Experiences on Jordan Research and Training Reactor Licensing

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1. Introduction

The Jordan Atomic Energy Commission (JAEC) commenced the Jordan Research and Training Reactor Project (tentatively called JRTR Project hereinafter) in January 2009. The Korea Atomic Energy Research Institute (KAERI) and Daewoo Engineering and Construction Co. established the KAERI/Daewoo Consortium (KDC) and signed a contract on March 30, 2010 with Jordan to build the Middle Eastern country's first nuclear research reactor.

Owing to an insufficient regulatory infrastructure in Jordan, the JNRC (Jordan Nuclear Regulatory Commission) determined to cooperate with Korea Institute of Nuclear Safety (KINS) to support the regulation on the construction and operation of the JRTR. On Aug. 15, 2013, the JNRC issued a Construction Permit (CP) for the JRTR and at the end of this year, KDC will apply for an Operating License (OL).

In this paper, the Jordanian regulatory framework and the experiences on the JRTR CP licensing will be discussed.

2. Introduction to JRTR Project

The Jordan Atomic Energy Commission (JAEC) commenced the Jordan Research and Training Reactor Project (tentatively called JRTR Project hereinafter) by issuing a request for proposal in January 2009. The JRTR will serve as an integral part of the nuclear technology infrastructure in Jordan, and become the focal point for a Nuclear Science and Technology Center.

The Korea Atomic Energy Research Institute (KAERI) and Daewoo Engineering and Construction Co. established the KAERI/Daewoo Consortium(KDC) for the project. KDC signed a contract on March 30, 2010 with Jordan to build the Middle Eastern country's first nuclear research reactor by 2016. The reactor and associated systems proposed by the KDC will be able to support the functionalities as follows:

a) Education and training in support of programs in nuclear engineering and nuclear reactor operations;
b) Forensic analysis (e.g., neutron activation analysis);
c) Radioisotope production (e.g., Mo-99, I-131, Ir-192, etc.) for medical and industrial applications;
d) Neutron beam applications including nondestructive examination (e.g., neutron radiography) and neutron science applications;
e) Neutron Transmutation Doping (NTD) and irradiations.

As a multi-purpose research reactor, the JRTR proposed herein is a facility used to produce and utilize neutrons, as well as foster manpower.

The following table shows the general overview of the JRTR Project.

Table 1: JRTR Project Overview

Project Name	Jordan Research and Training Reactor (JRTR) Project
Owner	Jordan Atomic Energy Commission (JAEC)
Contractor	Consortium of KAERI and Daewoo E&C
Contract Type	Turnkey EPC Contract
Project Period	Aug. 1, 2010 to First half of 2016
Site	Campus of JUST (Ramtha, Jordan)
Scope of Supply	▪ Design and Construction of JRTR (Reactor, Reactor building, Service building including RI production facility, Aux. buildings, and Training Center) ▪ Education and Training of Jordanian Staff

3. Background of Nuclear Program in Jordan

The Jordan Nuclear Energy Commission (JNEC), an agency whose board of directors was chaired by the Minister of Energy and Mineral Resources, was involved in developing a national strategy for the introduction of civilian nuclear power.

To develop nuclear power in Jordan, a High Level Ministerial Committee, chaired by the Prime Minister, was established in November 2006 for introduction of nuclear power in the country. The committee produced a “roadmap” that outlined the strategic goals and activities to be undertaken to implement a nuclear power program.

King Abdulla II announced that Jordan would launch a nuclear power program in 2007, taking into account national goals for energy security and diversification, a desire to reduce the dependence on and uncertainty of imports, and a reduction of the reliance on fossil fuels while meeting growing energy demand.

This was accompanied by the allocation of resources for planning and enacting National Laws to establish guidelines and institutions, specifically the JAEC and the JNRC.

The national organizational structure for the implementation of the nuclear power program is depicted in Fig. 1. As shown in Fig. 1, the JAEC has the direct responsibility for the development and implementation of the nuclear power program. The JNRC regulates, monitors, controls and issues licenses for applications of nuclear energy to ensure nuclear safety and security. Both JAEC and JNRC[1] report to the Prime Minister.

