NUCLEAR SECURITY – INTEGRATED LICENCE FOR OPERATION OF FIRST UNIT OF BARAKAH NPP IN THE UNITED ARAB EMIRATES

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Abstract

This paper presents the process of the licence for operation of Unit 1 of Barakah Nuclear Power Plant (NPP) that has been followed by Federal Authority for Nuclear Regulation (FANR) in regards with the nuclear security requirements of the United Arab Emirates (UAE). FANR, the nuclear regulator of the UAE in accordance with the Federal Law by Decree No. 6 of 2009 on Peaceful Uses of Nuclear Energy, has to issue, for nuclear power plant, a construction licence and an operation licence (for loading of the fuel and operating the unit); the commission part is inside construction and operation licences. Through its Integrated Management System (IMS), FANR has established an integrated (safety, nuclear security and radiation protection) process for both licences of nuclear power plant. In the construction phase, the security team of FANR has mainly to focus on the protection against theft of category III of nuclear material when the nuclear unirradiated fuel is stored. FANR has to ensure that this storage of nuclear material is in accordance with the requirements of the regulation FANR-REG-08, for Physical Protection of Nuclear Material and Nuclear Facilities. For the operation of Unit 1 of Barakah NPP, the focus has to be moved to look more at the radiological sabotage issue. The process of licence for operating a Nuclear Power Plant has begun with the submission by ENEC (Emirates Nuclear Energy Corporation) to FANR of the Final Safety Analysis Report (FSAR). The FSAR followed the Preliminary Safety Analysis Report (PSAR), provided for the construction phase of the Unit 1 of Barakah NPP and includes a Chapter 20 on physical protection. The Chapter 20 is a summary of the Physical Protection Plan (PPP), which contains sensitive nuclear information not to be disclosed to the public. FANR security team has reviewed the PPP for operation as well as the associated documents such as the target sets analysis, the cyber security program manual, the vulnerability assessment and the contingency plan. During the period of reviewing, from 2015 to 2019, FANR security team has Request Additional Information (RAIs) – 150 - to ENEC and ENEC have answered in accordance with the regulation and/or the regulatory guides developed. The number of RAIs decreased to attain nil after the process is achieved. For the operation of the plant, it is also needed to verify that the plant has been constructed as per the requirements from the safety and the nuclear security. FANR has done this task through inspections. Especially, FANR security team verified that the physical protection system is conform to the description formulated in the PPP for operation. The findings were immediately communicate to ENEC to correct the observations before the loading of the fuel. Finally, FANR has to check the readiness of the unit to operate. FANR performed inspections and general exercises (emergency and security) to ensure that the unit is ready to operate. For example, FANR security team conducted inspection on the security organization on the site as well as all the related procedures. The security exercise has been performed by ENEC to demonstrate and improve the effectiveness of the Physical Protection Plan in the protection of the Nuclear Power Plant using scenarios up to and including the Design Basis Threat (DBT). For the issuance of the licence for operation of Unit 1 of Barakah NPP, FANR gathered the three following reports: the global Safety Evaluation Report (SER) on the FSAR, for both safety and nuclear security, the report on the findings of inspections (construction as design), the report on the findings following the inspection for readiness to operate and the results of exercises, for both safety and security.

1. INTRODUCTION

This paper aims to present the process followed by the Federal Authority for Nuclear Regulation (FANR) for the licensing of operation of the first unit of a nuclear power plant (Barakah NPP) in the United Arab Emirates (UAE) in regards with the nuclear security regime.

Firstly, the legislative and regulatory frameworks, concerning the nuclear security, in the UAE will be shortly presented for nuclear power plant. Then, the integrated process for licensing nuclear power plant will be shown as well as the process of inspection at a nuclear power plant.

The review and assessment of nuclear security conducted for the licensing for operation of Unit 1 of Barakah NPP will be described in detail. This part will be followed by the security inspections as well as the security exercise performed for obtaining a license for operation.

Finally, this paper will conclude on the safe and secure operation of Unit 1 of Barakah Nuclear Power Plant.

