



المجلس الاستشاري الدولي
INTERNATIONAL ADVISORY BOARD

Twelfth Semi-Annual Report 2015

Brief summary on the International Advisory Board for the UAE nuclear program

The International Advisory Board (IAB) was a concept first developed by the UAE government to augment the transparency of its peaceful nuclear energy program. Indeed, the commitment to form such a body was among the original commitments undertaken by the UAE government in its original white paper describing its intent to evaluate and potentially deploy peaceful nuclear energy within its borders.

More specifically, the IAB represents an unprecedented collection of internationally recognized experts in various disciplines associated with the nuclear energy sector. The board includes world-class expertise in the areas of nuclear safety, security and non-proliferation, as well as regulation, quality assurance, operations, human resource development and waste management associated with the construction, operation and decommissioning of civil nuclear power plants. Led by Dr. Hans Blix, the former Director General of the International Atomic Energy Agency (from 1997-1982), the IAB is charged with conducting semi-annual reviews of the UAE's entire peaceful nuclear energy program and subsequently preparing a semi-annual report summarizing their observations, findings and recommendations. The decision by the UAE government to make these reports available to the public in hard-copy form and over the internet represents yet another example of the latter's commitment to achieving the highest standards of transparency in its peaceful nuclear energy program.

The IAB, while not invested with any legally binding powers, has nevertheless been designed to be an independent advisory body. As stated above, after each of its semi-annual meetings, the Board will issue a report detailing the consensus views of its members with regard to the progress achieved by the program, as well as any areas of concern that merit special attention. The government will not seek to edit these consensus IAB views and will undertake to publish them free of modification, as intended by the IAB members. Notably, however, the government and the IAB membership have agreed to work together to make those modifications necessary to avoid the dissemination of any sensitive security-related information to which the IAB may have access.

While the IAB's semi-annual reports may address additional topics, they will always be required to specifically address the issues of:

1. Nuclear safety
2. Nuclear security
3. Nuclear non-proliferation
4. Program transparency
5. Program sustainability

The UAE government, and those entities involved in the UAE will use the Board's semi-annual reports to improve performance and, where necessary, allocate additional resources in order to ensure the successful implementation of the over-all program. It is hoped that the UAE populace and the international community will use the reports as an objective source of information via which they may become more informed about and follow the progress of the UAE's nuclear sector.

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Dr. Hans Blix, IAB Chairman

CHAIRMAN'S PREFACE

With great pleasure, I transmit to you the twelfth report of the International Advisory Board on the development of the United Arab Emirate's Nuclear Power Program. We note with satisfaction that our earlier recommendations have been or are being carefully considered and implemented. As always, the members of the Board are also pleased that all nuclear entities reporting to it are showing a strong commitment to transparency and to the goals set by the Board.

The UAE program is nearing the date when commercial operations will begin at Barakah Nuclear Power plant (NPP) Unit 1. Accordingly, increasingly special attention is given to Unit 1, however, construction work at the remaining three Units continues to progress as scheduled with each of the three reactors beginning operations in one year intervals following the start of operations at Unit 1.

This report discusses host of items: the updated status of the Barakah NPP, emergency preparedness & response readiness, construction license and progress, the safety and review task force, receiving fuel, international cooperation, decommissioning, capacity building, physical protection as well as waste policy.

At its next meeting the Board would appreciate further reports on the various time lines involved in waste disposal, the effect on FANR now that it's under the Prime Minister's jurisdiction and on how ENEC will coop with minimal time to conduct tests prior to Unit 1 beginning operations.

The Board congratulates the UAE on the continued success and progress of the nuclear power program and concludes that the UAE remains fully committed to the principles of safety, security, non-proliferation, transparency and sustainability.

With respect,
Dr. Hans Blix

BOARD MEMBERS



Ambassador Thomas Graham



Mr. Takuya Hattori



Dr. KunMo Chung



Lady Barbara Thomas Judge



Sir John Rose



Mr. Jukka Laaksonen

Introduction



The twelfth semi-annual meeting of the International Advisory Board (IAB) for the United Arab Emirates (UAE) peaceful nuclear power program was held in Abu Dhabi on October 11th and 12th, 2015. The Chairman, Dr. Hans Blix, along with all other members were present. The session began with moment of silence, as directed by the Chairman, in memory of our fellow member, Dr. Mujid Kazimi, who passed away several months ago, while on a trip to China. Dr. Kazimi will be greatly missed by all. The Chairman also expressed his and the Board's condolences to the people of the UAE for the tragic losses of military personnel in Yemen.

