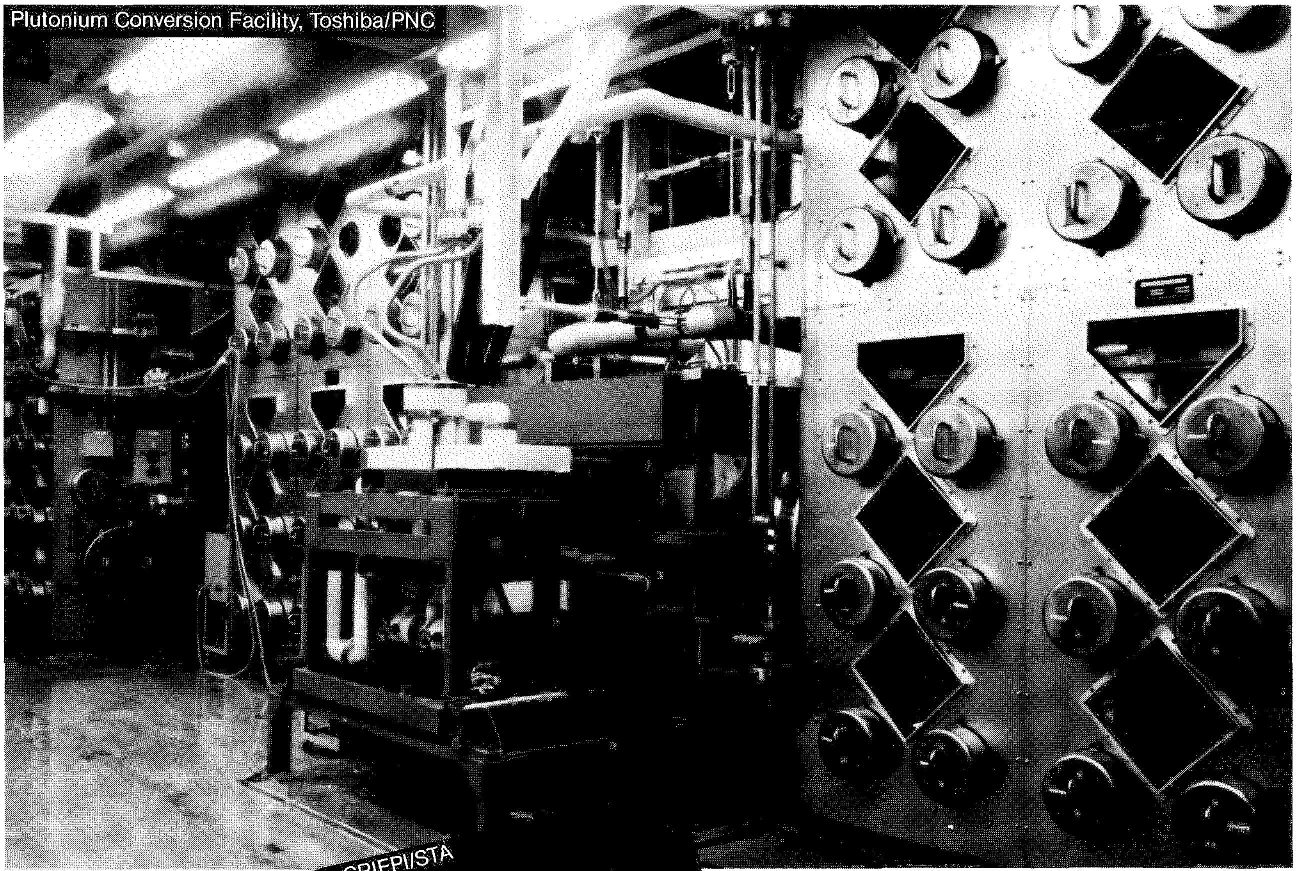
The 20th JAIF ANNUAL CONFERENCE

ABSTRACT

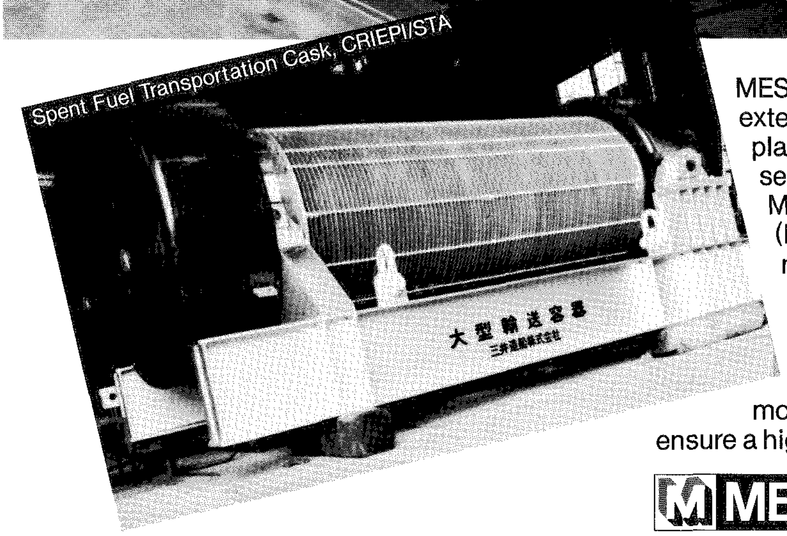
14-16 April 1987

Nissho Hall, Tokyo

JAPAN ATOMIC INDUSTRIAL FORUM, INC.



Plutonium Conversion Facility, Toshiba/PNC



Spent Fuel Transportation Cask, CRIEPI/STA

MES provides a wide variety of service extending from research and development to plant installation and after-installation services to meet diversified needs of clients. Mitsui Engineering & Shipbuilding Co., Ltd. (MES), proud of its high-level nuclear technology and rich experience in building chemical plants worldwide, has been doing its utmost to develop and construct facilities related to nuclear fuel cycle by selecting and combining the most appropriate materials and processes to ensure a high degree of safety and optimum operation.

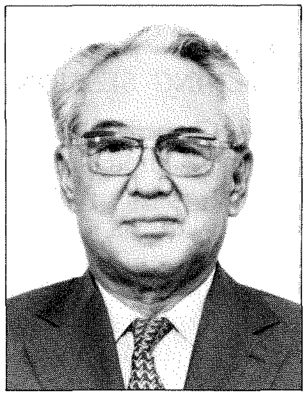
MES MITSUI ENGINEERING & SHIPBUILDING CO., LTD.

Nuclear Energy Systems Division
6-4, Tsukiji 5-chome, Chuo-ku, Tokyo 104, Japan Phone 03-544-3254

MES Facility Related to Nuclear Fuel Cycle

From Planning to Construction

Hiromi Arisawa
Chairman, JAIF



Isamu Yamashita
Chairman, Program Committee

Basic Theme – Nuclear Power: For the Progress of World Economy and Society

At present, installed nuclear generating capacity in Japan has grown up to provide about 30 percent of the total electric power generation of the nation, and nuclear power has thus become highly expected to fulfill roles as an even more stable and reliable electricity supply source.

At the 20th JAIF Annual Conference, extinguished specialists coming from Japan and abroad are all expected to vividly discuss not only new challenges toward nuclear energy R&D, having over 30 years of experience, but also the measures for firmly establishing nuclear fuel cycle, which is one of the most important tasks imposed on the nuclear industry today.

Chernobyl nuclear accident in the last year indeed gave considerable adverse effects on each country's nuclear power program. However, presentations will be made from representatives from the International Atomic Energy Agency (IAEA) and advanced nuclear power countries on the significance of the nuclear energy development and utilization, and on how to best proceed with the development in this regard in future.

Developing countries in Asian region are also expected to represent their perceptions for the necessity of nuclear power development and countermeasures to overcome the tasks associated with it.

It is our sincere hope that the conference of this year will provide a precious opportunity where every and all participants from various countries would make full discussions on the possible deployment of nuclear power and clarifying the ways of sound development of nuclear energy in Japan as well.

20TH JAIF ANNUAL CONFERENCE

PROGRAM

TUESDAY, APRIL 14

9:30 am – 10:40 am
OPENING SESSION

Chairman:

Shoichiro Kobayashi	Chairman The Kansai Electric Power Co., Inc. Vice Chairman Japan Atomic Industrial Forum

Remarks by Chairman of Program Committee

Isamu Yamashita	Vice Chairman Japan Atomic Industrial Forum

JAIF Chairman's Address

Hiromi Arisawa	Chairman Japan Atomic Industrial Forum

Remarks by Chairman of Atomic Energy Commission

Yataro Mitsubayashi	Chairman, Atomic Energy Commission Minister of State for Science and Technology

10:40 am – 6:10 pm
SESSION 1: ROLE OF NUCLEAR ENERGY TOWARD THE 21ST CENTURY

Chairman:

Fumio Watanabe	Chairman The Tokio Marine and Fire Insurance Co., Ltd. Vice Chairman Japan Atomic Industrial Forum

"Nuclear Power Development Policy of France for the 21st Century"

Jean-Pierre Capron	Administrateur General Commissariat à l'Energie Atomique France

"The Nuclear Technology Development Program in the U.S.S.R."

Nikolai Lukonin	Minister of Atomic Power Engineering U.S.S.R.

Chairman:

Tatsuo Kawai	President Kyushu Electric Power Co., Inc.

"International Cooperation in Nuclear Power Development and Nuclear Safety:
The Post-Chernobyl IAEA Perspective"

Hans Blix	Director General International Atomic Energy Agency

"The Energy Strategy of the United Kingdom"

Walter Marshall	Chairman Central Electricity Generating Board The United Kingdom

"The Evolving for Nuclear Power Development in India"

Raja Ramanna	Former Chairman India Atomic Energy Commission

Chairman:

Katsushige Mita	President Hitachi, Ltd.

"The Outlook for Nuclear Power Development in Japan – Promotional Issues to Be Faced"

Gaishi Hiraiwa	Chairman The Tokyo Electric Power Co., Inc.

"Setting the Course to Maintain the Nuclear Option in the United States – The U.S. Industry's Program to Revitalize Nuclear Power"

Frank Graham	Vice President Atomic Industrial Forum U.S.A.

"The Nuclear Power Development Policy of Taipower"

Jen-Hwa Chen	President Taiwan Power Company

6:30 pm – 8:00 pm
JAIF CHAIRMAN'S RECEPTION

Room "AKEBONO"
HOTEL OKURA
(Basement 2nd Floor, South Wing)

WEDNESDAY, APRIL 15

9:30 am – 12:00 noon
SESSION 2: NEW ASPECTS IN NUCLEAR RESEARCH AND DEVELOPMENT

Chairman:

Masao Sakisaka	Commissioner Atomic Energy Commission, Japan

"Long-Term Prospect for Nuclear Research and Development and Future Tasks"

Keichi Oshima	Professor Emeritus The University of Tokyo

"Regulatory Initiatives Related to Nuclear Research and Development"

Kenneth M. Carr	Commissioner The U.S. Nuclear Regulatory Commission

"Methods of Promotion of Nuclear R & D in the Federal Republic of Germany and International Cooperation"

Günter Lehr	Director General Bureau of Energy, Biology and Ecology The Federal Ministry for Research and Technology The Federal Republic of Germany

Commentators:

Takao Ishiwatari	Executive Vice President Power Reactor and Nuclear Fuel Development Corporation
Takashi Yamazaki	Managing Director Chubu Electric Power Co., Inc.
Joichi Aoi	Executive Vice President Toshiba Corporation
Yoneho Tabata	Professor The University of Tokyo

Chairman's Resume

12:20 pm – 2:15 pm
LUNCHEON

Room "HEIAN"
HOTEL OKURA
(1st Floor, Main Building)

Remarks: Hajime Tamura
Minister for International Trade and Industry

Special Lecture: "Forest–Its Value and Culture"
Tsunahide Shidei
Professor Emeritus
Kyoto University

1:00 pm – 2:10 pm
FILMS

CONFERENCE HALL

Most recent films on nuclear power development will be shown.

2:30 pm – 5:30 pm
SESSION 3: INTERNATIONAL NUCLEAR COOPERATION IN ASIA (Panel Discussion)

Chairman:

Hiroshi Murata	Vice Chairman Japan Atomic Industrial Forum

Keynote Address:

"Nuclear Development and International Cooperation in Asian Areas – Future Direction International Cooperation"

Tsuneo Fujinami	Commissioner Atomic Energy Commission, Japan

Panelists:

Hans Blix	Director General International Atomic Energy Agency
Toyoaki Ikuta	President The Institute of Energy Economics, Japan
Ding-Fan Li	Vice Minister Ministry of Nuclear Industry, China
Yong-Kyu Lim	Auditor-General and Professor Korea Advanced Institute of Science and Technology
Michio Mutaguchi	Vice President Japan International Cooperation Agency
Hiroshi Oishi	Managing Director The Kansai Electric Power Co., Inc.
L. M. Panggabean	Director Energy Conversion and Conservation Technology Development BPPT, Indonesia
Raja Ramanna	Former Chairman India Atomic Energy Commission

THURSDAY, APRIL 16

9:30 am – 12:30 pm
SESSION 4: EVOLUTION OF NUCLEAR TECHNOLOGIES

Chairman:
Masao Nakamura — Editorial Writer
The Yomiuri

"Superphenix FBR"
Jean-Paul Crette — Technical Adviser
NOVATOME
France

"Decommissioning Technologies of Japan"
Michio Ishikawa — Director
Department of JPDR
Tokai Research Establishment
Japan Atomic Energy Research Institute

"Nuclear Power Generation and High Technology"
Reijiro Aoki — Director
Mitsubishi Heavy Industries, Ltd.

"Slowpoke Energy Systems: A Role for Nuclear Technology in District Heating"
G. F . Lynch — General Manager
Local Energy Systems
Atomic Energy of Canada Limited

Chairman:
Yoichi Kaya — Professor
The University of Tokyo

"Remote System Technology for Nuclear Fuel Cycle Facilities"
Kunihiko Uematsu — Executive Director
Power Reactor and Nuclear Fuel Development Corporation

"New Technologies around Nuclear Fusion"
Kenzo Yamamoto — Senior Adviser
Japan Atomic Industrial Forum

"Laser Technology and Its Application in Atomic Industry"
Hiroshi Takuma — Director
Institute for Laser Science
The University of Electro-Communications

"High Energy Accelerators – Technology & Industrial Applications"
Ken Kikuchi — General Research Coordinator
National Laboratory for High Energy Physics

2:00 pm – 6:00 pm

SESSION 5: ISSUES AND TASKS IN THE NUCLEAR FUEL CYCLE INDUSTRY

Chairmen:

Tadao Ohgaki	President Japan Nuclear Fuel Industries Co., Inc.
Kenzaburo Kobayashi	President Japan Nuclear Fuel Service Co., Ltd.

Keynote Address:

"Roles and Tasks of Nuclear Fuel Cycle Industry in Japan"

Masatoshi Toyota	Executive Vice President The Tokyo Electric Power Co., Inc.

Lectures:

"Present Status and Future Prospects regarding French Involvement in Uranium Enrichment"

Jean-Hubert Coates	Deputy Director Division of Isotopic Separation and Physical Chemistry Commissariat à l'Energie Atomique, France

"Urenco's Contribution of the Enrichment Market"

Juergen A. Paleit	Director Urenco Ltd.

"Recent Developments in the U.S. Uranium Enrichment Enterprise"

John R. Longenecker	Deputy Assistant Secretary for Uranium Enrichment Office of Nuclear Energy The U.S. Department of Energy

"Reprocessing: The Strategy for a Competitive Nuclear Energy"

Jean-Pierre Rougeau	Vice President COGEMA, France

"Perspectives of Reprocessing Nuclear Fuel in the Federal Republic of Germany"

Wulf Bürkle	Vice President Kraftwerk Union AG (KWU) The Federal Republic of Germany

"Reporcessing of Oxide Fuel at Sellafield, UK"

William L. Wilkinson	Deputy Chief Executive British Nuclear Fuels, plc.

"Japan and the Conversion Industry"

Jerome Pellissier-Tanon	Chairman and Chief Executive Comurhex, France

"MOX Issues: The Approach to Large Scale Utilization"

Hubert Bairiot	Vice President COMMOX

"Industrial and Technological Aspects of MOX-Recycle"

Wolfgang Stoll	President ALKEM GmbH The Federal Republic of Germany

MEMBERS OF THE PROGRAM COMMITTEE FOR THE 20TH JAIF ANNUAL CONFERENCE

(in Alphabetical Order)

Chairman	Isamu Yamashita	Vice Chairman Japan Atomic Industrial Forum, Inc.
Members	Kohei Abe	Executive Director The Federation of Electric Power Companies
	Joichi Aoi	Executive Vice President Toshiba Corporation
	Kozo Iida	Executive Vice President The Kansai Electric Power Co., Ltd.
	Hiroshi Ishikawa	Vice President Japan Atomic Energy Research Institute
	Tatsuo Kida	Executive Vice President Sumitomo Atomic Energy Industries, Ltd.
	Shunsuke Kondo	Professor The University of Tokyo
	Yasushi Matsuda	Senior Advisor for Research The Institute of Energy Economics, Japan
	Goro Nagane	Executive Vice President Power Reactor and Nuclear Fuel Development Corp.
	Sakae Nagaoka	Scientific Commentator
	Koji Nakamura	Technical Advisor Kobe Steel, Ltd.
	Masao Nakamura	Editorial Writer The Yomiuri
	Hidehiko Nakane	Managing Director Mitsubishi Heavy Industries, Ltd.
	Masataka Nishi	Executive Vice President Hitachi, Ltd.
	Takamitsu Sawa	Professor Kyoto University
	Mamoru Sueda	Executive Director The Committee for Energy Policy Promotion (Japan)
	Katsuhiko Suetsugu	Member of Editorials The Nihon Keizai Shimbun
	Atsuyuki Suzuki	Professor The University of Tokyo
	Tatsuo Suzuki	Executive Director The Japan Development Bank
	Shuzabuzo Takeda	Professor Tokai University
	Yasumasa Tanaka	Professor Gakushuin University
	Yoshio Tanaka	Executive Vice President The Japan Atomic Power Co., Ltd.
	Toyozo Terashima	Director National Institute of Radiological Sciences
	Masatoshi Toyota	Executive Vice President The Tokyo Electric Power Co., Inc.
Observers	Mitsugu Ishizuka	Deputy Director-General Science and Technology Agency
	Kuniichi Aisaka	Deputy Director-General, Director-General's Secretariat Agency of Natural Resources and Energy Ministry of International Trade and Industry
	Mitsuhei Murata	Deputy Director-General The United Nations Bureau Ministry of Foreign Affairs

TUESDAY, APRIL 14

9:30 am – 10:40 am
OPENING SESSION

Remarks by Chairman of Program Committee

JAIF Chairman's Address

Remarks by Chairman of Atomic Energy Commission

REMARKS BY CHAIRMAN OF PROGRAM COMMITTEE

－MEMO－

JAIF CHAIRMAN'S ADDRESS

— M E M O —

REMARKS BY CHAIRMAN OF ATOMIC ENERGY COMMISSION

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TUESDAY, APRIL 14

10:40 am – 6:10 pm
SESSION 1: ROLE OF NUCLEAR ENERGY TOWARD THE 21ST CENTURY

It is about thirty years since the development of nuclear power began in Japan, and it is now firmly established as a major power source above oil-fired thermal generation. At the same time, in some country, policies for the development of nuclear power have been changed with the recent fall in prices of fossil fuels, the Chernobyl accident, and other factors. But when global problems relating to resources and the environment are taken into consideration, it is natural for nuclear power to take the lead as the alternative energy source to oil. For this reason, nuclear power must continue to be recognized as superior to other forms of energy. Through presentations from representatives from each country, the aim of this session will be to introduce the targets and methodologies of nuclear power development, as well as to reconfirm the necessity and role of nuclear power from an overall and long-term viewpoint.

