Redirection of DPRK Nuclear Talent to the LWR Project

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Estimated number of personnel engaged: 520
Estimate Cost:

I. Background

General - Pursuant to the Agreed Framework, agreed between the US and the DPRK and signed in 1994, the US, Japan and the ROK formed the Korean Peninsula Energy Development Organization (KEDO). The purpose of KEDO was to implement the elements of the Agreed Framework, including the deployment of two commercial light water nuclear reactors (LWR) to replace the reactor at YongByon, DPRK, which was to be dismantled. The Korea Electric Power Company (KEPCO) was named as the Prime Contractor to provide the LWRs on a turnkey basis. KEDO had overall project management responsibility and assumed the role of owner for the units until they would be turned over to the DPRK nuclear operating company upon completion. However, at about 35% construction complete, in December 2006, the project was terminated after the revelation of the DPRK' s clandestine HEU program and its subsequent violation of the Agreed Framework.

Site preparation and infrastructure work began in August 1997. Actual construction of the LWR units began in February 2000 but was suspended in December 2004 and the project was officially terminated in December 2006. During the suspension period a significant effort was made to document the engineering and construction status of the units and to establish and maintain preservation measures so that work on the units could be restarted if and when political conditions permit. When KEDO and the contractors left the site in early 2005, despite the level of progress achieved, no nuclear technology or nuclear equipment had actually been transferred to the DPRK.

-- The Challenge of Meeting International Standards
The existing DPRK nuclear program was developed in relative isolation and would not meet international standards. Therefore, KEDO also assumed responsibility to ensure that the DPRK was competent to both operate the LWRS and to regulate their design, construction, operation and maintenance. Given the long lead time to do so, KEDO began developing and implementing programs to develop such competency. For example;

1. Training of about 125 nuclear plant operators had begun. The extent of this training and a profile of the participants is discussed further below.

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2. KEDO had employed the Korea Institute for Nuclear Safety (KINS), the technical arm of the ROK nuclear regulator to assist the DPRK regulator to develop a regulatory framework and technical competence that would enable them to regulate consistent with international standards.
3. KEDO had developed and had initiated negotiations on a Plant Takeover Memorandum of Understanding which detailed and would commit both parties to a process leading to the ability of the DPRK LWR operating company to operate and maintain the LWR units safely and consistent with the norms of the international commercial nuclear industry.

All of these support activities were terminated when the project was suspended. Based on these interactions with the DPRK personnel involved with the LWR project, the authors have concluded that they genuinely accepted the need to adhere to international standards and considerable information was provided to them in that regard. For example, they requested and were provided with a complete set of USNRC regulatory guides applicable to the type of reactor being provided by KEDO.

Considering the current progress of nuclear talks with the DPRK it would be logical to begin considering options to employ DPRK persons in activities related to the peaceful uses of nuclear energy to the extent practical. If the LWR construction were to be resumed, all the regulatory and plant takeover preparation activities planned by KEDO also needs to be resumed. A significant number of DPRK personnel will need to be involved in these activities.

The purpose of this paper is to identify where there are opportunities to employ DPRK nuclear experts from YongByon in activities related to the LWR Project.

The authors had the primary responsibility within KEDO for management of the LWR project and thus have intimate knowledge of the planned regulatory and plant takeover activities discussed in this paper.

Nuclear Training – KEDO established a comprehensive program to facilitate the training and qualification of DRPK engineers on the operation and maintenance of the LWR units and DRPK regulators in the principles of regulation of plant construction, operation and maintenance.

- *Senior Managers:* Prior to beginning the formal training of engineering personnel, KEDO provided a Senior Management Orientation program for about 20 DPRK nuclear program senior managers. This training included a two week tour of European nuclear facilities including a nuclear power plant in Spain and a waste depository site in Sweden. The DPRK had requested to visit US facilities but the political climate at the time precluded such a visit.

