

INTERNATIONAL CO-OPERATION IN THE MANAGEMENT OF RADIOACTIVE WASTES

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ABSTRACT

The use of nuclear energy faces with the problem of radioactive waste disposal. The public simply abhors radioactive wastes without rightful cause. Hence, the immediate concern is to overcome this hostile preconception of the public, and to come up with safe and economic ways of disposal which are acceptable to the public. Without it, the public may not accept the idea of further use of nuclear energy. Some have concern about safeguards of fissile plutonium with respect to proliferation while others have concerns regarding protection beyond national borders related to movement of radioactive wastes for foreign disposal. Now, the disposal of radioactive waste is a global problem rather than a problem for individual nation. In this aspect, close international cooperation is recently being brought up more than ever in jointly: improving public acceptance, minimizing waste generation, eliminating the burden on future generations, developing internationally acceptable practices, exploring disposal concepts, and collaborating on R&D.

INTRODUCTION

In June of 1997, the Korea Atomic Energy Research Institute (KAERI) asked a group of academic, research and industrial scientists and engineers in various disciplines, to perform a study called "Evaluation of Domestic Technical Capability to Establish the Disposal Concept of High Level Waste (HLW) in Korea." The study is all together a two-year project. And the scope of work specifically includes: evaluation of present and past domestic research and development (R&D) work; investigation of foreign technical capabilities; categorization of main technology; evaluation of domestic technical capabilities usable for site characterization, performance assessment, engineering and construction; identification of lacking technologies; and establishment of work plan (what to do concerning lacking technologies).

While performing the study, it was learned that the safety of radioactive waste disposal is rather a regional or global problem than the problem of individual nation. The issue of close international collaboration has naturally come up in the area of radioactive waste management, and its absolute necessity has been solicited more than ever. In the same line, the International Atomic Energy Agency (IAEA) recently developed a Joint Convention on the safety of radioactive waste management, which was adopted by a diplomatic conference under the sponsorship of IAEA. This is the most recent evidence of consensus reached among nations at the international level on the issue of radioactive waste management. Now the issue is of interest for policy makers as well as in the scientific and technical communities. We think the Convention is a good start of discussing close international cooperation, and a regional conference like the Pacific Basin Nuclear Conference (PBNC) could actively strengthen it.

The international cooperation could start in the areas of:

- improving public acceptance,
- minimizing the amount of waste generation,
- removing the burden of waste disposal on future generations,
- setting up internationally acceptable practices,
- exploring the best concepts of disposal, and

- integrating individual R&D work and sharing the expenses.

PROMOTION OF ENVIRONMENTALLY-CLEAN NUCLEAR ENERGY

As the economy grows and people seek a better quality of life, energy consumption increases. Conventional fossil energy, however, is the major source of generating toxic chemical gases as well as carbon dioxide. Hence, our generation faces a new dilemma in choosing the options between economic development and environmentally clean nature. We strongly believe that nuclear energy is the only solution in facilitating the energy-related environmental and global warming problems, and in achieving the desired economic growth at the same time by supplying abundant inexpensive energy.

For further reduction of environmental problems, the multi-purpose utilization of nuclear energy is very demanding. The use of nuclear energy for other than large electricity generation is being actively considered in the areas of district heating, desalination, ship propulsion, hydrogen generation and process heat generation. The promotion of multi-purpose use of nuclear energy in international level is well under way, and will contribute eventually to ease air pollution and global warming problems in the future. We believe the IAEA Symposium on Desalination of Seawater with Nuclear Energy held in Korea in May of 1997 is a good example.

ENHANCEMENT OF PUBLIC ACCEPTANCE

As long as there exists a potential for large growth in future energy demand and global warming becomes the key constraint in economic development, nuclear should continue to be one of the most important sources of the world energy supply. However, nuclear energy is confronted by a unique problem of radioactive waste disposal. Without presenting safe and economic methods for its disposal, the public may not accept the idea of continuous use of nuclear energy.

