Introduction

Most recent official program of Japan Atomic Energy Commission for the future is given in the Long-Term Program for Research, Development, and Utilization of Nuclear Energy issued by the Commission in 1994. From the program, selected topics are discussed in this paper to limit the discussions to those related to ordinary power production:

1. Advanced model light water reactor
2. Plutonium utilization
3. Radioactive waste disposal
4. Other related generic topics:
   - Nuclear non-proliferation
   - Safety assurance
   - Understanding of the public
   - Site acquisition
   - Human resources
   - International cooperation

Outline of the Commission’s Program

The summaries of the Commission’s programs for each topics are as follows:

Advanced Model Light Water Reactors

Recognizing that:

- The light water reactor has shown itself to be a very reliable reactor. (safe, reliable and economic). It has come through three stages of design improvement and sophistication programs and made satisfactory achievement,
- Backed up by the recent expectation of longer uranium supply prospect, the light water reactor is expected to continue to serve as the major power reactor for a while,
• Light water reactor power plants have some technical areas yet to be improved (to make more economic, safe and reliable---in the areas of safety, waste disposal, designed-in decommissioning measures etc.), and
• There may be some delay in FBR commercialization---that calls for the need of Pu-thermal operation, efforts in the following areas will be made:
  • Further reduction in the occurrence of troubles and incidents,
  • Enforcement of periodical safety review,
  • Appropriate measures for aged reactors,
  • Severe accident measures,
  • Human factor considerations (through system simplification, and improved automation of the operation),
  • Utilization of up-to-date technique such as probabilistic approach in safety design and evaluations,
  • Refinement of such technologies as automatic device for testing and maintenance work to reduce personnel radiation exposure, and
  • Further refinement of operation and management method of utility companies including the review of the appropriateness of the time intervals of operation cycle and of periodic inspection by utility companies, within the strict pre-requisite of assurance of safety.

Furthermore, following efforts will be made from the viewpoint of further-off future:
• Improvement of fuels and core technology for introduction of higher burn-up fuel, MOX fuel etc.,
• Improvement of siting technologies, such as introduction of Quaternary (Cenozoic Era)-period-land siting and off-shore siting, and
• Anti-seismic design improvements to improve siting technology.

As prospective research and development, following areas will also be pursued:
• Future-model small and medium sized light water reactors with some inherent safety features which enhances safety and reliability, and
• Research on light water reactors which suppresses the consumption of plutonium in the core while producing the power so that it enables the in-reactor storage of plutonium.

The above stated development program, that is the enhancement of light water reactor technology which is now in a fully commercialized state, is basically to be carried out by civilian effort. Government, however, will cooperate in such areas as :
• Establishment of related codes and standards, and
• Testing and experiments related to the safety assurance and/or to the public acceptance.
Plutonium Utilization

Recognizing that:

- Uranium resource is quite limited as the fossil fuel resources are and the supply will be tightened at around the middle of the 21st century,
- Fissile fuel recycle is effective in ascertaining the future energy security,
- Fissile fuel recycle is also valuable for the conservation of energy resources, for the conservation of the environment and also for the adequate treatment of the radioactive waste,
- Though MOX utilization in light water reactors is presently more costly than the direct disposal of spent fuel, there is no essential economic discrepancy between them if overall generation cost is considered,
- FBR will become the main nuclear power supplier, after a certain period of co-existence with light water reactors,
- Fuel cycle activity of a certain capacity will be needed to achieve acceptable economics of nuclear fuel cycle, and
- Efforts to obtain international trust in Japan’s non-proliferation attitude is indispensable,

efforts will be made in such ways as:

- Steady R&D work on FBR technology will be continued aiming at its commercialization by around 2030. Utilities will be responsible for the construction of demonstration FBR and associated R&D, while the government assume the responsibility on R&D on generic FBR technology,
- A commercial size reprocessing plant will be constructed, and its operational experiences will be accumulated,
- Fuel recycles with existing light water reactors and new conversion reactors will be established also,
- Efforts to improve economics of MOX fuel operation will be continued on the long term basis through such efforts as the unification of fuel element technical specifications etc.,
- Fissile materials will be placed under strict management, and
- No excess plutonium will be kept over the amount necessary to suffice the programmed necessity, and effort will be made to make its inventory account transparent to other nations.

