LONG-TERM ATOMIC ENERGY RESEARCH, DEVELOPMENT AND UTILIZATION PROGRAM FORMULATED

The Atomic Energy Commission on September 12 reported to the Government the decisions it had made on a new Long-Term Atomic Energy Research, Development and Utilization Program. The AEC's long-term programs have been revised every five years since the first one was formulated in 1957. The new one is a revised version of the program established in June, 1972, the fifth of the series.

The oil crisis occurred in 1973, after the previous program had been formulated. In recent years, there has been growing opposition to atomic energy development in Japan, and on the international front, the trend is to ensure nuclear non-proliferation. In view of these severe circumstances in Japan and the world over, attention has focused on what kind of program the AEC will draw up.

The new long-term program that has been announced sets a basic line for Japan to follow in the years ahead, to promote the development and utilization of atomic energy, calling for:

(1) Efforts for the present to ensure that LWRs have come to stay, with the nuclear fuel cycle established so as to expand the scale of nuclear power;

(2) Commercialization of FBR by the year 2000;

(3) Practical application of nuclear fusion at the earliest possible date in the 21st Century.

To achieve these objectives, the new program sets out the outline of measures that should be taken over the next ten years. Importance is attached, in particular, to the promotion of research and development projects on nuclear power. A total of eleven projects are listed in a tabulation of major development tasks and schedules for the next ten years, with an estimate of the funds needed for this. This is something that differs from preceding programs, and apparently indicates that the AEC is prepared to earnestly promote research and development projects for the years ahead.

Below is an outline of the new long-term program:

Chapter 1 Basic Line on the Research, Development and Utilization of Atomic Energy

This chapter sets out four major principles that must be followed in accordance with the basic philosophy of promoting the development and utilization of atomic energy.

1. Establishment of Peaceful Uses of Atomic Energy

The development and utilization of atomic energy should be promoted strictly in such a way as to serve peaceful purposes only. Rigid safeguards will be applied in the spirit of the Atomic Energy Basic Law and the Non-Proliferation Treaty to make sure that atomic energy will be used for peaceful purposes only.

2. Safety Control and the People's Support

The research, development and utilization of atomic energy should be based on the premise of safety control. Efforts will be made to provide the assurance of safety, including the preservation of public health and environmental protection. This assurance of safety will provide a basis on which to obtain the people's support for the development and utilization of atomic energy.

3. Firm Independence Combined with International Cooperation

Active efforts will be made to promote international cooperation in research and development of atomic energy, and in developing cooperation with resources countries.

At the same time, technical steps are needed to establish a circle of independent nuclear technologies and nuclear-power oriented industry, and the nuclear fuel cycle should be set free from as many external limitations as possible, so that Japan can maintain its independence.

4. Planned Promotion of Atomic Energy R & D Projects and Preferential Policy

Atomic energy research and development projects should be promoted and planned from a comprehensive and long-range point of view. Great care must be given to raising funds and using them effectively. This requires that preferential consideration be given in the application of policies.

Chapter 2 How to Promote the Research, Development and Utilization of Atomic Energy

This chapter presents a long-range vision for the future, with priority measures to be taken for the development and utilization of atomic energy.

1. Nuclear Power

(1) Development Scale of Nuclear Power

There should be no delay in implementing the plan to build a nuclear power generating capacity of 33,000 MW by 1985 and 60,000 MW by 1990 -- the targets set by the Advisory Committee for Energy and reported to the Council of Cabinet Ministers for Energy. Siting is the biggest problem that has to be resolved to carry out this plan. The Government and industry are asked to strive to find a way to resolve the siting problem.

(2) Improvement and Standardization of LWRs

LWRs are now under good safety control, but they have to be improved and standardized under a plan set for 1980, to improve reliability and availability factors, to reduce occupational radiation exposure and to raise the level of efficiency in inspections.

2. Selection of Future Reactor Types and the Development of A Advanced Reactors

(1) Selection of Future Reactor Types

LWRs cannot be regarded as the mainstay for a long time to come, because they are expected to run short of the uranium resources they will need. FBR should be developed, and efforts should be made to establish the uranium-plutonium cycle, making these the mainstay of power reactors of the future. This is the basic line being followed by promoting the development of ATR as complementary reactors, on which a policy has soon to be decided on building a demonstration reactor and on later stages of development of the project. With regard to the introduction of CANDU reactors, a policy will be decided after evaluation and studies have been completed on the implication for the independent development of advanced reactors and for the nuclear fuel cycle, and concerning economy.