- *Engineers* - Training for the engineers was to consist of both Classroom Training (CRT) and On-the-Job training (OJT). The first CRT program for 125

engineers lasting 13 weeks and taught by KEPCO engineers was completed in October 2002. The CRT was conducted in the modern Nuclear Power Training Center constructed by KEDO near the plant site. The CRT program covered a wide range of topics from basic reactor theory to management of plant operations and maintenance. The first session of OJT had been scheduled to be held following the CRT. It was to be conducted at YoungWang 3&4 nuclear units in the ROK; however, that training was delayed and eventually cancelled as the political situation deteriorated.

As noted above KEDO employed KINS to assist and train the DPRK regulator. In late 2002, 50 DPRK engineers participated in a nuclear regulator orientation program at the KINS offices in the ROK.

The KEDO training programs were suspended and eventually terminated due to the political crisis which developed due to the DPRK HEU program. These training programs must be reconstituted if the LWR Project restarts. Such training is essential to meaningful participation in the activities noted below.

Staffing Required to Complete and Operate the LWR Units – KEDO held extensive discussion with the DPRK as regards the organization requirements for the LWR Units. The agreed organization requiring a staffing level of about 520 O&M (full time, permanent) personnel was based to a large extent on ROK experience on their nuclear stations. Some modifications to that experience were made to accommodate the situation in the DPRK. It was assumed that the plants would be operated by DPRK staff with supervision for a period of time by KEPCO licensed Senior Reactor Operators. On that basis it was planned to train 160 licensed plant operators and 360 support staff.

The size of the regulatory body had not been fully determined. However, KEDO planned to have KINS train about 100 engineers overall.

Considering that it will take seven years to complete the LWR project from the onset of the KEDO Training Program, KEDO decided on the trainee selection criteria to be mid-thirty to mid-forty years of age with a BS degree in engineering and about 5 to 15 years of professional experience. This would ensure the staff would consist of relatively experienced people who could be at the plant for a reasonable period of time before they retired.

Before starting the CRT, KEDO examined the qualifications of the DPRK trainees (plant operators) and selected 520 trainees out of about 750 candidates. Trainees were from various R&D and educational organizations such as Atomic Energy Research Institute and other technical organizations under the ministries of energy and resource and mechanical engineering. Many were graduated from KimChaek Engineering University and have 5~15 years of practical experience in domestic industry.

II. Potential Activities Employing DPRK Nuclear Engineers and Scientists in the LWR Project

1. **LWR Project Reactivation** (20-30 DPRK Regulators) – Before construction of the LWRs can be restarted it will be necessary to conduct a detailed evaluation of the material condition of the construction works and formulate and implement plans to repair, replace or accept as is anything that may have been degraded since construction stopped. The regulator will have the final say regarding restart. In our opinion, it will require in the range of 20-30 KINS persons and 30-40 KEPCO persons at least a year to inspect, document, plan, mobilize and complete any repairs. About 20-30 DPRK regulatory personnel should be employed in the process since the DPRK, as a sovereign nation, is solely responsible for licensing these reactors and must be convinced that material conditions are acceptable and any rework to reestablish acceptable conditions has been completed and appropriately documented. KEPCO and KINS should be asked for their opinion on the manpower and time requirements to complete this process. It should be noted that, during the construction, the DPRK took a strong position regarding its role in QA and licensing and would be expected to continue to assert itself in these areas if the project continues.