NUCLEAR POWER DEVELOPMENT POLICY OF FRANCE FOR THE 21ST CENTURY

Jean-Pierre Capron
Administrateur General
Commissariat à l'Energie Atomique

I - In France, the early decision to resort to nuclear energy in a large scale was a deliberate governmental choice.

This ambitious, daring choice, steadfastly implemented, has proven to be the right one, bringing economic rewards (low kWh cost, power exports, decrease in fossil fuel imports) a dramatic increase in energy independence, a competitive edge for our industry and advances in a high technology field (as exemplified by FBR's).

It is also a safe choice:

- We have carried out a rigorous safety policy, with exacting standards. We are in favour of international cooperation in this field; however we are convinced that a good safety can only be a national responsibility.

and a responsible choice:

- At the national level, nuclear power has diversified the French energy supply by covering one quarter of our global primary energy requirements; it has also had a positive effect on the environment:

- because replacing fossil fuel plants (76% of the electricity produced in France in 1986 was nuclear) has reduced air pollution levels drastically;

- because, thanks to our closed cycle policy, nuclear wastes are disposed of safely without adverse environmental impact.

- At the international level, France works towards bringing the benefits of nuclear energy to developing nations, within the IAEA safeguards regime which we fully support.

For us, nuclear energy is not a transition energy, it is here to stay and grow.

II - The development of our nuclear program will proceed with the objectives of energy independence, reliability of energy sources, reasonable cost, excellence in safety.

This will entail:

For reactors:

- in the near term, meeting electric consumption growth with new advanced reactors of the all-French N-4 design, more fuel efficient, and introducing MOX fuel in our PWR's, to use reprocessed plutonium;

- around 2000, introducing a new design of advanced PWR, optimized for the characteristics of the power grid, ease and safety of operation and maintenance, lower costs, and, if current R & D predictions are confirmed, incorporating undermoderation and spectral shift for greater efficiency of plutonium utilization;

- progressive introduction of FBR's: very early on, we have had faith in this reactor type. We have therefore developed successfully this technology (Rapsodie, Phenix), and have shared it in the framework of a European cooperation (France, FRG, Italy) that has led to Superphenix, which reached 100% power on December 9, 1986. We are resolved to pursue our endeavour in FBR's, which are, as for Japan, an essential part of our nuclear program. Our objective is to make FBR's economically competitive with LWR's.

For the fuel cycle:

- maintaining the share that our fuel cycle industry has gained in the world market and increasing it whenever possible;

- as regards uranium enrichment, the CEA devotes a large R&D effort to the laser separation process;

- as regards reprocessing, the CEA keeps working towards improvements of the process; construction of UP2-800 and UP300 proceeds on schedule; SGN, an engineering company of the CEA group, will be a key partner in the construction of the new Japanese reprocessing plant;

- as regards radioactive waste management, a site has been chosen for the second low level waste repository, while preliminary geophysical work is beginning on four sites in order to be able to select, later on, a permanent high level waste repository.

Nuclear power is the right choice for France. It can and must be an essential contribution to meeting energy needs of industrialized countries, because the oil prices may rise again and because these countries could thus avoid depriving the developing countries from scarcer oil resources. Nuclear power can also become a valid option for the most advanced developing countries, and France is ready to help them through bilateral cooperations, and through IAEA.

THE NUCLEAR TECHNOLOGY DEVELOPMENT PROGRAM IN THE U.S.S.R.

Nikolai Lukonin
Minister of Atomic Power Engineering

INTERNATIONAL COOPERATION IN NUCLEAR POWER DEVELOPMENT AND NUCLEAR SAFETY: THE POST-CHERNOBYL IAEA PERSPECTIVE

Hans Blix
Director General
International Atomic Energy Agency

The accident at the Chernobyl nuclear power plant had a serious physical impact in the Soviet Union and also eroded public acceptance of nuclear power in industrialized countries. Nuclear power programmes in several countries were also negatively affected. How can confidence be restored so that nuclear power will remain a major energy option for the future. Many of the actions which must now be taken by States are at the international level, and there seems to exist a political will to take them. These actions fall into several categories:

Correct information must be made available in an understandable form. There now exists a climate in which there is interest not only in accurate information about the accident, but also about comparative risks of different energy production methods.

Weaknesses in the existing safety regime revealed by the accident must be remedied. The new conventions on early notification in the case of accidents and on emergency assistance are two examples of remedial actions already under way. Another series of actions includes the updating of international safety standards and stronger commitment to them, the sending of international operational safety review teams to visit power plants at the request of host countries, an incident reporting system, and assessments of the root causes of incidents at plants. These measures aim at ensuring the maintenance of a high level of operational safety in nuclear plants all over the world.

Which direction should be chosen for the future development of nuclear power plants in order to obtain ever higher levels of safety? Should there be an evolution based on the present designs or should we opt for new, more forgiving designs? The answer is that both options are likely to be pursued, but with different time horizons.

At the national level, major efforts are being devoted to obtaining excellence in operation, both in performance and in safety. An international information exchange will support these efforts.

In normal operation, environmental concerns about nuclear power have centered on the waste management and disposal issue. The technology to solve this problem exists, and it is now appropriate to compare the waste management regimes of different energy technologies.

Some international action needed is unrelated to safety. This is true for long-term supply assurances, which, however are less acutely demanded in the present buyers' market. In this matter a longer-term perspective is needed to assure that nuclear power will be able to help more countries to a higher degree of energy independence.

Non-proliferation assurances have always been an essential condition for stability in international nuclear supplies and transfers. The IAEA safeguards system has so far managed to keep pace with developments and created confidence in the non-proliferation assurances given. There are future challenges for the regime, both in its effectiveness and in its coverage.

Taken together, the actions mentioned would strengthen nuclear safety world-wide. This is very much needed to restore confidence in nuclear power.

THE ENERGY STRATEGY OF THE UNITED KINGDOM

Walter Marshall
Chairman
Central Electricity Generating Board

On 12 March this year, the UK government gave full planning approval and full financial approval to the construction of a PWR at Sizewell in Suffolk.

Work on site begins immediately. The CEGB has welcomed this decision and has announced that, depending upon growth in electricity demand, we plan to build further PWRs in subsequent years. That nuclear construction programme will have a coal station construction programme in parallel.

This decision follows a long pause in power station construction in the UK. The Sizewell PWR project was actually initiated by the British Government in 1979 but approval was subject to a wide ranging public inquiry. The inspector for the inquiry was Sir Frank Layfield. The public inquiry set an all time record for the UK. It started in January 1983, it sat for 340 working days and the report was published on 26 January 1987. The inspector reviewed the safety of the design and of nuclear power in general and gave an exhaustive comparison of the economics of nuclear power compared to the generation of electricity by coal. He ended with an unambiguous recommendation that the project go ahead.

The Layfield report was debated in the House of Commons on 23 February and the House of Lords on 2 March. The CEGB sanctioned the expenditure in early April and this immediately triggered the manufacturing contracts.

The nuclear inspector has stated that there are no outstanding safety issues which concern him. We expect a site licence during April. Preliminary works will start in June, and the station is due to operational in 1994.

THE EVOLVING STRATEGY FOR NUCLEAR POWER DEVELOPMENT IN INDIA

Raja Ramanna
Former Chairman
India Atomic Energy Commission

- History of Nuclear Sciences in India
- Nuclear Energy as a Source for Power Generation
- Strategy Adopted for the Indian Nuclear Power Programme
- Progress of the Nuclear Power Programme
- Progress in Supporting, Areas of the Nuclear Power Programme
- A Long Team Programme for Setting up PHWRs
- Role of Nuclear Energy in India during the 21st Century
- Conclusion

The Outlook for Nuclear Power Development in Japan

– Promotional Issues to be Faced –

Gaishi Hiraiwa
Chairman
Tokyo Electric Power Co., Inc.

The world economy has entered a new stage of growth--albeit low growth--following painful adjustments in the wake of past oil crises. At the same time, energy demand is expanding at an even slower rate, due to the structural changes in industry and improved efficiency in energy use. Furthermore, progress in the development of alternative energies and technical innovations in both the supply and use of energy have sharpened competition between energy sources.

Demand for electricity is also increasing at a slower pace, leading to a worldwide slow-down in nuclear power development. Nuclear power itself is facing new and trying circumstances. The recent plunge in oil prices has made fossil-fuel-fired thermal power cost competitive with nuclear power. Furthermore, Chernobyl has shaken the world's confidence in nuclear power. Combating the declining popularity of nuclear power around the world has made it necessary to seriously rethink its economy, safety, and reliability. Its very future as a major energy source depends on this outcome.

When reviewing the necessity and significance of nuclear power, one must return to the basic question of how to effectively use energy from a global perspective and see the great and compelling need to develop alternate energy sources as a defense against the supply and price instability of finite oil reserves. Considering this, nuclear power is an attractive alternate source of energy because of its availability, abundant reserves, ease of transport and storage, and when used properly, its minimal impact on the environment. Since oil also has a variety of higher-value-added applications, nuclear power should be allowed to do what it does best, especially in the generation of electric power.

Obviously, to do this we must thoroughly upgrade the safety and economy of nuclear power. At the same time, it is vital to secure a consensus of support in public opinion for continued nuclear power development.

Safety has been the keystone of nuclear power development in Japan. From the start we have spared no effort in seeking to establish fail-safe management by questioning and eliminating overconfidence in large-scale technologies, observing stringent safety requirements, and instituting multiple safeguards against human error. The massive facilities of nuclear power stations are the epitome of advanced technology. However, in considering the safety of equipment and facilities, which is so extremely important, the human factor remains its most critical element. As Chernobyl so tragically illustrated, the foundation of overall safety lies in such measures as comprehensive staff training. As a major force in nuclear power development, the electric power industry has a clear responsibility to redouble its efforts to create a safe operating environment, and we have renewed our resolve to do so.

We also aim to improve even further the economy of nuclear power, within the bounds of safety and reliability, to minimize electric power generation costs by optimizing the total system for nuclear power generation including the nuclear fuel cycle.

In Japan's long-term strategy for the development of nuclear power, our basic plan is to switch from light-water reactors to fast-breeder reactors (FBR), as the latter use plutonium most efficiently. Every effort is being made to have FBR reactors up and running at an early date. However, given the outlook for the development of their technology and the supply and demand situation for uranium, we estimate that this won't be achieved until 2020 or 2030. With this timetable in mind, it will be important to prepare for the coming age of FBR by mastering the technologies of and establishing the foundation necessary for plutonium utilization. To this end, we plan to expand our use of plutonium to an appropriate scale, at the earliest possible date.

The Japanese government and private sector are actively cooperating to set up a nuclear fuel cycle which will include reprocessing necessary for plutonium use. We are now in the process of constructing three facilities--a reprocessing plant, an enrichment plant and a low-level nuclear waste storage facility--in Aomori Prefecture.

Japan is thus making steady progress in developing her nuclear power capabilities, although strong opposition to nuclear power exists at the international level. With the arrival of a multiple energy era before the turn of the century, as I mentioned earlier, I believe that nuclear power on an appropriate scale should be developed for electric power generation. To this end I offer two suggestions:

1. We need to build a consensus for the use of nuclear power. Although social organizations and customs differ between nations, if we are to create a consensus for public acceptance, it is of vital importance that basic and common strategies are developed to promote nuclear power.

2. We need to strengthen international coordination and cooperation regarding nuclear power. Such coordination and cooperation are also important for consensus building. In view of the fact that safety is a major concern in promoting nuclear power development, it is essential that it be secured through an

international cooperative system, while coordination at both the government and private sector levels is strengthened.

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Setting the Course to Maintain the Nuclear Option in the United States

Frank W. Graham, Vice President,

Atomic Industrial Forum, Inc.

This paper addresses commitments being made in the United States to assure that nuclear power will help meet the growing demand for electricity. The following issues are discussed.

o *Where the U.S. program stands today*

The U.S. program is the world's largest and is continuing to expand. Last year, seven new plants received start-up licenses in the U.S. bringing to 106 the number operable at year's end. It accounts for 31% of the world's total nuclear plant capacity. It provides as much electricity as was produced in the entire country in 1953 when President Eisenhower launched the "Atoms for Peace" plan.

o *The outlook for the U.S. nuclear program*

To grasp the future role of nuclear power in the U.S., one first must recognize that, in today's interdependent world, nuclear energy does not exist in a vacuum. The central energy concern of the past 15 years has been the price and the supply of oil. It was no accident that the decline in world oil prices paralleled the world's growth in nuclear electrical generation. President Eisenhower had not anticipated that his "Atoms for Peace" program would play an important role providing a lower cost for today's oil. Nuclear power can continue in this role. However, in the U.S., utilities are not currently ordering central-station generating facilities. They are working off a surplus of capacity that has accrued from slower than anticipated demand. The expanding population in the U.S., the projected increase in Gross National Product, and the penetration of electricity into other energy markets with less certain or more expensive fuel supply will deplete the oversupply and create shortages by the early 1990's.

o Steps to make nuclear power the energy option to meet demand

The first and foremost goal is to ensure the safe and reliable operation of the current generation of reactors. The industry has in place several institutions designed for this purpose. Examples are the Institute of Nuclear Power Operation (INPO), the National Academy of Nuclear Training (NANT), and the Nuclear Safety Analysis Center (NSAC).

Further evidence of this commitment is the restructuring of the organizations which represent the industry in Washington. The realignment combines communication activities and provides additional resources for resolving important issues *in licensing and regulation.*

The Chernobyl accident in April 1986 also gave rise to an intensive industry analysis of nuclear power to determine if the lessons of that accident could enhance the safety of U.S. reactors. It conluded that the design of the Soviet Chernobyl-type reactors are so unique that last year's accident offers no major lessons that would require immediate changes in U.S. reactors.

For nuclear power to be an energy choice for generating electricity, it must be economically competitive with other energy options. A study completed last year by an AIF Study Group concluded that under current trends, standardized plant designs in the U.S. would significantly cut the cost of building new nuclear plants - by more than half.

At the same time, both industry and government are moving ahead to maintain U.S. nuclear technology at the cutting edge. As an example, the Electric Power Research Institute (EPRI) has a cooperative research program under way to advance the state of light water reactor technology for the next round of orders.

And those orders are expected by the end of this decade or early in the 1990's. The industry, through the commitments outlined in this paper, is positioning itself so that nuclear power will be the energy option of choice for base load new generating capacity in the United States.

THE NUCLEAR POWER DEVELOPMENT POLICY OF TAIPOWER

J. H. CHEN, PRESIDENT

TAIWAN POWER COMPANY

Taipower began its nuclear power epoch in 1978 when the first unit of its First Nuclear Power Station was synchronized to the system on November 1977. At present, Taipower has six units installed in three nuclear power plants, totalling 5144 MW in operation. These units are the mainstay of the 16,600 MW system and have played a significant role in the energy supply of Taiwan. This paper will firstly give a brief overview of Taipower's system, then introduce Taipower's nuclear power policies within the frame of issues on nuclear power economy, nuclear fuel cycle management, nuclear safety and environmental concerns, radioactive waste management, public communications and personnel training. At last, this paper will present the prospect for future nuclear power development in Taiwan with reference to the above discussion.

WEDNESDAY, APRIL 15

9:30 am – 12:00 noon
SESSION 2: NEW ASPECTS IN NUCLEAR RESEARCH AND DEVELOPMENT

Research and development in the fields of power reactors and nuclear fuel cycle need to be carried out more efficiently both internally and internationally, because the techniques in these fields have been expanded and become commercialized. This session will consider the future direction of research and development, including the institutional issues and international cooperation as well, from the long-term standpoint. The session will introduce actual cases of overseas research and development relating to nuclear power, and review development projects in other countries.

LONG-TERM PROSPECT FOR NUCLEAR RESEARCH AND DEVELOPMENT AND FUTURE TASKS

Keichi Oshima
Professor Emeritus
The University of Tokyo

1. Nuclear energy development of Japan has now entered the second round. Specifically, nuclear power generation has become the first largest source of electricity, assuming and important role in Japanese economy. LWR technology has now been well established an autonomous Japanese technological system, though started from basic technology imported from the United States. Development of advanced reactors and nucelar fuel cycle are now in the stage of industrialization promoted by the efforts of national projects.

   It is necessary, on the one hand, for Japan to continue further research and development efforts to promote nuclear energy to play its roles as a safe, low-cost, and reliable energy source, but on the other hand, the efforts should be expand to meet the expectation that nuclear energy will be an important high technology sector which will fulfil a role of a locomotive for major scientific and technological innovations.
   However, under the recent low economic growth which apparently will last for the time being, substantial increase in expenditure for research and development in industry cannot be expected. In fact, such highly advanced large scale research as nuclear energy requires financial resources and high spirit to meet with technological challenges.

2. Under these circumstances, nuclear R&D in Japan is entering into a new era and requires new evolution both in basic R&D strategy and in organizational arrangements. The following four issues are considered to be important.

   1 Enhancement and accumulation of basic and key technology for nuclear R&D
   2 Promotion of creative research and development

3 Maintaining technological and financial foundation fo research and development

4 Enhanced efficiency of research and development

3. In the presentation, discussion will be extended to what and how the respective roles of public & private research institutions should play in promoting nuclear R&D in Japan, especially Japan Atomic Energy Research Institute (JAERI), Power Reactor and Nuclear Fuel Development Corporation (PNC) and utilities.

U.S. REGULATORY INITIATIVES RELATED TO NUCLEAR RESEARCH AND DEVELOPMENT

Kenneth M. Carr, Commissioner
U.S. Nuclear Regulatory Commission

The importance of the continuity of research and development in the U.S. regulatory environment is discussed as a basis for enhancing safety in existing nuclear power plant designs as well as laying the groundwork for even safer designs for the future. The paper also emphasizes the importance of safe and reliable operation of current facilities in order to create an environment for continued nuclear research and development. Such research is essential for continued evolution of the nuclear technology and will enhance the role of nuclear power as an important contributor to energy security into the 21st century.

The importance of international cooperation and information exchange is emphasized to improve safety of operational units and to restore and sustain public confidence in the technology. Key safety issues for operating U.S. nuclear power plants are outlined. Regulatory safety initiatives underway at the U.S. Nuclear Regulatory Commission (NRC) are highlighted. Examples of U.S. nuclear industry activities for improving reactor safety are also identified.

The role of research in assuring the safety of the evolving nuclear technology is emphasized. Areas of the NRC research program are discussed in which additional information is needed to confirm previous regulatory decisions, to support the resolution of major policy issues related to safety, and to identify uncertainties in anticipation of future licensing actions. Topical areas of research in which the NRC will be concentrating efforts in the near future are also discussed. Management initiatives to improve the focus of the NRC research program as it relates to the regulatory program are briefly described. The importance that NRC places on international research cooperation is underscored, and examples of current cooperative research activities are given.

The commission's close cooperation with the U.S. Department of Energy (DOE) is highlighted regarding DOE's research and development efforts directed at improving the design of light water reactors and in promoting the development of advanced nuclear concepts. NRC initiatives intended to promote nuclear safety by encouraging standardization of future nuclear power plants and to provide an accurate, efficient, and more effective licensing process are described.