The first two briefings were carried out by the Federal Authority for Nuclear Regulation (FANR) and the Ministry of Foreign Affairs (MOFA) in the early evening of October 11th. The Briefing by FANR was conducted by the Director General, accompanied by Deputy Director General for Operations, and the Deputy Director for Administration, as well as a number of other senior officials. The MOFA briefing was carried out by the UAE Ambassador to the International Atomic Energy Agency (IAEA), Ambassador Hamad Al Kaabi. As has been the practice for several years now, the second day of meetings was scheduled to include a site visit to the Barakah Nuclear Power Plant (NPP). Accordingly,

the briefing by the Emirates Nuclear Energy Corporation (ENEC) was carried out at the Barakah NPP site. This was the fourth visit by the IAB to the site. The ENEC briefing was led by the Chief Project Officer (CPO), accompanied by eight other senior ENEC officers. The Board carried out its private discussion at the Barakah site following the ENEC briefing.

The nuclear power program of the UAE is based on upholding the highest standards of the five principles of safety, security, non-proliferation, transparency and sustainability. The IAB is tasked with reviewing the UAE program twice a year with a focus on the five principles and the degree to which they have been adhered to as the program moves forward. Thus, this report is divided into five sections each of which covers one of the five principles. At this meeting, the twelfth meeting of the IAB, the presentations were made as indicated by MOFA, FANR and ENEC. While there is a consistent and heavy emphasis on safety, the report also covers all activity centered on each of the five principles as with previous publications.

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construction work at the remaining three Units continues to progress as scheduled with each of the three reactors beginning operations in one year intervals following the start of operations at Unit 1.

As witnessed in recent months, the threat posed by climate change continues to increase. More and more the world community is beginning to understand that it must move away from the heavy reliance on fossil fuel sources of energy and increasingly rely on power from non-carbon emitting production. While the world community is reacting slowly to this existential danger – this will likely change as a result of the Paris intergovernmental meeting on climate change. (The Paris agreement aims to limit global warming 1.5 °C by 2100). In order to achieve such a goal, it is necessary to minimize and replace power generation using fossil fuels by expanding electricity supply by renewable energy sources and low carbon nuclear power. Without baseload clean energy such as nuclear electricity, developing nations that rely on importing energy resources may not sustain socio-economic development for a better quality of life. In this all-important area the UAE continues to lead the way. By 2020, when Unit 4 is expected to commence operations, a significant portion of the electricity produced within the UAE will be generated from a safe, clean, and reliable source of power – the Barakah NPP.

Safety

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FANR's newly appointed Director General, Christer Viktorsson began the evening session by introducing himself and his new senior officers. FANR stated that it has established a new Department called the Department of Development, which will be responsible for strategic planning and management quality. It will be developing a strategic plan for 2020 when all four reactors will be in full operation. This plan will be designed to manage operations post 2020.

The Director General noted that FANR was undertaking actions to improve efficiency across the board. Security work recently has focused on the issue of ensuring smooth governmental function in the event of an accident. Priority strategic goals include licensing and inspections. FANR had just received approval from its Board to begin work on decommissioning planning.

The Deputy Director for Operations stated that the review of the operating license for Unit 1 was now fully moving ahead. An application was received from ENEC on March 25, 2015 and FANR followed up with an acceptance letter to ENEC on March 31, 2015. The initial review of the Operating License Application (OLA)/Final Safety Analysis Report (FSAR) was completed in September 2015, one month prior to the IAB meeting.

FANR has issued over 1,000 Request for Additional Information (RAIs) to ENEC. Of the "active" RAIs 392 were now closed, 97 have not yet been submitted by FANR and the remaining 583 are still open. However, there are a number of late report submittals by ENEC which are yet to be delivered. For example, the grid stability report and the grid reliability study will be submitted to FANR at the end of September, 2016. The Accident Management Plan and the Fukushima related commitments will be submitted on March 31, 2016 and July 31, 2016 respectively.

A realistic milestone schedule based on ENEC's OLA submittals in 2016 was then discussed by FANR. Some of the late ENEC submittals are not scheduled to be available until the second half of 2016. Once ENEC submits the remaining OLA documents next

year, resolves any associated RAIs and FANR approves all Safety Evaluation Reports (SERs); FANR will then send license recommendations and supporting documents to its Board of Management. Chairman Blix asked what will this mean for issuance of the OLA. The Director General replied, issuance will be expected in February, 2017.

The FANR inspection program is ongoing at the site. An inspection is underway for pre-operational testing with respect to Unit 1 to verify that: the test program is being conducted as set out in the construction license application; test personnel, test procedures and acceptance criteria meet necessary requirements; and test results show that System, Structures, Components (SSCs) conform to the design.

There is a plan to inspect ENEC's general readiness to operate, the plant itself, with the personnel involved and the process. Such inspections will be part of the inputs used by FANR as part of the operating license review.