2. **Development and Implementation of the DPRK Regulatory Structure and Organization** (100-150 people)– The DPRK needs to develop a regulatory structure based on international standards. The structure should include regulations and an organization to develop, maintain and enforce those regulations. During the period leading up to issuing an operating license, as a minimum, they will need a competent technical and administrative staff to develop the regulations, review licensing documents such a the Final Safety Analysis Report, perform inspections of the construction works, and examine and license plant operators. In our opinion, immediately on resumption of the LWR Project the DPRK should assign a 100-150 people to these activities; however, the ROK regulator should be consulted to determine what it took to initially set up and implement their regulatory structure. It would be extremely valuable to assign some DPRK regulatory personnel to the regulatory bodies in one or more other countries to gain an understanding of the regulatory practices that are considered acceptable in international nuclear community. The USNRC could likely provide such assistance to the DPRK under its Bilateral Relations program which is designed to provide regulatory assistance to other countries. KINS has previously established a relationship with the DPRK regulator and has actually provided training to them in the ROK. Thus KINS would also be a good candidate to provide assistance.

Development of the organization, processes and procedures to safely and effectively operate, maintain and refuel a licensed nuclear plant. (~500 plant operators and maintenance staff) - Operation and maintenance of a two unit nuclear station is complex requiring a large operating plant staff having a high degree of training and skill as well as carefully structured processes and procedures to control all aspects of operations and maintenance and supporting activities such engineering and procurement. An organization for the nuclear operating company was discussed and agreed in discussions between the DPRK and KEDO and it was estimated that roughly 500 people would be required to operate and maintain the plant. A large number of these people should be assigned immediately if and when the LWR Project is restarted. Most of these people need to be involved early in construction so that the nuclear operating company is fully competent to accept responsibility for the units when fuel is loaded. A summary of the type of persons and functions is provided below: Overall these activities could involve over 500 people.

- ***Management*** – Key personnel need to be assigned in every management position from the start so that they can direct the work necessary to be prepared to accept responsibility for operation of the LWR units. Many of these people should be trained and licensed as plant operators. They will need to qualify as operators in parallel with managing preparation activities.
- ***Control Room Supervisors and Operators*** – Licensing of an operator requires at least six months of classroom training, subsequent training on the reactor simulator and periodic re-qualification on the simulator. Supervisors should receive additional training and spend time in the control rooms of plants in other countries to observe and understand the “safety culture” that is critical to safe operation. Trained operators are needed as early as possible to develop operating procedures and verify and validate those procedures on the simulator. Also, as the plant is completed, these operators will participate on system turnover teams to verify mechanical completion on system-by-system basis and will accept responsibility for those systems as they are turned over from the construction organization. The DPRK nuclear operating company should join the World Association of Nuclear Operators (WANO) and through WANO arrange for
- ***Engineering Staff*** - An operating plant requires a significant engineering staff in order to support maintenance and operations. Engineering leads and at least a few engineers in each engineering discipline should be assigned to learn the plant design and design basis and continue to develop their engineering technical and supervisory skills. In addition, they should be establishing the processes and procedures which will be used to control engineering work need to support maintenance and modification of

the plant subsequent to turnover. Since the administration and control of engineering activities on an operating plant differs from new construction, these people should be assigned to work at one of KEPCO's operation plants for at least several months to learn the processes and safety culture required to do operating plant engineering support.

- ***Maintenance Supervision*** – Similar to the engineering staff, the maintenance supervisory staff needs understand the design of the plant and develop the process and procedures which will be used to do maintenance. Spending some time in the maintenance department of one of KEPCOs plants should be mandatory.
- ***Craft and Craft Supervision*** – Those DPRK craft and craft supervisors who will be potentially assigned to the operating plant should be immediately integrated into the construction organization to ensure that they develop the necessary basic skills (e.g. nuclear grade welding, electronic maintenance, etc.) which they will need to properly maintain the plant. After these people have honed their basic skills they should be integrated into the plant maintenance organization and undergo specialized training on the maintenance processes and procedures in to instill in them the safety culture needed to do work safely on an operating plant.
- ***Quality Assurance/Quality Control*** – QA/QC is one of the most important aspects of confirming that nuclear power plant meets the plant design basis and that subsequent modifications and maintenance continue to maintain the design basis. The basic principles and practices of QA are no different for new construction than for operating plants. Therefore, the QA/QC personnel to be assigned to the operating plant staff should be integrated into the construction QA/QC organization to learn the principles of QA and to develop basic skills in areas such inspection, non-destructive testing, etc. After a learning period in the new construction organization they should be reassigned to develop establish the QA processes and procedures to be used a the DPRK takes responsibility for the operation and maintenance of the plant on a system-by system basis.

