

The “Koreanization” of Nuclear Power Technology: The case of a Joint Design*

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The original concept of the Joint Design was a brainchild of Han Pil-soon (한필순), as crystallized in his inauguration speech as Korea Atomic Energy Research Institute (KAERI, 한국원자력연구소) president on April 9, 1984. He said, “The only way for a developing country to reach nuclear power technical self-reliance is to take part in the commercial Nuclear Power Plant (NPP) construction projects in the areas of KAERI’s expertise. We have no money, time, and experienced manpower to bring it up from scratch.” That was the beginning of a long road to bring KAERI to take responsibilities in the NPP reactor systems and initial core design technologies, which was assumed by taking a prime contractor’s role in the Yonggwang (영광) Nuclear (YGN) project.

The first Joint Design concept was put into practice in 1985, when the reload fuel localization of the Pressurized Water Reactor (PWR) project was started with Kraftwerk Union (KWU) of Germany. Already seventy-plus KAERI fuel engineers were sent to KWU fuel design center in Erlangen, Germany, to conduct the core analysis of reload together with the German counterparts in a joint design under a technology transfer contract. All design tools were transferred to KAERI before the engineers returned to Korea by 1987. The first reload core fuels designed by KWU and KAERI, then manufactured by Korea Nuclear fuel Company (KNFC, 한국원자력연료 주식회사) in Daedeok (대덕), were being loaded into Kori (고리) units. This successful experience of Joint Design in the reload fuel projects gave a strong impetus for a bigger and more complicated Nuclear Steam Supply System (NSSS) reactor systems design project to be conducted in a similar fashion. Now the stage was set to expand the fuel experience to the entire NPP reactor systems with different actors.

* This essay is an excerpt from Kim Byung-Koo’s memoir, *Nuclear Silk Road: The “Koreanization” of Nuclear Power Technology* (forthcoming in 2011).

Preparation

Immediately after Combustion Engineering (CE) was selected as the successful bidder of the YGN and NSSS partner company in September of 1986, the Power Reactor Systems Division at KAERI was realigned to be the same as the CE Windsor organization. We knew right away the most efficient way to absorb the system design technology would be to emulate the mentor-to-be's technical infrastructure as much as possible to prepare for the upcoming Joint Design missions on a one-to-one approach in five technical disciplines: reactor engineering (RE), fluid systems engineering (FSE), mechanical design and analysis (MDA), instrument and control (I&C), and safety analysis (SA). The manpower pool within KAERI had reached over eighty when the very first team of forty-six (Group A) was sent to Windsor at the end of 1986, having grown from thirty-three members just about a year before. Already word had gotten around in and out of KAERI that the most ambitious nuclear project in history was about to begin. We were assured and thus fortunate to be able to hire new recruits outside of the government manpower authorization limits, since the entire manpower cost was to be supported by the Yonggwang project cost once the contracts were signed. The new Power Reactor System Division at KAERI (PRSD) team was composed of five technical groups of highly educated engineers with graduate degrees (about 50 percent with MSs, 30 percent with PhDs, and 20 percent with BSs) in engineering disciplines, mainly nuclear, mechanical, electrical, chemical, and physics backgrounds.

Conversational English training courses were held at KAERI with native US speakers. With all their academic credentials, the KAERI team may have appeared to be well- or even over-qualified; however, we had a definite shortage of (in fact, zero) experienced manpower with NPP systems design backgrounds. No one with such qualifications existed in Korea as of 1986. We were all young, well educated, and well motivated, but had no practical experiences to speak of. The only way to overcome this shortage was to put the team through a series of rigorous training courses in combinations of Class-Room Training (CRT), On-the-job Training (OJT), and On-the-job Participation (OJP), later called "Joint Design" or "Joint System Design," plus field trips to NPPs and component manufacturing sites.