Radioactive Waste Disposal

Recognizing that:

- Radioactive waste is diversified in terms of the levels of activity and the kinds of radioactive materials etc.,
- Radioactive waste may be useful from the viewpoint of material re-utilization,
- Exclusions and exemptions of some of the materials from regulation of the radioactive waste materials may be necessary,
Sea dumping of radioactive waste has social and political problems,
Responsibility over the radioactive materials lies, basically, on those who generated the waste, namely on utilities,
High level radioactive wastes will be disposed of deep under the ground, after the cooling off storage time of 30 to 50 years, where the government will assume the responsibility of assuring that sure and appropriate disposal be done,
The government will also assume the following responsibilities in order to assure the safety:
  • to establish overall disposal plan,
  • to confirm the safety of disposal, and
  • to establish regulatory measures for long term assurance of responsibility of radioactive waste disposal, and
Utilities will not only provide the required funding but also play an appropriate role in R&D as the institution that is closely related to the generation of the radioactive waste,
efforts will be made in the following areas:
  • Possibility of re-utilization of radioactive wastes will be studied, and necessary R&D works will be carried out.
  • Exclusions and exemptions of some of the radioactive materials from framework of regulation will be dealt with taking international trend into consideration.
  • Sea dumping of radioactive waste will not be done considering the social and political circumstances, though it will be re-considered if the circumstances change substantially in the future.
  • Shallow depth disposal of low level radioactive wastes will be continued, and PNC (Power Reactor and Nuclear Fuel Development Corp.) will for the moment carry out related R&D work and geological survey.

Generic Areas

Nuclear Non-Proliferation

Recognizing that:
  • Japan continues to strictly limit its development and utilization activity of nuclear energy to peaceful uses,
  • Transparency to the public of the activity is ensured by the strict compliance with the international non-proliferation system, and
  • It is important to be internationally trusted that Japan’s activity is strictly limited to peaceful uses, especially in the present situation of rapid international change,
efforts in the following areas will be made:
  • Japan will make more efforts in strengthening and rationalizing the IAEA safeguards, in compliance with physical protection measures and in the strengthening of export control on particular nuclear energy related equipments.
• Necessary system to carry out the inspection, analysis and data processing of nuclear materials with sufficient credibility will be established, so that substantial increase in nuclear materials in the future can be appropriately handled.
• Efforts to enhance the transparency of information will further be made under the strict adherence to the principle of no surplus plutonium.

Safety Assurance
Recognizing that:
• Though nuclear facilities in Japan have shown good safety record so far, an incessant effort to keep that record is important,
• Further efforts to refine the safety codes and standards reflecting latest scientific and technical knowledge and operating experiences are necessary, and
• It is important to deal with the nuclear safety issues under the close cooperation of concerned countries, with the understanding that the issue is of common international concern,

efforts in the following areas will be made:
• Efforts to build nuclear safety culture that could be proud of will be established through more strict and rational safety regulation measures.
• Effort to reflect latest scientific and technical data and information upon codes and standards will be made.
• Preventive safety assurance measures will be enforced to cope with the increase in highly-aged-reactors, studying the data and experiences that have been gained from the incidents and troubles within and out of the country and the more recently obtained scientific and technical knowledge.
• Safety research related to nuclear reactor facilities, fuel recycle facilities, nuclear fuel transportation, seismic design, and probabilistic safety evaluation will be carried out.
• Collection, analysis and evaluation of the information related to incidents and troubles of world wide nuclear facilities will be made to contribute to the enhancement of world-wide nuclear safety.
• To support nuclear safety assurance effort in other countries, dispatch of related personnel, offer of personnel training opportunities and offer of providing information related to safety regulations will be promoted.