The discussion then turned to the subject of the transport, handling and storage of fresh nuclear fuel.

ENEC is expected to file for a license later in 2015 to cover the receiving, unloading and storage of fresh nuclear fuel. Justification will be provided relating to which operational programs will need to be in place, either fully or partially. FANR will prepare a license in time to support the delivery of fresh fuel by ENEC. A mock fuel transport exercise in the UAE is planned for December 2015 and the final fuel transport plan is expected to be implemented soon. It will also include the physical protection arrangement. Nuclear fuel is expected to be shipped to Barakah in multiple shipments beginning in May, 2016.

An Emergency Preparedness Review (EPREV) mission was conducted by the International Agency on Atomic Energy (IAEA) in the UAE from March 21-31, 2015. The purpose of the mission was to review the Emergency Preparedness Response (EPR) arrangements and capabilities at the Barakah NPP including: the onsite emergency preparedness and

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response plan; national and local offsite EPR arrangements; the interface between the NPP and the offsite EPR authorities; and arrangements for international notification pursuant to IAEA safety standards. Numerous UAE government entities cooperated with the Mission, including ENEC, FANR, MOFA, National Emergency Crisis and Disasters Management Authority, and the Ministry of Interior, along with a several others. The outcome was positive.

Many strengths from the UAE planning process were identified, such as the roles and responsibilities being clearly defined; the operational emergency management system well established; the draft EPR plans and procedures consistent with IAEA safety standards; and great progress was observed in the development of facilities and capabilities to manage the mechanical aspects of a nuclear emergency.

There were also a few recommendations and suggestions; there was a perceived need to develop a formalized process for determining protective actions based on all available information; the requirements for the emergency planning zones: the Urgent Protective Action Zone, the Extended Protected Zone (beyond the site) and the International Protected Zone (out to 500 kilometers), should be reviewed to ensure that they are consistent with IAEA safety standards. In addition, detailed evacuation plans for construction

personnel should be developed and all relevant emergency plans and procedures should be tested and fully implemented before the full-scale exercise for onsite and offsite emergency plans scheduled before the first arrival of spent fuel.

Ambassador Hamad Al Kaabi also had important comments on the Emergency Preparedness Review Mission of March, 2015. Ambassador Al Kaabi noted that the Emergency Preparedness Review (EPREV) Team identified particular UAE strengths in establishing a clear definition of roles and responsibilities and significant progress in the development of facilities to manage any necessary medical response. Good practices included the co-location of the emergency operations centers for the management of onsite and offsite response; and effective participation in the Gulf Cooperation Council regional response plan to ensure good coordination with neighboring nations during a nuclear emergency. Progress, however, was believed to be needed in the following areas: additional clarification of how to best protect the public during an emergency; consistent public relations arrangements for a nuclear emergency; ensuring that sufficient qualified personnel to protect the public are available in case a prolonged response to an emergency is necessary; and current efforts to complete test plans, facilities, tools and systems must be maintained.

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Technical discussions among FANR, IAEA, and ENEC have been undertaken in order to integrate safeguards, containment, and surveillance measures into Barakah NPP. The IAEA in this regard has made two technical visits to the Barakah NPP site. Because the first introduction of nuclear material is expected in the first quarter of 2016, FANR is completing its preparations for full-scope (both Part 1 and Part 2) safeguards. FANR is prepared for the submission of the UAE's Initial Safeguards Report to the IAEA soon.

FANR is actively reviewing two updated attachments submitted by ENEC in September; in order to be ready to discuss Subsidiary Arrangements pursuant to Safeguards with the IAEA in connection with the ENEC nuclear material license application.

Comprehensive criteria were documented for each safeguards functional area; for example nuclear material accountancy and control, reporting inspections, and lastly design information. There were individual document reviews to ensure accuracy and completeness. In addition, multiple meetings to discuss reviews prior to formal written responses were made to ensure they all understood what FANR expected.

ENEC's Chief Program Officer then gave an overview of the construction progress. He commented on some of ENEC's delayed responses explaining that the pace of material manufacturing has slowed down the program. Also, because of slower progress in Korea plant operations, there will not be as many years of operations at Shin Kori 3, as first anticipated, from which to derive lessons learned. However, it is likely there will still be at least a year's worth of operational experience from Barakah for ENEC to leverage. The delays at Shin Kori 3 were in part caused by the necessity of removing the electrical cable and reinstalling it. Shin Kori 3 still doesn't have its operating license, and is expected to receive it by next month. Commercial service for Shin Kori 3 could begin in May, 2016. With regards to Barakah Unit 1, the operating license was awarded in October 2015, which may be challenging to begin operations in May, 2017. However, there is a fair level of confidence to

begin generating power by the end of 2017. Construction of Barakah Unit 1 is progressing well. All the internals are done. Internal parts of the plant are all completed. In addition, the associated buildings as part of the first unit are nearing completion. Unit one and two's water facilities are now also providing water. The raw water reservoirs are where water is de-mineralized and sent on to the reactors. De-mineralized water can now be processed on a 24-hour basis. Water is also now in the Unit 1 refueling pool. Given that Units 1 and 2 share a number of facilities, good coordination of such facilities is important.

