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《特別寄稿》

Quality Assurance Experience in Korea

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ABSTRACT

This paper describes the evolution of quality assurance in Korea from it's total reliance on foreign contractors to the present status of conducting all QA functions independently. A brief status of the Republic of Korea Regulatory Bodies, licensing precess, codes and standards, and the quality organization of the Korea Electric Power Corporation are also included.

INTRODUCTION

The first nuclear power plant, Korea Nuclear Unit No. 1, known as Kori Unit No. 1, a 600MWe class pressurized water reactor, was placed on order in June, 1970, and began commercial operation in April, 1978. The second and third units, wolsung Unit No-1 (600MWe class PHWR) and Kori Unit No-2 (600MWe class PWR) began commercial operation last year. Presently Korea Nuclear Unit Nos. 5, 6, 7, 8, 9, and 10, all 900MWe class PWR's, are at various stages of construction. KNU Nos. 5 and 6 are scheduled to be completed in June, 1985 and March, 1986 respectively, and from then, one unit will be added each year until 1990.

The first 3 units, Kori unit Nos. 1 and 2 and Wolsung unit No. 1, were turnkey projects, that is, overall responsibilities, including quality, were delegated to the contractors. From KNU Nos. 5 and 6, the Korea Electric Power Corporation took a non-turnkey approach. KEPCO is responsible for overall project management and quality assurance but KEPCO's contractors are required to establish and implement quality assurance programs consistent with the requirements of the KEPCO's project quality assurance programs.

REGULATORY BODIES

The Korea regulatory authority for nuclear power plant construction and operation is with the Ministry of Science and Technology (MOST). All regulatory actions are administered by the Atomic Energy Bureau (AEB) of MOST. These actions include licensing of nuclear power plants, drafting and enforing safety rules and regulations, and issuing permits to domestic manufactuers for production of nuclear safety-related items for nuclear power plants.

The Nuclear Safety Center (NSC) within the Korea Advanced Energy Research Institute (KAERI) was established in January, 1982 to support AEB/MOST in enforcing safety regulations. NSC reviews safety analysis reports, reports on design and construction methods, and performs inspection of nuclear facilities on behalf of MOST. The regulatory requirements for quality assurance require that the applicant, KEPCO, establish and implement an effective quality assurance program. AEB/MOST, in conjunction with NSC/KAERI, performs regular reviews, inspections and audits of KEPCO and its major contractors. Resident AEB and NSC inspectors are assigned to each power plant construction site and operating station to perform daily inspections to verify compliance with the regulatory requirements.

The regulatory organization is shown in Figure 1.

LICENSING PROCESS IN KOREA

The Atomic Energy Act of 1958, as amended, defines general rules for the peaceful utilization of atomic energy in Korea. The Presidential Decree on Nuclear Power Plant Construction and Operation and the Prime Minister's Decree on Nuclear Power Plant Construction and Operation define requirements for the licensing of nuclear power plant construction and operation in Korea. Various Ministerial Ordinances concerning nuclear power plant construction and operation are also in the process of being developed and issued.

The first step in the licensing process for nuclear power plants in Korea is the construction permit. For this stage, an applicant must submit an application for nuclear power plant construction to the Minister of MOST together with a preliminary safety analysis report and an environmental impact report.

If the applicant would like to obtain approval for site preparation, including excavation for the reactor building, he must submit an application for the site approval to the Minister of MOST Prior to the submission of the application for the construction permit.

If the applicant wants to start subsurface construction work, the Minister of MOST many grant a limited work authorization for subsurface construction work.

The applicant is also required to submit the Project Quality Assurance Manual to the Minister of MOST at the time of PSAR submission.

The second step in the licesning process is the submission of a report on the design and construction methods to the Minister of MOST prior to the commencement of construction work. This stage is divided

into several packages consistant with design completion.

The third step in the licensing process concerns inspection. The applicant shall submit and application for preoperational inspection to the Minister of MOST. This stage is divided largely into two areas. The first is facility inspection including construction acceptance testing and the second is plant functional testing. The latter included system functional testing, core physics examination and power ascention tests.

For an operating license, the applicant is required to submit a final safety analysis report to the Minister of MOST and obtain approval from the minister of MOST prior to the fuel loading.