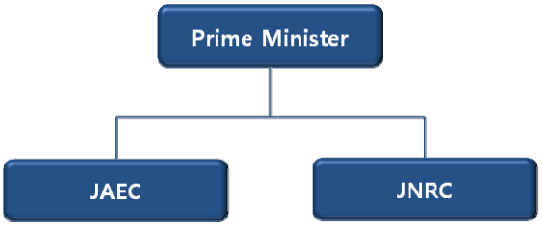

Fig. 1. Structure for Jordanian Nuclear Power Program

4. Regulatory Authority of Jordan

JNRC and JAEC were established in 2007 as successors to the former Jordan Nuclear Energy Commission (JNEC), established in 2001. JNRC is an independent and adequately empowered regulatory body, as shown in Fig. 2.

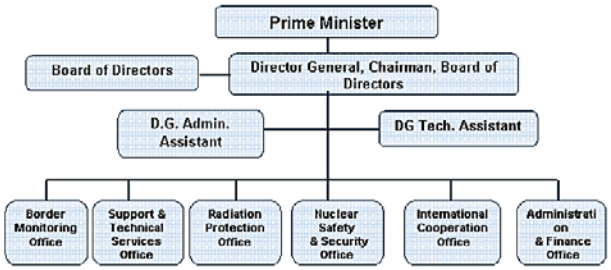

Fig. 2. Nuclear Regulatory Structure in Jordan

The main goals of the JNRC are to work, in coordination with the relevant bodies, on achieving the following:

- Regulating and monitoring the use of nuclear energy and ionizing radiation.
- Protecting the environment and human health and property from the hazards of radiation and related pollution.
- Ensuring general radiation protection and nuclear safety and security.

The JNRC has the duty of regulating nuclear materials and nuclear installations and facilities, to ensure the reliability and availability of the safety and security conditions and requirements for nuclear materials and nuclear installations and facilities, and the preparation of a system for the inventory and accounting of nuclear materials in Jordan under the Safeguards Agreement applied by the IAEA.

In regards to the current law, JNRC has the duty of preparing the legislative framework of nuclear regulations, safety instructions and guidelines to control the peaceful use of nuclear energy in Jordan.

5. Experiences on JRTR CP Licensing

5.1 CP Licensing Process

According to the contract between JAEC and KDC, the JRTR design complies with the current Jordanian laws and regulations. In addition, internationally applicable standards and guidelines as set in the following documents are used as a top tier requirement.

- Korean Regulation and Guidelines
- The IAEA Safety Requirement, NS-R-3, NS-R-4
- The IAEA Safety Standard, SSG-20
- US NRC report NUREG 1537 Part 1
- Industrial Codes & Standards(KEPIC, ASME, IEEE, ASTM etc.)

The licensing procedure of the JRTR follows the licensing regime consistent with the proposed technology's country of origin, that is the Republic of Korea or with that of the US NRC. Two step licensing procedures, CP and OL are adopted for the JRTR project.

Because there is an insufficient regulatory infrastructure in Jordan, JNRC determined to cooperate with Korea Institute of Nuclear Safety (KINS), and made a Special Agreement between KINS and JNRC to support regulation on the construction and operation of JRTR in 2011.

Upon JNRC's request, KINS reviews the application documents and delivers the review results and recommendations for licensability according to Korean regulations.

[1] The Jordan's regulatory bodies including JNRC merge into the EMRC in April 2014, to strengthen Jordan's radiation and nuclear regulatory infrastructure by providing more resources and influence.

Fig. 3 shows the process of JRTR CP documents review.

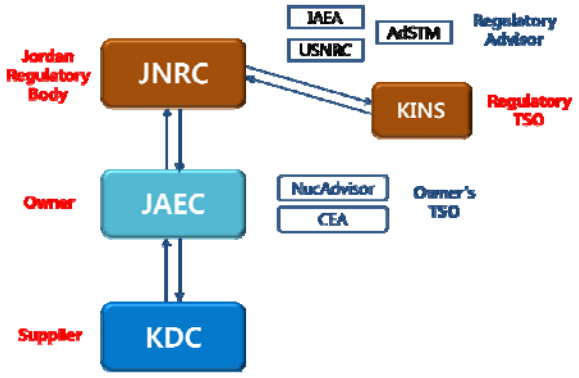

Fig. 3. Process of JRTR CP Documents Review

JNRC and JAEC receive technical support from international organizations such as the IAEA and several technical support companies such as NucAdvisor. They have reviewed the JRTR CP documents and proposed some recommendations and suggestions regarding the JRTR design.