One crucial six-week Class Room Training (CRT) course was organized by the IAEA Technical Cooperation project specially tailored for the KAERI system design engineers at the KAERI campus in October 1986. A brief Memorandum of Understanding for the system design advanced training was signed between CE and KAERI only two weeks after the successful bidder announcement. Everyone was eager and willing to take the risk, to get on with the training even though the main contract negotiations had yet to start. We were able to bring in most of the CE engineering managers or supervisors as the lecturers. CE management put high priority in sending their best technical managers, all of them for the first time, to Korea. Regis Matzie (reactor engineering), Dan Peck (mechanical design and analysis), and Bill Gill (instrument and control) were among the first group of CE managers who came to Korea. During and after the formal CRT hours, they were enthusiastic about the first opportunity to get to know each of their Korean

counterparts besides delivering the technical materials. Matzie recalls his first visit to KAERI:

I was surprised to meet so many young PhDs, but Kuh Jung-Eui (구정위) and his team made me feel right at home from the very first day. We went out for dinner with the whole RE group, got to know them personally, and I was impressed with their engineering enthusiasm. I felt they had the right DNA in mental capacity to master the system design know-how's in no time. Kuh's team appeared more academic than practical, but it suited fine with my area of reactor engineering.”¹

Obviously this kind of initial building of rapport had lasting effects as they moved to Windsor for the Joint Design in the coming months. Mental comradeship was forming between the mentors and mentees among the engineers, supervisors, and managers from both sides, overcoming the cultural and geographical barriers. Perhaps the degree of camaraderie between two organizations would differ from team to team depending on the personal character of each of the managers, but I overall felt comfortable enough to judge that we were in for a long haul, and we had the right teachers and right mentors from the very beginning.

We took the CE lecturers to Gyeongju (경주), the ancient capital of the Shilla (신라) dynasty, after the first CRT (Class Room Training), which turned out to be effective in understanding Korean culture and nurturing the team-building. (They saw the original Cheonmachong (천마총) and Shilla golden crown at the Gyeongju National Museum then.) As a symbol of lasting cooperation and friendship, KAERI presented the replica of the Shilla golden crown to CE in 1988 (fortunately, this one symbolic piece still proudly occupies the main entrance hall of the Westinghouse Windsor plant today). This small gesture of cooperation made over two decades ago is worth revisiting today. It exemplifies how the original dream of technical self-reliance on the Korean side became a reality with CE as the strong partner and mentor, as engraved on a small plaque attached to the crown, reading:

This exact replica of the ancient Shilla Gold Crown (Cheonmachong, circa 5th century A.D.) is presented to Combustion Engineering, Inc. on the occasion of the KAERI Windsor Site Office opening ceremony held on the twenty-ninth of January 1988. This symbolizes long lasting partnership between CE and KAERI through this Joint Design and Technology Transfer during the implementation of Yonggwang 3 & 4 Project. CE's contribution in helping to establish indigenous nuclear power technologies is recognized for the energy independence in the Republic of Korea.

¹ Author's interview with Regis Matzie at Windsor.

Technology transfer, Korean style

It took a relatively short time before the “Korean Pilgrims” started to be integrated into the CE Windsor NSSS engineering departments. After a brief two-week orientation of CRT, given to the newly arrived Korean engineers (Group A) to Windsor in January 1987, each one was assigned to his respective NSSS engineering department for the following four months of OJT. This was the crucial period for the KAERI team to prove themselves worthy of conducting the NSSS system design activities for the first time, while fully being integrated into the existing CE infrastructure.

At the end of the four-month OJT program, every Korean engineer was evaluated and declared fit for service without a single failure. Despite the English language deficiencies, every team member survived the initial tests of functioning as a design engineer to initiate, to review, and to obtain supervisors’ approval on a mock-up design activity. The first informal progress report from Lee Byung-ryung (이병령) or ‘BR Lee,’ the first engineering manager of the KAERI team at Windsor) was sent to President Han via a seventeen pages of hand-written facsimile message at the end of March 1987.

Lee was expressing his satisfaction on the progress of the OJT of each team member in preparation for the real Joint Design to start as soon as the formal Yonggwang contract was signed. Detailed curriculum of subtasks, objective, design description, output products, interface requirements, and schedule of design activities for each member were being implemented as agreed. CE supervisors were evaluating KAERI members’ knowledge on the technical subject matter as well as communication skills. Lee’s overall conclusion in the fax report was confidence in the system design technical areas per se; however, he made a recommendation to improve the project management capabilities in planning, scheduling, manpower loading, interface coordination, and, most of all, quality control and quality assurance. These were the areas the KAERI management was not well prepared for at the beginning. In fact, we did not know what it would take to integrate vast system design activities across different disciplines in reaching the major milestones in the project.