2. LEGISLATIVE AND REGULATORY FRAMEWORKS

Studies conducted by the Government of the UAE show that national annual peak demand for electricity will annually growth about 9 percent. An analysis of conventional and alternate energy sources revealed that nuclear energy is a reliable and viable option for the UAE. Studies concluded that nuclear energy is an economically and environmentally competitive source of energy when compared to other power sources. In 2009, the nuclear power programme was launched with the construction of 4 Units in Barakah. The UAE has chosen an advanced third-generation light water reactor, known as APR1400.

The Law on peaceful Uses of Nuclear Energy was made by Decree No. 6 of 2009 issued by the President of the UAE, H.H. Sheikh Khalifa Bin Zayed Al Nahyan, in September 2009. The Law affirms the UAE's commitment to develop and control the nuclear sector towards peaceful purposes only and in accordance with the international treaties and agreements by giving highest priority to safety, nuclear safety, radiation protection and safeguards and by forbidding enrichment and reprocessing of fuel in UAE. The Law establishes Federal Authority Nuclear Regulation (FANR) as the independent nuclear regulator and empowers FANR to determine all matters relating to the regulation, inspection, and oversight of the nuclear field with respect to nuclear safety, nuclear security, radiation protection and safeguards. Finally, the Law determines civil and criminal penalties, including penalties consistent with the Convention on Physical Protection of Nuclear Material.

The Regulation for Physical Protection of Nuclear Material and Nuclear Facilities, based on the revision 5 of INFCIRC/225, FANR-REG-08 was issued in August 2010. In particular, it describes requirements that the applicant for a license to construct and operate a nuclear facility must comply with. The applicant is required to submit a Physical Protection Plan (PPP), which addresses the protection of nuclear materials and the nuclear facility against unauthorized removal of nuclear material and radiological sabotage up to and including the DBT. After a period of 5 years, the regulation has been reviewed and version 1 was issued in August 2016.

Moreover, regulatory guide were developed to complete the regulatory framework. The regulatory guide are issued to describe methods and/or criteria acceptable for meeting and implementing specific requirements in the regulations. The following regulatory guide have been issued, in accordance with FANR-REG-08:

- FANR-RG-010, Identification and Maintenance of Target Sets and Timeline Analysis (Guidance on how to identify target sets of radiological sabotage, in accordance with U.S. NRC Regulatory Guide 5.81 "Target Set Identification and Development for Nuclear Power Plants" and to develop a Vulnerability Assessment);
- FANR-RG-011, Cyber Security at Nuclear Facilities (Guidance on the development, implementation and maintenance of a Cyber Security Programme. It is recommended to use Nuclear Energy Institute (NEI) 08-09, "Cyber Security Plan for Nuclear Power Reactors", Revision 6);
- FANR-RG-025, Physical Protection for Transportation of Nuclear Material (Guidance for the licensee and the carrier that plans to transport nuclear material on acceptable methods to meet the requirements of FANR's Regulation FANR-REG-08);
- FANR-RG-026, Response and Contingency Plan of Nuclear Facilities (It gives recommendation on the way to notify on nuclear security event to FANR, to respond to it through procedure and finally to respond to security events up to DBT by implementing the Contingency Plan); and
- FANR-RG-032, Development and Modifications of Physical Protection Plan of Nuclear Power Plant (Guidance to develop and implement a Physical Protection Plan of a Nuclear Power Plant as well as to submit changes to FANR to a previously approved Physical Protection Plan).

3. INTEGRATED PROCESS FOR LICENSING NUCLEAR POWER PLANT

FANR is an integrated regulator. It means that it will regulate the safety, security and radiation protection in an integrated manner.

An Integrated Management System (IMS) was implemented by FANR through the establishment of a manual defining the vision, mission and core values, organizational policies and processes by which the staff of FANR fulfills the organization's mandate. In particular, this IMS manual provides the integrated processes and supporting procedures that enable FANR to implement and demonstrate its actions in an efficient and transparent way.

FIG. 1. Chart showing FANR Process Map.

The Core Process 2 is related to the authorization process. For nuclear power plant, the process is described in an implementing procedure for the construction or operating license.