Significant construction progress was also achieved in the Switchyard for all four Units. This is where TRANSCO transmission lines connect to the Barakah NPP. The switchyard is the point of where electricity generated from the plants is transmitted to the UAE power grid. The gas insulated switchgear is close to being fully installed, while the installation of the overhead line feeder is also progressing. There is much electrical and instrumentation & control progress to go along with this. The main transformer is expected to energize the switchyard by the end of 2015. Lastly, Unit one's bypass pump house and mixing basin is progressing as planned.

Construction progress on each of the remaining three units remains on schedule and is expected to come online subsequently to one another as per the schedule.

Construction progress for Barakah Unit 2 has been progressing smoothly. In July 2015, the steam generator was installed. The circulating water intake structure and the essential service water structure are both also nearing completion for Units 1 and 2. With respect to Unit 3, the pressure vessel is expected to be installed by May 2016 and the steam generator in July 2016. Major construction for Unit 4 is expected to begin in August 2016.

ENEC's Nuclear Risk Director gave a presentation in which he discussed a safety assessment conducted by ENEC's Safety Review Task Force following the Fukushima Daiichi accident. This program has led to several proposals on safety upgrades of

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the Reference Plant design, mostly based on lessons learned from the Fukushima Daiichi accident. The Safety Review Task Force was established soon after the Fukushima Daiichi accident in March 2011. The Task Force completed and submitted its safety assessment report to FANR. The implementation of the design improvements proposed in the report (Fukushima action items) is expected to be completed by September 2016.

According to the comparable Probabilistic Risk Assessment (PRA) studies of the Reference Plant design versus the Upgraded Barakah NPP units, the estimated Core Damage Frequency (CDF) has dropped to one third. The calculated CDF for Barakah NPP is now $1.24E-06$ /year.

The Safety Review Task Force also assessed consequences of external hazards, i.e. seismic events, flooding, and sand storms. Furthermore, the task force also considered ways to further enhance the reliability of maintaining adequate Spent Fuel Pool cooling and inventory.

The improved design features comprise of:

- Improved seismic capacity (i.e. resistance to seismic induced vibrations) of several components and structures;
- Installations of several water tight doors/gates and protection of selected outdoors tanks from flood damage;
- Improving fire protection design features and facilities;
- Strengthening of electrical systems by means of providing manual cross-tie options, DC recharging options with mobile generators, extended battery duty times, enlarged fuel storages of diesel generators to extend autonomic onsite power supply time;
- External water injection connections (for connecting fire truck pumps) to steam generators, the reactor coolant system, and the spent fuel pool

- Installation of passive autocatalytic hydrogen recombiners to spent fuel pool areas; and
- Installation of additional measuring devices.

Some of the assessment areas included material events as the effect of seismic incidents, flooding and sandstorms. The Chairman asked how often sandstorms occur in the UAE. The Nuclear Risk Director replied that there had been several sandstorms over the last few years. The Barakah NPP has several offsite power sources with backup emergency power sources, to provide multiple defensive layers in preventing and mitigating the Loss of Offsite Power (LOOP) caused by sandstorms or other external events.

Other assessment areas included fire/explosion, station blackout and loss of the alternate heat sink, Spent Fuel Pool (SFP) inventory and cooling and severe accident management improvements.

FANR also listed a number of issues from the 11th meeting of the Board as "needing attention."

FANR has found that the Safety Depressurization and Venting System (SDVS) provides a reliable means for depressurizing the reactor coolant system during an accident. The SDVS has four pilot-operated safety relief valves in two independent trains. Severe accident analysis demonstrates that operation of two valves will depressurize the reactor coolant system prior to the occurrence of a breach.

In addition, ENEC's Probabilistic Risk Analysis indicates that the contribution to the frequency of large releases of radioactivity resulting from the loss of a SDVS is extremely low.

The Accident Management Program (AMP) has been developed to enhance nuclear safety by focusing on Beyond Design Basis Accidents (BDBA). Such incidents may include:

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1. Loss of Large Areas (LOLA) including loss of the control room due to an explosion or fire. An event that could potentially initiate such losses include a plane crash,
2. A Fukushima related event, that focuses on the risk management of a Station Blackout with simultaneous Loss of the Ultimate Heat Sink, and
3. Severe accident management, focusing on risk management after core related damage.