CODES AND STANDARDS

Codes and standards applicable to each project may be different because the codes and standards of the country of origin are adopted. All projects, except Wolsung Unit No. 1 and KNU Nos. 9 and 10, are of U.S. origin, therefore, these QA programs are structured in accordance with the requirements of 10 CFR 50, Appendix B, ASME Boiler and Pressure Vessel Code, Section III, and other applicable U.S. nuclear and indutrial standards. Even though Wolsung Unit No. 1 has a QA program per CSAZ 299, an KNU Nos. 9 and 10 have QA programs per IAEA Safety Series No. 50-C-QA, the quality assurance programs for these projects are also written to meet the requirements of the U.S. 10 CFR 50, Appendix B.

KEPCO QUALITY ORGANIZATION

KEPCO established a quality assurance program to meet the specific needs of each project.

Typical QA organizational elements and functions are as follows:

Home Office Quality Assurance

- Perform audits of contractors
- Perform internal audits
- Maintain QA program manuals
- Manage preservice and inservice examination per ASME Section XI
- Prepare quality requirements for equipment and construction specifications
- Provide quality assurance training and indoctrination

Site Quality Assurance (Construction)

- Prepare and implement field QA procedures
- Perform site audits of contractors
- Perform internal audits
- Report unresolved and significant problems to the Home Office Manager-QA for resolution.

Site Quality Assurance (Operations)

- Prepare and implement operations QA procedures.
- Perform internal audits.
- Surveillance of all operation activities

Site Quality Control

- Quality verification of work performed
- Surveillance inspection of contractor's on-site quality control program implementation
- NDE and welding control
- Review of contractor's quality control programs
- Monitoring construction work quality

Overseas Office

- Witness and inspection of overseas vendor's shop test
- Review technical specifications for the inclusion of quality requirements and instructions
- Obtain and compile quality assurance records

KEPCO QA Organization is shown in Figure 2.

QUALITY ASSURANCE EXPERIENCES

When quality assurance for nuclear power plants was mandated in the U.S.A by 10 CFR 50 in 1970, Kori Unit No. 1 Project was in the early stages of construction. The Project management then decided to adopt U.S. quality assurance requirements in their entirety. These include the 18 criteria of 10 CFR 50 Appendix B, ASME Section III NA-4000, and ANSI N 45.2-1971.

Since nuclear projects and nuclear quality assurance were relatively new to Korean industries, the major difficulties we faced in achieving quality assurance objectives have been mainly due to lack of understanding of the purpose and necessity of quality assurance.

At the beginning of the first nuclear project, KEPCO didn't fully understand the necessity and requirements of quality assurance and had no independent quality organization of its own.

For kori Unit No. 1, Westinghouse, the prime contractor, provided the QA program for construction based on codes and standards effective as of the contract out-off date in 1968. Fortunately most major equipment was manufactured in the U.S.A. under the U.S. nuclear QA standards.

In 1973, a resident IAEA expert from the U.S.A. strongly recommended to our government that KEPCO establish its own QA system in the Corporation even though the contract was for a turnkey project.

KEPCO adopted a QA program in 1974 and established a QA organization which gradually expanded to the present status.

In 1975 KEPCO began hiring QA consultants from the U.S. as well as other overseas consulting companies.

Now KEPCO has qualified QA engineers, and in conjunction with the expatriate QA engineers from various foreign companies, can conduct all important QA functions independently.

In the early stages of developing a QA program in our country, it was believed that the QA system was needed only as a formality and that it contributed nothing to the final product. Naturally there was no enthusiasm or motivation for the systematic and productive QA function. Insufficient knowledge of QA, specifically the QA dequirements for different items, caused many problems in the beginning. Sometimes the necessary quality requirements were ignored and sometimes excessively strict requirements were placed on manufacturers of non-safety related items.

The following are identified causes of quality problems abstracted from cases compilied during plant construction.

- Insufficient know-how to implement program requirements through the use of procedures and other control methods
- Little incentive for suppliers to make the necessary investment for QA due to relatively small quantities and contract amount
- In some cases, management ignored quality requirements in order to avoid cost overruns or impact on contruction schedule
- Failure to indoctrinate and train the personnel to appreciate the value of quality assurance
- Language barriers have created difficulties and misunderstandings. This has been especially troublesome in interpreting and applying the requirements of other nation's codes and standards. This has been compounded because the three countries that have provided nuclear steam supply systems each use different codes and standards.