(2) Development of Advanced Reactor

(a) Fast Breeder Reactor

Commercialization of the FBR is scheduled for the year 2000. The prototype reactor (300 MW) is scheduled to reach criticality by 1985, with the demonstration reactor to follow in the first half of the 1990's.

(b) Advanced Thermal Reactor

Efforts will be made for practical application. Operation of the prototype reactor (165 MW) is continued for the present, along with research and development on building larger reactors. A decision is to be made by 1980 on the construction of a demonstration reactor.

(c) Multi-Purpose High Temperature Gas-cooled Reactor

A multi-purpose HTGR will be developed to use the reactor process heat for steel-making, hydrogen gas production, coal gasification and liquefaction. The first step will be the construction, with operation scheduled for the second half of the 1980's, of an experimental reactor designed to develop gas temperatures of up to 1,000°C.

3. Fuel Cycle

Cooperation will be made in international efforts to achieve c compatibility between the peaceful uses of atomic energy and the prevention of nuclear proliferation. At the same time, efforts will be made to build an independent nuclear fuel cycle by promoting independent prospecting and development of uranium resources, development of independent enrichment technology, and the construction of reprocessing plant in Japan.

(1) Procurement of Natural Uranium

Prospecting is being done in other countries, with the aim of importing approximately one-third of Japan's annual requirements from such sources. Production from successful projects carried out by Japanese companies will be purchased, on principle, by the electric utilities. Concrete steps will be taken for the stockpiling of uranium resources.

(2) Uranium Enrichment

Development of uranium enrichment technology by the centrifuge method will be promoted. Plans are for a pilot plant, to be followed by a demonstration plant, scheduled to be built in preparation for a commercial plant to come into operation by 1990.

(3) Reprocessing of Spent Fuel

Reprocessing technology will be established by the operation of the Tokai reprocessing plant. It will be necessary to build a second reprocessing plant to come into operation by 1990. Foreign services will be commissioned for reprocessing pending the start of operations of Japan's second reprocessing plant.

(4) Use of Plutonium

One important task, pending the commercialization of FBR, is to recycle plutonium with thermal neutron reactors. To this end, ATR is to be used to demonstrate the use of plutonium, with demonstration tests also for recycling Pu into LWRs.

(5) Management of Radioactive Wastes

Low-level wastes should be disposed of either in the sea or on the land.

Solidification and storage are subjects of study in demonstration tests to begin around 1985 for the treatment of high-level wastes. Demonstration tests for disposal will begin in the first half of the 1990's.

4. Nuclear Fusion

A critical plasma testing device (JT-60) will be completed in the first half of the 1980's, so that Japan can overtake the work done in the United States, the European Community and the Soviet Union. Studies will continue in preparation for construction of a core engineering testing device in the first half of the 1990's.

Along these lines, research will be done on non-circular plasma, high β plasma, superconducting magnets, tritium and materials. Helictron and inertial confinement will also be studied for application to formulas other than the tokamak types.

Bilateral and multilateral international cooperation have to be increased.

5. Nuclear Ships

Shielding repairs and a general safety review will be made on the first nuclear ship "Mutsu," which will then be put through trial operation. A research system will be established to promote research and development on advanced marine reactors and related equipment.

6. Use of Radiation

The uses of radiation will be studied to promote medical applications (treatment for cancer, diagnosis, radio-sterilization, etc,), industrial applications (non-destructive testing, radiation chemistry, etc.) and agricultural applications (food irradiation, breeding, etc.)

Steps are to be taken for the domestic production of radioisotopes and for the treatment of radioactive wastes.

7. Safety Studies

Research on engineering safety will be carried on in respect of LWR, ATR, plutonium-handling facilities, spent fuel reprocessing facilities and nuclear fusion reactors.

The environmental effects of radiation is a theme to be grappled with, by promoting the monitoring of environmental radioactivity levels and the evaluation of results, as well as research into the biological effects of low-level radiation.

8. Fundamental Studies and Training of Scientists and Engineers

Fundamental studies should be expanded and strengthened, as necessary to provide a basis for the promotion of big research and development projects and to tap new sources of technological developments. Training of nuclear scientists and engineers must be advanced.

9. Nuclear Power Industry

Related companies are asked to make further efforts to establish the nuclear power industry, such as can produce economical and constant supplies of dependable nuclear equipment and fuel.