ENEC has committed to provide severe accident management guides for the operators use. FANR will evaluate the basis and adequacy of such guides once available by March, 2016.

With respect to the release of non-condensable gases from containment, ENEC's submittals to date indicated that the containment integrity is maintained under the postulated severe accident scenario for 72 hours without the need for venting. The review of long-term containment performance is currently ongoing.

In 2011, FANR requested ENEC to conduct an evaluation of the lessons learned from the Fukushima accident by following similar guidance to the EU "stress test" specifications. The evaluation included an analysis of the margin versus the probabilistic approach along with an evaluation to identify margins to "cliff-edge" effects. FANR also required deterministic and probabilistic safety assessments in the evaluation of severe accidents.

ENEC's Deputy Vice President for Operational Readiness gave a presentation on fresh fuel receipt. The presentation began with a brief review of the regulatory requirements. For security, a Physical Protection Plan (PPP) must be established, and FANR must grant licenses for: possession of nuclear materials; receipt and handling of new fuel; transportation of new fuel; as well as the import of new fuel. An operational radiation protection program should also be established and procedures for fuel receipt and nuclear material accounting must be developed. Furthermore, prior to any

nuclear fuel management that may take place, an authorized, trained and qualified senior reactor operator must be present who will be responsible for the control and handling of the nuclear fuel.

The fuel will be shipped in multiple cargos to mitigate the risks associated with sea transportation. There will also be intervals between the arrivals of the fuel shipments.

The fuel will be inspected upon arrival for cleanliness, foreign material erosion, discoloration, scratches and dents. The inspections will be carried in order to identify any damage or contaminant developed during shipping, while also ensuring that all fuel nodes are in the correct place within the assembly. There will be ten new fuel assembly inspections daily. A protocol is also expected to be established with the fuel supplier in the case of flawed fuel to secure a necessary replacement.

Once it is time to begin loading the fuel into the core, an elaborate and thorough process will be followed to prepare the reactor for operations. Such activities will require employees with special qualifications, such as overhead crane operators, spent fuel handling machine operators, fuel inspectors, and fuel management engineers.

ENEC officials also provided the Board with an update to the commissioning status. ENEC has contracted with KEPCO to execute the commissioning of Barakah NPP from the initial test program through to full operations of all four units. KEPCO in turn has subcontracted this work to Korea Hydro & Nuclear Power (KHNP). Currently, there are 449 contracted specialists involved in the commissioning and maintenance activities. Commissioning tests undertaken prior to full fuel load will be completed under the Construction License, while fuel load and tests following fuel loading is expected to be carried out under the Operating License. Several milestones within the commissioning process include:

- The overall commissioning process is 12.38% complete for Unit 1

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- 28 out of 28 startup administrative procedures have been issued by KHNP
- 548 of 773 test procedures have been issued
- 70% of the electrical distribution has been energized
- The fore-bay flooding has been completed
- The de-mineralizing water plant is operational and producing demineralized water
- Air systems are also operating

The major tests that lie ahead are:

- Initial energization of the Standby Auxiliary Transformer (SAT) via the switchyard from the offsite power grid
- Cold Hydrostatic Pressure Tests on reactor coolant and Secondary Sides (CHT and SHT)
- The Hot Functional Tests (which verifies the operability of various systems under hot conditions before fuel loading)
- Fuel loading
- Power ascension tests. These tests verify that the systems, components for the Unit are ready to be operated at plant power capacity

There was also a discussion of ENEC's future operating company and its current status.

ENEC stated that the formation of the operating company is due to be completed soon. This transition has been underway for many months. The launch of the operating company will enable ENEC to bring more focus on its key program milestones, such as the successful completion of the construction of Units 1 through 4 and the continued relationship with FANR to obtain the requisite operating licenses.

The vision of the operating company is to be

globally recognized as a top nuclear utility and UAE employer of choice by 2025. Its mission is to safely and reliably generate electricity from nuclear energy to advance the UAE's growth, development and quality of life for generations to come. The company will be a fully independent utility, capable of meeting all regulatory requirements and exclusively responsible for the safe and reliable operation of the Barakah NPP. This will include:

- establishing a strong safety culture
- overseeing the commissioning and acceptance of new units
- implementing an Integrated Management System
- implementing an operational readiness program
- operating and maintaining the four units at Barakah NPP
- developing local talent capacity building and creating career aspiration
- entering into strategic agreements to support safe and reliable operations
- producing electricity which is commercially competitive

As the operator, it will also be undertaking all liability for nuclear damage. Liability for nuclear damage is channeled exclusively to the holder of the operating license. This is established by the 1997 Vienna Convention on nuclear liability, which is part of UAE law. Once the company is formally established and FANR has successfully completed its review, the operating license will be issued to the operating company. It then will become the Licensee under the terms of the Convention, and therefore be subject to liability for nuclear damage as provided and limited by the Convention. The operator will be required to acquire insurance and is subject to the liability itself if the insurance fails to pay out. This liability is subject to the terms of the Convention.