METHODS OF PROMOTION OF NUCLEAR R & D IN THE FEDERAL REPUBLIC OF GERMANY AND INTERNATIONAL COOPERATON

Günter Lehr
Director General
Bureau of Energy, Biology and Ecology
The Federal Ministry for Research and Technology

The promotion of nuclear research and development in the Federal Republic of Germany is part of the overall R&D policy and is geared to the long-term energy policy goals. Nuclear energy development has been successfully promoted for more than thirty years, the non-nuclear energy technologies for almost 15 years. As a result of this support for new technologies, energy production has become more efficient and cost-effective and with regard to fossil energy sources also markedly less detrimental to the environment.

Nuclear energy research policy is an integral part of energy research policy as a whole, which particularly aims to increasingly promote renewable energy sources, above all photovoltaic and wind energy, the utilization of biomass and geothermal energy as well as the development of various energy storage methods. In addition to some mining projects which aim to reduce coal production costs, promotion in the field of fossil energy sources concentrates above all on power plant engineering and combustion techniques - i.e. environment-oriented technologies. In view of future supply patterns, projects on coal conversion are continued; with present supply and price structures for mineral oil and natural gas, however, commercialization of coal conversion cannot be expected to be launched on a large scale.

Nuclear energy development still ranks high within energy research policy. However, major parts of the development and exploitation of this technology have been successfully concluded and constitute the present "state-of-the-art". German nuclear energy development, which from the very beginning was meant to be a joint activity of the Federal Government, the scientific community and industry, can be rated as highly successful. One decisive feature of this successful cooperation between government, scientific community and industry was a distribution of roles among the three partners which was not fixed for the entire period of a development programme but was modified in accordance with the progress made during such development.

It was the Federal Government's task to establish a reliable legal framework - which it did above all by adopting the Atomic Energy Act in 1959 - and at the same time ensure an appropriate basis for scientific work - which it provided by the further development of institutes in universities and in the Max Planck Society as well as the establishment of government-based national research centres.

The national research centres, a new structural element of the government-funded R&D sector, have a major share in nuclear energy research. Since the mid-1970s, the Federal Government allocated increasing additional funds above all for projects in the industrial sector; this funding reached its peak in 1982 and is now sharply declining. At present, project promotion and basic funding of national research centres involve similar amounts of funds.

The promotion items are in a different way distributed among the fields of

- reactor safety reserach
- advanced reactors, i.e. breeder and high-temperature reactor development
- enrichment, particularly also laser enrichment
- reprocessing and recycling
- disposal
- fusion research.

The example of advanced reactors (sodium-cooled fast breeder and helium-cooled high-temperature reactor) may be used to illustrate the typical method of nuclear R&D promotion: it starts with preparatory research work, which is followed by the construction and operation of experimental reactors in the respective national research centres and finally by the construction and operation of prototype reactors with gradually increasing participation of German industry. At present, the two prototypes (SNR 300 and THTR 300) are nearing completion and, concluding this development, industry must now decide whether any follow-up projects are to be implemented and if so what they should look like. Government participation will then be reduced to related problem areas such as safety. As nuclear technology reaches maturity, financing and management tasks are being gradually transferred from government to industry.

A supporting measure which has always been of substantial importance for nuclear energy research and development is the embedding of such R&D work into the programmes mounted by large international organizations such as EURATOM, IAEA or OECD-NEA.

Like fusion research even today, future breeder development exemplifies the significance and benefit of international cooperation under bilateral or multilateral agreements.

Cooperation with Japan seems promising as regards some major nuclear energy projects; its further extension may well benefit all those participating.

New Progress in Nuclear Energy Research and Development

- Comments from a Governmental R&D Organization -

Takao Ishiwatari
Executive Vice President
PNC

Nuclear energy R&D conducted so far in Japan has entered into a new stage of development for commercialization. The achievement of technological innovation and more extensive application have become important themes to be pursued. Qualitative change of role is required for a R&D organization.

1. R&D for Uranium Utilization

The dominance of LWRs will last longer than estimated. This makes it more important to establish a nuclear fuel cycle for utilizing uranium by LWRs. Especially, centrifuge uranium enrichment and LWR fuel reprocessing are now under commercialization. In this stage, technical transfer has become very important.

2. R&D for Plutonium Utilization

In Japan, who depends on overseas uranium resources, it is politically important to develop a plutonium utilization system centering on FBRs. This is more needed in Japan than in European countries. In this respect, the role of a governmental R&D organization is indispensable. It is necessary to steadily promote plutonium utilization for LWRs and ATRs in order to enable this for FBR commercialization.

In the development of FBRs, their safety, reliability, and economical efficiency must be improved on basis of the experience acquired by the prototype FBR "Monju". It is also important to develop innovative technologies integrating the plant system and the fuel cycle. For this, basic research will become particularly important.

3. New R&D Orientation

In order to flexibly comply with the varying and upgrading needs for nuclear energy, technological innovation must be achieved by creative research instead of conventional "catch-up type" research. It is also important to develop technologies for more extensive applications of nuclear energy.

4. Importance of International Cooperation

Japan, who has well progressed in technological development, is requested to cooperate as an equal partner rather than a licencee. Japan should intensify R&D, work out new concepts, achieve technological innovation and contribute to the international society.

[COMMENT]

Future Deployment for Nuclear Research and Development

Takashi Yamazaki

Managing Director
Chubu Electric Power Co.,Inc.

Preface

In Japan,the nuclear share in total electricity generated overtook that of oil-fired power plants in 1985, and counted at over 28 percent in 1986.

On the other hand,three of commercialization projects are currently under the way at Shimokita Area in Aomori Prefecture to complete the closure of nuclear fuel cycle,which has been our long-standing issue.

In order to realize better utilization of nuclear energy for the betterment of our social economy,however,we are convinced that continuous efforts on research and development should be propelled in most efficient and practical manner. Honoured being given this opportunity,I would like to speak several points in this regards.

1.Japan's course of nuclear R&D in the past and toward future

In the early stage of introduction of light water reactors (LWRs),Japan's nuclear business faced with such troubles as stress corrosion cracking in pipings and leakage through thin but innumerable tubes in steam generators,with which experience we recognized the needs to have our own technology in troubleshooting and solving matters. That lead us to a series of R&D programs called "LWR Improvement and Standardization Program" under the concerted efforts rendered by the government, electric utilities and manufacturers,which resulted in such excellent operational performance as high reliability and low radiation dosages Japan has been appreciating these years.

We perceive Japan should heretoafter tackle to the innovative fields firstly of "the LWR sophistication and the subsequent closure of nuclear fuel cycle",and secondly of "FBR commercialization".

2. Utilities' Phylosophy for the nuclear R&D in Future

2-(1) R&D for the LWR Sophystication and the Subsequent Closure of Nuclear Fuel Cycle

At present, since commercial use of FBRs seems to have been put further away than expected and the LWR era will have to last for longer, our first priority has placed in sophysticating LWR technology and closing nuclear fuel cycle aiming to improve its total economy along with maintaining and improving the present safety and reliability.

More specifically, keeping the top priority for safety, efforts should be directed to achieve the best economy with the harmony of the highest availability, the lowest construction cost, the most optimized operation and maintenance, and the most efficient fuel utilization through higher burnup fuel design in reactor technology, along with the optimized fuel cycle economy from the front-end to the back-end.

Thus we believe the total nuclear generation cost can be minimized through technological development.

2-(2) R&D toward FBR Commercialization

Looking toward the coming 21st century, in view of our goal of better utilization of natural resources and stable energy supply for extended period of time, Japan has formulated its baseline strategy "From LWRs to FBRs" in its nuclear energy development.

We are very convinced that FBRs should be regarded as the mainstem of our nuclear generation in future.

Japanese utilities have set a target for the full-fledged commercialization of FBRs in around 2030 in their "Nuclear Energy Vision", by the time of which we would have been able to solve major problems in its technical and economical aspects.

To realize this goal, Japan is currently constructing the prototype FBR plant "Monju",and has projected the development of two to three demonstration plants may be required following "Monju",through which experiences the existing handicaps in FBRs' economic competitivity against LWRs is expected to deliquesce gradually. The series of projects will be deployed aggressively not necessarily sticking to the domestically isolated manner, but under international collaborations if available.

3. R&D System in Japan

3-(1) Changes in the R&D System

The nuclear research and development in Japan started in the latter half of 1950s, when the government shared the broad fundamental reseach mainly with Japan Atomic Energy Research Institute(JAERI), a national organization, and the private sectors focused in introduction of actual power plant technology

In 1967, the Power Reactor and Nuclear Fuel Development Corporation(PNC) was established as another national organization, who started the development of such big projects as the construction of the prototype Advanced Thermal Reactor "Fugen" and the experimental FBR reactor "Joyo" designed by our own technology mostly under the initiative of the Japanese government.

As for LWRs, on the other hand, a number of troubles, as mentioned before, occurred in the early stage of development, forcing us to keenly feel the necessity for improving reliability by our own technologies.

To meet the requirement, the LWR improvement and standardization program was initiated in the latter half of 1970s, under the concerted efforts by both our government and national sectors in the field of LWRs, many of which demonstration tests have been performed by the Nuclear Power Experiment Center (NUPEC). At the same period, a system called "Collaboration Study among Electric Utilities" was established in order to solve effectively the common problems with which the private sectors face.

3-(2) Innovative Deployment of R&D for the Future

Although most part of nuclear research and development ranging from fundamental studies to near-demonstration stage ones have been carried on by the government and its related organization, the roles to be played by the private sectors is becoming more important today in the field of technology development, as many projects undertaken are shifting to their demonstration stage and some has already reached the stage of commercialization as seen in the cases of nuclear fuel cycle.

Reflecting the circumstances, purpose-oriented private organizations have been formed one after another for each project, as shown by the establishment of Laser Atomic Separation Engineering Research Association of Japan (LASER-J) and Advanced Nuclear Equipment Reseach Institute (ANERI), and by the formation of business companies for nuclear fuel cycle projects.

In order to deploy the ever-diversifying R&D works efficiently, it is of most importance to share properly the roles to be played by the government and the private sectors respectively, and to assure the smooth technology transfer of the accumulated expertise from the national organization to the private sectors for succesful application of achievements. We, as the private business, will bulldoze our R&D specifically focussed on such applied technologies as those to upgrade reliability, improve economy and optimize operation and maintenance.

On top of these, it is considered that a wider collaboration extended even internationally can be a desirable tool for us to develop highly risky, expensive and time-consuming technologies.

Conclusion

I have outlined from the utility point of view of what we have done and are going to push forward the nuclear research and development in Japan.

At the present point of time, I think we are now at a turning corner in nuclear bisiness, envisaging such current situations as of stable operation of LWRs, to complete the closure of nuclear fuel cycle and to tackle with commercialization of FBRs.

Since a nuclear research and development project requires vast span of time and tremendous amount of money to commercialize it, we are convinced that we should formulate an innovative development strategy to properly select and prioritize our subjects through the considerate cooperation between the government and the private sector and put those achievements into practice most effectively and economically, with strong recognition that the success of the ultimate nuclear business in future hinges on such deployment at present.

[COMMENT]

NEW ASPECTS IN NUCLEAR RESEARCH AND DEVELOPMENT MANUFACTURERS' VIEW POINTS

J. Aoi

Chairman
Committee on Atomic Energy Policy
The Japan Electrical Manufacturers' Association

Executive Vice President
Toshiba Corporation

Already it is about thirty years since Japan initiated research and development on nuclear power, and about twenty years since the first commercial nuclear power plant came into operation. Since LWR technology was introduced to Japan in mid 1960's, we have endeavored to establish our own domestic technology, and to improve it further. Today, our LWR technology is reaching its maturity, which has been well demonstrated by recent good operational records of LWR plants on reliability, availability, radiation exposure dose level, and radioactive wastes.

This success in LWR power generation owes very much to the government and Japanese electric utilities' strong leadership and good support on research and development activities. At the same time, Japanese manufacturers are taking a pride in themselves to that the success is also a result of their constant efforts to carry out actual tasks for the activities by investing money and putting resources of their own.

Entering into the "Nuclear First, Oil Second" era of Japan and to meet with the expectation as a principal power source of

Japanese energy, we are making efforts towards further sophistication of LWR technology, which is going to be materialized as advanced LWRs, that is, ABWR and APWR.

Closing the nuclear fuel cycle and developing FBR are two major tasks of Japanese nuclear power research and development for years to come.

Regarding uranium enrichment out of the fuel cycle, related manufacturers jointly formed the Uranium Enrichment Machinery, Ltd., UEM, in 1984 to supply the gas centrifuge machine to the commercial enrichment plant of JNFI, established by utilities. Research and development works on LASER enrichment are also being carried out.

To establish the technology for reprocessing and plutonium utilization is the main objective of Japanese nuclear power development program, in order to insure the nation's energy security on a long term basis. To support such national policy, Japanese manufacturers are positively participating in reprocessing plant supply and associated development works.

FBR is regarded as the most promising successor of LWR, which best serves the future energy needs in Japan. The largest activity on FBR at present is the construction of the prototype reactor Monju, and we will do our best to make steady progress in the construction work. Towards commercialization of FBR after Monju, extensive development efforts on Demonstration FBR are being carried out, recognizing that economical improvement is the most important task.

In the nuclear research and development from now, it is necessary for manufacturers to maintain technical expertise and qualified human resources for a long time and to improve technology, in spite of limited business opportunities. For this purpose, it is indispensable for us to obtain research and development work and supports from the government and utilities continuously.

Nuclear power generation will continue to play a key role as the principal electrical power source in Japan in the future, and the government nuclear policy will be deployed to establish plutonium utilization system centering FBR towards the next century. We will continue to work towards these objectives to achieve further success in peaceful uses of nuclear power.

[COMMENT]

Yoneho Tabata
Professor, Faculty of Engineering
The University of Tokyo

A comment will be given on further development of basic research in the field of nuclear science and technology. Importance of the basic research and some problems facing the development will be pointed out.

1) Field of basic research in nuclear science
   - Energy: Electricity and non-electricity
   - Non-energy: Radioisotopes and radiation

2) Direction of basic research
   - Basic research and underlying research
   - Nuclear research and so called "high technology"

3) Present status in the United States and Europian countries

4) Present status in Japan

5) Organization for promoting basic research
   - Role of Universities
   - Role of National Insitutes

WEDNESDAY, APRIL 15

2:30 pm – 5:30 pm
SESSION 3: INTERNATIONAL NUCLEAR COOPERATION IN ASIA
(Panel Discussion)

Peaceful uses of nuclear energy should be developed by international cooperation to enable a large number of countries, whether industrial or developing, to benefit by it. As an advanced country in the Asian region in terms of nuclear power, the cooperation of Japan is sought for the sound development of nuclear energy in this region. This session will discuss appropriate ways for the effective development of nuclear power in conformity with the situation in each country, through presentations from the countries taking part.

Nuclear Development and International Cooperation in Asian Areas

-- Future Direction of International Cooperation --

Tsuneo Fujinami
Commissioner
Atomic Energy Commission

1. The peaceful use of nuclear energy holds out, as an important substitute for oil, considerable promise for the future against the potential strain in the world supply and demand situation for energy. The contribution that nuclear research and development activities make to the general advancement of science and technology is so outstanding that it can be regarded as a key to social and economic development. From this point of view, steady progress should be expected in the peaceful use of nuclear energy around the world.

On the other hand, nuclear non-proliferation and safety must be secured internationally as essential conditions for promoting the research, development and utilization of nuclear energy. Further to this, substantial amount of manpower and investment is required to conduct the research and development of nuclear energy.

Taken these peculiar features into consideration, it is much more effective when peaceful use of nuclear energy is promoted under the conditions of international cooperation as well as mutual understanding.

2. The Atomic Energy Commission is now working to draw up a new "Long-term Program for the Development and Utilization of Nuclear Energy", where international cooperation is an important issue for deliberation.

In this context, a group of specialists is studying the way it ought to be in the future. In view of the demand inside Japan and out for its internationalization and the circumstances surrounding the nuclear energy of this country, the specialists are suggesting a new direction, in line with the provision of the Atomic Energy Basic Law which prescribes that Japanese nuclear activities shall "contribute to international cooperation".

In a departure from the catch-up stance or the passive attitude that Japan has thus far assumed, Japan should take up a manner more responsible and more active than ever in international activities, keeping nuclear non-proliferation secured. In doing this, the followings are fundamental objectives which the specialists believe appropriate:

(1) active pursuit of the interests common to the world,
(2) internationally effective use of human and financial resources of each country,
(3) contribution toward providing an appropriate international environment for nuclear activities.

3. Asian nations stand in close geographical and economic relations to Japan. In the field of nuclear energy, they have many common tasks to solve in promoting the utilization of radiation and radioisotopes,the introduction of nuclear generation systems and the safety of nuclear power.

The acquirement of foreign technologies transferred and development of its own have enabled Japan to come to the point of establishment of the light water reactor technology. Now we must be fully aware of our international responsibility, as stated above, especially in regard to our neighbors in Asia, so that we can be of much help to them in facilitating progress in their research, development and utilization of nuclear energy.

4. The basic philosophy we should have in this respect consists in getting a good grasp of our partners' needs in the light of their national conditions. We then should consider extending our cooperation to each of the nations, according to its level of development, particularly in laying the foundations of research and technology. Cooperation should be promoted in such a way that nuclear development of these countries will be accelerated with due consideration of nuclear non-proliferation.

Nuclear cooperation agreement and other measures should be considered to set framework for our cooperation with those nations which have relatively higher levels of nuclear development while the appropriate division of work should be achieved among us and our partners. For the purpose of promoting such cooperation, it might be advisable to consider cases where an entire region can be brought in on a joint project to achieve the maximum efficiency in utilizing its human and financial resources.

In addition to the utilization of radiation and radioisotopes that has already been in practice, cooperation will be extended to cover the use of research reactors, and then power generation.

5. Implementation of the foregoing cooperation activities will not be facilitated unless an appropriate measures are taken for it on the domestic front. The necessity exists to:

(1) work out a system of policies for international collaboration and cooperation and operate it organically through the joint efforts of government and industry,

(2) internationalize research institutions as channels for promotion of cooperation, and

(3) organize training for cosmopolitans who play the leading role in the promotion of cooperation.

[KEYNOTE]

INTRODUCTORY STATEMENT

Hans Blix
Director General
International Atomic Energy Agency

Asia comprises the fastest developing countries in the world. It is not surprising that nuclear as an advanced technology forms part of this development and plays a role in agriculture, industry and, indeed, power. Rapid development needs and feeds on electricity. Nuclear power is one of the few viable sources of electricity. The rapidly developing countries in Asia are already making increasing use of nuclear power. Co-operation between them will be natural.

The IAEA expressly supports and promotes regional co-operation and has done so in the Asian region longer than anywhere else through the Regional Cooperative Agreement for Research Development and Training Related to Nuclear Science and Technology (RCA), which has been functioning since 1972. With time, this project has increased in importance and in scope. Through RCA, it has been possible to provide outside assistance in some critical sectors and to improve cooperation between the 14 States now participating. The subject areas are diverse and include, e.g., nuclear techniques in animal production, plant breeding, fighting tropical parasitic diseases, diagnostics and industry, but also improvement of instrument maintenance and electricity system planning techniques.

New areas of cooperation which could be useful would be in exchanging experience between plant operators and operator training centres in the region with the purpose of improving both operations and operator qualifications.

It is finally noted that the region offers situations which could be the basis for joint nuclear power projects, tried already in Europe and North America. Guandong is one example of such a joint project.