Related companies are asked to put research and development efforts into the fields of construction of nuclear reactors, fabrication of nuclear fuel and manufacture of uranium enrichment equipment.

Chapter 3 Promotion of Atomic Energy Research and Development Projects

The focus of this chapter is on research and development projects for the next ten years. Tasks and schedules are set out, along with an estimate of the investments necessary to carry them out.

1. Promotion Plans for Atomic Energy R & D Projects

The atomic energy research and development projects which should be promoted over the next ten years, in accordance with the basic lines set out in Chapter 1 and the methods in Chapter 2, come under the following eleven categories:

1) Development of uranium resources

2) Uranium enrichment

3) Reprocessing and use of plutonium

4) Management of radioactive wastes

5) FBR

6) ATR

7) Multi-purpose HTGR

8) Nuclear fusion

9) Nuclear ships

10) Research on engineering safety

11) Research on the environmental radioactivity

2. Raising Funds for Atomic Energy Research and Development

A total of ¥4 trillion (at 1977 costs) will be needed over the next ten years (1978-1987) to promote the foregoing research and development projects, which breaks down as follows:

1) Development of uranium resources and uranium enrichment	¥400 billion
2) Reprocessing, use of plutonium, and management of radioactive wastes	¥400 billion
3) FBR and ATR	¥1,600 billion
4) Nuclear fusion, multi-purpose HTGR, and nuclear ships	¥900 billion
5) Safety studies, fundamental studies, etc.	¥700 billion
Total	¥4,000 billion

Funds will have to be raised in rapidly increasing sums during the first five years of the program, because most of the larger facilities are to be built during that period.

It is hoped that financial policy consideration will be given to the raising of funds for this purpose, in view of its being mainly research and development. One the other hand, some projects by nature could better be promoted if private funds are used and financial means made available. It is also necessary to consider asking the consumers of energy to bear their share

- Promotion Program of Atomic Energy Research and Development Project -

1. Development of Uranium Resources

To make sure of a constant supply of natural uranium, efforts will be continued to evaluate and prospect for uranium resources overseas. Research and development will aim at developing refining and conversion techniques.

(1) Prospecting for Foreign Uranium Resources

The aim of prospecting for uranium overseas is to ensure that imports will cover about one-third of Japan's annual needs.

(2) Development of Continuous Refining and Conversion Techniques

A Pilot plant is to be built for continuous refining and conversion, with operation scheduled to begin in the early 1980's A big plant will come into operation in the middle of the 1980's to promote continuous refining and conversion.

(3) Development of Mining Techniques

Japanese uranium deposits at Ningyo-toge and Tono will be used to develop mining and refining techniques.

(4) Development of Technology for Recovery of Low Grade Uranium

Research and development on techniques for the recovery of low grade uranium will continue to yield the necessary knowledge to determine whether or not these techniques can be applied for practical purposes.

2. Uranium Enrichment

To build a uranium enrichment plant to use independent technology, efforts will be made to expand centrifuge technology for uranium enrichment. In addition to the centrifuge method, research will also be done on laser and other methods.

(1) R & D on the Centrifuge Method

a) A pilot plant will come into partial operation in the summer of 1979, with full operation scheduled for the early 1980's to confirm the performance (durability, in particular) of centrifuges and the performance of plant.

b) To confirm economic feasibility, a large experimental plant will be built and will start to operate in mid-1980's

c) Efforts will be made to raise the efficiency of centrifuges and to develop techniques for mass production.

(2) Other Uranium Enrichment Studies

Studies will be done to acquire the necessary knowledge to evaluate uranium enrichment techniques by other than the centrifuge method.

3. Reprocessing and Use of Plutonium

The operation of the Tokai reprocessing plant will be used to ensure that Japan's own reprocessing technology can be established. Research and development to improve reprocessing-related techniques, such as reducing radioactive emissions into the environment, will be undertaken.

To make effective use of plutonium as it is recovered by reprocessing, R&D will go into using plutonium in LWRs.

(1) Operation of Tokai Reprocessing Plant

The operation of the Tokai reprocessing plant will help establish reprocessing technology.

(2) R&D on Reprocessing-Related Techniques

R&D will aim at evolving techniques to reduce radioactive release into the environment; these include evaporative treatment of liquid effluents, the removal of krypton, improving reprocessing machines and equipment, and evolving reprocessing-related techniques such as for experimental coprocessing -- all to accumulate the technology necessary to build and operate a second reprocessing plant.