The CP of JRTR was issued on Oct. 15, 2013, and now KDC is preparing OL documents. At the end of this year, KDC will apply OL, and the application documents will be reviewed through the same process as the CP review.

5.2 Applied Codes and Standards

The JRTR design complies with the IAEA safety standards and Korean regulatory requirements and guidelines.

The IAEA safety standards are applied as the top-tier safety requirements for the JRTR. Since IAEA standards do not cover all engineering and/or practical requirements, Korean laws and regulations are applied for the safety design of the JRTR to complement the detailed technical requirements.

KEPIC has been adopted as the industrial code and standards for the JRTR according to the Notice of the NSSC, "Guidelines for Application of KEPIC as Technical Standards of Nuclear Reactor Facilities", which is based on the internationally acceptable USA industrial codes and standards such as ASME, IEEE, ACI, and ANSI.

The codes and standards are applied to SSCs in a manner commensurate with the safety classification according to the Notice of the NSSC, "Regulation on Safety Classification and Applicable Codes and Standards for Nuclear Reactor Facilities".

5.3 Special Issue : IAEA Recommendation

The safety classification of the JRTR follows the Korean/US classification system. Korean/US classification is based on ANSI 51.1. ANSI 51.1 classifies the structures, systems and components as SC-1, 2, 3 and NNS. SC-1 and 2 SSCs are pressurized equipment, but JRTR has no such equipment. Thus JRTR's SSCs are classified into two categories, SC-3 and NNS. NNS equipments are divided into two subcategories. One is NNS with Quality Class T/Q and NNS with Quality Class S. Quality Class S is applied to general industrial equipment.

The IAEA's classification has three categories, Safety System, Safety-related item, Not Important to Safety. The point of the IAEA's recommendation is that items important to safety must be classified into safety classes, not NNS. However this is only a difference in classification terminology. The NNS system, which is important to safety is assigned Quality Class T/Q, and this quality class is also assigned to SC-3 equipment. In addition, this equipment has to comply with the selected requirements from ASME NQA-1, a nuclear quality assurance program.

Fig. 4 shows correspondence of JRTR classification to IAEA and US Classifications.

IAEA general concept (for instance, in NS-R-4)	Items important to safety		Items not important to safety
	Safety system	Safety-related items	
	⇕	⇕	⇕
JRTR	Safety Class 3 (Quality Class Q)	NNS Class with specified functions (Quality Class T/Q)	NNS Class (Quality Class S)
	⇕	⇕	⇕
ANSI 51.1	Safety Class 1, 2 and 3 (ASME NQA-1)	NNS Class with specified functions (selected requirements from ASME NQA-1)	Other NNS Class items

Fig. 3. Correspondence of JRTR Classification to IAEA and US Classifications

Thus, KDC's conclusion is that we understand IAEA's recommendation but our classification is not deviated from the IAEA's classification philosophy. After several hard discussions, the IAEA tentatively agreed with KDC's conclusion, whereas, it seems that both sides need to discuss this issue furthermore at the OL stage.

This issue springs from the difference between US and IAEA classification terminology. This issue teaches us that understanding of the regulation philosophy of other countries is essential for a smooth project. Understanding is needed, not only for the regulatory body but also foreign suppliers.

6. Conclusions

The cooperation between the JNRC and KINS on the JRTR CP review process is a good model of international cooperation on nuclear regulations. Moreover, the experiences on the JRTR licensing will be a good lesson to those countries that plan to introduce a nuclear program, but do not have a sufficient regulatory infrastructure.

Additionally, the understandings on the differences and resemblances between the US and European regulatory philosophies on nuclear safety are needed for countries that plan to introduce a nuclear program. These understandings are also needed for the nuclear facility suppliers.

The licensing process, applicable regulatory standards and guidelines shall be clearly stated in written form under the contract conditions. If not, unpredictable variables from the difference between US and European regulatory standards may cause a delay in the project schedule. In the case of the JRTR project, clearly-stated licensing process, applicable regulatory standards and guidelines on the contract conditions minimized the delay of the licensing period.

ACKNOWLEDGMENT

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REFERENCES

[1] Notice of the NSSC, “Regulation on Safety Classification and Applicable Codes and Standards for Nuclear Reactor Facilities”, 2013.
[2] ANSI/ANS 51.1, “Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants”, 1983
[3] IAEA Safety Requirements No. NS-R-4, “Safety of Research Reactors”, 2005