Lee’s recommendation was well taken once the contract was duly signed and the full scope Joint System Design activities commenced in May 1987. Thanks to the hard work of several industry-minded KAERI project management teams at Windsor, the need to establish an Engineering Logic Network was recognized by the KAERI management. They were able to acquire sufficient know-how from CE internal practices on how best to set up the KAERI specific system design integration processes, coupled with the schedule and cost control. A separate KAERI Windsor Site Office was created with the special mission to build up the project management capacities, including schedule control, quality control, and document control. Lee made an important contribution during the initial period of KAERI’s settlement into the bona fide system design engineer’s role at Windsor.

All members were asked to come into work thirty minutes earlier and stay two hours after the normal working hours, even on Saturdays, for internal seminars. No one dared to complain as there was so much to learn and absorb. Lee provided leadership to promote useful means to better organize one’s work activities, to learn about other members’ work activities, as well as to improve English communication skills, including how to raise questions to CE mentors. In hindsight, his major role as the KAERI engineering manager in Windsor at the early stage is to be recognized in building team spirit. In the 1990s, Lee made one more major contribution to the Korean nuclear scene while serving as the project manager for the Ulchin (울진) 3&4 system design at KAERI, in selecting the Korean Standard Nuclear Power Plant (KSNP) model for the Korean Peninsula Energy Development Organization (KEDO, 한반도 에너지 개발 기구) project with Ulchin 3&4 as the reference plant. (This topic is covered in Chapter 7 of Kim’s forthcoming memoir.) Lee also served as the Yuseong (유성) District Office superintendent, an elected public official post in Daejeon (대전) city, administering for Daedeok Science Town (대덕 연구 단지) in the 2000s.

Additional waves of KAERI design engineers arrived in Windsor in 1987 and 1988 in Group B (thirteen) and Group C (twenty-two) to join the Joint System Design activities following the similar CRT and OJT training as Group A. Altogether, over two hundred KAERI engineers were dispatched during the project life cycle, which peaked to one hundred and twenty in 1988, accumulating over three hundred man-years of expatriate experience at Windsor. Beginning in 1989, KAERI manpower receded gradually as they completed the Joint Design assignments and returned home (the Initial Core Design team was the first to return) to build on the project design center at Daedeok.²

Integration with the mentor

Designing and building a nuclear power plant is a complex task involving thousands of highly trained, dedicated professionals in several dozen different organizations, mostly made up of engineers in many disciplines. Among the most difficult, thus challenging, task would be the system design of the reactor system, or in the industry jargon, the Nuclear Steam Supply System (‘N triple S’). An added dimension to an already complex task on our hands was to integrate organizations from two countries from opposite sides of the Pacific, to start the design process in the US first and then to move the entire design center to Korea to complete the second half under the so-called “Transition Plan.”

Reactor system design activities are categorized in three different levels. Level 1 design is the “conceptual design,” involving several hundred independent activities to identify the skeleton of the reactor system for the intended power level, the

² Lee Ik-hwan, *Annual Report of Windsor Site Office*, KAERI/GP-62-76/89, Internal Report, Dec. 1990.

process system, and the safety system. Level 2 design involves roughly eighteen hundred separate design activities, called “basic design,” enough to issue the Preliminary Safety Analysis Report (PSAR) and design specifications for the long-lead items such as the reactor vessel and steam generators. Level 3, called “detail design,” typically involves twenty thousand design activities to generate all the documents and drawings for construction, procurements, and final commissioning start-up tests. When a utility orders a new NPP, typically the reactor vendor has a certified basic design from the national regulatory authority, and the detail design has to be redone from the reference plant design to suit the specific site and upgrade items as necessary.

