Collaboration between North and South Korea on Nuclear Energy for Peaceful Uses

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Preface

Ever since the signing of the Agreed Framework between US and North Korea in September of 1994, the frozen relationship between S. and N. Korea has been thawing away gradually to bring a historical occasion for making the joint statement of N. and S. Korea on June 15, 2000. The joint statement was made 6 years after the signing of the Agreed Framework.

Continuous and consorted efforts were made for the cultural and economical exchanges between N. and S. Korea, that brought the reunion of separated family, various civic, religious, and social exchanges, and some commercial joint ventures.

Though it has been expected, however, exchanges or collaborative works on science and engineering field have not been taken place except some initiation of light industrial joint ventures.

It is the expectation of the scientific community that the scientific and engineering collaboration may take place some time in a near future following other fields of mutual cooperation. The purpose of this presentation is to provide a view of the type of a brainstorming on what we should expect from and what we should offer to N. Korea in the area of nuclear science and engineering.

The Korea Energy Development Authority (KEDO), the organization for the implementation of the 1994 Agreed Framework, has been steadily working with N. Korea on the implementation of the Agreed Framework, including the construction activities of two units of 1000 MWe LWR. As was the case of the canning of the spent fuel from the 5 MWe Yongbyun reactor, engineers from KEDO and N. Korea have been working side by side, and provided opportunities for informal person to person type dialogue further understanding each other. For the LWR construction at Shinpo, N. Korea, engineers and workers from both N. and S. Korea (KEPCO staff) are working side by side, day and night for a long time, and promoted the occasion for mutual understanding out side the formal channel of N. and S. Korean governments. In addition, through the KEDO works, opportunities were provided for engineers and scientists on both sides for further understanding that may bring the future collaboration.

For the cooperation and collaboration, it is essential to know the capabilities of scientist and engineers along with their facilities in N. Korea and have an educated guess what they may benefit from what we can offer as joint collaborative projects or programs.

Technical Capabilities and Achievements in North Korea

Technical Capabilities in North Korea

In general, nuclear engineers in N. Korea heavily rely on analytical approach for the solution of technical problems. On the other hand, in S. Korea, a computer oriented approach is very common.

For an approach to a nuclear analysis of a reactor, a homogenized reactor system that requires material or geometrical bucking calculations is used as a start in N. Korea, and with the parametric data on homogenized reactor a localized cell calculation is conducted for the over all rector core system. In S. Korea, utilization of an existing computer code would be a start for a system design.

Basic and Advanced Training and Education

Many nuclear engineers are trained in various technical or universities in N. Korea. In general, there are very few illiterates in N. Korea and even non-technical people, such as laborers, office clerks and manual laborers have their compulsory high school or equivalent education and training. They are able to handle basic mathematics, such as fundamental algebra or geometry, and can follow rather complicated operational procedures of equipment or an operational system with minimal training.

Most of the nuclear engineers with Doctoral degrees are trained as a post graduate fellow or research associates in various former eastern block institutions, such as Dubna Institute in former USSR. They have substantial analytical capabilities, and may not require intensive training for the utilization of western computer programs for various analysis. For handling, operation, and use of modern equipments, they need introductory training, not an intensive theory oriented one, because they may already have theoretical bases for the principle of the equipments and apparatus.

Technologies Indigenously Developed in N. Korea

Off hand, we could not think of any technology that may be needed in S. Korea right away, because S. Korea is capable of developing those technologies indigenously or be able to get those technologies from other countries. However, technologies in the following areas might be useful for future nuclear programs:

- **Graphite Technologies.** N. Korea developed indigenously the nuclear-grade graphite for the Yongbyun 5 MWe graphite moderated nuclear reactor. The natural graphite contains impurities such as Lithium (Li) and Boron (B). Depending on the methods of treatment, nuclear-grade graphite can be formed more than a dozen of different kinds, ranging the densities from 1.67 (CX-2002U) to 1.90 (GSP-50) g/cc, and Young's Modulus (Gpa) 6.5 (GR-280) 14.14 (PGA), thermal conductivities of 42 (GSP-50) to 800 (GPX) W/mk, thermal expansion coefficient (10^{-6}/k) 3.2 for GR-280 to 6.8 for GR-1. These physical characteristics depend on methods of purification and on treatment temperatures, usually ranging 2,600 – 3,000^{o} C. The impurities, Li and B, are poison to neutrons and desirable to be removed. What technologies N. Korea used for the purification are unknown. Purified graphite are used for the Pebble Bed type Gas Cooled Reactors, to be coated on to a UO_2 pebbles and as a Si-Graphite sealant and many other nuclear industry as a moderator and a reflector for neutrons.

- **Sealing, Sealant, and Leak Proof Technology.** N. Korea developed Gas Cooled Reactor that requires pressure sealing for the cooling system. These technologies may be a contribution from N. Korea to the nuclear industry or for component development for the Pebble Bed type gas cooled reactors.

- **Front and Back-end Fuel Cycle.** N. Korea developed a full "Front and Back-End Fuel Cycle" system including complete reprocessing of the Magnox-type spent fuel by PUREX system. The technology could be utilized in a future as a means of treatment of a high level radioactive waste.

Approaches for the Implementation of Selected Programs and Training

Currently KAERI has a program on " N.- S. Nuclear Cooperative Program Plan," which has a sound bases on what S. Korea to offer to N. Korea. Recently a group of prominent scientist and engineers has reviewed the program on March 23, and June 27, 2001. Project Manager is Dr. Lee Kwang Seuk, Policy Analysis Team of KAERI. The program has analyzed on "what" and "how" S. Korea could offer to N. Korea. Also "what" benefits would these collaborative programs bring to both N. S. Korea and "why" are included. The following summaries KAERI's selected program areas for cooperation: Exchange of technical articles; technical conference or workshop; atomic and nuclear dictionary; the Cooperative Center; supply of radioactive isotopes (RI); technological utilization of radiation and RI; N.-S. mutual inspection on radiation environment; and sharing equipment.

Education and Training

In addition to the eight selected areas, a special attention was given to the education and training:

- **Background.** Upon conclusion of the Training Protocol of the LWR Supply Contract, extensive training program is formulated by KEPCO through KEDO and soon to be implemented. Also the N. S. Summit Declaration had enhanced the possibility of N. Korea to send trainees of the future LWR O&M staff to S. Korea where all the training facilities are located. The KEDO training is strictly on LWR O&M, while other areas of training are also essential.

- **Training Need.** The existing N. Korean nuclear infrastructure is based on one small 5 MWe GMR, which is quite different from that of future 2 units of 1000 MWe PWR. The establishment of a new infrastructure based on PWR requires many renovations and modifications of the existing one. Because S. Korea already established the infrastructure based on PWR, and other nuclear systems, S. Korea would be the best source of assistance.

- **Area of Training.** Following would be the area that N. Korea may need; Basic PWR nuclear technologies, PWR O&M, Safety Rules and Regulations, Policy, Planning, Control of nuclear system, RI utilization, Nuclear Power Production related technologies, Nuclear Expert Training, Industrial Radiation and Nuclear Safety Technologies.

- **Implementation.** The training can be conducted through the training institutions in KEPCO, various institution of nuclear safety, nuclear R&D, academic, industrial, and the government.

Approach for the Implementation of the Selected Programs and Training

For the implementation, the following steps may be taken; Transmit the letter of "Intention for Collaborative Program" to the N. Korean government institution, establish a channel to discuss and formulate various selected programs and training of staff. Take advise and suggestions from industrial group who has experiences with establishing business with N. Korea, opinions and advise from R & D and academic communities, and S. Korean government institutions. In the following, further details of implementation plan of selected programs are summarized:

Exchanges of Technical Articles

To increase the understanding on current activities between N and S. Korea, and as a precursor of personal and academic exchanges, exchange KNS journals, industrial and RI periodicals from S. Korea and "Atomic Energy." Also, introductory pamphlets of N. and S. Korean Institutions should be included in this category.