[KEYNOTE]

Raja Ramanna
Former Chairman
India Atomic Energy Commission

[KEYNOTE]

INTERNATIONAL COOPERATION IN PEACEFUL USES OF NUCLEAR ENERGY IN CHINA

Ding-Fan Li
Vice Minister
Ministry of Nuclear Industry

China's nuclear industry has been evolved over the part 30 years. Since the year of 1987 when China adopted the open-door policy to the outside, she has broken away the nuclear industry from the past isolation and actively undertaken the international cooperation for peaceful uses of nuclear energy.

In this context, China has adopted the following policies: Efforts exerted in learning advanced experience of the world, at the same time making its own self-reliance, actively carry out international cooperation on the bases of equality and mutual benefit, keep the uses of nuclear energy solely for peaceful purposes and do not stand for nuclear proliferation.

As the competent authorities over nuclear activities in China, the Ministry of Nuclear Industry has taken various ways in its international cooperation: On uranium ores prospecting, joint exploration and development made with other countries, on building of nuclear power stations, technology exchanges and trade actions by purchasing foreign equipment combined to promote learning of technologies, and on nuclear fuel cycle, etc., experience gained through taking the forms such as inviting foreign experts, sending abroad scientists and holding seminars, etc.

Since its admission into the International Atomic Energy Agency in 1984, China has actively carried out activities in nuclear energy, nuclear safety and the applications of radioisotopes as well as nuclear technologies, which involves many national economy areas of industry, agriculture and medicine, etc.

Our experience shows that as a developing country, active expansion of international cooperation will strongly give impetus to China's nuclear industry. China wishes to launch more extensive cooperation with other countries, including those Asian countries in various fields of peaceful uses of nuclear energy.

[KEYNOTE]

Yong-Kyu Lim
Auditor-General and Professor
Korea Advanced Institute of Science and Technology

Nuclear power project traditionally involve huge financial investment, highly sophisticated technology, and long lead time.
Because of these requirements many countries find it impossible to implement their nuclear power programs without technical cooperation and assistance from advanced countries. This is particularly true for developing countries.

In this Asia and Pacific Region, seven countries have commercial nuclear power units in operation and/or under construction, with the rest expected to introduce nuclear energy in the near future. Korea has six nuclear power units in operation, and three under construction.
Active nuclear cooperation has been instrumental in implementing her abmitious nuclear power programs successfully.

Nuclear cooperation is one of the widely recognized necessities, which is quite often talked about among the countries of the Asia and Pacific Region.

But the differences in nuclear maturity and national interests among those in the region seem to be standing against it. Given the constraints, it is not easy to select appropriate areas for cooperation.
There is no doubt, however, that they should include the nuclear policy, nuclear safety, radwaste management, radiological protection, and the management of nuclear units.

In order to effectively promote nuclear cooperation in the Region, the scope of RCA activities must be expanded to include the nuclear power area.

The Regional Nuclear Data Bank, the Regional Training Center and the Nuclear Emergency Response Center, for example, would be the effective tools for cooperation to meet the demands of the countries in the Region.

In view of the technological gap between Japan and all others in the region, we cannot speak of a regional nuclear cooperation without heavily counting on Japan, the most advanced nuclear state in the region.

For these reasons, Japan is expected to share an increasing portion of her nuclear technology with others.

She must play a leading role in promoting the regional nuclear cooperation.

[KEYNOTE]

SOME ISSUES RELATED TO THE DEVELOPMENT OF NUCLEAR POWER PLANT IN INDONESIA

L. M. Panggabean
Director
Energy Conversion and Conservation
Technology Development
BPPT

Indonesia being a member of ASFAN belongs to the group of developing country. If Indonesia decides to embark on the establishment of nuclear power plan then the country will have no choice but to discuss the following issues: Safe operation of the plant and management of the nuclear waste.

Safe operation of the power plant is important not only from the point of view of hazards to human being, or economic loss, or even death, but equally important it is also from the psychological point of view in that not to loose the society's confidence in the overall nuclear power plant programme in the future.

The issue of safe operation involves both a safely designed system as well as skilled personnels to execute a well designed operation procedure.

The issue of nuclear safety is getting more and more attention lately for various, some due to a deep concern about the quality of the inherent safety of the nuclear power plant to be built, others may just use their emotion to ask questions like "what ifs."

The issue of nuclear waste is as fundamental as the plant safety. Common people make very little difference between an atomic bomb and waste from a nuclear power plant.

Another issue is one of transfer of tecnnology which needs to be tied up with the overall industrialization process, meaning that embarking on nuclear power programme needs to contribute to local industrial activities, at least for some parts or components which can be manufactgured locally.

[KEYNOTE]

Nuclear Power Development and Utilization in Asian Countries Viewed through the Operations and Activities of the Japan International Cooperation Agency (JICA)

Michio Mutaguchi
Vice President
JICA

1. Outline of JICA's Activities

(1) With a view to contributing to the social and economic development of the developing world, thus serving for the further promotion of international cooperation, the Government of Japan established the Japan International Cooperation Agency (JICA) in August 1974.

JICA is a 100% Government-sponsored agency whose main function is to extend most of the technical cooperation of Japan to developing countries based upon agreements reached between the Japanese government and the governments of these countries.

The principal forms of technical cooperation are: 1) Acceptance of Overseas Trainees, 2) Dispatch of Japanese Experts, 3) Supply of Equipment and materials, 4) Project-type Technical Cooperation (organically integrating the above items 1)-3)), 5) Development Survey (formulation of master plans for development program or basic surveys for specified projects, etc.).

JICA performs these activities in cooperation with Japanese public and private organizations specialized in the related technologies.

Other forms of cooperation include 1) Japan Overseas Cooperation Volunteers (JOCV), 2) Development Cooperation (investment in and financing of development projects), 3) Capital Grant Assistance and 4) Emigration Service.

(2) Japan has duly reinforced her economic and technical cooperation with developing nations year after year so as to fulfill her responsibilities and role worthy of her international status at a time when interdependent relationship deepens more and more among nations. Japan's performance of ODA (on a net disbursement basis) in 1985 is the third largest (¥905.7 billion) in the world following the U.S.A. and France. JICA's activities also are sharply expanding in both quality and quantity, with the fiscal 1986 budget amounting to ¥95.7 billion (up by 8% from the previous year). Cooperation is extended to 126 countries, and Asia accounts for nearly half of the regional distribution ratio (the fiscal 1985 actual).

The recent trends show, on one hand, diversified requests for JICA's cooperation including those emphasizing software such as management and quality control, improvement of productivity and trade promotion, and on the other, a rapid increase in those related with high-tech fields such as material science, computer science and biotechnology. JICA also responds to requests for cooperation made by such international organizations as IAEA.

2. Activities Related to Nuclear Power

(1) JICA is engaging in the cooperation activities mainly for the development and utilization of isotopes and radioactive rays, by ways of training at and study visits to research institutions in Japan of the engineers and researchers of developing nations, dispatch of Japanese experts for joint research, guidance and advise on research.

In addition, JICA began accepting trainees in fiscal 1985 in connection with the basic technology in nuclear generation. Experts are also dispatched increasingly for cooperation related to nuclear generation such as nuclear power station safety examination systems and reactor operation monitoring systems. As to the geographical distribution, most requests for cooperation (approx. 70%) are made by organizations in Asia, followed by the nations in Central and South America including Brazil and Colombia.

(2) In extending cooperation in this field, equipment supply is also important, because a lack of required equipment often impedes effective cooperation activities. For this purpose, JICA provides these countries with neutron diffractometer, protective rooms and related materials and equipment through project-type technical cooperation or other equipment supply program.

(3) The project-type technical cooperation comprises mainly medical and biological utilization for medical treatment and diagnosis using isotopes and radioactive rays in the public health and medical service fields. As for development surveys, two cases of uranium resources exploration in Indonesia and Morocco were conducted in the past under the category of Basic Surveys for Resources Development Cooperation. Currently, however, no such projects are implemented.

3. Immediate Problems Concerning Cooperation in the Nuclear Power-related Field

The actual results of cooperation in the nuclear power-related field are increasing in the past few years, but the ratio to total activities is small at present. (Acceptance of overseas trainees and dispatch of Japanese experts account for about 1%, respectively.) For this reason, people consider that JICA does not necessarily attach importance to the cooperation in the nuclear power field. Against such criticism, JICA would like to point out:

(1) Official requests from the recipient governments are few:

JICA's technical cooperation deals with the government-to-government cooperation activities, based upon treaties or other international agreements. Therefore, implementation of these activities is premised on official requests from a recipient government. Upon these requests, consultation is made between both governments before items for cooperation are determined.

Currently, JICA receives few requests from these countries probably because of the relatively low national priority in the nuclear power field as compared with other fields from the view-point of economic and social development plans in these countries.

(2) JICA's Basic View:

JICA is an executive organization that carries out economic cooperation with developing countries only when such cooperation has been discussed between the Japanese Government and the requesting governments and has been determined as the most suitable economic cooperation to both countries. JICA is well aware of the fact that developing countries also have a strong desire for cooperation in high-tech fields, and does not take the stand that the development of developing countries should be started with the buildup of infant industries.

(3) Relationships with Domestic Cooperation Organizations:

JICA cannot implement these activities without cooperation from public and private organizations (laboratories, research institutions, universities, private enterprises, etc.) in Japan even if an agreement is reached between the Japanese Government and requesting governments. JICA will continuously seek cooperation from such organizations concerned, but they may sometimes be restricted by personnel, expenses and seasonal factors according to their circumstances. It is desired that their systems and organizational structure be further improved or reinforced so that international cooperation may be carried out regularly on a full scale in the nuclear power field.

[KEYNOTE]

Toyoaki Ikuta
President
The Institute of Energy Economics, Japan

The Asia Pacific region is regarded as being one of the high economic growth areas of the world, and it is expected to show further economic development in the years to come. In parallel with this growth, the energy consumption of the region has been increasing at a high rate because there are many newly industrializing countries and non-oil producing developing countries in the area. In particular, oil consumption accounts for the major share of the region's energy consumption.

On the other hand, looking at the sources of energy, the area has relatively limited oil resources compared with other areas, although it is abundant in natural gas and coal.

All of this shows that there is a possibility of energy imbalances occurring in the region, between both production and consumption and supply and demand. Especially, it should be noted that the area's high dependence on oil from the Middle East could lead to uncertainties in supply from the geopolitical point of view.

In addition to the basic energy problems of the Asia Pacific area just mentioned, there are two other aspects which need careful consideration. These are:

(1) The consumption of non-commercial energy is reaching a high level in the region, and

(2) Power consumption is rapidly increasing in all the countries in the area, and therefore there is a strong expectation that power generation schemes will be further planned and implemented.

Regarding the first point, conversion from non-commercial energy resources to commercial energy sources is necessary for the modernization of the economic structure and the way of life in these countries. Furthermore, the large-scale consumption of non-commercial energy resources will cause severe problems of environmental disruption; for example, a great drain on the area's tropical forests, requiring proper measures for solution of such problems.

Next, in connection with the second point, a remarkable increase in power consumption can be expected in the high economic growth areas, based on assumptions borne out by worldwide trends, which clearly show a positive correlation between per capita GNP and per capita power consumption. Besides this, the promotion of power generation plans is regarded nowadays as a symbol of economic modernization. In the past, the establishment of iron and steel industries was the symbol of economic progress and industrialization in the developing countries. However, this has now changed to the promotion of power generation as the new objective.

This line of thinking suggests that there is a high potential for a variety of cooperative measures for energy development in the Asia Pacific region, and one of these potential areas of cooperation is in the field of nuclear power.

In talking about cooperation for nuclear power development, the exporting of reactors and their related equipment, and the construction of nuclear power plants, are usually thought of primarily in terms of cooperation for the development of hardware. However, it is also necessary to cooperate in the aspect of software in parallel with cooperation in hardware development, although of course the importance of the latter cannot be denied.

Let us take a look at some of the details involved in cooperation for software development. These are:

(1) A correct understanding of the energy situation in the country concerned, especially in terms of the arrangement of statistics and data bases;

(2) The macro-planning of energy development;

(3) Determing the correct position of nuclear power in the plan under item (2) just mentioned; and

(4) The phased preparation of a master plan, a pre-feasibility study and a feasibility study in turn for each project (for example, the construction plan for a nuclear power plant).

In addition, the general development of personnel including the power plant operators is essential. This list of items is not limited to cooperation for nuclear power development alone. Many of them can be common to other aspects of cooperation also. However, there are two additional factors which are essential for cooperation in nuclear power development. These are:

(1) The establishment of maximum measures for the prevention of nuclear proliferation, through careful studies with the highest attention being paid to all the aspects involved; and

(2) The establishment of measures to ensure maximum safety.

If cooperation for the use of nuclear power were to result in nuclear poliferation, this would be greatly detrimental to world peace. Moreover, the occurrence of an accident in the region involving nuclear power, if serious, might force the country involved or the whole region to undertake a fundamental correction of its energy plan, and furthermore might lead to an unexpected situation requiring the total stoppage of operation and the checking of all the reactors of the same type throughout the world.

Therefore, cooperation for the development of nuclear energy in the region will greatly contribute to the development and growth of the area, but it should be promoted only with full consideration being given to all of the factors mentioned above.

[KEYNOTE]

ASIAN NUCLEAR ENERGY DEVELOPMENT AND INTERNATIONAL COORPERATION

Hiroshi Oishi
Managing Director
The Kansai Electric Power Co., Inc.

1. Nuclear energy development in our neighbouring countries in the Southeast Asia and issues

In the recent years, there has been a remarkable power demand increase in our neighbouring countries because of the encouragement by the respective governments of domestic industries, ever-improving living standard, and other factors.

On the other hand, such factors as the long-term energy perspectives envisioned by the respective countries and the structural change of energy supply system in the post-oil industrial society, have made every country keenly feel the needs for developing nuclear power generation capability.

However, it will become necessary in the development and utilization of such a giant project of nuclear power generation system, to tackle many a task from the long-range perspectives that we, Japan undertook in meeting such requirements as fund rasing in a colossal amount, the securing and training of human resources, and the streamlining of industrial infrastructure.

2. Japan's approach toward international cooperation

The occurrance of Chernobyl plant accident in the last year made it known anew worldwide that the aftermath of such a serious accident would affect not only the country in question, but also other countries.

As you know well, the nuclear power generation technology was first introduced into Japan from the foreign sources, and the joint efforts of the government and the private sector being exerted to this date in the nuclear field - particularly to the cause of enhanced plant safety and reliability - have enabled us to take an extremely high place among the advanced nuclear countries in terms of operating nuclear plant capacity and the level of nuclear technology.

Our nuclear history during the last 20 years from its initial developmental stage thru the substantial establishment of nuclear power generation system would, in our judgement, be rich in the valuable lessons; therefore, we are intended to be positively responsive to the needs of our neighbouring countries through an effective transfer of those lessons.

Accordingly, henceforth it is intended on our part to give our energetic cooperation to our neighbouring countries in due consideration of their domestic affairs as well as in line with their actual needs, so as to enable them to concentrate their nuclear energy developmental efforts in an efficient and timely manner.

3. Japan's structure for international cooperation

In March last year, a report on the modalities of basic international cooperation was compiled by the members of the Sub-committee on Nuclear Energy of Advisory Committee for Energy, the Ministry of International Trade and Industry, describing the following roles of the government and private sector:

(1)Roles of the government

The report goes that the government will establish in detail the international cooperation policy, and that in light of the nature of an extended international cooperation program for developing nuclear power generation system and those relevant problems such as nuclear non-proliferation, the government will, for the purpose of facilitating the steady progress of such cooperation program, act as a liaison agent in dealing with every foreign country and also will take over the overall management of domestic parties activities.

(2)Roles of the private sector

It is essential for the private sector in supporting every international cooperation program, to establish an expert agent to whom every foreign party may feel easy to access and who is capable of precisely having a good grasp of diversified needs on the part of every foreign party looking for the cooperation.
Hitherto, either one of Japan Atomic Industrial Forum, Inc. (JAIF) and Japan Electric Power Information Center, Inc. (JEPIC) has been standing proxy for the domestic parties in handling all the business matters pertaining to every international cooperation program; however, any new cooperation program will be carried out in accordance with the following scheme:

* JAIF will be one agent in dealing with any foreign party looking for such program for its nuclear power generation system under planning or study.

* JEPIC will be another agent in dealing with any foreign party looking for such program for its nuclear project that has already been beyond the prepratory stage of on-site construction.

4. JEPIC activities in the international area

It was May 1958 when JEPIC was organized for acting as the agent for the electric utilities in the field of international cooperation, and every program itself has been worked out by the utilities.

In order to expand and enhance the scope and essence of every cooperation program in the nuclear power generation field, the Cooperation Committee for Nuclear Technology was organized by the joint members of the government and electric utilitles in August 1985.

The developmental program of nuclear power generation system in Japan has, under the superintendence and guidance of the government, been carried out mainly by the electric utilities in close collaboration with plant manufacturers and general contractors, with the objectives of promoting the self-reliant technology as well as of persistently striving for plant safety and reliability.

It must be mentioned in this respect that the electric utilities have been consistently endeavouring to training talents and stockpiling nuclear technology indispensable for the initial stage of working out the developmental for and of introducing into the power system of nuclear power plants and also for the subsequent stages ranging from the execution and management of on-site nuclear plant construction activities thru plant operations and maintenance practices.

It is contemplated on our part that our cooperation program for the neighbouring countries will place major emphasis on the establishment and enhancement of their technical and human resources, and the following will be provided for the enhancement of human resources:

* Opening(by JAICA in January 1986) of Nuclear Power Generation Course

* On-site training course for QC control practices during a period of plant construction

* Training course for power plant operations and management

* Dispatching of our lecturers to technical courses to be held in the neighbouring countries

Incidentally, the details of the technical cooperation program are given in the attached table.

In light of the foregoing focusing on the international cooperation activities of the electric utilities thru the good offices of JEPIC, it is extremely important for the purpose of achieving the reality of such cooperation between the neighbouring countries and Japan, to establish the bilateral relations of mutural understanding and trust.

In particular, as for the overall technical cooperation field to be undertaken by the electric utilities of Japan, we have to ask for understanding of all of the neigtbouring countries for its contents, cooperation practice, and other relvant matters, and also we would like to contribute positively to the development of nuclear power generation system in every neighbouring country by offering in an effective manner and on continuing basis our nuclear power generation technology accumulated for the last 20 years. (END)

(APPENDIX)

DEVELOPMENTAL STAGE-WISE COOPERATION PROGRAM

STAGE	DESCRIPTION	COOPERATIVE APPROACH
PLANNING	•BASIC DEVELOPMENT PROGRAM •SITING STYUDY •ENVIRONMENTAL STUDY	•INFORMATION TRANSMITTAL •OPENING OF/ PARTICIPATING IN SYMPOSIA/ SEMINARS
PLANT CONSTRUCTION	•QUALTY CONTROL •SCHEDULE CONTROL •TEST RUNNING	•RECIPROCATIVE VISIT BY ENGINEER/S •TECHNICAL GUIDANCE BY VISITING ENGINEERS
PLANT OPERATIONS	•QUALTY CONTROL •OPERATION MANAGEMENT •MAINTENANCE MANAGEMENT •SAFETY FUEL MANAGEMENT	

THURSDAY, APRIL 16

9:30 am – 12:30 pm
SESSION 4: EVOLUTION OF NUCLEAR TECHNOLOGIES

Nuclear power is a technology-based energy source deriving from human activity, and progress in this technology is the key to the future development of the nuclear industry and the use of such power. Newly-developed technologies and new ideas are therefore being introduced in power generation and other related fields of the utilization of nuclear energy. This session will introduce by visual means the current state of development of nuclear technologies, including those at the stages of commercialization, and will examine their availability.