Security

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The Nuclear Fuel Executive Director delivered a presentation on the security practices relevant to the shipment of nuclear fuel. The International Convention on the Physical Protection of Nuclear Material is the relevant international instrument. Under the Convention, states are obligated to protect nuclear material. The Convention has 151 parties, the UAE joined in 2003. Eighty-four states are party to the amendment, the UAE signed in 2009. FANR has adopted extensive regulations in support of this obligation. The transportation and delivery of fuel assemblies to Barakah NPP is a KEPCO Nuclear Fuels (KNF) responsibility. However, ENEC as the transportation Licensee needs to submit a transport license application to FANR for the transportation of nuclear fuel within the UAE's geographical boundaries. The transport license application is solely based on the security arrangements for the protection of nuclear fuel shipments. ENEC is currently developing a transport security plan in collaboration with the UAE's security stakeholders and is to be submitted for FANR to gain approval for fuel transportation within the UAE.

ENEC's Nuclear Fuel Executive Director explained in some detail the design of the shipping casks that would be used. He also described the tests of the casks that have been done, including dropping the cask from a height of 9 meters and subjecting it to a temperature of 800 degrees Celsius for 30 minutes. This is done pursuant to Korean law

and IAEA regulations. All tests demonstrated that the casks met FANR's requirements, in particular the fuel rods inside the cask remained intact after the 9 meter drop and the temperature inside the cask did not exceed a temperature in the range of 260°C, which is below the melting point of the fuel material inside by a wide margin.

The transportation plan was then explained. Final arrival of fuel is expected in 2016, pending regulatory approval. Prior to the fuel shipment, a mock fuel assembly will be shipped from Korea to the UAE to be used as part of the commissioning testing. This mock fuel exercise will be utilized to simulate the actual transportation plan.

With regards to fuel fabrication, all fuel assemblies are expected to be completed by the end of January, 2016. Quality assurance activities are being performed to ensure zero defect quality. Consultants are present at KNF facilities to carry out oversight activities, as well as at other facilities where fuel assembly components are produced for ENEC.

FANR reported that revision four of the Construction physical protection plan, including fresh fuel storage, is to be submitted by ENEC. After approval by FANR, the Transport Security Plan must be implemented at least 30 days prior to the fuel arrival on site. The PPP for Operation (PPP-O) was submitted by ENEC in March 2015. In the PPP-O beyond

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those tasks already completed, such as the Security Organization on site and the Physical Protection System, two tasks remain; the contingency plan and the Vulnerability Assessment.

Non-Proliferation

Non-Proliferation Assessment and Recommendations including Waste Management

Ambassador Al Kaabi gave an update on the development of the national strategy for safe and secure management of spent nuclear fuel and radioactive waste.

In considering its spent fuel management strategy, the UAE is keeping options open but at the same time it emphasizes planning of measures that are common for all options. The fuel cycle choices currently foreseen are 1) fuel leasing, 2) direct spent fuel disposal, and 3) spent fuel reprocessing abroad and return to the UAE for final disposal.

In the discussion with the IAB the importance of the following measures was stressed:

- completing the legal and regulatory framework for spent fuel and radioactive waste management;
- definition of organizational responsibilities for both interim and long term management of spent fuel;
- provision of safe and secure interim spent fuel storage facilities; the strategy should permit interim storing of all spent fuel that will be generated during the entire lifetime of the Barakah plant;
- timely provision of funds for spent fuel management and NPP decommissioning;
- regular review of available fuel cycle choices and their respective costs of options in light of technological development and services being provided internationally;
- transparency and public communication of spent fuel strategy;
- geological studies to find a potential permanent disposal site within the UAE either for high level reprocessing waste or direct disposal of spent fuel.

The legal framework is included in the Nuclear Law of 2009 and most of the regulations are already completed. The remaining regulations on decommissioning, the Decommission Trust Fund and disposal of radioactive waste are under preparation.

The interim storage of spent fuel and the longer term storage for low-level and intermediate-level radioactive waste, generated continuously during the NPP operation, will be located onsite and be under responsibility of the operating organization. A waste management organization tasked to implement the long term management of spent fuel and the final disposal of spent fuel or radioactive waste does not exist yet. The latest international Joint Convention review meeting held in Vienna in 2015 listed that the establishment of such an organization as one of the challenges for the UAE.

