Long-Term Program for Research, Development and Utilization of Nuclear Energy and Partitioning/Transmutation Technology in Japan

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1. Introduction

Atomic Energy Commission, which is responsible for the planning, deliberating and decision-making necessary for Japan's development and utilization of nuclear energy, revised the Long Term Program on 24 June 1994. The last Program was published in 1987, and AEC started its deliberation for the revision in 1992.

The circumstances among Atomic Energy has changed drastically since the publication of the 1987 Program, such as the collapse of cold war structure, global concern for environmental problems and the loss of public reliance on the safety of nuclear power plants after the Chernobyl accident. The new program was consolidated through careful and energetic study of AEC, taking public opinion into account.

The new Program attaches particular importance on treatment and disposal of radioactive wastes and decommissioning of nuclear energy facilities, which are defined as "back-end measures", from the stand point of accomplishing a consistent system of nuclear power generation. The basic research and development on Partitioning and Transmutation technology is to be promoted as a future technology in this area.

This report shows the outline of the new program and how the technology is described in the report briefly.

2. Long-Term Program for Research, Development and Utilization of Atomic Energy

(1) Back Ground for the Revision

During 7 years from the publication of the 1987 Long-Term Program, the situation inside and outside Japan concerning the atomic energy development and utilization has changed dramatically, which necessitates careful deliberation for the revision of the Program. Followings are major international changes recognized by the AEC.

(a) Collapse of the cold war structure

Reduction and destruction of nuclear weapons is welcoming change, however, the treatment of the nuclear materials such as plutonium has become an important issue. Concern for proliferation of nuclear material is deepened and the safety of the nuclear plants in former East world also becomes major issue.

(b) Awareness of Global Environmental Problem

Global environmental problems such as global warming and acid rain are now of the international concern, and sustainable development consistent with environment becomes very important task.

(c) Increase in the Global Energy Consumption

Global energy demand is increasing especially among developing countries. It is important to secure the supply of energy for long-term.

(2) Major Role of Nuclear Energy

Energy is indispensable fundamental for economic and social activities as well as daily life. Presently more than 90% of the world's energy consumption depends on fossil fuels. Because of the limitation of fossil resources and environmental impact by the use of them, non-fossil fuels are expected to play a larger role in the years to come. New energy such as solar energy and wind power are seemed to be promising as dispersal energy. There are, however, many problems to be solved because of their characters, such as low energy density, being easily affected by changeable natural conditions.

Nuclear energy, on the other hand, has already overcome all basic problems in technical, economical and other terms and already occupies the position of a practical and stable source of energy. Nuclear energy can supply large amount of energy without emitting carbon dioxide, nitrogen oxide etc. Treatment and disposal of radioactive wastes is one of the important issue to be addressed for nuclear energy, but the amount of wastes is relatively small (an analysis shows about 85g/person-year in Japan) and the safe disposal of the wastes is technologically feasible.

International contribution is another important aspect of the development and utilization of nuclear energy. If the developed countries of economic power monopolized easy-to-use fossil energy, it would disturb the development of other countries. Nuclear energy enlarges options of energy supply and avoids friction related to energy resource allocation. Nuclear energy requires certain level of technology, therefore, it may not be feasible for every country. But if the advanced countries reduce the emission of carbon dioxide by introducing nuclear energy, it would be a remedy for the global environmental problem.

(3) Basic Principle for the Development and Utilization of Nuclear Energy

The new Program shows the basic principle of Japanese nuclear energy development and utilization:

(a) Development of Nuclear Energy Policy as a Nation Committed to Peaceful Use of Nuclear Energy

Japan today enjoys fruits of its past efforts in development and utilization of nuclear energy with consistent limitation to the peaceful purposes. It is vitally important for Japan to keep its commitment to peaceful use of nuclear energy in the future. That being the case, Japan intends to redouble its efforts with respect to gaining international confidence on nuclear non-proliferation regime, developing nuclear technology for peaceful use, acting internationally in a way that befits an advanced nation committing to peaceful use of nuclear energy and enhancing transparency and availability of information.

(b) Establishment of a Consistent System of Nuclear Power Generation by Light Water Reactors

Light water reactors, which today account for nearly 30% of Japan's total electric generation, have come to be considered a highly reliable type of reactor. Light water reactors are expected to continue to be the main-stream of nuclear power generation for a considerably long period in view of the basic trend of easier supply of natural uranium in recent years and the technical difficulties in developing commercial FBRs.

Therefore it is necessary to work for further improvement of their economic performance while ensuring their safety and reliability. Particularly important may be to enhance safety measures for aged nuclear power plants, and wastes disposal and decommissioning measures. The most important remaining task for the sake of ensuring a consistent system of nuclear power generation is the establishment of ways of accomplishing appropriate treatment and disposal of radioactive wastes and decommissioning of nuclear facilities. Our generation which enjoys the benefit of nuclear energy should be responsible for carrying out this task.