Based on FANR-REG-06 for an Application for a Licence to Construct a Nuclear Facility, the licensee submitted a Preliminary Safety Analysis Report (PSAR) to FANR for a construction of nuclear power plant and based on FANR-REG-14 for an Application for a Licence to Operate a Nuclear Facility, the licensee provided with the Final Safety Analysis Report (FSAR) for operating a nuclear facility. In both applications (PSAR and FSAR), the Chapter 20 contained the Physical Protection, which is a non-classified part of the Physical Protection Plan as well as complementary documents. It can be noted that, in the UAE, two licences shall be granted for a nuclear power plant - construction licence and operation licence -; which means that the operation begins with the loading of the fuel in the reactor.

The process for licensing is the same as for safety, security and radiation protection. An established team reviewed defined chapters of the PSAR or FSAR. Then, the team requested additional information to the licensee, which has to answer to this Request for Additional Information (RAI). When all requests have been answered correctly by the licensee; a Safety/Security Evaluation Report (SER) is drafted for all chapters. In final, based on the SER, the Board of Management of FANR issued the related licence.

The Core Process 3 is for assurance of compliance for safety, security, safeguards and radiation protection. It is supported by integrated procedures on inspection and on the generic inspection guidance. An annual plan of inspection is prepared for Barakah NPP, including the security. In particular, inspections are performed to check that the construction of the plant has been done as per the requirements and to verify that the plant was ready to operate the nuclear power plant. These two types of inspection has to be conducted before the operation of the nuclear power plant.

For issuing the licence of Unit 1 of Barakah NPP, FANR proposed to the Board of Management the SER for the FSAR (safety, security and radiation protection) as well as the results of inspections verifying the construction of the plant as design and being ready for operating safely and securely and the results of exercise (emergency excise and security exercise).

4. LICENSE FOR CONSTRUCTION AND STORAGE OF NUCLEAR MATERIAL

A decree of December 2009, established Emirates Nuclear Energy Corporation (ENEC), which is charged with implementing the UAE nuclear energy program. In May 2016, Nawah Energy Company, owned by ENEC, was initiated to obtain from FANR the licence for operating Barakah NPP.

In December 2010, ENEC submitted an application, including the PSAR, to FANR for a licence to construct the first two units of a nuclear facility at the proposed site of Barakah and in April 2013 for a licence to construct the Units 3 and 4 of Barakah Nuclear Power Plant.

ENEC submitted as part of the Construction Licence Application, Physical Protection Plans, which provide an overview of the physical protection program for the construction. In the construction phase, the review has mainly to focus on the protection against theft of category III of nuclear material when the nuclear unirradiated fuel is stored in accordance with the requirements of the regulation FANR-REG-08, for Physical Protection of Nuclear Material and Nuclear Facilities.

Following the review instruction for Physical Protection for Construction of Nuclear Power Plant and for Storage of Nuclear Material, the assessment of the provided Physical Protection Plan were performed by FANR. After the review by FANR of the Physical Protection Plans and its approval, the licence for construction was issued on the 17th July 2012 for Unit 1 & 2 and on the 15th September 2014 for Unit 3 & 4.

Before loading the fuel in the reactor of Unit 1 of Barakah NPP, the nuclear fuel has to be transported from South Korea to Barakah NPP and stored inside the plant. ENEC submitted to FANR the Transport Security Plan in accordance with regulation FANR-REG-08 and following the regulatory guide FANR-RG-025. FANR assessed the Transport Security Plan based on the review instruction for the Physical Protection for Transportation of Nuclear Material. The licence for transportation of nuclear fresh nuclear fuel was issued on the 15th December 2016. It should be noted that the fresh fuel for Barakah NPP is Category III of nuclear material as regulatory guide FANR-RG-025 is recommended to provide with a transport security plan for Category III of nuclear material inside the UAE.

5. LICENCE FOR OPERATION OF BARAKAH NUCLEAR POWER PLANT

On 26 March 2015, the license for operation of Units 1 & 2 of Barakah Nuclear Power Plant has been requested with the Final Safety Analysis Report (FSAR). Chapter 20 of the FSAR referred to the physical protection plan for operation (PPP-O), which contained the main attachments:

- The identification of target sets,
- The cyber security programme,
- The vulnerability assessment,
- The contingency plan.