Recently, public confidence in nuclear energy appears to be deteriorating. The public misconception on radioactive waste is even worse than nuclear energy itself. The present problem, in public acceptance, lies on the fact that the public simply hates nuclear energy without any rightful cause. The way the mass media handle nuclear-related matters does not help the public to understand nuclear energy as it is, either. A more fundamental cause, however, is the lack of basic knowledge among the general public on need for energy, energy-related environmental issues, peaceful use of nuclear energy, and nature of radioactive waste. It is caused by many factors. Inadequate opportunity of right education is one. Systematic efforts are required to develop a comprehensive education program to improve the public relation. The program should be aggressive and well-organized. It could start: in disseminating to the public accurate information on facts of radioactive waste in conjunction with peaceful use of nuclear energy; and in arranging special seminars and workshops on energy and environment open to the general public including media people, environmentalists, school teachers, and young students.

It also has been pointed out that the pro-nuclears did not have enough fighting spirit for what they have believed in. We think it is the right time for pro-nuclears to speak out loud and clear on behalf of the silent majority of the general public. The voice of pro-nuclear should be persuasive and patient. We should not allow the small group of anti-nuclears to force an irreversible stupid decision of giving up nuclear energy, by just raising their voices.

REDUCTION OF WASTE GENERATION

The first issue to address for effective management of nuclear waste is to minimize the amount of waste generation. The generation of radioactive waste heavily depends on back-end fuel cycle options; direct disposal versus recycle. It is well known that the recycle of spent fuels via reprocessing is the best way of achieving waste reduction.

In Korea, the fuel cycle strategy is principally based upon recycle option. PWR spent fuels will be recycled, and for PHWR spent fuels, meanwhile, we are still reviewing the option of direct disposal against reprocessing. The philosophy behind the strategy is to minimize the amount of ultimate disposal wastes as well as to maximize the utilization of uranium resources. Korea is presently adopting the two-reactor PWR/PHWR policy. The main benefit of this policy is to minimize not only natural uranium requirements but also spent fuel disposal requirements. The program of Direct Use of PWR Spent Fuels in CANDU (DUPIC) in progress is designed to be proliferation free, and to reduce spent fuel disposal requirements less expensively than direct disposal. DUPIC will be developed through joint cooperation among Korea, Canada and U.S.A. This is one example of close international cooperation pursuant to nuclear non-proliferation treaty. Table 1 shows the equilibrium natural uranium and fuel disposal requirements in various fuel-cycle options of the two-reactor PWR/PHWR system. Even though the ongoing nuclear power program is based upon thermal reactors, the ultimate approach relies on future commercial development of fast reactors for the purpose of optimal utilization of nuclear fuel resources. It is the general view that plutonium recycling in thermal reactors is the best policy today and the fast reactor is the best long-term option.

Table 1 Equilibrium Natural Uranium and Fuel Disposal Requirements for PWR/PHWR System

Fuel Cycle	Natural U Requirements (TU/GWY)	Fuel Disposal Requirements (THM/GWY)
PWR with Enriched U	218	33
PWR with Pu Recycled	185	28
PWR/PHWR (2.9/1) with RU Recycled in a PHWR and Pu Recycled in a PWR	143	22
PWR/PHWR (2.4/1) with DUPIC Fuel in a PHWR	154	24

The option of direct disposal is usually adopted by nations that have sufficient energy resources and do not feel the urgency of securing energy. Meanwhile, the recycle option is strongly pursued by the nations that are short of energy resources and heavily depend on foreign imports. They consider energy security is a matter of survival or death of the nation. The separation of plutonium from spent fuels by reprocessing, however, imposes a risk of proliferating nuclear weapons. Some worry about the risk so seriously that the suggestion is that recycle of spent fuel should be banned world-wide. It is absurd to unilaterally apply the same argument to all the nations. Some are even blaming the present world situation of low public confidence in nuclear on this absurdity. The safeguards issue should be dealt separately as it is, but not mixed with other nuclear policies. No doubt, the careful control and management of plutonium is a challenge. Nevertheless, it is absolutely certain that a successful solution will be developed on time in near future since the storage of plutonium under international safeguards has already been successfully demonstrated in Europe.