(3) R&D on LWRs for Use of Plutonium

Demonstration tests will be carried out on plutonium recycling in LWRs.

4. Management of Radioactive Wastes

R&D will seek to improve techniques for the treatment and disposal of medium- and low-level wastes discharged from nuclear power plants, and of high-level wastes from reprocessing facilities, aimed at establishing a system for the treatment and disposal of radioactive wastes.

(1) Medium- and Low-Level Wastes

a) Demonstrations of asphalt solidification will be made in a bid for practical application.

b) Ocean dumping and land disposal of low-level wastes will be demonstrated for establishing a treatment and disposal system.

(2) High-Level Wastes

a) A plant will be built to solidify high-level liquid effluents from the Tokai reprocessing plant, so as to demonstrate methods of solidification and engineered storage of liquid effluents.

b) R&D on waste disposal will be promoted in preparation for disposal in geologic formations.

(2) High-Level Wastes

a) A plant will be built to solidify high-level liquid effluents from the Tokai reprocessing plant, so as to demonstrate methods of solidification and engineered storage of liquid effluents.

b) R & D on waste disposal will be promoted in preparation for disposal in geologic formations.

Items \ Term	FY1975-1977 (results)	1978- 1977
(1) Management of Medium- and Low-level Wastes		
1) Asphalt Solidification Plant (reprocessing concerned)	Design	Construction Operation
2) Experimental Ocean Dumping	Preparations	Practice
3) Experimental Land Disposal		Preparations Practice
(2) High-level Wastes		
1) R & D		
2) Solidifications, Engineering Storage Plant		Design Construc- tion Opera- tion
3) Disposal in Geologic Formations	Investigation/ Basic Research	Preparations

5. Fast Breeder Reactor

The FBR is an epoch-making reactor which produces more nuclear fuel than it consumes, and its development will be pushed so that it can come into commercialization in the second half of the 1990's.

(1) The experimental FBR "joyo" will be remodeled into a 100 MW irradiation facility to carry out irradiation tests.

(2) Construction work on the prototype "Monju" will be complete in the second half of the 1980's, to give experience in its operations.

(3) Results from operation of the prototype will be improved by advancing the necessary R & D for a demonstration reactor to be brought to criticality in the first half of the 1990's.

(4) R & D on the fabrication and reprocessing of plutonium fuel will be conducted, and the construction and operation of prototype reactor-related facilities will be promoted to study the possibility of establishing a nuclear fuel cycle for FBRs.

Items \ Term	FY1975-1977	1978-		1987
(1) Experimental "Joyo"	Construction	Operation	Remodeling into a Facility for irradiation	Irradiation Test
	Reached Criticality in Apr. 1977			
(2) Prototype "Monju"	Design	Construction		Operation
(3) Demonstration Reactor			Design/R&D	Construction
(4) Facilities for Fuel Production				
1) Facility for Prototype		Design	Construction	Operation
2) Facility for Demonstration Reactor			Design	Construction
(5) FBR Reprocessing Pilot Plant		R & D	Design	Construction

6. Advanced Thermal Reactor

Steps will be taken to promote development of the ATR, to make effective use of plutonium and depleted uranium as they are recovered from the reporcessing of spend fuel from LWR,s thus reducing the demand for uranium resources and enriched uranium.

(1) The operation of the prototype ATR "Fugen", which began generating electricity in July this year, will be utilized to confirm the technical performance of the ATR.

(2) Much R & D will go into the design of a demonstration reactor, aimed at construction of larger reactors.

(3) Results of the operation of prototype reactors and the results of research and development on larger reactors will be summed up so that a conclusion can be reached on the construction of a demonstration reactor by 1980.

7. Multi-purpose High Temperature Gas-Cooled Reactor

To expand the use of atomic energy to cover the non-electric power sections of industry, steps will be taken to develop a multi-purpose HTGR with a coolant outlet temperature at about 1,000°C, for nuclear energy to be used for steel making and for hydrogen gas production.

- Results of Research and Development and Actual Conditions

(1) Experimental reactors have gone through the stages of basic design, conceptional design and overall systems design, to the point where they are now on their way to detailed design.

(2) Results are being produced in the testing of fuel and materials with the in-pile helium gas loop (OGL-1) of the materials testing reactor (JMTR), and in the testing of heat-resistant metal materials and graphite materials. Construction work on a demonstration test loop for large scale equipment is making progress.