Understanding of the Public
Recognizing that:
• In order to promote nuclear energy utilization, it must be well accepted by the public,
• Confidence of the public in the government and industry in the use of nuclear energy is important,
 Accumulation of reliable records in safety assurance and in nuclear non-proliferation is important in gaining the confidence of the public,

The thought that information on nuclear energy utilization is unjustly restricted has been one of the key factors for the discontent of the public, and

Education of the young generations on the nuclear energy is quite important and effective in obtaining understanding of the public,

efforts in the following areas will be made:

• Basically all the information will be made public, though the ones related to physical protection, nuclear non-proliferation, protection of property rights etc. will be exempted.

• Systematic method of making the information public, such as the one through the information network, will be taken as much as possible.

• More efforts to provide accurate and objective information to the mass communication media will be made.

• To provide more learning opportunities for the young generations, improvement in training facilities and exhibition halls, and publication of the materials that are effective in promoting understanding will be made.

Site Acquisition

Recognizing that:

• Acquisition of new plant sites to construct required number of plants is necessary but needs substantial efforts,

• Considering the required long lead time of siting and plant construction, it is necessary to take appropriate siting measures as soon as possible,

• Sites for related fuel cycle facilities are also necessary, and

• Expectations of the local communities for the siting are getting more and more versatile,

efforts in the following areas will be made:

• Government ministries and agencies related to siting will make joint efforts in promoting the welfare of the people in the siting areas.

• In order to promote the understanding of the local public, active measures such as the one through mass media will be taken.

• New siting technologies as Quaternary-land siting, off-shore siting and underground siting as well as the enhancement of seismic plant design technology will be studied further.

Human Resources

Recognizing that:

• It is indispensable to make constant efforts to educate, train and secure people with outstanding capability to serve as human resources in the field of nuclear energy
from the standpoint of both further enhancement of safety assurance in the development and utilization of nuclear energy,

- It is desirable that universities take the central role of training nuclear researchers and engineers, while private sectors take necessary actions for training nuclear power plant engineers and technicians,
- In order to smoothly promote to secure necessary personnel, it is desirable that many people take nuclear engineering as something worth choosing as their profession, or at least understand its future possibilities, and
- In school education, nuclear energy need to be educated more fully,

efforts in the following areas will be made:
- The government will support the training activities of universities and private sectors.
- Opportunities for young generations to study or learn nuclear energy will further be provided.
- Cooperation among government-related research and development organizations and institutions will be strengthened in order to secure necessary personnel.
- Acceptance of foreign researchers and technical experts will be promoted to meet the recent trend of internationalization of nuclear energy research and development.

International Cooperation

Recognizing that:
- Not only the technical cooperation but some other forms of cooperation are also needed to cope with the recent international situations such as nuclear non-proliferation problems,
- Both bilateral and multilateral dialogues on nuclear energy policy are becoming more and more important,
- Though Japan have had good record of technological development so far in nuclear energy utilization, further efforts to promote the development under international cooperation should be made, and
- In promoting further technical development, it is important to carry it out in cooperation with technically advanced countries,

efforts in the following areas will be made:
- Every opportunity to enhance the mutual understanding through contacts with policy makers and opinion leaders of other nations will be taken.
- Efforts will be made to utilize the fast breeder prototype reactor MONJU and other government-owned large-scale research and development facilities related to nuclear fuel recycle as international joint study facilities.
- Efforts will be made in the areas of active exchange of technological information and effective utilization of knowledge accumulated in other countries be inviting engineers and researchers from other industrialized countries.
• International cooperation will be promoted on research and development of actinide recycle technology and other advanced recycle technology so that Japan’s posture of working for nuclear non-proliferation can easily be seen.
• International cooperation is emphasized in research and development work on technological problems common to countries concerned, as treatment and disposal of high-level radioactive wastes.

**Points to be Noted and Conclusion**

There are a few points to be noted about the plan; for example:
a. Number of tasks to be done.
b. Priorities in carrying out the plan.
c. Responsibilities for each tasks.
d. Alternatives and/or back-ups.
e. Funding.
f. International considerations.

The plan covers almost all the areas concerned, and it may not be easy to actually carry out all the tasks. However, as the energy situation in Japan and in many of other countries is in nearly critical condition, it is indispensable for Japan to exploit nuclear energy. And in doing so, international cooperation is indispensable and also is beneficial for all concerned.