ELIMINATION OF THE BURDEN ON FUTURE GENERATIONS

In December of 1996, the Korean government abolished the existing Radioactive Waste Management Fund that had been levied on Korea Electric Power Corporation (KEPCO) for 10 years. It also decided to divide KAERI's responsibility of radioactive waste management into two organizations: KEPCO for low level waste (LLW) disposal and spent fuel storage; and KAERI for R&D programs on spent fuel management. Accordingly, the Nuclear Environmental Technology Evaluation Center (NETEC) was newly founded under KEPCO. Figure 1 shows the organizational structure of radioactive waste management in Korea.

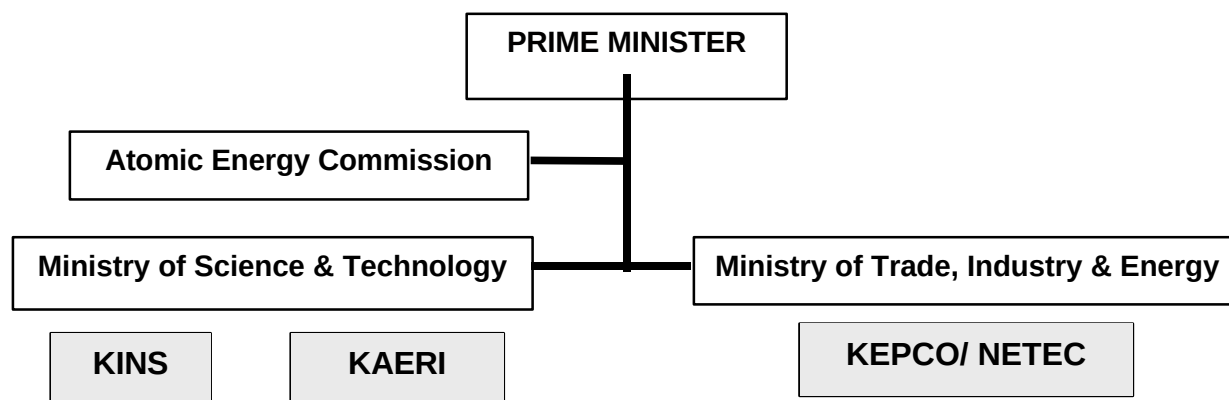


Figure 1 Organizations for Radioactive Waste Management in Korea

The present generation must not impose the burden of waste disposal on future generations. The solution should be developed during our generation. At least, our generation should pay for the wastes that have been generated during our generation. The financial burden should not be delegated to future generations. The imposition of a waste fund on waste producers is the best way of preparing for the expenses that will incur in the future for disposal of radioactive wastes.

The consolidation of different responsibilities in one robust organization under the auspices of strong government support is also very important to assure the safety of waste disposal. At least, the clear responsibility of each responsible organization should be well defined from the beginning. Along with the issue of imposing waste fund, the structure of well-defined and powerful organization should be continuously proposed in international level in order to assure the safety of radioactive waste management.

ESTABLISHMENT OF WORLD-WIDE ACCEPTABLE PRACTICES

To adequately protect the public and environment from potential undue risk of radioactive waste management, it is very important to set up internationally accepted practices and let the nations comply with them. The preparation of common guides and standards and setup of rules and regulations should be one way of achieving it. The IAEA has recently developed and published nine principles for radioactive waste management: protection of human health; protection of environment; protection beyond national borders; protection of future generations; burden on future generations; national legal framework; control of radioactive waste generation; waste generation and management interdependencies; and safety of facilities. As a consequence, the IAEA is in the process of preparing appropriate standards and guides.

Recently, the whole of Korea was in turmoil and expressed its deep concerns on the decision that the Taiwan Power Company made on transporting and disposing of some of its LLW in North Korea. The candidate repository site proposed for the transported wastes is located 100 kilometers north to the border between North and South Korea. The maritime transport of the wastes from Taipei, China to the site will be made through the Yellow Sea which touches along the western shoreline of South Korea. Hence, most South Koreans express their concerns of securing the safety since the proximity of the disposal site could impose direct detrimental effects to the public and the environment. The main concerns lie on the lack of belief in observing the internationally accepted rules and regulations, and securing the ultimate safety.