International Conference or Workshop

Exchange of academic and technical exchanges in non governmental levels. Locations and Length of these meetings: Seoul and Pyongyang for 3 to 4 days for those who are in nuclear research, academic, industrial and policy making institutions.

Atomic and Nuclear Dictionary

Unifying the terminology and show off the cooperative efforts in respect to those terms used not only in N. and S. Korea but also in reference to those terms in U.S. and Russia. The KEDO training documents will be made of terms used in Korean Standard Nuclear Plant (KSNP).

The Cooperative Center

Build the Center in the de-militarized zone for meetings, trainings, conferences, and technical exchanges. S. Korea will support the construction, maintenance, and operation, however, the center will be administered by both parties. The Center should be also utilized for the KEDO training and meetings.

Supply of Radioactive Isotope (RI)

It will be a symbolic display of cooperative measures. RI and production technologies also will be made available to both parties. Items of interests are; Tc-99m, I-131. Ir-192, Tc-99m, and others.

Technology Utilization of Radiation and RI

Exchanging technical experts of N. and S. Korea and industrial tour of the facilities and laboratories will be conducted for the food irradiation, nuclear medicine, Non Destructive Testing (NDT), industrial Gages, and tracer technologies.

N-S Mutual Inspection on Radiation Environment

Establish a system similar to the existing inspection system in N. Korea for the radiation environment and emergency response to radiation or nuclear accidents in S. Korea.

Sharing Equipment

Exchange or share the monitoring and inspection system and equipment between N. and S. Korea. Equipment and inspection system used in N. Korea may not be compatible to that of in S. Korea. To have a uniform system, it is desirable to have same kind of equipment and inspection system both in N. and S. Korea.

In addition to the eight selected program areas, others, including radioactive waste management and disposal; dismantling the nuclear facilities in Yongbyun and other areas; and the exchange of academic personnel, could be added as program areas if both parties of N. and S. Korea justify the needs and so desire.

Mutual Cooperation between N.-S. Korea on Peaceful Uses of Nuclear Energy

Once an agreement is reached to cooperate on programs on peaceful uses of nuclear energies, both parties would engage in meetings, conferences, and negotiations. Prior to any formal establishment of the mutual agreement, a few actions should be taken.

Show of Wills for the Peaceful Use

Both parties, though it has been declared previously, should declare their strong and uncompromising wills for adhering to the stipulations on NPT. This strong will should be known to all the other nations and both parties should be aware that their activities are under the watch full eyes of many nations.

Assured Transparency

Without the assured transparency, cooperation may not be realized just declared will alone. It is an essential process for building a mutual trust and confidence. Both parties have to show how they are going to provide technical means to assure transparency on their activities. Those technical means should be able to show every step of various nuclear activities with minimum complexities and be accepted by both parties as means of achieving their objectives. Both parties not only adhere to the agreed upon procedures but also provide a room to modify those procedures if any needs arises.

Some Observations on Mutual Cooperation

Prior to or during the negotiations for achieving agreements, both parties should give every effort for the understanding of the stated, underlying or even the implied meaning of agenda. Because of the isolation of the N. Korea for more than a half a century, though the Korean language has not been changed, the culture and the use of terminologies that reflects the language have been changed. Also fundamental approaches and means for resolving various issues are quite different in both N. and S. Korea, and it is important to understand the thought process and justification they may have reached. Otherwise, many of the misunderstanding would bring not only suspicion, but also frustration with animosities.

It is also important to recognize the cooperation between N. and S. Korea is not only for the present generation, but also for the benefit to the coming generations. Therefore the attitude for facing various issues should be more accommodating than narrowly confining and confronting.

Most of all, facing counter parts with confidence and respect rather than suspicion and disrespect would bring desired results.

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