SUPERPHENIX FBR

Jean-Paul Crette
Technical Advisor
NOVATOME

SUPERPHENIX I, the 1,200 MWe LMFBR plant built at Creys-Malville in France under collaboration has reached nominal power in December 1986.

The preoperational tests have been very instructive: we show a movie of the insdie of the reactor during hydraulic tests.

A brief presentation of the reactor structures is given, explaining how the 3,500 tons of sodium circulate through the structures for better understanding of the video tape pictures.

The movie has been taken during preoperational. tests, sodium temperature was 180 degrees C.

It visualizes the free level of the sodium, the structures which are in the gas plenum in the upper part of the hot plenum, also the structures concerned by the problem of oscillations.

The movie was a good help for the understanding of the physical phenomena in the reactor and to check that the simple modification made has been efficient.

In conclusion, it is outlined that the thermalhydraulic tests have given results in good agreement with predictions and confidence in the methods used for the design of such reactors.

DECOMMISSIONING TECHNOLOGIES OF JAPAN

M. Ishikawa
Director, Department of JPDR
Japan Atomic Energy Research Institute

1. Introduction

In 1982, the Atomic Energy Commission published the report "Long-Term Program on Nuclear Energy Development and Utilization". The report states that it is necessary to develop and demonstrate reactor decommissioning technologies through the Japan Power Demonstration Reactor (JPDR, BWR, 90MWt) Decommissioning Program of the Japan Atomic Energy Research Institute (JAERI). In accordance with this philosophy, JAERI initiated the JPDR Decommissioning Program under contract from the Science and Technology Agency (STA). JAERI has been developing decommissioning technologies from 1981 through 1986 and will dismantle the JPDR using these technologies from 1986 through 1991. During this dismantlement, a wide variety of data will be collected for commrcial power reactor dismantlement use in the future.

All buildings and facilities of JPDR will be dismantled except for the administrative building and warehouse. The JPDR site will then be renovated and landscaped.

2. Decommissioning Technology Development by JAERI

JAERI is developing eight technologies necessary for nuclear reactor decommissioning.
These technologies are as follows:

a. Radioactive inventory estimation
   technologies to evaluate the radioactive inventory of nuclear reactors
b. Measurement of radioactivity inside pipe
   technologies to measure contamination in pipes with non-destructive techniques
c. Reactor disassembly and demolition
   technologies to dismantle radioactive components such as RPV, core internals, biological shielding, etc.
d. Decontamination for reactor decommissioning
   pre-decontamination and post-decontamination techniques
e. Radioactive waste treatment, transportation and storage
   management of decommissioning radioactive wastes
f. Radiation control
   radiation control techniques for reactor decommissioning
g. Remote handling
   remote handling techniques under radioactive circumstances
h. Decommissioning systems engineering
   techniques to design reactor decommissioning plans (computer code)

In May of 1985, the Reactor Decommissioning Technology Evaluation Group of JAERI evaluated the technologies and stated that the capabilities of these technologies were satisfactory to dismantle JPDR. The decision to proceed with dismantlement of JPDR using the developed technologies was then made. Data related to the developed decommissioning technologies will be acquired during the JPDR dismantlement to demonstrate the usefulness and applicability of these technologies for future commercial power reactor decommissioing.

Final check-out tests (mock-up tests) of reactor disassembly and demolition systems and remote handling systems will be conducted to confirm their desired performance as a system and to avoid unexpected troubles in the containment vessel. This test facility provides full scale simulation of the JPDR pressure vessel and biological shielding.

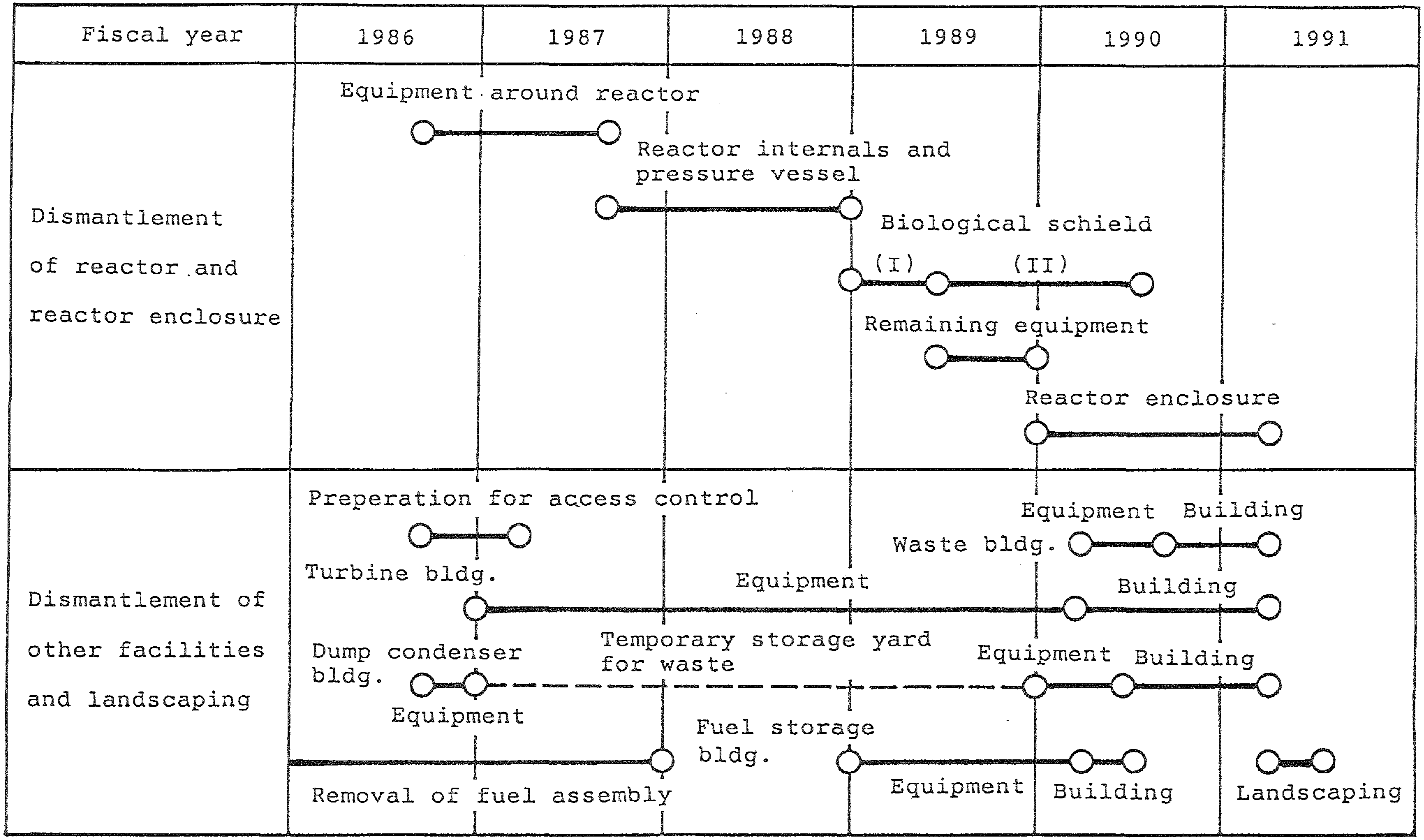
3. JPDR Decommissioning Plan

Radioactivated and contaminated components, pipes, structures, etc. exist in commissioned nuclear power plants. Therefore, it is necessary to dismantle these facilities in a radioactive environment and to treat radioactive wastes in a safe and appropriate manner. Therefore it is necessary to pay close attention a) to the use of appropriate dismantling techniques and procedures to minimize worker exposure, b) to the maintainance of the facility for safety assurance of dismantling activities and c) to the treatment of radioactive wastes in accordance with the type and level of radioactivity, etc.

The Nuclear Safety Commission published the report "Philosophy of Safety Assurance during Reactor Dismantlement - Dismantling JPDR" in December 1985. This report states the philosophies of facility maintenance, safety assurance, radioactive waste treatment, dismantling completion assurance, etc. during the dismantlement of a reactor. The JPDR decommissioning will be conducted based on this philosophy.

Table shows the JPDR decommissioning schedule.

Table JPDR Decommissioning Schedule



NUCLEAR POWER GENERATION AND HIGH TECHNOLOGY

Reijiro Aoki
Director
Mitsubishi Heavy Industries, Ltd.

Nuclear Power Generation (especially Light Water Reactor) in Japan has almost reached the stage of maturity through the stage of domestic production, standardization and so on. Furthermore significant efforts have been made toward improving reliability, safety and economy of it, worth-while to play the major role of future electric supply in this counrty.

Improvement of nuclear power plants and associated works have been promoted on the basis of technology specific to the nuclear industry, but incorporating the technology developed in the non-nuclear industries.

I would like to introduce the relation between High-Technology (Advanced Technology), such as electronics expanding rapidly, and nuclear power generation as well as some of the latest status of application.

(Advanced Material)

Development of improved material has been carried out based upon conventional material such as SCC(Stress Corrosion Cracking) resistant piping material to prevent the reoccurrence of component defects and so on, and has contributed to improve reliability and availability of the nuclear power plant.

On the other hand, in other industries, various advanced materials with excellent characteristics compared to the conventional materials have been practically utilized such as fine ceramics with wear-resistant and corrosion-resistant characteristics or coating thereof. Recently the research work to apply these advanced materials to nuclear components have been rapidly proceeded in order to significantly improve the equipment endurance and reduction of personnel exposure by applying them to the equipment friction part and/or parts contacting with fluid.

Few data are available for enough judging whether these advanced materials utilized in other industries are applicable to the various conditions imposed to the nuclear equipments. Therefore candidate material is selected through the elavorated trials such as the fundamental material test, reevaluation of manufacturing process or development of modification. Although many of such application study have just started, some example of application to the equipment/parts can already be found. It is expected that the advanced materials contribute to nuclear power plant in the areas of not only improving reliability, personnel exposure but also improving economy.

(Electronics)

Computer has been utilized in nuclear power generation from the beginning, as design tool for analysis and simulation and also as plant operation supporting tool like reactor core management.

Electronics, information process technology, optoelectronics, sensor technology and related have been applied to various areas of nuclear plant and contributing to its improvement, along with progress of technology and reduction of its cost.

For example, in design field, CAD(Computer Aided Design) is spreaded and contributing to rationalize design and improve quality, and expanding to CAE(Computer Aided Engineering). In maintenance and repair field, it is applied to inspection and diagnosis equipment, remotely operated automatic apparatus (so called robotic), and maintenance data management system,and is effectively improving reliability, availability and reducing personnel exprosure. Especially in operation and instrumentation field, the followings are being promoted;

① Upgrading of monitoring, operability and man-machine interface by incorporating advanced information processing and CRT(Cathodic Ray Tube).
② Expansion of operation support function by incorporating plant diagnostic and operation guidance system.
③ Expansion of automatic control and easiness to flexible operation by incorporating digital control technology.
④ Simplification of cabling and improve reliability by optical multiplexing transmission technology.

Along with the progress of Knowledge Information Processing Technology or AI(Artificial Intelligence) technology, research and development work is being carried out to apply it to various areas in nuclear power plant. It is expected that it contributes to further improve the reliability and efficiency of nuclear related works such as to strengthen the supporting function to the engineers.

(Robotics)

Application of robots to nuclear power plant is conducted for the purpose of improving reliability, efficiency and reducing personnel exposure in maintenance, repair or monitoring works. Therefore starting from mechanizing specific work from the beginning, proceeding to computerize it and make it light and small at the next step, and some already reached the stage to be called "high-performance specific robot".

On the other hand, development of fundamental technology needed for intelligent and advanced robot with visual recognition and autonomous control has also been energetically implemented. Being applied with these technologies, proto-type high-performance intelligent robot, enable to perform multi-jobs and the jobs requiring delicacy and dexterity as mankind, has been demonstrated for nuclear purpose. Although these proto-type robots have not been practically applied in view of smallness, interferance to the existing plants, economy and others, they brings us a lot of suggestion in the future.

It is considered that extensive part of maintenance and repair works will be replaced to the advanced, systemized, intelligent, both specific and multi-purpose robot, in order to meet the social requirement in the future.

I introduced the relation between the typical advanced technologies and nuclear power generation. I would sincerely expected that these advanced technologies contribute to further upgrade nuclear power generation together with extensive various technologies supporting nuclear power generation and progressing on a day-by-day basis.

SLOWPOKE ENERGY SYSTEMS:
A ROLE FOR NUCLEAR TECHNOLOGY IN DISTRICT HEATING

G.F. LYNCH
LOCAL ENERGY SYSTEMS
ATOMIC ENERGY OF CANADA LIMITED

As the world demand for energy increases, alternatives to fossil fuels are urgently being sought. For many countries, twenty-five percent of the primary energy demand is used to satisfy building heating requirements. Since nuclear generated heat is one of the cheapest forms of energy available on a global scale, it is appropriate to ascertain the necessary technical, economic and safety criteria that must be met if nuclear technology is to contribute to this particular energy sector.

In a major departure from traditional nuclear power technology, AECL has developed the Slowpoke Energy System - a 10 MWT nuclear heat source specifically designed to satisfy the needs of local heating systems used by buildings and institutions. Based on the technology which has been reliably demonstrated in the Slowpoke research reactors over the last sixteen years, a prototype heating reactor has been constructed at the Whiteshell Laboratory. The design, construction and testing of this facility was aimed at verifying in a very demonstrative way that the technical, economic and safety criteria for nuclear district heating systems can in fact be met.

A Slowpoke Energy System, sized to deliver up to 10 MWT in the form of hot water, will economically heat buildings with a floor area of over 150,000 square metres for more than twenty years with an inflation resistant fuel source. Because the nuclear heat source is small, operates at atmospheric pressure, and produces hot water below 100 degree centigrade, intrinsic safety features will permit unattended operation and allow the heat source to be located close to the load and hence to people. In this way, a Slowpoke Energy System can be considered much like the oil or coal-fired furnace it is designed to replace.

The low capital investment required for a Slowpoke Energy System coupled with the possibility of a relatively high degree of localization provides an economically attractive alternative to fossil fuels, particularly for those countries which are dependent on imports to satisfy their energy requirements.

Remote System Technology for Nuclear Fuel Cycle Facilities

K. Uematsu

Executive Director
Power Reactor and Nuclear Fuel Development Corporation (PNC)

Because of high radiation level, operators cannot usually approach process equipment inside the cell of nuclear fuel cycle facilities. Once trouble occurs, it takes much time for inspection and repair and operator's radiation exposure greatly increases. Therefore, in order to improve safety and maintain high availability of the facility, it is important to reduce trouble frequency and shorten repair time.

Trouble frequency will be minimized by developing suitable materials and improving design and manufacturing techniques. Repair time will be shortened by remote system technology.

Power Reactor and Nuclear Fuel Development Corporation (PNC) is developing the following remote systems applicable to reprocessing and high-level waste management facilities and others:

a) High-performance manipulator systems
   - Two-armed bilateral servo-manipulator system
   - Optical fiber signal transmission system
   - Radiation-hardened high-definition TV system

b) Rack systems
   - Rack design
   - Remote fluid connector
   - Remote electrical connector

c) Remote sampling system

d) In-service inspection system

e) Low-flow ventilation system

NEW TECHNOLOGIES AROUND NUCLEAR FUSION

Kenzo Yamamoto
Senior Advisor
Japan Atomic Industrial Forum, Inc.

In order to obtain net power output by nuclear fusion, it is necessary, for example, to heat thin deuterium-tritium mixed fuel gas of some 10^{-5} - 10^{-6} atmospheric pressure up to 100 million °C or more, and to keep it in a vacuum space for about one second being untouched with the vessel wall. Industrialized countries in the world have all continued for the past thirty years to exert their nation-wide efforts for clarifying physical methods that enable to achieve these conditions, in particular the principle for stable confinement of high temperature plasma, and for developing specific or critical technologies necessary for realizing them. Based on the results from these major efforts, large-scale test devices, TFTR (USA), JET (EC) and JT-60 (Japan) have been constructed. And now, experiments are going on to achieve above-mentioned conditions, in other words, to demonstrate scientific feasibilities concerned.

Typical examples of the technologies so far developed in fusion research field are introduced below. The subject of technical development of nuclear fusion can be said in general to relate to electro-magnetic as well as electronic precison composite system, the total system of which is designed to operate with the aid of computer system.

1. The power supply system of JT-60 provides 1,300MVA pulsive power in ten minutes with about 10 second duration each time when totalled power for generating magnetic confinement field with that for plasma heating. Thus, it has become providing an unprecedented technological field of power electronics where feasible controlling system is to be pursued for such a high electric power following the experiment sequencies. It is featured in that, in addition to the direct supply from the electric power line, three units of vertical shaft motor-generators are used that serve to enable storing and releasing energies of as large as 8 GJ in total. For instance, one of the three

units can store energy of 4 GJ (about 1,000 kWh) using a 600 ton flywheel. Meanwhile, a vacuum circuit breaker of 92 kA, 25 kV has been successfully developed needed for D.C. break phenomenon that is necessary for producing plasma current of 2.7 MA. This breaker is considered useful for D.C. transmission technology. Furthermore, for fast control of magnetic field, considerable numbers of Thyrister elements (4 kV, 3 kA) are being used as AC-DC converter (total installed capacity of 1,100 MW). These elements are regarded most excellent in the world in terms of their performance and scope.

2. As regards to plasma heating apparatus, both types of Neutral Beam Injector (NBI) and high power radio frequency (RF) heating device are developed in parallel. Fourteen units of NBI with ion current of 35 A x 2, 75 kV are equipped in JT-60. This large current ion source of 35 A is indeed such an extraordinarily larger ion source than conventional ones as having 30 cm aperture of ion beam extracting electrode. Because of its favorable applicability, it is now extensively used for surface curing and processing of materials and semiconductors. Negative ion source of hydrogen has also been developed to the extent of 1 A class at present. On the other hand, for RF heating apparatus, a Klystron amplifier of about 2 GHz, 1 MW (10 sec.) output class and 56 GHz, 200 kW output mili meter wave Gyrotron have been completed. A 120 GHz (wave length 2.5 mm), 200 kV class is currently under development. It is expected that these ultra-high frequency high power technology can be effectively utilized in future.

3. Material and Processing

Low Z (atomic number) material coating for the surface inside the vessel exposed to high temperature plasma has resulted in leading primarily to the development of coating technologies for such ceramics as TiC and SiC. As an application, this material has now become widely used for surface curing as an intensively resistant material against heat, wear and corrosion. In addition, as technologies for large area plating between SiC and metals has been developed successfully, it is bringing about extremely high performance as a promising electrode for MHD generator. Development of non-magnetic steel is now actively advanced, being expected to become highly useful for magnetic levitation train. Meanwhile, large-scale 110 kW electron beam welding has been developed and put on commercial use for accurate processing of such 15 mm class thick structures as JT-60 tokamak and its supporting structure.