III. Recommendations

1. Short Term

As noted in II.1 above, a comprehensive program to inspect the existing LWR project works will be required to assess the current conditions and establish and implement a program to remobilize, make the necessary repairs, get regulatory approval and fully reestablish construction activities.

This is expected to take at least a year and perhaps up to two years. Thus there will be sufficient time to evaluate and assign DPRK personnel to LWR project activities previously planned during the original project construction period.

A. *Identification of Candidates for the LWR Project* - As the first step, it will be necessary to identify candidates for the LWR unit's staff. One obvious source would be those previously selected by KEDO for the KEDO training program. Records of the selection process and candidate names may be available from KEPCO. In October 2002, the DPRK constructed a new residential village next to the KEDO Community area. KEDO was told that the trainees would be relocated there before they went to the ROK for OJT. It is not known whether they have maintained there residences in this village. In any case those that have already completed the 13 weeks of CRT should be given high priority for inclusion in the program. Perhaps they could form the core team to be supplemented by others from YongByon.

   Since an objective is to employ many of the workers from YongByon in the program, they should also be given a high priority. They will need to be screened in a manner similar to initial screening used by KEDO; however, some requirements may need to be relaxed as long as safety is not compromised.

B. *Orientation Program for DPRK Senior Nuclear Officials* – Similar to the KEDO Senior Management Orientation Program, a number of DPRK senior officials (20-30) should be invited to visit US nuclear power plants as well as other nuclear organization such as the USDOE, USNRC, INPO, WANO. These organizations should be encouraged to run a short orientation program for them (perhaps a week long) and engage in discussions about providing longer term assistance.

C. Have KEPCO develop a *refresher course* for any of the DPRK trainees who have already previously completed the CRT.

D. Engage the DPRK in reestablishing the *LWR plant organization*

E. Establish contracts with KEPCO and KINS and others as necessary to provide *expert assistance to the DPRK and to conduct training*.

2. Mid-Term – Resumption of O&M and Regulator Training Programs

A. *Conduct refresher training course* and reinstitute the KEDO Training program as it was originally planned. This would include conducting the OJT in the ROK for the first class and continuing with additional classes of CRT and OJT as appropriate. Depending on the availability and qualifications of the DPRK personnel, the OJT program should be reviewed and updated as necessary.

B. *Begin assignment of DPRK personnel to the LWR* unit staff and begin planning for completion of the work items discussed in II.3 above with the assistance of KEPCO and KINS.

3. Long Term – Establishment of DPRK Nuclear Infrastructure which meets International Standards.

A. Assuring nuclear safety is most critical in operating the LWR units. To provide such assurance, it is very important that the *DPRK nuclear infrastructure be established/upgraded to meet international norms*. A detailed plan should be prepared and implemented to achieve a reasonably mature level of competence by the time the DPRK operator accepts responsibility for O&M and loads fuel. This plan should cover the gamut of required activities such as development of a competent DRPK operator's O&M staff, operating and maintenance procedures and administrative systems, a supply chain for O&M spare parts and consumables, emergency response procedures (on site and off site), a nuclear indemnity legal regime, nuclear regulations, a competent nuclear regulatory organization including engineers and inspectors, laws which give the regulator independent regulatory authority. A complete list of activities can be compiled with the assistance of KEPCO and KINS and/or the IAEA.

B. *Establish relationships with appropriate agencies in other countries* such a US utilities, USNRC, INPO and WANO to allow the DPRK regulator and operator to bench mark their infrastructure with other countries and to establish the appropriate degree of safety culture.