In analyzing the concerns, we concluded that there should exist at least a couple of fundamental principles on waste trade among nations. The first principle is that the ultimate responsibility for the safe management of radioactive waste such as treatment, transportation, and disposal including all the actions required for

post-disposal management of its repository shall rest with the original producer of the waste. This shall not be no way diluted by the separate activities and responsibilities of other parties and organizations. In this aspect, the international movement of radioactive waste should be carefully adopted since the safe and responsible management of such waste could be best achieved when it is disposed of in the nation where it was originally produced. The second principle is that, if shipping is considered only the practicable way to transport the radioactive waste to another nation for its disposal, it shall be done only after assuring the observation of internationally accepted rules and regulations and obtaining the consents from neighboring concerned nations. The concerned nations shall be offered sufficient opportunities to have the safety of the waste management scheme reviewed.

Under the circumstances, it is the right time to exchange our views and understandings on what are the internationally acceptable practices in moving radioactive wastes among nations, and come up with an appropriate way of safeguarding the world trade of radioactive wastes, especially in the pacific rim where nuclear businesses are most active. The discussion could be immediately started in the international conference like PBNC, and a mutually agreeable resolution could be drawn within this region. The discussion may include the means of mediation or cooperation (or regulation if it is required) within the region. This could be achieved through an international organization like IAEA, or a new separate cooperative body in the pacific rim.

DEVELOPMENT OF DISPOSAL CONCEPTS

On October 10th and 11th of 1997, an international symposium was held in Korea on the concept development of HLW disposal. World-wide experts were invited from various foreign nations. Towards the end of the symposium, a panel discussion was held specifically on how to find efficient ways of developing a HLW disposal concept. The suggestions proposed by each participant have been analyzed, and the general outcome of the panel discussion is summarized as follows:

- openness to the general public from the beginning of the project,
- fighting spirits against anti-nuclear movements, but with patience,
- importance of politics and social issues as well as scientific and technological issues,
- proper communications with scientists of disciplines other than nuclear,
- identification of clear responsibilities among organizations from the beginning,
- paramount importance of strong governmental support,
- securing the long-term stable funding,
- minimal paper work in site selection process,
- demonstration of safety through hardware performances like URL, and
- clear objectives defined for R&D.

We believe that every one of above suggestions is based upon the experience accumulated by each member of the expert panel. It is worthwhile to scrutinize each one of these suggestions. Actually, this paper is prepared based upon these valuable suggestions. By learning the wisdom, the same mistakes that they made should be avoided. This kind of panel discussion was an excellent example of good international collaboration.

We have to try our best efforts to explore the concepts for safe and economic disposal of radioactive waste including siting and site characterization, performance assessment, institutional management, and closure and post-closure management. Siting is the first and most important step in waste management, which is the process of finding a proper site for waste disposal. Some nations are experiencing hard times in finding proper sites. Sometimes, suitable sites for safe and economic disposal within the nation are limited. Hence, the program of exploring the best available sites in a global or regional sense could be a forward-looking approach. We could always look for most efficient sites through world-wide search. Such a

program could reduce the burden of finding a local cost-effective site, and eventually minimizes the global risk of radioactive waste management. And this program could be only initiated under international consensus.

COLLABORATION IN R&D

Most R&D work in radioactive waste management require a large amount of capital investment. The international cooperation could start in sharing expenses among nations in large R&D projects.

Duplicative R&D work are in progress individually in various nations without proper collaboration and integration, which is considered very inefficient. In the meantime, we often ask ourselves how much R&D is enough. The R&D should not be carried out in order to just satisfy the scientific curiosity of certain researchers. The necessity of specific R&D work should be in close scrutiny before it is accepted. The clear objectives should be defined for each of given R&D work.

KAERI set up an R&D scheme for HLW disposal as shown in Table 2. Without doubt, some of this work has already performed in some other nations or could be easily accomplished through close international cooperation at the minimum cost.

For the purpose of good international cooperation, an international body could be formed to disseminate the work with proper review among related nations so that the duplicative work could be minimized and the expenses could be appropriately shared. Through the body, we may also arrange joint R&D programs. The joint R&D program is also beneficial in gaining the public confidence by showing our combined efforts of pursuing the safety in international level.