(Reference)

To find more uses for reactors, studies are going on for the us of hightemperature reducing gas for steel making, with an experimental plant being built for the purpose of producing high-temperature gas.

(1) A demonstration test loop for large scale components is expected to come into operation in the second half of the 1980's, for testing fuels and materials.

(2) Construction of an experimental reactor will begin in the early 1980's, with operation scheduled for 1985.

(3) Designs for a prototype reactor (electrical output of about 500 MW) and other studies will begin in the mid-1980's.

8. Nuclear Fusion

Long-range research and development on juclear fusion is under way, with practical application scheduled for the early 21st Century, as an energy source that could be the ultimate for mankind.

(1) The critical plasma testing device (JT-60) already under construction will come into operation in the second half of the 1980's, to establish plasma conditions.

(2) Research will be done on the use of the non-circular cross-section torus and toroidal pinch systems for higher beta, and on the employment of the heliotron inertial confinement system.

(3) R & D will be promoted on superconducting magnets, tritium manufacture and handling, core material, blankets and shielding.

(4) Results of the foregoing researches will provide a basis for considering the construction of a core engineering testing device.

(5) Steps will be taken to promote international cooperation in all fields of nuclear fusion.

9. Nuclear Ships

Development of the first nuclear ship "Mutsu" will be continued, along with research and development on marine reactor plants.

(1) The N.S. "Mutsu" will undergo shielding repairs and a safety inspection before construction is completed, with trial operation in 1985. Experience in the construction and operation of the ship will make it possible to accumulate the necessary techniques to confirm the general safety and reliability of nuclear ships.

(2) Fundamental studies for the development of nuclear ships will be continued, and, in consideration of the need for a higher level of safety and reliability, research and development of advanced marine reactors and reactor plants will go on, such as for related equipment, along with examination of the economy of nuclear ships.

10. Research on Engineering Safety

Efforts will be made to build up confirmatory knowledge necessary for the safety examination of LWRs. Safety research will seek to give a quantitative dimension, with adding precision on standards and guidelines for safety examination.

(1) With respect to reactivity initiated structural accidents, the NSRR will be used to continue the testing of un-irradiated fuels, along with fresh efforts at testing irradiated fuels.

(2) With respect to loss-of-coolant accidents, the ROSA program will be advanced, while participation in the LOFT program will continue.

(3) To make sure of fuel safety, tests will be made on spent fuel in the facilities for post-irradiation tests of practial fuels.

(4) Research will be done on structural safety, the reduction of radioactive release into the environment, probabilistic safety analysis and aseismic provision.

(5) In regard to all the foregoing, necessary international cooperation will be strengthened.

Items \ Term	FY1975-1977	1978- 1987
(1) Research on Reactivity Initiated Structural Accidents	Construction of NSRR	Irradiated Fuel Tests
	Un-irradiated Fuel Test	
(2) Recearch on LOCA	POSA-II Program	ROSA-III Program
	Participation in LOFT Program	
(3) Research on Fuel Safety	Construction of Testing Facility for Post-irradiation Tests of Practical Fuels	Post-irradiation Tests
(4) Research on Structural Safety, Reduction of Radioactive Release, Probabilistic Safety Analysus and Aseismic Provision		

11. Safety Research on Environmental Radioactivity

Research will be done on the movement from the environment to the human body, and the effect on hymans, of radioactive substances released from nuclear plants into the environment. The aim will be to give a quantitative dimension and added precision to the standards and guidelines for safety examination.

(1) Research on Low-Level Radiation Effects

1) In connection with the late effects of low-level radiation, such as cancer causing, research will be done on the relations of does effect and the mechanics of development.

2) With respect to genetic effects, primates will be used for the study of the does effect of abnormal chromosomes induced, with a view to estimating in quantitative terms the genetic effect on humans.

3) As for internal exposure, various animals will be used for research to make a quantitative estimate of the effect of plutonium, and to consider countermeasures against internal damage caused by plutonium.

(2) Estimation and Study of Exposure Doses

1) Research will be done on the diffusion pattern and behavior of radioactive materials in the air, in the sea and on the ground.

2) Research will be done on the internal metabolism of radioactive substances.

3) Research for developing instruments for measuring low-level radiation will be done, aimed at standardizing methods for the analysis and measurement of radionuclides in the environment, and to establish an emergency survey method.

(3) Research on Biological Effect of Tritium

Research into its behavior in the environment, its internal metabolism and the genetic effects of tritium, will be done.