Over the years, quality problems in our country have decreased substantially, mainly due to an increased understanding of quality assurance programs.

SUMMARY

Significant progress has been made in the development of nuclear quality assurance since embarking on our first nuclear power plant in 1968. We have had to adopt unfamiliar codes, standards and regulations and learn a new technology. This was doubly difficult because of the obvious language difficulties. Despite these hardships, we have made steady progress, advancing from total reliance on foreign contractors and consultants to the point were we have an understanding of the merits of a systematic quality assurance program and are capable of implementing comprehensive nuclear quality assurance programs for construction of six nuclear units, simultaneously.

Now, most individuals who engage in the nuclear business in Korea recognize that quality assurance is an essential element of a nuclear project. Through experience, higher management has learned the

benefits of strong QA programs.

In spite of the considerable progress we have made over the years, much improvement is still needed. But we are confident that with our increased understanding of nuclear quality assurance and a firm government policy, future improvements will be achieved more quickly than in the beginning, which was over 15 years ago.

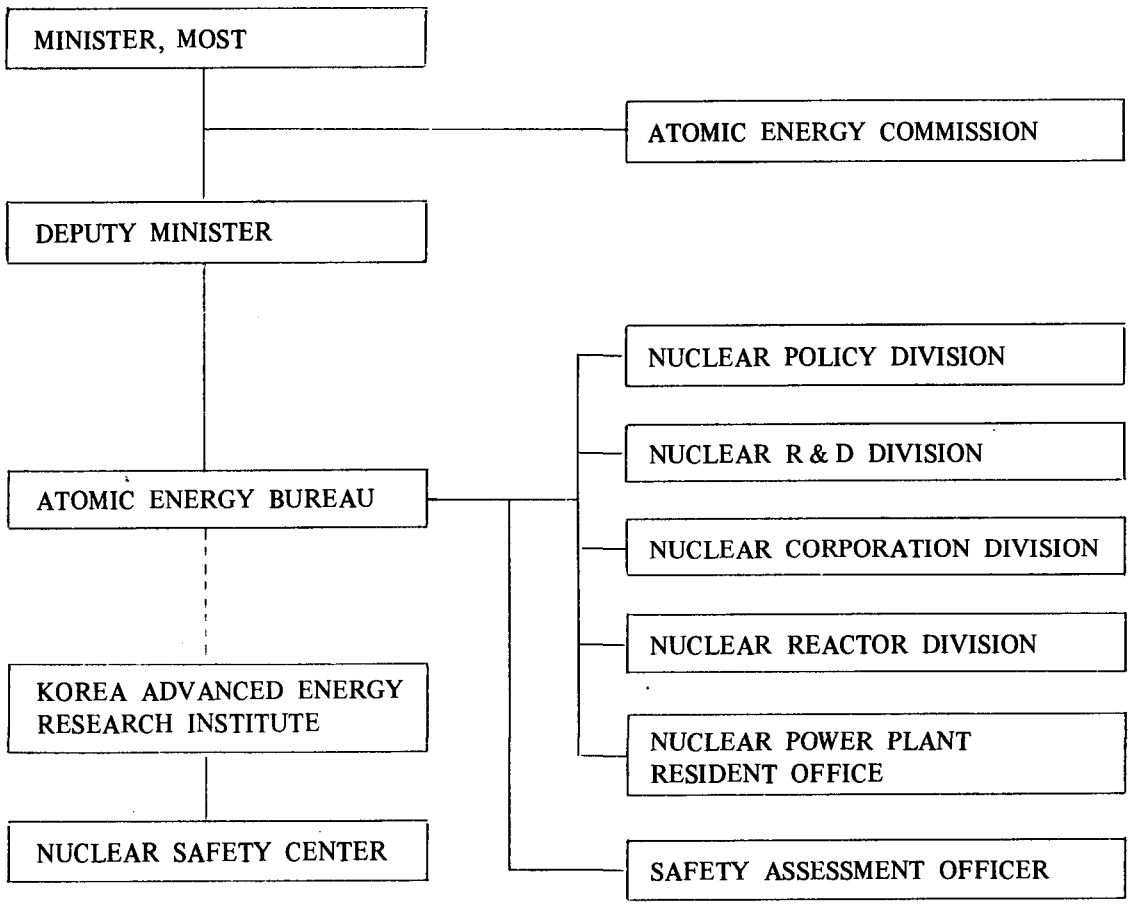

Figure 1. Regulatory Organization

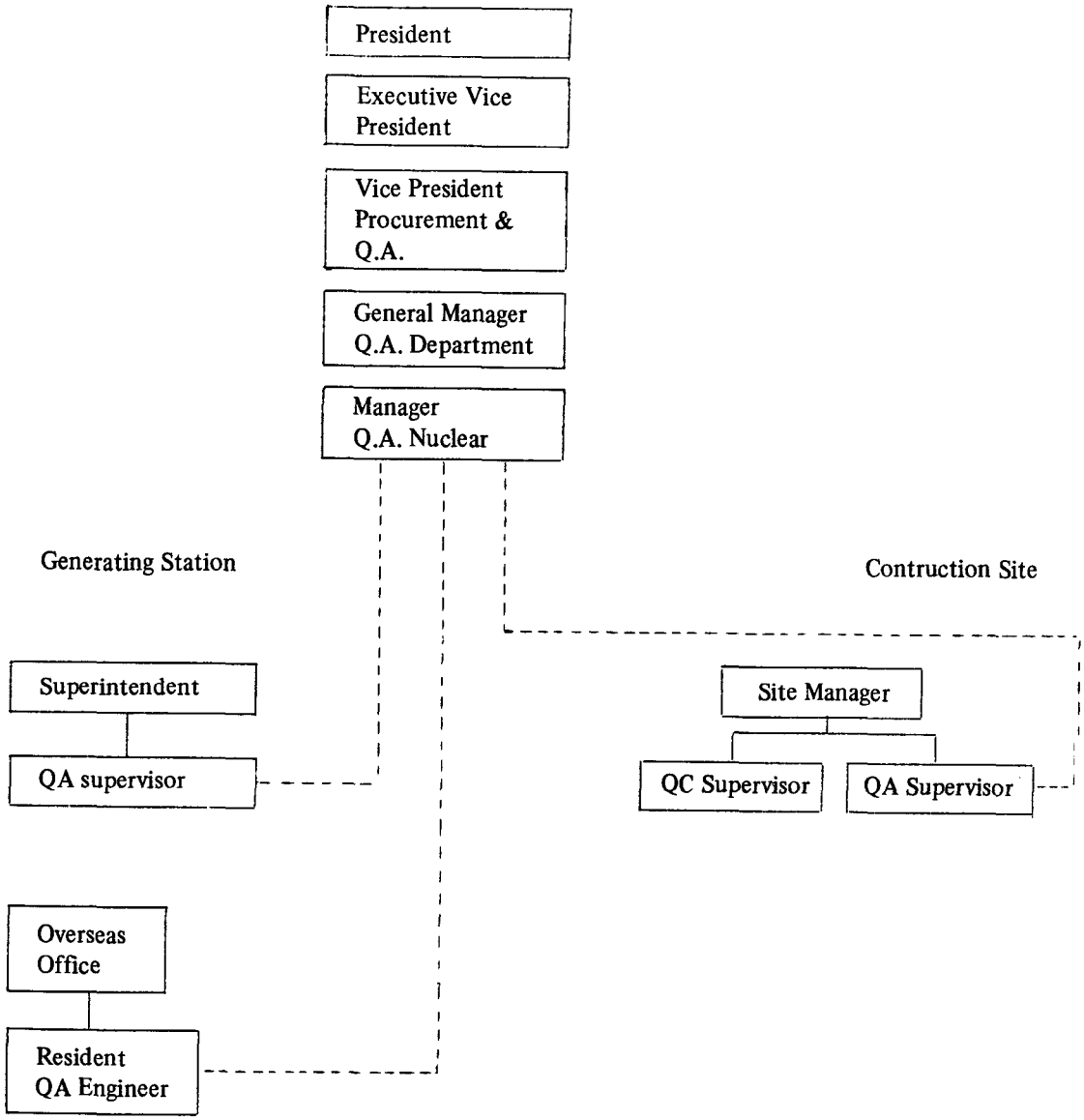

Figure 2. KEPCO QA Organization