Difficulty in the job assignments for KAERI members arose during the first year of Joint System Design at Windsor in 1987. It had to occur as both parties were bound to have conflicting views. KAERI’s team was determined to learn the core technology in the shortest time possible while stationed at Windsor (each one was given a two-year term) so they wanted to get to the most challenging design activities as possible. In addition, KAERI was in the customer’s position to CE, although they shared a mentor/mentee relationship. We made sure in the Joint System Design contract that KAERI would provide 50 percent of the overall design activities in volume without knowing exactly which 50 percent would be its share.

On the other hand, CE was given the overall responsibility and contractual warranty obligations should they fail to meet the delivery deadlines or performance warranty. Each of KAERI member’s capabilities and communication skills was still not fully proven for CE to be comfortable, although they all had passed the minimum qualification test after the initial four months OJT at Windsor. This mutually uncomfortable situation was more acute in the fluid systems engineering than others, mainly because of the nature of design activities being more repetitive and less innovative, and perhaps due to the personalities involved. It could be boring work for someone with a PhD degree and at a relative young age. In the area of instrumentation and control, often-times the design activities crossed boundaries between the system design and component design due to its very nature, thereby adding to the complexity. (Although BR Lee, the engineering manager, had some problems with job assignments, he was up against some tough-minded CE managers and had to make stands that were not always popular. All in all, he did a good job in a situation that was unprecedented.) As the years passed by, however, these initial problems did get resolved satisfactorily for both sides. I could confirm the facts through numerous interviews with many from both sides during the writing of this book. Of course, the final outcome of the technology transfer without a single drop-out among over two hundred KAERI expatriate engineers speaks for itself.³

Invariably the system design activities involved producing documents, be it design specifications and design data for procurement or manufacturing, or interface documents to other entities like the architect engineers, or calculation

³ Author interview with Jim Veirs at Windsor.

sheets and drawings. Almost all of these documents are considered company proprietary and become part of the company’s intellectual property. Each document is approved and signed off by the writer (cognizant engineer), an independent reviewer, and an approval authority from the technical supervisors. The integrated team of the Joint System Design members learned to produce literally thousands of these documents in a highly professional manner. The system of document control, known as the Nuclear Engineering Documentation System (NEDS), originated by CE during the previous Palo Verde project, was employed. This document control system added order to the management of these documents and proved quite beneficial to all parties during the course of the project. The system allowed virtually free access to all technical proprietary documents to Koreans at any time. The document control system was indicative of CE’s open and transparent corporate mentality.

This corporate attitude was the main difference from its competitor when we selected CE over Westinghouse in the first place, and was found to be faithfully practiced during the course of the project. I could safely say that CE’s attitude was to give Koreans everything they had, every ‘know-how’ they knew, without any reservations. At one time in the early period, CE Windsor had their internal discussion on the subject of as to what level CE’s proprietary technology should be open to the Koreans. Vice President Bob Newman made this point clear to everyone:

Remember, this opportunity is once in our lifetime. If we don’t succeed in transferring all we can to the Koreans, then our technology would be of no use anymore, and we might as well throw it into the Connecticut River.⁴

This one simple anecdote represented the entire corporate culture of CE on the technology transfer. It was a true blessing for Korea in reaching its goal of self-reliance. KAERI was able to establish its own document control system administered by the Design Document Control Center (DDCC) at Daedeok with a fully functioning electronic database accessible from any authorized desk-top PC in the intranet.

Transition Plan

The original plan to relocate the system design center physically from CE to KAERI was imbedded in the Joint System Design and the Technology Transfer contract documents, stipulating that we shall reach a concrete transition plan within eighteen months after the contract. It was one of the most important tasks given to me as the project manager of the YGN System Design to reach a mutually

⁴ An interview by the author with Jim Veirs at Windsor.

agreeable plan with my counterpart, James Crawford, director of NSSS Engineering at CE. After many meetings and deliberations, we were able to sign a document called the "Transition Plan" on May 1, 1988. It was to implement the physical relocation of manpower and design tools, including computer codes, design documents, and supporting infrastructures. Within a year's time, the Yonggwang reactor system design center would be fully operational at KAERI's Daedeok campus without interrupting the overall project schedule. This plan would also involve relocation of CE supervisory personnel to live in Daejeon for a longer period (a total of fifty man-years of CE supervisory staff was allocated for Daedeok assignments) with their families, plus gradual return of all KAERI expatriate engineers back to their home base. It was an ambitious plan to achieve. The overall project milestone of PSAR submittal to the Korean regulatory body and serious licensing discussions were beginning in mid-1988. Heavy components like the reactor vessel and steam generators were being casted and forged at the Korea Heavy Industries Corporation (KHIC, 한국중공업) Changwon (창원) plant based on our system design specifications, and the construction activities were moving into high gear by Hyundai Construction Company (현대건설) at the Yonggwang site. There was no question in anyone's mind that the center of gravity for the project was moving to Korea. We had to hurry back to be closer to the real actions as a consequence of the system design output.