4. Vacuum Technology

One of the characteristics of nuclear fusion devices is considered to be a large-scale ultra high vacuum vessel. In this connection, Helium Sniffer method has been worked out as an important technology that can detect extremely small leakage. This method is designed to operate helium leak detector through a fine flexible SUS tube and a sorption pump with molecular sieve zeolite. Detective sensitivity has been improved up to around 10^{-10}atom.cc/s, that is 10^3 - 10^4 times higher than conventional ones. A number of large-scale Cryo-pump of pumping speed 10^4 l/s are used for NBI as vacuum pump, and thus technologies thereof have also been upgraded. A turbo molecular pump (100 l/s) of ceramic rotator usable in magnetic field has been built for the first time. This pump is expected to be applied extensively, because it has advantageous characteristics in heat-, corrosion- and radiation-resistance.

5. In the next device following to JT-60, super conducting magnet is expected to be used instead of normal conductor coils. In preparation for meeting this plan, necessary tests on 3.5 m x 4.5 m coil are now carried out (international cooperative LCT-Program). A small tokamak TRIAM-1M composed of super conductor Nb_3Sn coil has been built and put in operation now, leading the world (Kyushu University).

Japan is also going ahead the world in carrying out studies on structural material of manganium alloy for ultra low temperature as well as on Nb_3AlGe, etc. for the next generation super conducting coils. In addition, a variety of pioneering developments are also in progress, including super computer for plasma analysis, international computer network, and robots for nuclear fusion reactor.

Research and development programs of Japan mentioned above are all positively advanced under the close cooperation between industries, universities, and governmental research organizations concerned. Especially, contributions from the industry are highly evaluated world-widely. We are now only in the middle of the course toward nuclear fusion goal, however, we are confident to say that close cooperation between fusion developing field and widely spreading scientific and technological fields has undoubtedly been essential for creating new technologies. It is therefore believed that more promising results could be obtained as more cooperation together with more developmental progress would be made in future.

LASER TECHNOLOGY AND ITS APPLICATIONS IN ATOMIC INDUSTRY

H. Takuma
Professor and Director
Institute for Laser Science, University of Electro-Communications

It has passed about 26 years since the first laser oscillation was achieved in a ruby crystal, and laser technology made a great progress in those years both in quality and variety. As a matter of fact, semiconductor lasers have been used in compact audio disc and video dics players. Cables have been replaced by optical fibers in the main telephone lines, and laser has become an indispensable component in modern communication networks.

Besides such low power laser applications which are very closly related to every day human life, laser power application techniques have also grown up: for example, carbon dioxide lasers and YAG lasers are now used as machine tools in production lines of variouse kinds of factories. Lasers are used also in routine medical treatments. Moreover, extremely efficient new method of uranium enrichment has been developed by applying the techniques of laser spectroscopy, which is one of novel fields which were born in the light of lasers. The issue of laser isotope separation is high energy efficiency due to its principle that the laser energy is primarily given only to uranium 235 atoms to ionize and extract them.

At present, only AVLIS (atomic vapor laser isotope separation) is considered to be practical, where dye lasers excited by copper vapor lasers are used to ionize uranium. An optimized design of dye laser, which consists of oscillator and series of amplifiers, can be readily done on the present background, but development of high power copper vapor lasers for industrial application is a matter of urgent importance. For economical consideration for total system operation, which is extremely important in designing an enrichment plant, quantitative knowledge on the rate constants of laser excitation and charge exchange collisions involved in the enrichment process are needed.

As for molecular vapor laser isotope separation (MOVLIS), there have been a significant progress in fundamental research works, although important technical problems are still left. Depending on a nuclear fuel policy, which is different from one country to another, just watching the outcome from MOVLIS study, like West Germany, can be a clever choice, because MOVLIS is in priciple superior to AVLIS if its technical difficulties of obtaining high separation factor and finding an efficient method to separate the selectively dissociated products were solved.

The laser application of ultimate high power limit is thermonuclear fusion of inertial confinment scheme. The essensial issue is to ablate a spherical fuel pellet by irradiating its surface by intense laser light, compress the pellet to a density of about 1,000 times of that of solid, ignite fusion reaction in a small fraction of the pellet volume at the center, and combusion covers the total volume of the pellet. So far a great deal of research works have been carried out to study the physics of implosion. Very important issue is the possibility of avioding the "first wall" difficulty of a reactor, by using "falling liquid metal wall". It is likely that the first crytical reactor experiment may be accomplished by Tokamak scheme, but ICF may be quite interested when a reactor desing is considered because of such advantage.

HIGH ENERGY ACCELERATORS – TECHNOLOGY & INDUSTRIAL APPLICATIONS

Ken Kikuchi
National Laboratory for High Energy Physics

High energy physics aims at the investigation of the ultimate constituent of matter and physics laws existing in nature, and high energy accelerators are inevitable means for the study of high energy physics. The high energy accelerators and experimental apparatuses used in high energy physics are the fruits of the newest scientific technology and construction of a new accelerator or an new experimental apparatus always needs R&D in technology. From this point of view, high energy physics has encouraged and promoted inovations of new technics in the past history. The results obtained by such developments do not necessary yield an immediate profit of the industry, but in a long term, promote development of new products, enlargement of markets and technical level-up of industries. Such economical benefits of industry produced by high energy physics were reported by a systematic survey performed by CERN (European Organization for Nuclear Research). It was indicated in this report that firms which had made contracts with CERN in the period 1953 - 1983 obtained resulting profits whose amount is about three times of the amount of contracts with CERN.

On the other hand, high energy accelerators which were first invented and developed as a tool to explore atomic nuclei or elementary particles have been used in various fields of scientific research and technical applications in recent years. From way back cyclotrons have been used for cancer therapy and for production of radio-isotopes, and electron linacs have also been used in medical applications or non-destructive inspections. In recent years, electron synchrotrons or storage-rings are used as sources of synchrotron radiations and now about twenty dedicated acceleraotrs are being operated in the world for synchrotron radiation research.

This report will describe the impact of high energy accelerators to technology and the use of them for other fields of science, especially for synchrotron radiation research.

Some examples of technical impact brought by high energy physics are:

1. Magnetic materials used in electromagnets
2. Superconducting wires and magnets
3. RF cavities for linac and RF acceleration system
4. Superconducting RF cavity
5. High-power RF tubes (klystrons)
6. Vacuum vessel materials and vacuum pumps
7. Large scale computer and soft wares to process quickly a great deal of experimental data
8. Large hydron-and helium liquefier and cryogenics
9. New materials for particle detectors
10. Materials with high radiation resistance
11. Civil engineering for precise alignment

Most of these have been used in the TRISTAN complex that was recently completed at National Laboratory for High Energy Physics (KEK), Tsukuba. The TRISTAN is an electron-positron colliding beam accelerator to explore elementary particle reactions in the new energy region which has not been reached by any electron-positron collider in the world. The accelerators consists of 2.5 GeV linear accelerator (with total length of 400 m), 6-8 GeV accumulation ring (with diameter of 120 m) and 30 GeV colliding ring (with diameter of 960 m). In the colliding ring electrons and positrons are accelerated in the clockwise and the anti-clockwise directions respectively, and make collisions at four intersections on the ring. Electrons and positrons are accelerated in tiny bunches and bunches intersect two hundred thousand times per second, but head-on collisions of an electron and a positron in each bunch take place only several ten times per day. If a collision occurs, the electron and the positron annihilate to produce highly condensed state of energy, which usually materialize into several tens of elementary particles. The particle detector measures instantaneously tracks and energies of these created particles. In this report new technics developed for TRISTAN accelerators and detectors will be described.

The synchrotron radiation research facility of KEK, which is named Photon Factory, is at present the highest in energy and the most reliable accelerator complex in the world. The synchrotron radiation, in comparison with the conventional X-ray or light sources, covers all range of wavelength from ultraviolet ray to X-ray, and the intensity is 1000 $\sim$ 10000 times larger and the direction is sharply collimated. It is useful in all fields of science and technology including medical applications. The Photon Factory is operated about 3000 hours per year and 2000 hours is available for experiments. More than 300 experimental proposals are approved and eighteen beam lines will become available in FY 1987. Four beam lines among them were constructed by private firms with their own funding. A demand for a brighter light source is increasing so that the use of insertion devices such as undulators or wigglers will play an important role in accelerators to be constructed in the near future. R&D efforts is also of great importance to attain a highly stable beam with a long beam life, which will be reported in the talk.

THURSDAY, APRIL 16

2.00 pm – 6.00 pm
SESSION 5: ISSUES AND TASKS IN THE NUCLEAR FUEL CYCLE INDUSTRY

For the steady development of nuclear power, the establishment of the nuclear fuel cycle is essential. In Japan, the fuel cycle industry is being actively developed. Since fuel cycle costs have a considerable influence on the cost of nuclear electricity generation, the economic efficiency of the fuel cycle must be improved by continued technological innovation and assuring the most appropriate conditions. This session will discuss the future of the fuel cycle industry, review the present conditions and indicate problems in future operatioins of the major business relating to uranium enrichment, conversion, reprocessing, and MOX fuel fabrication. Market trends will also be taken into consideration.

ROLES AND TASKS OF NUCLEAR FUEL CYCLE INDUSTRY IN JAPAN

Masatoshi Toyota
Executive Vice President
The Tokyo Electric Power Co., Inc.

1. Current Status and Outlook of Nuclear Power Generation:

We see that today nuclear power is the most superior source of electricity generation since it has less influence on the environment, advantage over fossil fuel in its economics, security in the supply of resources and stability in the electricity supply as well as good characteristics of easy storage and transportation.

Accordingly, we in Japan will continue the policy of placing nuclear power in the mainstream of energy development and will increase its share in the total electricity generation, while continuing our efforts towards the improvement of its safety, reliability and economics.

2. Roles and Tasks of Nuclear Fuel Cycle Industry in Japan:

It will be important to establish an industrial basis for a self-standing nuclear fuel cycle industry for the purpose of maintaining the long and stable operation of nuclear power generation by LWRs.

(Uranium Concentrates) Although there seems to be sufficient reserves of uranium to meet global demand, it is necessary to continue steady exploration and development activities in order to satisfy the long-term demand for the LWRs.

In Japan, uranium requirements up to the second half of the 1990's have been secured and new commitments will become necessary to fulfill the subsequent requirements. We are looking into diversifying uranium resources and the mode of supply, and are moving in the direction to increase the proportion of imports from Japanese joint-ventures overseas.

From such aspect, the foreign investment restrictions and upgrading policy in countries with natural resources are desired to be abolished or at least eased since these hinder the activities of exploration.

(Enrichment) It is our policy to have a 3,000 tons SWU/year supply capability of our own in the first several years of the 21st century, which corresponds to about one-third of domestic SWU demand. As the first step, construction of a plant with a capacity of 1,500 tons SWU per year utilizing the centrifuge process will be initiated, in Rokkasho-Mura, Aomori Prefecture, for start of partial operation in 1991.

Research and development of more efficient centrifuges will be promoted and they will be installed instead of the present ones, once proven to be commercially feasible.

In addition, a laser enrichment process will be developed as a next generation technology. For this purpose, LASER (Laser Atomic Separation Engineering Research Association) is to conduct an enrichment test on a scale of 1-5 tons SWU by the year 1990.

If the result is successful, we will proceed to commercialization in the beginning of the 21st century.

Although difficulty is foreseen in establishing international cooperation in the field of uranium enrichment which is facing intense international competition and non-proliferation problems, I hope to see specific proposals by speakers on how to proceed with international cooperation for increasing the efficiency of the development.

(Reprocessing) The reprocessing option is the basic policy in our country from the standpoint of making efficient use of uranium resources, as well as of managing spent fuel in a safe manner.

While from an economic standpoint it is more advantageous under prevailing conditions, to store spent fuel than to reprocess it immediately, it will be necessary to undertake reprocessing on an appropriate scale from above basic policy and for the purpose of establishing a technological basis for reprocessing, plutonium utilization, and the sound disposal of HLW towards the commercialization of FBRs.

When we take the above into consideration, it will be desirable to handle this matter in a flexible manner availing ourselves of other options such as interim storage for a certain portion of our spent fuel while maintaining the reprocessing option as our basic policy.

Our first commercial reprocessing plant with an annual capacity of 800 tons is to be built in Rokkasho-Mura, Aomori Prefecture utilizing the experience we have gained through operation of PNC's Tokai Plant, and indigenous technology of our domestic industry with the cooperation of France, the United Kingdom, and West Germany. We hope to receive long-term cooperation from these countries in establishing reprocessing technology in our country.

In order to establish indigenous technology and improve the economics of plutonium utilization in the field of reprocessing, it will be particularly important to promote technological development and cost reduction. Also, it will be necessary to pay attention to the development of technology for reprocessing high burn-up spent fuel, and MOX fuel. Improvement in the reprocessing plant's availability factor will be most important in improving the economics of reprocessing. For this purpose, such measures as the improvement of reliability of equipments, the advancement of operation/ maintenance technology, development of a practical plant operation and shutdown criteria taking environmental safety into consideration are considered to be necessary. I would like BNFL, COGEMA, and KWU gentlemen to comment on this matter.

As for construction of our second commercial reprocessing plant, while the provisional schedule for start-up is set at around the year 2010, its construction schedule should be determined with consideration of multiple factors such as forecasts of uranium price and reprocessing cost, future trends in plutonium demand, quantity of spent fuel to be stored, and the advent of high burn-up.

(Recycling of Recovered Material) Plutonium will be utilized in ATRs and LWRs until the era of full-fledged use in FBRs.

The scale of our plutonium recycling program, which comes from the forecast of the future balance of plutonium supply and demand, will be to load about 12 LWRs with MOX fuel for one-third of respective cores in the late 1990's.

The main issue in this program is the smooth transportation of recovered plutonium to Japan from the U.K. and France.

As for the fabrication of MOX fuel, a PNC plant of 40 tons per year capacity for a demonstration reactor of ATR is under construction. Since a 100 tons per year capacity will become necessary in the era of a full-scale Pu-recycling program, construction of a domestic plant by a private enterprise is being considered. The issue here will be the reduction in fabrication cost.

I would like to ask the gentleman from ALKEM and COMMOX to comment on the technological development and cost perspective of MOX fuel fabrication.

As for the recovered uranium, we would like to determine among utilization as matrix material for MOX fuel, conversion/reenrichment, blending, or interim storage for the time being, upon review of the technological and economic aspects.

I would like to ask COMURHEX, BNFL, DOE and URENCO gentlemen to give a presentation on the technological/economic outlook and capability to provide conversion/reenrichment and storage services, etc. regarding recovered uranium.

3. Direction of Solving Problems:

(Technological Development) Since intervals between construction of facilities are considerably long in the nuclear fuel cycle industry, it is necessary to improve the technology level through continuous efforts in developing technology of our own and the international exchange of information.

(Realizing Economic Viability) In the long term, the cost of the nuclear fuel cycle will have a significant influence on the economics of nuclear power generation. In order to lower the nuclear fuel cycle cost, it is important to (1) enhance the efficiency of the construction and operation of the plants by applying the fruits of technological development, and (2) avoid any over-investment by making a precise forecast of future demand.

(Safety and Public Acceptance) Since accidents at nuclear facilities bring about a broad adverse impact worldwide, it is important for nuclear enterprises in each country to make the securing of safety and the conservation of the environment the basis of their business philosophy.

(Cooperation Among Governments) It is desirable for the governments to cooperate in strengthening the IAEA safeguards system and in improving its efficiency.

PRESENT STATUS AND FUTURE PROSPECTS REGARDING FRENCH INVOLVEMENT IN URANIUM ENRICHMENT

Jean-Hubert COATES
Deputy Director
Isotope Separation Division
COMMISSARIAT A L'ENERGIE ATOMIQUE

SUMMARY

Although know-how gathered on gaseous diffusion and chemical exchange techniques is carefully kept valid, market assessments and technical choices have gradually led the French Commissariat à l'Energie Atomique to focus its present R & D efforts in the field of uranium enrichment on laser photoselective ionization (SILVA). Indeed, a breakthrough of advanced technologies seems highly probable in the long run, mostly for economic reasons but also for practical reasons such as plant modularity and versatility.

It is clear that France's commitment to nuclear energy which reflects the scarceness of other domestic sources of energy, compells the CEA Group i.e. COGEMA to remain an important and reliable supplier of enriched uranium. Beyond the obligation of securing the needs of its own domestic nuclear program and fulfilling its commercial obligations, the CEA Group finds itself in the position of belonging to what might be called second generation pioneers of nuclear energy and as such, feels largely accountable for the future of that industry.

The numerous difficulties which the nuclear community has to face are well known, and problems related to safety, proliferation hazards, intense capital needs, are common to all sectors of nuclear industry, enrichment included. In addition, enrichment has been characterised these last few years by a strong competition between producers which is commercially favourable to utilities, but may hamper cooperation between technology holders.

In spite of these difficulties of various orders, and subject to a wise and cautious approach, specific cooperative steps could be envisaged which would tend to increase the efficiency of development and improve the competitivity of future advanced enrichment techniques.

Urenco's Contribution of the Enrichment Market

Juergen A. Paleit
Director, Urenco Ltd.

The paper deals with the following main issues:

- Present status of Urenco Enrichment Plants and Order Book.
- Urenco's future development.
- The Western World enrichment supply situation.
- Urenco's Policy on the reliability of enrichment supplies.
- Urenco's contribution to a reliable, stable and competitive world enrichment market.

This paper commences with a summary of Urenco's order portfolio, current plant capacity and forward committed expansion plans up to 1990. Urenco's present position in the western world enrichment market is also described. The Urenco corporate structure and its mode of operation are also briefly outlined.

The paper then proceeds to elaborate on the potential of the Urenco centrifuge process to be utilised in the 1990's. Particular emphasis is given to the application of Urenco's centrifuge technology to the enrichment of recycles uranium. The relevance of laser enrichment development to Urenco is discussed.

The paper next discusses the structure and main characteristics of the major sectional markets of the western world enrichment market, i.e. particularly in the United States, Western Europe and Asia (Japan, Korea and Taiwan). Particular emphasis is given in this section on the impact of increased competition by the enrichment suppliers, political factors and exchange rate movements on the distribution of market shares of the enrichment suppliers in these areas.

Next Urenco's contractual approach regarding the reliability of enrichment supplies is discussed, i.e. Urenco's flexible and commercially orientated contract terms individually tailored to the needs of utilities. Particular emphasis is also given to Urenco's preparedness to negotiated with partners in suitable areas of the western world the establishment of enrichment plants in order to obtain enrichment business on a reliable, stable and competitive basis.

Finally, by way of a summary, it is shown that

- Urenco's development of the centrifuge process to the point of economic maturity
- Urenco's establishment of a multi-national commercial enrichment organization
- Urenco's achievement in the world enrichment market by a commercial and competitive approach
- Urenco's preparedness to negotiate suitable supply arrangements including the establishment of plants in other market areas

have vastly contributed to a stablilisation of the world enrichment market.

RECENT DEVELOPMENTS IN THE U. S. URANIUM ENRICHMENT ENTERPRISE

John R. Longenecker
Deputy Assistant Secretary for Uranium Enrichment
U. S. Department of Energy

Abstract:

Maintaining a healthy, stable, and competitive uranium enrichment capability in the United States is a high priority effort for the U.S. Department of Energy (DOE). The United States is committed to the nuclear power option as an important energy resource for the future of our global economy. The best way to assure that this commitment is realized is through a reliable supply of nuclear fuel at stable or declining prices. The DOE uranium enrichment enterprise has two major goals. The near term goal is to provide reliable, competitive enrichment services to our customers. The long term goal is to stabilize and maintain the U.S. uranium enrichment enterprise by restructuring, and introduce advanced enrichment technology.