Interim storage for spent fuel is provided for 20 years of normal plant operation in the pools located next to each of the reactor buildings. The IAB questioned whether such storage should be available for the entire plant lifetime. Following discussions amongst the stakeholders, it was concluded that 20 years gives an adequate time margin to consider alternative fuel cycle options and make a decision on storage space extension when the future development of available fuel cycle options can be foreseen more accurately. The international practice is to establish dry-cask storages for spent fuel and such storage facilities can be built relatively quickly once a decision is taken. In addition, building extra pool storage capacity in a similar time frame is also feasible. ENEC has kept adequate land space available on site for additional spent fuel storage.

Dr. Chung asserted that Korea should have adopted a longer timeframe for its onsite storage plan. It provided for 30 years storage on site instead of 40 years as the waste should be transferred to long-term storage after 40 years on site. The public understands the safety and reliability of onsite storage. Mr. Laaksonen intervened to say that it is important to have sufficient resources up front so that the optimal option can be chosen by a country, rather than have it driven entirely by economics. Mr. Hattori said that based on Japan's experience, it is necessary to insure that sufficient funds are set aside for future expenses even though such costs may change with time.

Non-Proliferation Assessment and Recommendations including Waste Management

Dr. Chung stated that there should be a public discussion on waste policy. Many people don't understand physics, and fear can be stirred unnecessarily. It is important to educate the public on these matters.

Dr. Chung applauds what the UAE is doing when it comes to engaging its stakeholders and community. Waste policy should be addressed on a broad basis – a regional discussion, perhaps a global interaction on this issue is appropriate.

Lady Barbara said that children have grown up thinking that nuclear power is bad. We must educate them. The UK had trouble finding a waste depository because people don't understand radiation. Those that defend nuclear power are educated on the subject and tend to do well. Women seem to do the best job because the strongest critic of nuclear power have been shown to be women. Mr. Laaksonen asserted that public acceptance is essential.

The Chairman intervened to say that there was a long term necessity of reprocessing. Mr. Laaksonen said that he agreed. The Chairman went on to point out that the French and the Japanese took the view that reprocessing means less waste but it proved to be very expensive and as a result both countries went to Mixed Oxide Fuel (MOX) fuel to recoup. The public's fear of waste is still very great.

Lady Barbara pointed out that Kazakhstan recently began work on a regional depository. The Chairman noted locating a depository went well in Sweden. The Chairman further commented that the public acceptance is

greater if not only men but also women take part in explaining nuclear power and radiation. Ambassador Al Kaabi noted that the UAE has a policy of including women in nuclear power discussions.

A Decommissioning Trust Fund (DTF) is required in the Nuclear Law from 2009. The DTF consists of two separate funds: a Decommissioning Fund and a High-level Radioactive Waste Disposal Fund. Fees to the funds should be annually paid by the Operator of the Barakah NPP, based on cost estimates that shall be reviewed every three years. The funds must be adequate to cover all decommissioning and all high-level radioactive waste disposal costs, including research and development, regulatory oversight and fund management. FANR is currently preparing a detailed proposal on the DTF that will be established by a Cabinet decision. The DTF should be fully established by the time the first unit starts to operate.

According to the current plan, the funds should be fully paid in at the end of the 40th operating year. The Board commented that in some countries it is required to collect most of the funds during the first years of the plant lifetime to ensure that sufficient funds are available should plant operation be terminated prematurely. It would also be possible to guarantee the funds at the beginning of the plant lifetime by insurance.

Concerning the fuel cycle choices, the IAB noted that the costs of different spent fuel management options depend on the strategy to be chosen. The highest cost alternative should be used as the basis for estimating



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the required fund value. According to the experiences in Finland and Sweden that are developing direct disposal of spent fuel, their approach has today significantly lowered costs than the fees charged on international markets for reprocessing. Therefore the cost estimate of the UAE should be based on the reprocessing service costs offered by current service providers, added to the cost of high level waste disposal. The cost estimates on high-level reprocessing waste disposal are found in international studies. The leasing option may not be offered by any service provider but one could expect that due to the public acceptance effect, the leasing service provider could ask for the highest price.

Transparency and public communication on nuclear waste plans is generally important for acceptance of nuclear power. Direct disposal is an option that can be implemented with existing technology and all steps can be explained in clear and understandable terms to the general public. Direct disposal could be the basic alternative to be explained, with an explanation that there is also the reprocessing alternative that is proven and thus technologically available. However, the reprocessing and high-level waste disposal technologies are improving fast and are being tested on a pilot scale. It is therefore wise to wait to consider this option until improved and lower cost reprocessing alternatives are offered on a large scale.

Domestic geological studies are well funded because it is uncertain whether the fuel leasing option will ever be available. Each country using nuclear power should be aware that it may have to dispose in its own territory either the spent fuel or the high-level waste that is returned to the customer after reprocessing.

