support Organisations
WANO	World Association of Nuclear Operators

ANNEX 2 – Executive Summaries of IAEA Peer Reviews

IRRS EXECUTIVE SUMMARY (full report here)

At the request of the Government of the United Arab Emirates (UAE), an international team of senior safety experts met representatives of the Federal Authority for Nuclear Regulation (FANR) and other organizations contributing to nuclear and radiation safety from 31 January to 8 February 2015 to conduct the IRRS follow-up mission to the UAE. The follow-up mission took place at the headquarters of FANR in Abu Dhabi. The purpose of the follow-up mission was to review the measures undertaken following the recommendations and suggestions from the initial IRRS mission conducted in 2011. In addition, the follow-up mission was extended to include a review of the transport of radioactive material.

The follow-up mission compared the UAE regulatory framework for nuclear and radiation safety against IAEA safety standards as the international benchmark for safety. The follow-up mission was also used to exchange information and experience between the IRRS follow-up Team members and the UAE counterparts in the areas covered by the IRRS.

The IRRS follow-up Team (the Team) consisted of six senior regulatory experts from six IAEA Member States and four IAEA staff members.

The Team carried out a review of the measures undertaken following the recommendations and suggestions of the 2011 IRRS mission in the following areas: responsibilities and functions of the government; the global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body related to regulation of nuclear power plants and use of radiation sources, including authorization, review and assessment, inspection, enforcement, and the development and content of regulations and guides. The additional area of the transport of radioactive material referred to above was also reviewed.

The follow-up mission included a review of reference material and interviews and discussions with management and staff from FANR and other organizations.

Throughout the mission, the Team was extended full cooperation in discussing regulatory and technical issues by all parties; in particular, the staff of FANR provided the fullest practicable assistance and demonstrated extensive openness and transparency.

The Team concluded that the recommendations and suggestions from the 2011 IRRS mission have been taken into account systematically by a comprehensive action plan. Significant progress had been made in many areas and many improvements were carried out following the implementation of the action plan.

The initial IRRS mission in 2011 made 57 findings; 18 recommendations and 39 suggestions.

As agreed between FANR and the IAEA during the IRRS follow-up preparatory meeting in September 2014, the findings related to Module 10, "Emergency Preparedness and Response", i.e. 4 recommendations and 5 suggestions, are to be addressed during the upcoming IAEA EPREV mission in March 2015. During this follow-up mission, the Team determined that 13 out of 14 recommendations reviewed and 30 of 34 suggestions reviewed had been effectively addressed and therefore could be considered closed. FANR should be commended for this accomplishment.

The Team concluded that FANR has further strengthened its regulatory oversight and made significant progress in addressing the findings of the 2011 IRRS mission and have demonstrated commitment for an effective implementation of the IRRS programme, by inviting an IRRS follow-up mission.

The Team identified certain issues warranting attention or in need of improvement. This report includes 3 new recommendations and 2 new suggestions. Key areas for improvement, including the findings from the extended part of the mission, i.e. transport, include:

• The Government of the UAE should develop a National Policy and Strategy for the management and disposal of spent nuclear fuel and radioactive waste;

• FANR should consider strengthening its capacity to implement its regulations on the safe transport of radioactive material;

• FANR should consider developing a procedure, in the integrated management system, to periodically review its regulations and guides to maintain consistency across the different regulated facilities and activities;

• The Government of the UAE should issue the Resolution concerning the administrative penalties and fines, that is required to provide FANR with the necessary authority to apply them;

• FANR and the relevant Health Authorities should develop and publish Diagnostic Reference Levels for the UAE.

EPREV EXECUTIVE SUMMARY (full report here)

An Emergency Preparedness Review (EPREV) mission was conducted by the International Atomic Energy Agency (IAEA) in the United Arab Emirates (UAE) from 21 to 31 March 2015. EPREV missions are designed to provide a peer review of emergency preparedness and response arrangements in a country based on the IAEA Safety Standards. The specific purpose of this EPREV mission was to review emergency preparedness and response (EPR) arrangements and capabilities associated with the Barakah Nuclear Power Plant.

The nuclear emergency preparedness and response framework in the UAE is being effectively built on an existing national crisis and emergency management structure that is clear, well defined and tested.

This all-hazard approach is consistent with IAEA safety standards and is a key to the future success of the emergency preparedness and response program. In addition, the EPREV identified particular strengths in the following areas:

- Roles and responsibilities are clearly defined;
- The operational emergency management system is well established and clear;
- Detailed draft EPR plans and procedures are developed for the Barakah Nuclear Power Plant, which are generally consistent with IAEA safety standards;
- Great progress is being made in the development of facilities and a capability to manage the medical aspects of a nuclear emergency;
- There is a national framework for recovery, on which to build the strategy for the transition to existing exposure situation following an emergency;
- Co-locating the onsite and offsite emergency operations centres is considered a good practice that can greatly enhance the coordination of these authorities during an emergency; and
- The participation of the UAE in the GCC Regional Nuclear and Radiological Emergency Preparedness and Response Plan is also a good practice.

The EPREV identified some areas where improvements need to be considered, or where progress in implementation should be sustained. These include the following key elements:

- There is a need to clarify the public protection strategy, including the decision-making process for the protection of the public during an emergency, addressing amongst others the field survey strategy and the use of measurements in the decision-making process;

- The national public communications strategy for nuclear emergencies needs to be accurately reflected in all plans;

- Key offsite emergency stakeholders need to ensure the availability of a sufficient number of qualified personnel for extended emergencies;

- The team encourages the continued strong efforts to complete the implementation and testing of relevant emergency plans and procedures, as well as the construction of emergency facilities and acquisition of equipment to ensure their readiness before the May 2016 largescale exercise.

The EPREV team noted the excellent cooperation of all organizations involved in the review mission. In particular, the team would like to commend all parties met during the mission for the safety culture attitude and the quest for excellence displayed.

This report serves as the final record of the EPREV mission. The IAEA will continue to work with the UAE to further develop and improve nuclear and radiological emergency preparedness arrangements. It is expected that the UAE will develop an Action Plan to implement the recommendations and suggestions contained in this report, and will invite the IAEA for an EPREV Follow-Up Mission within two to four years to review the implementation.