The first CE technical staff who came to Daejeon for an extended period was Robert Kirkman from Windsor in January 1988 to install and verify the computer codes at the KAERI computer center. His job was to hand-carry the source codes together with the binary codes for the system design. Over one hundred and ten codes (CE-owned codes, third-party-owned codes, plus some commercial codes) were installed at KAERI, followed by thorough verification checks.

By mid-1988, all design codes were running flawlessly in time for the KAERI design team's return home. Together with the documents that had already been delivered to KAERI beginning in 1987, the Design Center was well prepared to support the continuation of the system design in Daejeon. Over the course of the project, forty-six hundred proprietary documents and drawings were physically relocated to or developed by the Design Document Control Center.

Kirkman returned back to Windsor after a six-month stay in Daejeon. His working and living experience in Korea alleviated much worry from many CE staff who had some apprehension of coming to live in Korea according to the Transition Plan. In fact, his first hand working and living experience as a first-timer in a strange foreign country with a totally different culture turned out to be quite positive. His experience demonstrated to CE that comfortable living accommodations were readily available in a welcoming Korean community where local people were anxious to assist in any way. Undoubtedly it was more of a culture shock for CE staff to live in Daejeon than for KAERI staff to live in Windsor since no CE engineers spoke Korean, while the KAERI engineers were reasonably proficient in English.

The initial batch of KAERI engineers began returning home by the end of 1988. On April 18, 1989, CE Daedeok Office was formally opened with Jack Pucak as its

first site manager. Pucak’s role was mainly to liaise design activities between Windsor and Daedeok. Tom Natan, the engineering manager for the YGN, and Dan Peck, manager of mechanical design and analysis, came to stay three to four months in Daedeok to expedite the in-situ decision-making.

With more than two years of Joint System Design experiences at Windsor and the gradual return of experienced design engineers to Korea, and with the design infrastructures being ready with codes and documents in full operational mode, we felt reasonably comfortable to move the design center to Daedeok in 1989. Integration of the system design support team at Daedeok with the newly returning KAERI engineers from Windsor posed less of a problem than expected, as a continuous inflow and outflow program to and from Windsor was in place. Every move was in line with the Transition Plan. The first major task at the new design center was to finalize the Final Safety Analysis Report (FSAR) reflecting all the design upgrades and specifics as the plant was being built. Over eleven hundred design activities were scheduled to be performed at Daedeok, with KAERI engineers in the lead and CE supervisory functions as needed. Start-up test guidelines and regulatory updates were among the highest-priority items. A real motivation for the system engineers was the opportunity to eye-witness the manufacturing and construction of the components and systems they designed for verification and trouble-shooting any anomalies with implementing the design. Frequent visits to the KHIC Changwon plant, where the major components like the reactor vessels and steam generators were being fabricated, and to the construction site at Yonggwang became a routine part of the design verification activities. KAERI Yonggwang Site Office was formally opened in 1992 to expedite the start-up support activities.