The assessment by FANR of all these documents was performed following the review instruction on Physical Protection of Nuclear Power Plant. It could be noted that another document – Compensatory Measures – was provided by ENEC but FANR decided not to review and approve this document before the operation of Unit 1 of Barakah NPP.

During the construction of the units, the identification of the target sets (Definition of target sets in FANR-REG-08: "*The minimum combination of Target Elements, which if all are prevented from performing their intended function or prevented from being accomplished, would likely result in core damage and Spent Nuclear Fuel damage*") has been started following the U.S. NRC Regulatory Guide 5.81, Target Set Identification and Development for Nuclear Power Reactors. The first document on Target Set as requested by Article (8) of FANR-REG-08, was submitted on April 2013 and contained a deterministic identification of target sets on full power of the reactor. The assessment in conformance with the regulatory guide FANR-RG-010 of this document and the following other document was realized by an integrated team of FANR staffs from safety and nuclear security. The next document on identification of target sets, answered to additional information by FANR (RAIs) and submitted a schedule to take into account the site specific probabilistic risk assessment (PRA) and other modes of operation as well as maintenance activities. After several discussion and reviewing on the target sets, in November 2016, the licensee submitted the Target Set Analysis using the probabilistic results from the Barakah NPP PRA without any comment by FANR.

Also, during the construction of the units, the Cyber Security Plan has to be submitted to FANR as requested by Article (22) of FANR-REG-08 Version 1. In June 2013, the Cyber Security Program Manual was provided to FANR in accordance with regulatory guide FANR-REG-011 (established based on U.S. NRC Regulatory Guide 5.71, Cyber Security Programs for Nuclear Facilities). FANR has also recommended to use Nuclear Energy Institute (NEI) 08-09, Cyber Security Plan for Nuclear Power Reactors, Revision 6 and ENEC stated that they will follow the 8 Milestones defined by U.S. NRC. After reviews, requests for additional information by FANR integrated team (safety and security) and answers by ENEC, the Cyber Security Program Manual was revised for the 6 times and accepted by FANR. The implementation of the Cyber Security Program Manual was then checked during inspections at Westinghouse headquarter in Pittsburgh (USA) as well as at Barakah NPP (November 2017, March 2019 and June 2019). It appears that the Milestones 1 to 6 has been implemented before the loading of the fuel of Unit 1 of Barakah NPP. For Milestones 7 and 8, the implementation will be respectively done in 2020 and 2022.

The Physical Protection Plan for Operation (PPP-O) of Unit 1 of Barakah Nuclear Power Plant was submitted by ENEC in support of their application for the licence for operation (26 March 2015). The schedule of the plan contained those mentioned in the regulatory guide FANR-RG-032. Especially, the following items was developed:

- Security Organization,
- Physical Protection System (PPS), and
- Reporting and Records of Events.

The description of the security organization, which includes security personnel training and qualification and trustworthiness of personnel, was reviewed by FANR. For the time being, the security organization is managed by ENEC with a service providers United Security Group for the guards and the Critical Infrastructure and Coastal Protection Authority (CICPA) as armed response force. The training and qualification of personnel was reviewed by FANR in accordance with the U.S. NRC Regulatory Guide on Training and Qualification of Security Personnel. Article (16) of FANR-REG-08 described the requirements for Protection against the Potential for Insider Threats and FANR assess the detail provided by the PPP-O. This review was done in accordance with the best practice documents, including the U.S. NRC NUREG/CR-7183, Best Practices for Behavioral Observation Programs at Operating Power Reactors and Power Reactor Construction Sites and was conclude positively.

The physical protection system was designed for the first time in the UAE; KEPCO (South Korea), supplier with the four Units of Barakah NPP, was not involved in its definition. The design of the PPS was defined in 2014 and has been reviewed by FANR from this date. Then, the implementation of the modified design of the PPS at the site was launched in 2015. In the last updated of the PPP-O (Revision 4), a complete description of the implemented PPS, comprising detection, assessment, access to area, physical barrier, etc. was provided. FANR reviewed the implemented PPS based on the recommendations of IAEA Nuclear Security Series No. 13 (INFCIRC/225/Rev. 5) without any final remarks.

