Korea Atomic Energy Research Institute (KAERI) in the 21st century

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Abstract. KAERI (Korea Atomic Energy Research Institute), a national nuclear research institute in the Republic of Korea, celebrated its fortieth anniversary last April. It has played a key role in the Korean nuclear history such that it:

- initiated and promoted the peaceful uses of nuclear energy in the Republic of Korea;
- maintained nuclear expertise on whole spectrum of nuclear field through conducting nuclear R&D programs, operating nuclear research facilities, and training and educating specialized nuclear personnel;
- founded a cornerstone of Korean nuclear industry by participating in the establishment of a nuclear engineering company and a nuclear fuel company and localizing nuclear fuel and reactor technology ; and
- contributed to nuclear safety regulation by incubating a specialized nuclear regulatory body.

Recently, to concentrate on nuclear R&D on advanced technology, KAERI went through management reform such as:

- the transfer of nuclear engineering divisions responsible for NSSS design and nuclear fuel design to nuclear industry in 1996 ; and
- the downsizing of manpower in 1998.

Currently KAERI is in the challenging stage in terms of its missions and manpower. In the coming 21st century, KAERI is required to maintain the current R&D momentum and also to conduct priority-based research requiring concentrated effort.

Past history

Founding stage (60s)

1. AERI (Atomic Energy Research Institute), the initial body of KAERI, was established in 1959 as one of governmental bodies under the Ministry of Nuclear Energy. Its initial missions were:
   - to educate and train specialized nuclear personnel;
   - to promote the application of radiation and radioisotopes;
   - to perform nuclear basic research; and
   - to develop indigenous expertise in nuclear science and technology.

2. Priority was given to the establishment of nuclear infrastructure such as nuclear basic research, application of radiation and radioisotopes, construction of nuclear R&D facilities and training of manpower.

3. The first research reactor, TRIGA-MARK II (100 kW), began its operation at AERI in 1962. The second research reactor, TRIGA-MARK III (2 MW), began its operation at AERI in 1972.

4. To further application of radiation and radioisotopes, Radiological Research Institute (RRI) became independent from AERI in 1963 and so did Radiation Research Institute in Agriculture (RRIA) in 1966.

Exploring stage (70s)

5. In 1973, the Korean government restructured the national nuclear research system. KAERI was reborn as a government-affiliated nuclear research institute, merging AERI, RRI and RRIA.

6. Priority was shifted to nuclear power and nuclear fuel cycle technology development including researches on nuclear safety and nuclear materials in parallel with the construction of the first NPP in the Republic of Korea.

7. KNFDI (the Republic of Korea Nuclear Fuel Development Institute) was established in 1976 to devote special effort for nuclear fuel cycle. A pilot scale nuclear fuel fabrication facility was completed at KNFDI in 1978, which accelerated fundamental R&D on nuclear fuel manufacturing technology.

Enlarging stage (80s)

8. KAERI was reshaped with merging KNFDI in 1980 and moving from Seoul to its current site in Daeduk Science Town in 1984.

9. Priority was shifted to self-reliance of nuclear fuel and nuclear reactor technology along with the rapid growth of nuclear power in the Republic of Korea.

10. For the self-reliance of nuclear power technology, the Korean government assigned technological responsibilities for design, manufacturing, construction and maintenance of NPPs to several specialized organizations. The rationale for the division of responsibilities was to maximize the utilization of national resources such as high-level manpower, technical capability, facilities, etc.

11. KAERI was given the responsibility for design of NSSS and nuclear fuels for both PWR and CANDU in consideration that it possessed nuclear specialized personnel suitable for digesting those technology compared to other organizations in the Republic of Korea.

12. The active participation of R&D personnel in nuclear power projects was one of key factors which brought the success of the localization of CANDU fuel, PWR fuel and NSSS design.

13. Along the localization effort, KAERI's manpower doubled in 1989 compared to that in 1981 and its budget increased about eight times in 1989 compared to that in 1981.

14. KINS (the Republic of Korea Institute of Nuclear Safety) was separated from KAERI and became an independent organization

15. KAERI established NEMAC (Nuclear Environment Management Centre) as its affiliate, which took the responsibility of managing radioactive waste and spent fuel management.

Challenging stage (90s)

16. In 1992, the Korean government launched the mid and Long term nuclear R&D program covering from 1992 to 2001 to advance nuclear technology to the level of nuclear advanced countries, which streamlined KAERI's R&D projects.

17. Priority was shifted to large-scale nuclear R&D projects on nuclear advanced systems such as SMART (System-integrated Modular advanced Reactor), KALIMER (Korean Advanced Liquid Metal Reactor), DUPIC (Direct use of spent PWR fuel in CANDU), etc.

18. A multi-purpose research reactor, HANARO (high-flux advanced neutron application reactor, 30 MW), began its operation in 1995.

19. According to the Government's decision to restructure nuclear industry in the Republic of Korea, KAERI transferred its nuclear engineering functions (NSSS design, nuclear fuel design and manufacturing, radioactive waste management) including related technologies and personnel to nuclear industry in 1996. The rationale of the transfer was that the nuclear industry became mature enough to take over the functions and KAERI would concentrate its effort to nuclear R&D.

20. At the same time, the Korean government established nuclear R&D fund, which would secure financial resources for national nuclear R&D and is calculated based on a fixed monetary rate of on1.20(about 1.0.1) per kWh of electricity produced annually with nuclear power. KAERI is a major beneficiary of the fund.

21. The second phase of the mid and long term nuclear R&D program covering from 1997 to 2006 began in 1997, reflecting the changing national and international nuclear circumstances.