In the near term, DOE is reducing production costs at the gaseous diffusion plants (GDPs), and we've made significant progress already. For example, in 1983, the unit cost at the GDPs was $90 per separative work unit (SWU), and by 1986, unit cost was reduced to $68/SWU. GDP production costs are expected to decline even further in the near future.

DOE is also negotiating new power contracts for the GDPs. The new power contracts, capital improvements, and the use of more unfirm power should reduce our GDP average cost of production to about $60/SWU in the 1990s. To meet the goal of stabilizing the enterprise and deploying advanced technology, DOE is developing the Atomic Vapor Laser Isotope Separation (AVLIS) advanced enrichment technology. We've made significant technical progress on AVLIS recently. The highlight has been a series of half-scale integrated enrichment experiments using the Laser Demonstration Facility and the Mars separator. We are also ready to initiate testing in the full-scale Separator Demonstration Facility, including a 100 hour run that will vaporize over 5 tons of uranium.

To stabilize the U.S. uranium enrichment enterprise, and to allow the United States to compete effectively in the world enrichment marketplace, DOE is developing plans to restructure the enterprise into a more businesslike entity. The key objective in 1987 is to work with Congress to advance the restructuring of the U.S. uranium enrichment enterprise, to assure its long term competitiveness. We hope to establish in law the charter, objectives, and goals for the restructured enterprise. If we can do this, it will assure that the U.S. uranium enrichment enterprise will remain strong for the long term and that the interests of our customers, our employees, and the U.S. taxpayers are well served.

DOE expects that the world price for enrichment services will continue to decrease in the future. There should be sufficient excess enrichment capacity in the future to assure that competition will be keen. Such a healthy, competitive, world enrichment market will be beneficial to both suppliers and consumers of uranium enrichment services.

REPROCESSING : THE STRATEGY FOR A COMPETITIVE NUCLEAR ENERGY

Jacques COUTURE
Director for Contracts
Transports and Plannings
Reprocessing Division
COGEMA

Jean-Pierre ROUGEAU
Vice-President
Marketing and Sales
COGEMA

Abstract

- The course of development of a comprehensive nuclear power industry has its own pace which implies the timely progressive and consistent mastery of each industrial step. In the nuclear fuel it is not surprising that the back-end services have lastly reached the industrial stage.

- In France, we have now fully completed the industrial demonstration of the closed fuel cycle. Our experience covers all necessary steps : transportation of spent fuel, storage, reprocessing, waste conditioning, recovered uranium recycling, plutonium recycling in thermal MOX fuels, plutonium-based fuel for FBR.

- While FBR development is a long term target, recycling of fissile materials in present LWR reactors appears to be a source of noticable savings. In the meantime rational management of waste material is the key for increased safety and better environment protection.

- Reprocessing activity is certainly the major achievement of the back-end strategy. The proven efficiency of this technique as it is implemented at La Hague facility gives the full assurance of a smooth operation of the

under completion UP3 unit.

The base-load management system which applies during the first ten years of its operation will make possible a noticable reduction of the commercial price for reprocessing services by the end of the century.

- Industrial maturity being confirmed, economic maturity is now the outstanding merit of the reprocessing and recycling strategy.

  It is a permanent challenge, to which the response is definitely positive in the sense of reducing the nuclear KWh production cost.

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PERSPECTIVES OF REPROCESSING NUCLEAR FUEL IN THE FEDERAL REPUBLIC OF GERMANY

Wulf Bürkle
Vice President
Kraftwerk Union AG (KWU)

In accordance with the Atomic Law in the Federal Republic of Germany, reprocessing of spent fuel is requested as long as environmental protection from a reprocessing plant is achievable both in accordance with licensing regulations and with current scientific and engineering practice and is economically justified.

An integrated back-end fuel cycle concept has been developed over the past few years in a joint effort by politicians, public authorities and the utilities in the Federal Republic of Germany. This concept, described by the term "Integriertes Entsorgungskonzept", includes all activities concerning the reprocessing of spent nuclear fuel, disposal of radioactive waste and related steps like transport, interim storage and conditioning.

In 1985 the DWK (Deutsche Gesellschaft für die Wiederaufarbeitung von Kernbrennstoffen) decided to erect a nuclear fuel reprocessing plant in Wackersdorf in the state of Bavaria in the Federal Republic of Germany.

The plant will have a throughput of 350 metric tons of uranium per annum and about 2 metric tons a day.

A turnkey contract was awarded to a consortium of companies representing the most advanced know-how in nuclear and chemical technology in Germany. KWU is leading the consortium, with Hochtief/Dykerhoff and Widmann/Heitkamp for civil work, Uhde/Lurgi and KWU/Nukem/KAH for the process engineering and remote handling machines in the relevant reprocessing areas.

The Société Générale pour les Techniques Nouvelles (SGN) is being considered as a subcontractor for specialist work.

In September 1985 DWK was granted the construction license for the first plant section.

A specific feature of the German reprocessing plant will be the FEMO-technique in which subsystems of the chemical process are arranged to standardized arrays, the modules. One essential new aspect is the maintenance work not to be carried out by personnel, but by remote control manipulators.

This system satisfies legal demands for a minimization of radiation exposure for operating staff, while, on the other hand, it allows for continuous operational improvement by simply replacing various modules.

Cold operation is planned for 1993 and the start of hot operation for 1995.

REPROCESSING OF OXIDE FUEL AT SELLAFIELD, UK.

BY Dr W L Wilkinson
British Nuclear Fuels, plc.

An outline of the Thermal Oxide Reprocessing Plant (THORP), and the facilities required to support it at Sellafield is presented, together with capital costs and timescales.

The provision of facilities to reprocess irradiated fuels is highly capital intensive and, whilst attention is generally focussed upon the chemical separation plants, very significant expenditure is also required for the provision of support facilities necessary for the storage of fuels and treatment of wastes and effluents. The integration of all such facilities needed for thermal oxide fuel reprocessing in the UK will be considered in this paper.

Construction work on the THORP project commenced in 1983 when work started on the Receipt and Storage Plant. This work was significantly expanded in 1985 when the major construction of the Reprocessing Plant commenced and considerable progress has been made in this phase. The Receipt and Storage Plant is approaching completion and work on the Reprocessing Plant is well advanced. A brief description of THORP is presented and the current status of the project described using data on both material usage and financial indicators.

Reprocessing facilities comprise both mechanical and chemical processing units which require various degrees of maintenance to ensure safe and efficient operation. Whilst the major emphasis is placed upon the zero-maintenance philosophy, remote maintenance facilities have been provided for mechanical equipment and prudent provision has been made for access and maintenance to cover unforeseen circumstances.

Data on plant availability have been rigorously examined in order to determine the requirements to reduce interactions between adjacent process operations. As a consequence of this stochastic modelling work, previous assumptions about the overall availability are now considered to be unduly pessimistic. It is now foreseen that THORP should be capable of reprocessing an additional 1000t in the first 10 years, bringing the anticipated total up to 7000t. The results of this work are described.

The products of reprocessing are plutonium and recovered uranium. These materials have significant energy potential if recycled to fuel production facilities for further use in advanced reactors. Materials from THORP will be produced as PuO_2 and UO_3, both meeting specifications which would permit their further use in the fuel cycle. Proposals for recycle of the uranium recovered by reprocessing of thermal reactor fuels will be presented and the economic benefits arising from the recycle of uranium and the various parameters important in determining the overall benefit will be reviewed. The options for recycle in a short time after reprocessing and the possible reasons for delaying recycle have been examined. The technical and economic criteria for choosing between the two are discussed in the paper.

JAPAN AND THE CONVERSION INDUSTRY

Jérôme PELLISSIER-TANON

Chairman and Chief Executive Officer of Comurhex

Member of the Board of Urep

1) Although conversion is the least important step of the fuel cycle both natural U and reprocessed U have to go through it before further processing in the fuel cycle, such as enrichment or fuel fabrication.

2) Reprocessed uranium from LWR is available today from the UP2 400 plant (Cogema-La Hague, France) and the pilot plant of WAK (DWK, FRG)). New plants will be put on stream, in particular the UP3 plant (Cogema - La Hague, France) and the Japanese plant of Rokkasho-Mura.
Before the end of the century, reprocessing will make available 3000 TU/year.

3) Recovered uranium has to be converted to allow further processing in the fuel cycle. Conversion is necessary to produce UF6 needed for enrichment, or oxide for intermediary storage or MOX powder production.

4) As of today almost all the recovered uranium from LWR fuels (1600 tons U) has been converted into UF6 by Comurhex in its unique in the world 350 tons U/year pilot plant. Comurhex benefits from more than 10 years

of experience in this field. Uranium oxides have also been produced by Cogema in a specific pilot plant called TU2, with a capacity of 500 tons/year.
The marketing of these conversion services is the task of a joint company, Urep, a 50/50 Comurhex Cogema organization.

5) Early in the next decade a new large conversion plant will be put on stream, in order to offer sufficient conversion capacity to the utilities having to take care of their reprocessed uranium. This new plant will receive UNH as well as oxides and will produce UF6 and oxides.

6) The conversion techniques are derived from traditional chemistry but have to provide high quality and safety standard, high guaranteed yields and great adaptability to various products. This is true for standard conversion of natural uranium concentrates and becomes more essential with the break in of recovered uranium.
Conversion is a sensitive multi-facet industry.

7) There are five large converters in UF6 in the western world with a total capacity of 52000 T/year against a demand which will slowly grow up to 45000 T/year in the 1990'ies.

It is clear that the present producers will cope with this demand. Many years of experience have made clear that UF6 can be shipped, in special 48Y cylinders, with the utmost safety standards and reasonable cost to all the enrichment plants. The new market is concentrated on conversion of recovered uranium from LWR fuel. The fluorination of which has been so far industrially demonstrated only by Comurhex.

8) On a chemical view point conversion of recovered U is similar to natural U conversion. In another hand, despite the remarquable performance of the reprocessng, it carries slight amounts of radioactive by-products, partly related to newborn short-lived U232. Fluorination of REPU into UF6 at industrial scale (800 - 2000 T/year) will require the following features :

- A shop specially designed to cope with the remaining problems of radioactive pollution.

- Independent means of liquid and solid waste treatment.

This should lead to safe pollution-free operations, at costs compatible with the overall economy of recycled REPU fuel.

9) Although there is no major secret about conversion experience gained through years of operation in our facilities may appear useful to the Japanese industry. Cooperation is still a guarantee of better standards and higher quality. We wish it can develop between our industries in this field as it did in other steps of the fuel cycle.

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MOX ISSUES : THE APPROACH TO LARGE SCALE UTILIZATION

H. Bairiot
Vice President
COMMOX

The important German Contribution to industrial MOX fuel has been outlined in the previous presentation by Prof. W. Stoll. This paper will complete the perspective by providing an overview of the approach in the main European Countries concerned with MOX fuel and by commenting on the contribution of Belgium and France to large scale MOX utilization.

1. Pu ARISING FROM REPROCESSING

For each major country owning plutonium, the quantities of fissile Pu that will be produced by the reprocessing plants and together with the needs for FBRs and ATRs result in an excess of Pu to be recycled in LWRs. In this respect, the Japanese situation is similar to the European one.

2. POLICIES OF UTILIZATION OF THIS AVAILABLE Pu

Reprocessing or not is a national policy decision. The utilization of the Pu in excess over the FBR (and ATR) needs is governed by :

- the storage cost of Pu,
- the progressive degradation of the fissile content of the Pu,
- its ageing, imposing to utilize the Pu within 3 years after reprocessing or to purify it thereafter,
- the fact that Pu arising from the reprocessing of MOX fuel is nearly as adequate for FBRs as virgin Pu arising from the reprocessing of U fuel,
- the advantages of incorporating MOX fuel progressively into the power plants.

3. IMPLEMENTATION OF LARGE SCALE MOX UTILIZATION

The progressive incorporation of MOX fuel into the nuclear power generating system is implemented differently in the concerned European countries, according to the local situation.

In France (with a centralized licensing authority and large series of identical power plants), the MOX fuel constitutes immediately 1/3 of each reload and is incorporated in an increasing number of power plants : 1 in 1987, 2 in 1988, 4 in 1989, etc ... up to 12 in 1995.

In Germany (with local licensing authorities and diversified power plants), the MOX fuel is incorporated progressively in each selected power plant, e.g. : 4 assemblies the first year, 8 assemblies the second year, 12 or 16 assemblies the third year and the equilibrium number of assemblies each year thereafter.

In the other concerned European countries, the implementation policy is also adapted to the local situation. But it generally follows the same principle : the industrial utilization is started right away, without going through experimental and demonstration steps.

The reason is that the MOX manufacturing industry in Europe has already 20 to 30 years background on Pu fuel and over 10 years of industrial experience on MOX fuel, which has properly been demonstrated to various proportions of the reactor core and in various sizes of power plants.

4. PRESENT SITUATION AND FUTURE PLANS

The expertize accumulated in France by handling large quantities of Pu for FBRs and in Belgium where a specific experience on MOX fuel has been developed without interruption during 30 years have been the key ingredients in establishing a MOX industry which copes with the expanding needs. Its further development into the MELOX and DEMOX facilities benefits from the experience gained and the proper and timely evaluation of the requirements.

The present fabrication cost is already satisfactory and will be reduced in the future facilities, mainly through the size factor, a planned match of the expanding capacity to the needs and adequate adaptation of the process equipment to each product.

5. LESSONS LEARNED FROM EXPERIENCE

Amongst others :

- process performance is the largest factor influencing product quality and fabrication cost ;
- automation is effective in reducing exposure of the operating personnel. It has limits since it increases exposure to maintenance and service personnel and can increase fabrication cost due to down-times for repairs of the equipment, replacements of parts and especially settings of the tooling (e.g. BWR and PWR fuel) ;
- present LWR Pu age limit for fabrication is 3 years ; efforts to raise this limit to 5 years might be annihilated with the need to process Pu issued from the reprocessing of higher burnup U fuels ;
- MOX fuel can be designed, fabricated and licensed to the same standards as U fuel ;
- MOX fuelled LWRs can be operated without inconveniences.

INDUSTRIAL AND TECHNOLOGICAL ASPECTS OF MOX-RECYCLE

Wolfgang Stoll
President
ALKEM GmbH

Nuclear energy in Germany supplies now more than one third of electric power.

Future is characterized by consolidation of nuclear energy in the electric base load supply and by closing the fuel cycle.

Before the onset of future fast breeder reactors LWR power stations will obtain up to one third of their fuel reload in the form of MOX fuel. There is enough Pu available mainly from foreign reprocessing for fuelling up to 8 LWR licensed for MOX from 1988 onwards. Fuel design and irradiation experience allow future burnup target up to 55.000 MWd/t.

Fabrication processes are in steady development for higher throughput and more radiation protection. MOX fuel can compete economically with UO_2 fuel if current fabrication plants are used to their capacity.

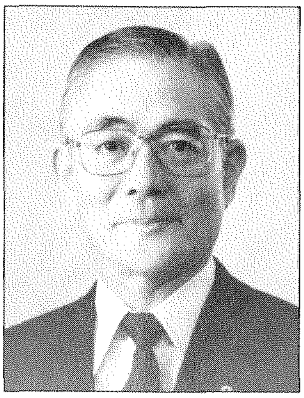
It is expected that in several years Pu-value can contribute substantially to recover part of reprocessing costs in favour of final fuel repositories as a potential alternative.

BRIEF PERSONAL HISTORY

OF

CHAIRMEN, SPEAKERS AND PANELISTS

OPENING SESSION



SHOICHIRO KOBAYASHI

Born on July 14, 1922
1946 Graduated from the University of Tokyo (Economics)
1947 Entered Kansai Electric Power Distribution Co.
1951 Above company name changed to the Kansai Electric Power Co., Inc. was continuously on the staff
1965 General Manager, Power Sales Dept.
1968 General Manager
1970 Director
1972 Managing Director
1974 Senior Managing Director
1975 Executive Vice President
1977 President
1985～Chairman
Other Major Post
1977 Vice Chairman, Kansai Economic Federation

ISAMU YAMASHITA

Born on Feb. 15, 1911
Education:
1933 Graduated from the Tokyo Imperial University (Mechanical Engineering)
Occupation:
1933 Entered Mitsui & Co., Ltd., Shipbuilding Department
1955 Director of Mitsui Engineering & Shipbuilding Co., Ltd.
1970 President
1979 Chairman
1985 Senior Adviser
Public Position:
1977～President of Japan Marine Science and Technology Center
1982～Vice Chairman of The Association for The Promotion of International Trade
1985～President of The Institute for International Studies and Training
1985～Chairman of The Telecommunications Council, Ministry of Posts and Telecommunications
1985 Japanese Chairman of The Trilateral Commission
1985～Chairman of Nuclear Sub-Committee, Advisory Committee for Energy, MITI
1986～President of International Organization for Standardization
1986～Chairman of The Board of Councillors of the Federation of Economic Organizations (Keidanren)

HIROMI ARISAWA

Born on Feb. 16, 1896 in Kouchi Pref.
1922 Graduated from the Tokyo Imperial University (Economics)
1926～28 Went to Germany to Study Economics, etc.
1945～56 Professor, University of Tokyo
1956～72 Commissioner, AEC (1965 ～ 72 Deputy Chairman)
1959～62 President, Hosei University
1958～Special Assistant to the Economic Planning Agency
1961～Member, The Japan Academy (President, 1980 ～ 86)
1973～Chairman, JAIF
1973～President, University Alumni Association
1984～86 Chairman, Social and Economics Congress of Japan

Rewards
1975 First Class Order of the Rising Sun (Japan)
1983 Order of Person of Cultural Merit (Japan)
1985 Officer de la Legion d'Honneur (France)
1985 Honorary Doctor of Chinese Academy (China)
1985 Commander's Cross of the Order of Merit (F. R. Germany)

SESSION 1

YATARO MITSUBAYASHI

Born on Nov. 22, 1918

1938 Graduated from the Teacher's College in Saitama

1951 Elected to a Member of the Saitama Prefectural Assembly

1964 Chairman of the Saitama Prefectural Assembly

1967 Elected to a Member of the House of Representatives

1972 Parliamentary Vice-Minister of Home Affairs

1973 Parliamentary Vice-Minister of Posts and Telecommunication

1986 Minister of State for Science and Technology

FUMIO WATANABE

Born on March 28, 1917

1939 Graduated from the Tokyo Imperial University

1939 Joined The Tokio Marine & Fire Insurance Co., Ltd.

1971 Managing Director

1975 Senior Managing Director

1977 Executive Vice President

1978 President

1984 Chairman

Other Titles:

- Director of The Mitsubishi Bank
- Auditor of The Meiji Mutual Life Insurance Company
- Director of Japan Airline
- Vice-Chairman of Japan Association of Corporate Executives
- Executive Director of Japan Federation of Employers' Associations
- Executive member of the Board of Directors of the Federation of Economic Organizations

JEAN-PIERRE CAPRON

1943 Born in Paris
– Graduated from Ecole Polytechnique and Ecole des Mines
1972~1977
Joined the Ministry of Economy, Finance and National Territory
1978~1984
Director General, Petroleum Division, the Ministry of Industry
1984~1985
Director in charge of Planning, Thomson S.A.
1985~1986
President, Technip S.A.
July 1986 ~
Administrateur General, Commissariat à l'Energie Atomique

NIKOLAI LUKONIN

Born on Mar. 3, 1928
1952 Graduated from Odessa Institute for Telecommunication · Electrical Engineering
1952~1976 Engaged in a number of major technical services in industries
1976 Superintendent, Leningrad Nuclear Power Station
1983 Superintendent, Ignarina Nuclear Power Station
1986~Minister of Atomic Power Engineering, USSR

TATSUO KAWAI

Born on Dec. 1, 1919
Education:
1940 Graduated from Waseda University (Science and Engineering Department, Electrical Engineering Course)
Work Experience:
1940 Employed by Kyushu Hydro Power Co., Ltd.
1942 Merged to Kyushu Power Distribution Co., Ltd.
(due to integration of power distribution)
1951 Merged to Kyushu Electric Power Co., Inc.
(due to reorganization of electric industry)
1968 General Manager of Purchasing Dept.
1971 Director, General Manager of Purchasing Dept.
1973 Managing Director
1977 Executive Vice President
1983 President
Other Positions:
1984 Chairman of Fukuoka Committee for Economic Development
1984 Chairman of Kyushu Committee for Economic Development

HANS BLIX

Dr. Hans Blix was born in 1928 in Uppsala. He studied at the University of Uppsala, at Columbia University and he received his Ph. D. at Cambridge.