The notification of nuclear security events to FANR or their recording have been defined in a procedure and described in the PPP-O as requested by Article (25) of FANR-REG-08. FANR reviewed the events mentioned in the procedure and verified that the notification of nuclear security events was in accordance with regulatory guide FANR-RG-026. The last version of the PPP-O (Revision 4) mentioned the related procedure.

When the design of the PPS is about to be completed and the identification of target sets is more or less achieved, the licensee may develop a vulnerability assessment based on the Design Basis Threat (DBT). In May 2017, the first established vulnerability assessment proposed to FANR was rejected due to the fact that it does not contain the necessary information to allow FANR to begin its review. In August 2017, a revised vulnerability assessment was submitted by ENEC to FANR and in December 2018, the revision 1 of the vulnerability assessment was provided to FANR to take into account the fact that both Unit 1 & 2 was included in the protected area. The vulnerability assessment ensures the effectiveness of the physical protection plan against the DBT.

The Contingency Plan, established to response to nuclear security events up to the DBT, in accordance with Article (4) of regulation FANR-REG-08 was first established based on certain concept of security organization. While the security organization on the site has evolved and are still changing; the contingency plans were revised and finalized in December 2018. FANR reviewed these plans following the regulatory guide FANR-RG-026 without any remarks.

FANR requested to review the management of the interface between safety and nuclear security. It was required by Article (9) of regulation FANR-REG-08. The licensee provided a procedure for managing the interface and included this in its management system. At the end of the process, a common inspection (safety and security staffs - October 2019) by FANR was performed to check if the plant is ready to operate in a safety and securely manner.

Following the assessment of all these documents, FANR has wrote a Security Evaluation Report (SER) for the Chapter 20 of the FSAR in support to the licence of operation of Unit 1 of Barakah NPP as well as a summary of the SER for the Board of Management, which stated that there reasonable assurance that the Unit 1 of Barakah NPP will be operated in accordance with the Law and regulation FANR-REG-08. Finally, FANR has submitted more than 150 Requests for Additional Information (RAIs) on this chapter. This figure does not take into account the follow-up of RAIs.

After the review and assessment of the revision 4 (December 2018) of the Physical Protection Plan for Operation as well as its complementary documents (identification of target sets, cyber security programme, vulnerability assessment and contingency plan), FANR has verified that the physical protection of Unit 1 of Barakah NPP has been constructed as design through inspections: Cyber Security Inspection (November 2017, March 2019 and June 2019) and Physical Protection System (October 2019).

FANR has also performed inspection to confirm that the Unit 1 of Barakah NPP is ready to operate (October 2019). In final, as requested by Article (29) of FANR-REG-08, a security exercise was performed on the 14th of November 2019 in order to demonstrate the effectiveness of the Physical Protection Plan by using scenario up to the DBT.

6. CONCLUSION

From the adoption of the national policy on peaceful uses of nuclear energy, the UAE has made many advances in implementing its civil nuclear energy programme. FANR has established a strong and holistic legislative and regulatory framework on nuclear energy and a management system which integrated both safety, security and radiation protection.

Based on this structured framework, FANR has reviewed and assessed the application of a licence for operation of Unit 1 of Barakah Nuclear Power Plant. The Licence has been issued in February 2020 to operate the Unit 1 of Barakah Nuclear Power Plant.

REFERENCES

[1] Federal Law by Decree No. 6 of 2009 concerning the Peaceful Uses of Nuclear Energy issued by the President of the UAE, H.H. Sheikh Khalifa Bin Zayed Al Nahyan, in September 2009 (Unofficial Translation).

[2] IAEA - INTERNATIONAL ATOMIC ENERGY AGENCY, Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Rev.5), Nuclear Security Series nº 13 (2011).

[3] U.S. Nuclear Regulatory Commission Regulatory Guide 5.71, Cyber Security Programs for Nuclear Facilities, January 2010.

[4] U.S. Nuclear Regulatory Commission Regulatory Guide 5.81, Target Set Identification and Development for Nuclear Power Plants, November 2010.

[5] U.S. NRC NUREG/CR-7183, Best Practices for Behavioral Observation Programs at Operating Power Reactors and Power Reactor Construction Site.

[6] Nuclear Energy Institute (NEI) 08-09, Cyber Security Plan for Nuclear Power Reactors, Revision 6.