Warranty conditions

The YGN contract was indeed one-of-a-kind in many respects, requiring the foreign subcontractors like CE and S&L to take full warranty responsibilities while being the subcontractors to the Korean prime contractors: KHIC, KAERI, Korea Power Engineering Company (KOPEC, 한국전력주식회사), and KNFC. Since the Korean prime contractors had no proven past credentials of delivering the whole NPP at that time, Korea Electric Power Corporation (KEPCO, 한국전력공사) had to make a special provision to induce CE and S&L to assume the warranty responsibilities by making the sub-contracts into tripartite agreements including the KEPCO signature. This measure was intended to provide additional protection in case the prime contractors failed to deliver on their roles and responsibilities. However, as it turned out, this additional protection was not necessary as the Korean prime contractors all managed to meet their obligations. CE had to take the largest share of warranty obligations as the NSSS technology holder. The scope of their warranties included:

- The thermal output performance at the steam generator outlet
- Delivery schedule
- System design accuracy
- Interface data correctness
- Regulatory licensing (from the Korean authority)
- The fuel cycle costs

It was clear from the beginning that the technology holder, CE, was the only qualified entity to assume the above warrantee conditions. These conditions included clear formulas for assessing the financial penalties in case any of the warrantees were not met. The most important of them all was the thermal output performance warranty. This warranty included a financial penalty that could accrue in the millions of dollars should the thermal output be less than the warranted designed value. It was a measure of the success of the project that the Yonggwang Project demonstrated all warranted conditions, and there were no contractual claims against any of the parties following start-up and full power demonstration testing. The plant was unconditionally accepted for commercial operation by KEPSCO on March 30, 1995.

The true sign of technical self-reliance must come with the ability to take up the full warranty conditions, including the financial burden. The Korean local prime contractors (which were identical to the YGN case) had to wait for the second NPP project, Ulchin 3&4 signed in 1991, to assume all the warranty obligations for the first time. This was the main reason Ulchin 3&4 NPPs were the first KSNP units to be called “Korean Standardized Nuclear Plant” (KSNP).

Manpower build-up

One may recall the original system design technical staff was only thirty-three when the Power Reactor Systems Design division was initiated at KAERI in 1985. In the next ten years’ time, these core members witnessed a dramatic growth to about four hundred technical staff responsible for the reactor system design of multiple NPP construction projects ongoing simultaneously: YGN, Ulchin 3&4, Yonggwang 5&6, KEDO project for North Korea, and Ulchin 5&6. By the 1995 timeframe, the entire KAERI project operation was at its peak with five project divisions (Yonggwang, Ulchin, Wolsong (월성), Light Power Reactor (LWR) fuel, and KEDO) supported by the Design Division in matrix organization. As the NPP projects had about a two-year time interval between new projects, a continuous flux of manpower from one project to another, and from design division to project division (or vice versa), was necessary to maintain the proper level of manpower loading for each project at any given time. A project management team was dedicated to each project for interface control, schedule, cost, and quality control, in addition to managing the site offices away from the Daedeok head office (Windsor, Yonggwang, Ulchin, and Wolsong construction sites).

The system design technology was central to and rested in the Design Division

composed of five technical departments: Reactor Engineering, Fluid Systems Engineering, Mechanical Design, Instrumentation & Control, and Safety Analysis. The YGN occupied the largest manpower share (nine hundred and eighty-eight man-years, at least) to cope with the technology transfer simultaneously with the joint system design, which started at Windsor first then transferred to Daedeok in the middle of the project. While the Joint System Design (JSD) manpower was implementing the design activities according to the project construction schedule, additional System Design Support manpower was allocated to follow the technology transfer in digesting technical know-how.

CE mobilized about three hundred man-years of effort for the first project, which dropped to minimal after several repeat projects. More JSD manpower was needed at Daedeok after the Transition Plan. About half of the overall manpower was dedicated to the SD Support activities at Daedeok to conduct activities including:

- Mock-up design and repeat design on technically significant activities
- Technical review and analysis reports on selected proprietary documents
- Preparation of the internal standard design manuals and procedures
- Establishing the design Quality Assurance system to acquire the ASME N-stamp certificate
- Install, verify and maintain all design computer codes imported from CE to be fully operational at all times
- Operate the Design Document Control Center (DDCC) at Daedeok to sort, store, and distribute.