(c) Progress in Nuclear Fuel Recycling on the Basis of a Clear Future Outlook

As a country practically without its own energy resources, it is indispensable for Japan to secure its energy supply on the basis of the future outlook in order to maintain and develop its economic and social activities. Uranium resources are limited just as fossil fuel resources are, and it cannot be denied that uranium supply-demand relation will be tight by around the middle of the next century if light water reactors are continued to be used. Japan intends to secure its future energy supply by recycling of nuclear fuel involving reprocessing of spent fuel and reuse of recovered plutonium, uranium, etc. Therefore, Japan is steadily carrying forward research and development efforts aimed at future commercial nuclear fuel recycling. Another reason for doing so is that recycling of nuclear fuel is also meaningful in terms of sparing resources and the environment and of improving the management of radioactive waste.

It is necessary to recycle nuclear fuel based on the principle of not having plutonium in excess of the amount required to implement the program, as well as having very strict management of nuclear materials, implementing rational and consistent program and keeping its transparency so as not to give rise to any international doubts on Japan's program.

(d) Promoting Nuclear Sciences and Technologies in Various Ways and Strengthening Basic Research

Nuclear power generation by utilizing nuclear fission is a well-known form of nuclear technology, but not the only one. The range of application of nuclear technology is extremely broad. Nuclear fusion, heat supply by high temperature gas-cooled reactors, propulsion power for ships and utilization of radiation are also important area of nuclear technologies. Japan intends to continue to engage in development of various nuclear technologies.

From the understanding shown above, the new Program arranges the research and development themes into following four fields.

i) Basic Research and Underlying Technology
ii) Production of Energy
iii) Radiation
iv) Nuclear Fusion

3. Partitioning and Transmutation Technology in the New Program

(1) Back-End Policy and Partitioning and Transmutation Technology

Back-End measures, which consist of treatment and disposal of radioactive waste and decommissioning of nuclear energy facilities are regarded as the most important task for the sake of ensuring a consistent system of nuclear power generation. As mentioned above, the new Program attaches particular importance to the back-end measures, especially to ensuring the smooth accomplishment of disposal of high-level radioactive waste.

In that context, the new Program stipulates procedure, schedule and responsibilities of entities concerned for the disposal enterprise. The entity to implement the disposal project will be established around the year 2000. The target for starting operation of a repository is in the 2030's or by mid-2040's at the latest.

The Partitioning and Transmutation technology, which would reduce the environmental impact of the disposal by utilizing useful nuclides in the high-level radioactive waste, is considered to be future technology in the new Program. The Japan Atomic Energy Research Institute (JAERI), the Power Reactor and Nuclear Fuel Development Corporation (PNC) and other organization such as Central Research Institute of Electric Power Industry (CRIEPI), are carrying out the basic research and development of these technologies. The check and review based on the progress of these activities will be carried out sometime in the second half of this decade.

(2) Partitioning and Transmutation as Nuclear Science and Technology

Partitioning and Transmutation technology will be promoted from two aspects. As basic research, the new Program urges the promotion of researches on TRU nuclides and on generation and utilization of various kind of beams. Beam technology is given a priority among underlying technologies.

Partitioning and Transmutation technology is also regarded as a technology for promoting effective production and utilization of energy.

4. OMEGA Project and Future Plan

As discussed above, the new Program supports the research and development of Nuclide Partitioning and Transmutation technology and R&D activities are being continued according to the Long-Term Program for Partitioning and Transmutation, which was published by the Advisory Committee for Radioactive Waste Management of AEC in 1988. The activities which follows this program is called OMEGA project (Options for Making Extra Gains of Actinides and Fission Products generated in Nuclear Fuel Cycle). The program selected the following areas for study and R&D are being carried out by three major organizations, namely JAERI, PNC and CRIEPI.

(a) Partitioning
- •Partitioning of nuclide in HLW
- •Recovery of metals from insoluble residue
- •Utilization of recovered metal

(b) Transmutation

- •Transmutation by using reactor
  - -Reactor physics
  - -FBR (PNC)
  - -Actinide Burner Reactor (JAERI)
- •Transmutation by using accelerator
  - -Proton accelerator (JAERI)
  - -Electron accelerator (PNC)

About six years has passed since the establishment of the program, and the check and review by STA/AEC is being planned according to the new Long-Term Program. One of the major consideration is the establishment of consistent program for OMEGA projects and actinide-recycle system which would recycle actinide elements (Np, Am, Cm etc) and is introduced to the new Long-term Program. Actinide-recycle system is aiming at improvement of resistance to nuclear proliferation as well as reduction of environmental impact.