FANR selected a consultant to provide guidance on arrangements for decommissioning, spent fuel and high level waste disposal. The consultant is also providing feedback on the drafting of a Cabinet resolution establishing the Decommissioning Trust Fund. A FANR review and recommendations for the Decommissioning Trust Fund which addressed the proposed

UAE solution for the Fund was presented by PricewaterhouseCoopers (PwC). It was based on international practice and guidance and its approach in various countries and included the funding of different waste categories, existing legal requirements and current thinking on fund management in the UAE.

The solution proposed by FANR's consultants involves the establishment of a Fund Entity as a public authority reporting directly to the Cabinet.

Recently as stated by FANR, the UAE presented its second national report in accordance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management at the fifth review meeting of the Joint Convention. The report described the legislative, regulatory and administrative measures undertaken by the UAE as a Contracting Party. Progress since the fourth review meeting was noted with respect to the development by the UAE of a national strategy on radioactive waste in a timely manner; sustainable human capacity development consistent with the strategy; and continued development of comprehensive regulations and regulatory guides to support the national strategy. Challenges recognized for the UAE are:

- establishing the waste management organization to implement the national strategy;
- ensuring that the Decommissioning Trust Fund is in place by the time of the operation of the first NPP Unit at Barakah;
- recruiting the necessary skilled workforce;
- and necessary timely decisions on radioactive waste and spent fuel.

Ambassador Hamad Al Kaabi completed the presentation for MOFA with an analysis of the outcome at the 2015 Nuclear Non-Proliferation Treaty Review Conference. He noted that the UAE played a constructive role throughout and contributed significantly to the debate.

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The UAE was quite disappointed that consensus at the Conference fell apart over the issue of a conference on a Middle East Zone free of nuclear weapons. That means there is no way forward for this issue. But the UAE will continue its work and hope to contribute to a success at the next Review Conference.

Transparency

Transparency Assessment and Recommendations



The UAE continues to carry out all activities related to the nuclear power program in a fully transparent manner. The week previous to the IAB meeting, FANR conducted a successful outreach event.

Sustainability

Sustainability Assessment and Recommendations

ENEC noted that its current staff headcount stood at 1,522 with women representing 20% of the total workforce. Emiratization has now reached 61% with the remaining workforce representing a total of 40 nationalities. There were also 202 new employees that joined ENEC from January, 2015. Forty-five scholarship graduates joined ENEC during 2015 and 39 candidates have joined the Energy Pioneers program. ENEC website showed 150 vacancies and stated that there have been 20,000 applications submitted for the vacancies. Scholarship students continue to select this field upon graduation. There are 106 reactor operators and 14 senior reactor operators amongst the students and additional students will be expected for Units 3 and 4. The first 300-400 Energy Pioneers will be working on Units 1 and 2.

FANR announced progress as well. Total headcount of staff stood at 185 of which 107 are Emiratis (58%) and 66 are women (36%). FANR has developed a Knowledge Management Framework which integrates Knowledge Management into the management system to assure knowledge transfer and FANR business sustainability. FANR has made it a high priority to develop the skills and competency of its existing and future management and leaders.

Conclusion



Dr. Chung emphasized the importance of National Laboratories in the nuclear field. The UAE doesn't have this capability so it is important for the UAE to develop its relationship with the global network of research facilities. This should be a high priority.

The Board welcomed progress reported on Emiratization, and noted that the 20,000 applications were impressive.

The presentation on waste disposal was excellent however questions remain. What is the rationale for interim storage? Why two moves instead of one? Is 20 years at the site long enough? The Board would like to learn more about the various time lines involved.

With respect to operations, can Unit 1 be operated as a stand-alone when it shares a number of facilities with Unit 2? The Board would very much like to be present at the commencement of operations, this will be a truly historic moment for nuclear power. The UAE Barakah NPP Project is not only important to the UAE but also to the global energy economy. It could be providing a realistic and viable option for curbing climate change.

Given that the Shin Kori plant is going to be delayed, there will be minimal time to conduct tests that ENEC were planning to rely upon prior to Unit 1 beginning operations. Now that ENEC may unlikely have previously expected testing phase, it is critical to understand what steps or tests are being planned to compensate for this?

FANR indicated in its briefing that it has moved under the Prime Minister's jurisdiction. What effect if any will this have on regulatory independence? It is also important for FANR to further develop its contacts with other government agencies.

The Board is grateful to the UAE and the supporting entities for three thorough and highly informative presentations at the 12th meeting of the IAB. The Board congratulates again the UAE on its continuing inspiring success and the progress of its nuclear power program. And as always, the IAB finds that the UAE in its nuclear power program remains fully committed to the principles of safety, security, non-proliferation, transparency and sustainability.

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