Table 2 KAERI's R&D Programs for HLW Disposal

- ☐ Repository System Development and Performance Assessment
 - ✓ Establishment of a reference disposal system
 - ✓ Development of safety/performance assessment methodologies
 - ☐ Geoenvironmental Science Research
 - ✓ R&Ds of geoenvironmental assessment methods
 - ✓ Site screening for an underground research laboratory and natural analogues studies
 - ✓ Site characterization study
 - ☐ Engineered Barrier Development
 - ✓ Waste form characterization and canister material corrosion
 - ✓ Canister and/or overpack development
 - ✓ Development of buffer material and its characterization
 - ☐ Underground Radionuclide Migration Study
 - ✓ Radionuclide sorption study and D-base development
 - ✓ Radionuclide migration experiment through geologic medium
 - ✓ Colloidal transport of radionuclides
 - ☐ Geotechnical Engineering Study
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- ✓ Design, Construction and Operation of shallow underground test facility
 - ✓ THM coupling phenomena study and related field-experiments
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CONCLUSIONS AND IMPLICATIONS

To reduce the environmental problems resulting from the massive use of energy in the modern age, nuclear should play a key role. The use of nuclear energy, however, produces radioactive wastes, and we must not forget that the use of this valuable energy resource may not be sustainable without presenting a good way of disposing of radioactive wastes.

The work of radioactive waste disposal, however, is one of the most sophisticated forms of multi-disciplinary effort, and usually requires a long-term planning and implementation. And an enormous capital investment is also envisaged. Hence, systematic cooperation is essential in each stage of planning and implementation for success. In particular, international cooperation is extremely required in each of the areas as follows:

- to enhance public acceptance, persuasive education of the public with patience, and encouragement of fighting spirits on behalf of silent majority;
- to minimize waste generation, promotion of plutonium recycling, and development of appropriate safeguards system;
- to eliminate the burden of waste disposal on future generations, imposition of a waste fund and formulation of a robust organization;
- to establish world-wide acceptable practices, preparation of standards and guides, and control of international movement of wastes;
- to explore disposal concepts, a world-wide search of cost-effective sites, and development of disposal methods; and
- to collaborate in R&D, prevention of duplicative work, sharing of expenses, and selection of appropriate R&D topics.

Compartmentalism imposes a danger of division into sections lacking normal interaction and cooperation. The danger becomes even worse if it exists among nations. We wish an international conference like PBNC could break the rigid compartmentalism, and plant the vision of close cooperation among nations into our minds, so that we could all be able to solve the difficult problem of radioactive waste disposal in harmony.

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REFERENCES

Ministry of Trade, Industry, Energy and Resources, *White Book of Nuclear Power Generation*, 1997.

Bonne, A. A., "High Level Radioactive Waste Disposal: Consensus on the International Level," *Proceedings of International Symposium on the Concept Development of the High Level Waste Disposal*

System Development, Taejon, Korea, 1997, KAERI.

Boczar, P. G., P. J. Fehrenbach, and D. A. Meneley, "CANDU Fuel Cycle Development Potential," Proceedings of the 5th International Topical Meeting on Nuclear Thermal Hydraulics, Operation & Safety, Beijing, China, 1997, NUTHOS-5.

Kang, C. S., "Advanced Nuclear Systems in Korea," *The 4th Japan-Korea Workshop on PSA*, Yokohama, Japan, 1997, JAERI & NUPEC.

SEO, J. K., et al, "Advanced Integral Reactor (SMART) for Nuclear Desalination," IAEA-SM-347/40, *Proceedings of Symposium on Desalination of Seawater with Nuclear Energy*, Taejon, Korea, 1997, IAEA.

Chun, K. S., "R&D Programs for HLW Disposal in Korea," *Proceedings of International Symposium on the Concept Development of the High Level Waste Disposal System Development*, Taejon, Korea, 1997, KAERI.

KEY WORDS

Radioactive waste management, high level waste disposal, international cooperation, disposal concepts, HLW R&D