This extra effort was the reserve manpower trained for the coming new projects like Ulchin 3&4 and Yonggwang 5&6. In fact, what may appear to be excessive manpower loading at the beginning, turned out to be the exemplary program of manpower training and build-up to start from CRT to OJT to JSD for the very first project YGN, then moving on to subsequent projects. This was all possible due to the fact that Korea kept on building the standardized fleet of twelve more NPPs during the last twenty years: Yonggwang 3&4, Ulchin 3&4, Yonggwang 5&6, Ulchin 5&6, Shin-Kori (신고리) 1&2, Shin-Wolsong (신월성) 1&2, all of the same design Generation II NPPs (the suffix “Shin” means “new” in Korean, thus “Shin-Kori” refers to the new NPP site adjacent to the “old Kori” site). The ultimate sign of technical self-reliance comes from the ability to take up the warranty responsibilities for the performance and delivery of the new NPP. While CE was responsible for the warranties for the YGN, KAERI (later KOPEC) was responsible for all subsequent system design projects from Ulchin 3&4.

Mission “95-by-95”

On December 7, 1995, a quiet celebration was going on at the KEPSCO head office in Seoul following the technical self-reliance evaluation symposium. It was declared by internal as well as external experts that the dual project milestones of

Yonggwang Unit 3 going into commercial operation and the technical self-reliance goal of 95 percent had indeed been reached. The component design and equipment supply of the reactor coolant pump, man-machine interface system in the main control room, and the third-party-owned computer codes were the only remaining 5 percent yet to be localized. The unique strategy of the joint design seemed to have worked to overcome the shortages of experienced manpower, budget, and time. We all experienced a big sigh of relief that the major milestone was achieved. At least we knew we could replicate the design of the same NPPs indigenously. The next challenge was how to move up to a truly Korean reactor model design to compete with the Generation III models being developed by other international suppliers. Every indication was positive in that we were ready to take up the next challenge: the Korean Next Generation Reactor (KNGR) development.

From the day one of the very beginning of the YGN project, KEPCO announced the goal of reaching 95 percent of technical self-reliance for the entire NPP plant design and construction by the year 1995, when the Unit 3 was to be completed, thus the nickname “95-by-95.” It was not clear at all at the beginning what was meant by “95 percent self-reliance” and how to measure its progress. Thanks to KEPCO’s rigorous system of accountability in project management, the project management team from Electric Power Group Cooperation Council (EPGCC) was able to agree on the formula with relative weighing factors that could result in an evaluation of the 95 percent goal by the year 1995.

It is interesting to note that the fuel design/manufacturing, and site construction technologies were deemed 100 percent self-reliant by 1995 due to their past experiences in the existing NPP construction and reload fuel projects. Relative weighing factors were agreed upon primarily based on the contract prices covering the entire spectrum of nuclear power technologies in design, manufacturing, and construction. Each nuclear entity (which formed the Electric Power Group Cooperation Council from 1985 on) knew for sure that they were in for the most challenging episode in the company’s history, as each one was assured of exclusive rights and responsibilities in the standardized fleet of NPPs to come.

One of my prime responsibilities as the project manager of system design was to set the annual detail implementation plans for technical self-reliance and confirm it for the monthly progress checks. Numerous internal and external meetings were held at Daedeok, Changwon (창원), and Seoul to discuss, modify, and argue with other entities. It seemed like a nightmare scenario in those days to trace thousand of different design activities and the status of where we lacked confidence. In hindsight, it was the necessary step in gaining confidence, and, most of all, beginning to comprehend the scope of our shortcomings, that is, what we really did not know. There was the natural process of gaining the “know-why” beyond the “know-how” by repeating the nearly identical NPP construction projects and having to defend the adequacy of the design to Korea Institute of Nuclear Safety (KINS, 한국원자력안전기술원) and KEPCO for each new project to reconfirm the application of the previous project design and to justify the changes that were incorporated into the new projects.

In parallel, the Technology Transfer contract was implemented to 1) transfer documents, codes, patent rights, 2) conduct a series of training courses for the system designers, 3) separate training for the supervisory capacity and project management, 4) procure special computer control equipment. Additional efforts were made on the System 80+ R&D projects together with CE to enhance further understanding of the know-whys leading to the next-generation power reactors to come. In that sense, the mission “95-by-95” was accomplished over and beyond the original expectations. There was a good reason to celebrate on that night of December 7, 1995.⁵

⁵ Han Ki-in, et al., *Yonggwang 3&4 Final Report on the Reactor System Design Project: Technical Self-reliance Experiences*, KAERI, Dec. 31, 1995.