22. KAERI, like other research institutes in the Republic of Korea, went through hard downsizing of its manpower due to the Korean economic crisis in 1998.

Present situation and challenges

Missions

23. KAERI restructured its missions in 1996 to concentrate its effort to nuclear R&D. Its current missions are as follows: to carry out integrated nuclear R&D such as
    - nuclear basic research,
    - nuclear safety research,
    - advanced reactor technology development,
    - advanced fuel development,
    - back-end fuel cycle research,
    - research reactor utilization,
    - radiation and radioisotope application; and
    - other subsidiary missions such as support for national nuclear control (safeguards, export control), training of specialized nuclear personnel, and national nuclear policy research.

24. These missions are expected to be continued in the new century considering the Korean government's positive and active position on nuclear energy.

R&D areas

25. The current R&D areas of KAERI cover almost whole spectrum of nuclear field such as nuclear reactor, nuclear fuel cycle, radioactive waste management, nuclear safety, radiation/radioisotope applications, radiation protection, and safeguards/physical protection.

26. Maintaining whole spectrum would be one of KAERI's strengths and also one of its weaknesses. KAERI could maintain broader nuclear expertise but might not reach deeper level of expertise. KAERI needs to be more streamlined and specialized in some areas not all.

27. The concentration of KAERI's effort to the self-reliance of nuclear power technology had resulted in relatively little concern on researches on the application of radiation and radioisotopes and on hardware-oriented R&D's. These areas would get relevant concerns in the new century.

Manpower

28. KAERI's manpower dropped to 1000, half of that in 1996, due to the transfer of nuclear engineering functions in 1996 and the downsizing in 1998. The split of nuclear expertise could impact KAERI'S R&D for the time being until KAERI gets back its momentum.

29. KAERI's manpower structure is another challenge. KAERI is forty years old, hence the manpower structure looks like a diamond skewed upward. There are very few under 30. It is difficult to maintain a sound manpower structure under the Korean culture.

30. Furthermore, the young generation's interest on nuclear field is declining, like in other countries, considering the fact that the number of students in nuclear engineering departments in the Republic of Korea is decreasing. This could be a big barrier to the recruitment of manpower in the future.

R&D facilities

31. KAERI maintains fairly well established R&D facilities such as HANARO (a multi-purpose research reactor, 30 MW), PIEF (Post-Irradiation Examination Facility), IMEF (Irradiated material Examination Facility), etc. They are in full utilization now and are expected to be so in the new century.

Financial resources

32. KAERI's financial resources come from the Government and from nuclear R&D fund established in 1996. The 1999 budget of KAERI except affiliated organizations records US$ 137 million.

33. The current financial status of KAERI is relatively stable, while having some uncertainty due to the restructuring of electricity industry in the Republic of Korea expected to occur in the near future.

Other issues

34. After the transfer of nuclear engineering functions to nuclear industry, it became more important for KAERI to keep close ties with the nuclear industry for maximizing the utilization of nuclear resources.

35. Public acceptance on nuclear energy is a key issue in the Republic of Korea like in other countries. Therefore, KAERI is making effort to keep sincere and close relationship with the local society, public media, NGOs, etc.

International co-operation

36. KAERI puts great importance to international nuclear co-operation with international organizations and various nuclear research centres in the world.

37. International nuclear co-operation is believed to be a viable way to overcome challenges most nuclear research centres in the world are facing. Many developing countries are in needs of nuclear technology and infrastructure, which nuclear research centres in the developed countries in concern have maintained.

International collaboration on research reactors

38. Research reactors are necessary for various purposes such as nuclear fuel and material irradiation testing, radioisotope production, neutron beam research, neutron activation research, neutron transmutation doping, manpower training, etc. There are and will be much needs for research reactors and their related technologies over the world, especially in developing countries. Usually building a research reactor has been the first step for introducing nuclear energy in a country. Nuclear specialized personnel have been first raised through research reactors.

39. However, the reality seems to be far from fulfilling the needs. The total number of research reactors over the world has been decreased to about two thirds of the peak number in around 1975. About two thirds of the reactors are over 30 years old, and more than 80% are over 20 years old. Generally the construction of new reactors becomes harder due to the tighter regulation and the poorer public acceptance in advanced countries. Developing countries lack of financial resources and technology to build research reactors.

40. Therefore, the first viable way to meet the needs for research reactors would be to maximize the utilization of the existing research reactors over the world. The important point here is to match the possible demand and the possible supply. Many developing countries are in needs of nuclear technology and infrastructure while many nuclear research centres in developed countries are suffering lack of demand.

International Nuclear University

41. The expected growing need of nuclear energy in the coming future requires relevant human resources and knowledge. However, we are experiencing the declination of nuclear personnel over the world, especially of the younger generation's interest on nuclear field. We should take preparations to meet for the nuclear future.

42. In this respect, the establishment of a human resources development mechanism, so called "International Nuclear University (INU)", would be a viable option, which could help fill the gap expected in the new nuclear age.

43. INU would provide professional education and training in the nuclear field with emphasis on global and interdisciplinary perspectives and hence offer professional staffs and younger generation broader opportunities and motivation to acquire and improve their knowledge on nuclear field.

44. INU would organize a world network of nuclear related departments and specialized training centres of Member States so as to fully utilize their facilities and human resources. Professional staff of the IAEA and Member States, either actively in service or retired, could be a source of faculties and advisors for INU.

45. KAERI, with the IAEA, is willing to take a leading role of elaborating and realizing the concept of INU.