In 1959 he became Doctor of Laws at the Stockholm University and in 1960 was appointed associate professor in international law.

From 1963 to 1976 he was Head of Department at the Ministry of Foreign Affairs (MOFA) and served as Legal Adviser on International Law. In 1976 he became Under-Secretary of State at MOFA in charge of international development co-operation. He was appointed Minister of MOFA in October 1978. In September 1979 he was again appointed Under-Secretary of State at MOFA in charge of international development co-operation.

Since 1961 he has been a member of Sweden's delegation to the United Nations General Assembly, and from 1962 to 1978 a member of the Swedish delegation to the Conference on Disarmament in Geneva.

He has written several books on subjects associated with international and constitutional law and was leader of the Liberal Campaign Committee in favour of retention of the Swedish nuclear energy program in the referendum in 1980.

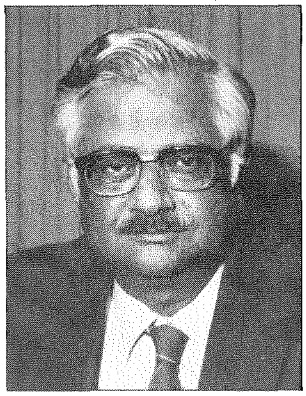
WALTER MARSHALL

Lord Marshall of Goring was born on 5 March 1932 in Rummey, Wales.

He attended the University of Birmingham where he obtained a BSc in Mathematical Physics in 1952 and a PhD in 1954 for research on antiferromagnetism and neutron scattering from ferromagnets.

On leaving University he joined the Harwell Laboratory of the United Kingdom Atomic Energy Authority. He was appointed Director of Harwell in 1968, a post which he held until 1975 when he was appointed to the post of Deputy Chairman of the UKAEA. From 1974 to 1977, he also held the post of Chief Scientist of the Department of Energy. In February 1981, he became Chairman of the UKAEA. In July 1982, he was appointed Chairman of the CEGB.

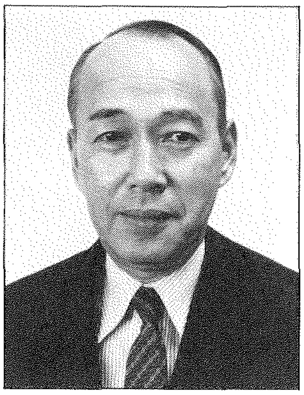
He is also a fellow of the Institute of Physics and the Physical Society, the American Physical Society, the Institute of Mathematics and its Applications, the Swedish Royal Academy of Engineering Sciences, and is also a Foreign Associate of the National Academy of Engineering of the United States of America. In 1973, he was made a CBE in the New Year's Honours List. In June 1982, he received a Knighthood in the Queen's Birthday Honours for his work within the Atomic Energy Authority. In December 1982, he received an honorary DSc for his work within the Atomic Energy Authority.



RAJA RAMANNA

Born in Mysore, January 23, 1925, early education at Bangalore. B.Sc. (Hons.) from Madras University; Ph.D. from London University; D.Sc. (Honoris Causa) from several Universities. Joined Tata Institute of Fundamental Research in 1949. Transferred to the erstwhile Atomic Energy Establishment (The present Bhadha Atomic Research Centre in 1953 as Head of the Nuclear Physics Division. Was Director, Bhabha Atomic Research Centre and Member for Research & Development, Atomic Energy Commission from June 1972 to June 1978. He was Scientific Adviser to Defence Ministrer; Director-General, Defence Research & Development Organisation and Secretary to the Government of India for Defence Research from July, 1978. He returned to BARC in January, 1981, as Director, Bhabha Atomic Research Centre and Secretary to the Govt. of India, Department of Atomic Energy and Member for Research & Development in the Atomic Energy Commission. Since September, 1983, he was the Chairman of the Atomic Energy Commission and retired from service on Feb. 28, 1987.

Dr Ramanna had collaborated in the design, installation and commissioning of the Research Reactors, Apsara, Cirus and Purnima and the Variable Energy Cyclotron at Calcutta and the Fast Breeder Test Reactor at Kalpakkam. He led the Group which was responsible for the Peaceful Nuclear Explosion at Pokharan in 1974.



KATSUSHIGE MITA

Born in Apr. 1924

1949 Graduated from the University of Tokyo (electrical engineering)

1949 Joined Hitachi, Ltd. and worked on the design of process control equipment at its Kokubu Works

1969 Transferred to the Omika Works, a factory specializing in the production of switchboard and process control equipment

1971 General Manager, the Omika Works

1975 Member of the Board of Directors

1977 Executive Managing Director

1979 Senior Executive Managing Director

1980 Executive Vice President and Director

1981～President and Representative Director

GAISHI HIRAIWA

Born on August 31, 1914

Education:

1939 Graduated from Law Department, The Tokyo Imperial University

Professional Career:

1939 Joined Tokyo Electric Lighting Co.

1951 Moved to Tokyo Electric Power Co., Inc.

1964 General Manager of General Affairs Department

1968 Director (in charge of General Affairs Department)

1971 Managing Director

1974 Executive Vice President

1976 President

1984～Chairman of the Board of Directors

Other Major Posts:

- Vice-Chairman of the Federation of Economic Organizations (Keidanren)
- Member of National Public Safety Commission
- Chairman, The Committee for Energy Policy Promotion
- Member of Special Committee on Economic Restructuring, Economic Council

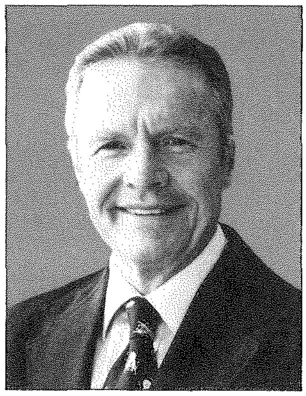
Awards:

1980 Awarded the Honorary Commander of the Order of the British Empire

1983 Awarded Legion d'Honneur Officier

1984 Awarded First Class Order of the Sacred Treasure

1985 Awarded das Große Verdienstkreuz des Verdienstordens der Bundesrepublik Deutschland



FRANK W. GRAHAM

Born on June 26, 1922, Peoria, Illinois

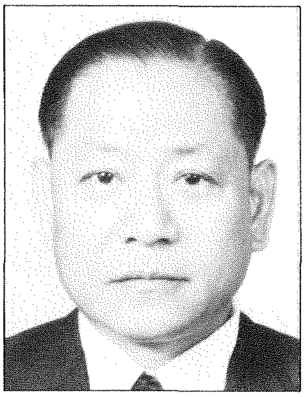
Mr. Graham is Vice President at the Atomic Industrial Forum. He is also Secretary to the AIF Committees on International Nuclear Policy, Financial Considerations, and Fusion.

Before joining the Atomic Industrial Forum, Mr. Graham was associated with Consolidated Edison Company at its Indian Point Nuclear Site as Manager, Nuclear Planning.

He received his nuclear training in the U.S. Navy under the Director, Division of Naval Reactors, AEC (Admiral Hyman G. Rickover) and commanded the Polaris submarines USS THEODORE ROOSEVELT (SSBN-600) and USS FRANCIS SCOTT KEY (SSBN-657). He was also Director, Attack Submarine Division in the Office of the Chief of Naval Operations, and Director, Polaris Operations, on the staff of the Commander-in-Chief, Atlantic. In addition to his nuclear training, Mr. Graham has an undergraduate degree in mathematics and an advanced degree in international relations.

He is a member of the American Nuclear Society and the Institute of Nuclear Material Managers.

SESSION 2

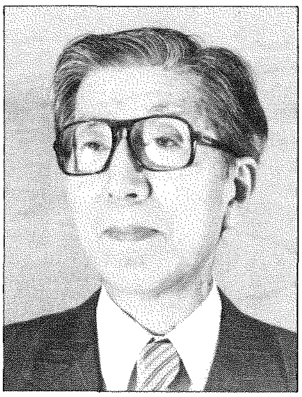


J. H. CHEN

Born on July 25, 1924
Education:
- University of California, Berkeley, 1969–1970 M.S. in Nuclear Engineering
- National University of Amoy, 1942–1946 B.S. in Electrical Engineering

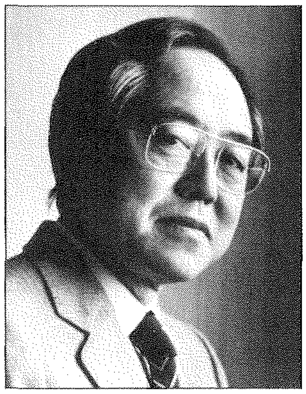
Experience:
Full Time (Taiwan Power Company)
1968 Deputy Director Power Research Lab.
1972 Deputy Director Atomic Power Department
1973 Superintendent Chinshan Nuclear Power Station
1976 Deputy Chief Engineer Nuclear Construction & Operation
1982 Chief Engineer Nuclear Power Operation
1982 Vice President Nuclear Power Operation
1984 Executive Vice President Nuclear Energy Group
1985~ President

Part Time:
1972 ~ 1984
Professor Nuclear Engineering Department National Tsing Hua University



MASAO SAKISAKA

Born on April 9, 1915
1938 Graduate (B.A.) Department of Economics, Tokyo Imperial University
1948~66:
Career official of the Economic Planning Agency; retired in 1966 after serving as Director of the Agency's General Planning Division.
1967 Founded the Institute of Energy Economics; served as President and Member of the Board of Directors of the Institute until 1976; from 1976 has served as Chairman of the Board of Directors.
1974~1979:
President, National Institute for Research Advancement (NIRA).
1980 Founded the International Energy Forum; currently serves as its Chairman
1985~ Commissioner, Japan Atomic Energy Commission.



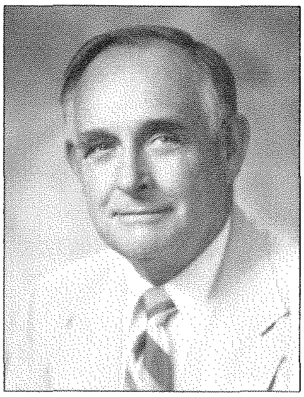
KEICHI OSHIMA

Born on Jan. 12, 1921 in Tokyo

Education
1944 Graduated from Department of Applied Chemistry, Faculty of Engineering the University of Tokyo
1959 Doctor of Engineering, the University of Tokyo

Employments
1950 Associate Professor (Applied Physical Chemistry), Institute of Science and Technology, the University of Tokyo
1958 Associate Professor (Cryogenics) Institute for Solid State Physics, the University of Tokyo
1961~81 Professor (Reactor and Radiation Chemistry) Department of Nuclear Engineering, Faculty of Engineering, the University of Tokyo
1974~76 Director for Science, Technology and Industry, OECD Paris (on leave from the University)
1981~ Professor Emeritus, the University of Tokyo
1981~ Vice Chairman, Industrial Research Institute, Japan

Other Professional Activities
1961~ Member of Advisory Committee on Industrial Technology to MITI
1977~ Member of Advisory Committee on Overseas Economic Cooperation to the Prime Minister
1979~ Advisor, STA, Prime Minister's Office



KENNETH M. CARR

Mr. K. M. Carr was sworn in for a five-year term as a member of the Nuclear Regulatory Commission on August 14, 1986. He retired from the U.S. Navy as a vice admiral on May 1, 1985, last serving as Deputy and Chief of Staff to the Commander in Chief of the U.S. Atlantic Fleet.

Mr. Carr enlisted in the Navy in 1943 and served as a crewman on an assault landing craft in the Pacific theatre .

In 1950 he entered submarine school in New London, Connecticut, and in 1953 was assigned to the precommissioning detail of the nuclear submarine USS NAUTILUS. With the exception of a one-year period for nuclear power training, he served as a member of the NAUTILUS crew until 1960.

He was assigned to the Office of the Chief of Naval Operations (Research and Development) in 1968. In 1973 he assumed duties of Military Assistant to the Deputy Secretary of Defense.

From June 1977 to May 1980, he commanded the Submarine Force, U.S. Atlantic Fleet. He served as Vice Director of Strategic Target Planning at Offutt Air Force Base, Nebraska, before assuming duties as Deputy and Chief of Staff to the Commander in Chief, U.S. Atlantic Fleet on April 1, 1983.

Commissioner Carr was born in Mayfield, Kentucky, on March 17, 1925, and is married to Molly Pace of Burkesville, Kentucky.

GUNTER LEHR

Director-General, Bureau of Energy, Biology and Ecology of the Federal Ministry for Research and Technology (BMFT)

Born in 1923

Studies and PhD in Physics (University of Marburg/Lahn)

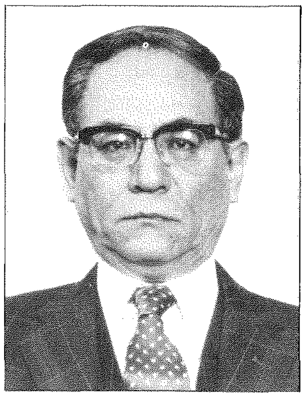
1950 Teacher in Higher Education

1956 Foreign Office

1957 Ministry for Atomic Affairs

1960 Max-Planck-Society, Institute for Plasma Physics

1968～Ministry for Science Research, for Education and Science, for Research and Technology



TAKAO ISHIWATARI

Born on Jan. 1, 1927 in Tokyo

1951 Graduated the Department of Metallurgy, the Faculty of Engineering, the University of Tokyo

1952 Joined the Ministry of International Trade and Industry (MITI)

1967 Director of Technology Research and Information Division, General Coordination Department, Agency of Industrial Science and Technology, MITI

1971 Director of Inter-ministerial R&D Division, Research Coordination Bureau, Science and Technology Agency (STA)

1974 Director of Promotion Division, Promotion Bureau, STA

1976 Counselor of Minister's Secretariat, STA

1978 Counselor of Minister's Secretariat, the Environment Agency

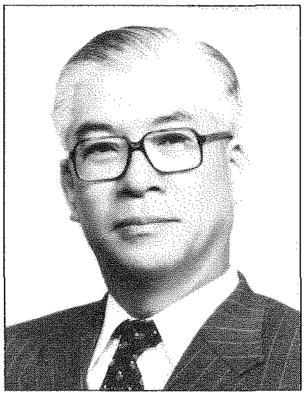
1979 Dirctor-General of Atomic Energy Bureau, STA

1982 Science Councillor, STA

1983 Vice Minister for Science and Technology, STA

1984 Resignation from STA

1984 Executive Vice President, Power Reactor and Nuclear Fuel Development Corporation (PNC)



TAKASHI YAMAZAKI

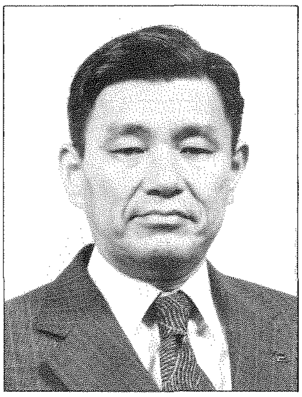
Born on Nov. 23, 1925 in Shizuoka Pref.

Title: Managing Director, Chubu Electric Power Co., Inc.
Vice Chairman, Nuclear Development and Policy Board, The Federation of Electric Power Companies

1949 B.S., Electrical Engineering, Nagoya University
1949 Entered Chubu Electricity Distribution Co. (Now Chubu Electric Power Co., Inc.)
1977 General Manager
1981 Director
1983 Managing Director

Official Position:

- Atomic Energy Society of Japan, Chairman of Chubu Branch
- Atomic Energy Commission Member, Radioactive Waste Committee
  Member, First Subcommittee Long-term Vision Committee
- Sience & Technology Agency Member, HLW Geological Disposal Committee
- Ministry of International Trade & Industry
  Member, Advisory Committee for Energy
  Member, Safety 21 Committee



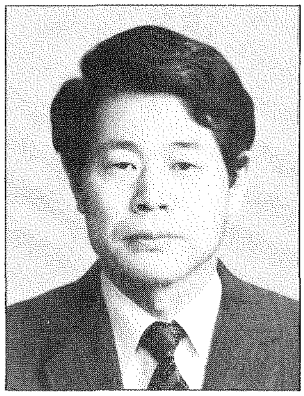
JOICHI AOI

Born on March 30, 1926

1948 Graduated from University of Tokyo, Electrical Engineering, Joined Tokyo Shibaura Electric Co., Ltd. (current Toshiba Corporation)
1978 Deputy Group Executive of Nuclear Energy Group (NEG) and Director
1980 Group Executive of NEG and Director
Senior Vice President and Director
1982 Executive Vice President and Representative Director
1984 Exectuve Vice President and Representative Director

Member of Committees (Major):

- Member of Sub-Committee on Nuclear Energy of Advisory Committee for Energy, MITI
- Member of Basic Policy Committee of Sub-Committee on Nuclear Energy of Advisory Committee for Energy, MITI
- Member of No. 1 Sub-Committee of Advisory Committee on Long-Term Program for Development and Utilization of Nuclear Energy, Atomic Energy Commission
- Chairman of Committee on Atomic Energy Policy, The Japan Electric Manufacturers' Association
- Member of General Project Planning Committee, Japan Atomic Industrial Forum, Inc.



YONEHO TABATA

Born in 1928, Nagano, Japan

1952 Undergraduate degree from Department of Applied Chemistry, the University of Tokyo
1961 Doctor of Engineering, the University of Tokyo

Academic Appointment:
Lecturer, (1956 ~ 1961)
Associate Professor, (1961 ~ 1972)
Professor, (1972 ~ present) at the University of Tokyo

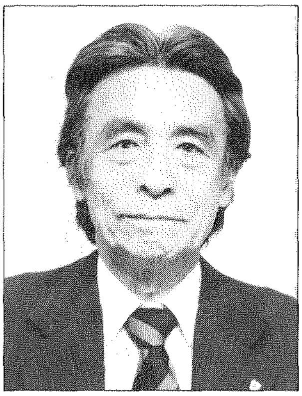
Guest Appointment:
Visiting Scientist, French Atomic Energy Commission, Saclay (1964 ~ 1965)
Visiting Professor, University of Maryland (1971)
Visiting Professor, Hahn-Meitner Institute, Berlin (1979)
Visiting Scientist, Japan Atomic Energy Research Institute (1966 ~ present)

Memberships:
Japan Chemical Society
Polymer Society of Japan
Japan Radiation Chemistry Society
International Society for Radiation Research
Atomic Energy Society of Japan

LUNCHEON

HAJIME TAMURA

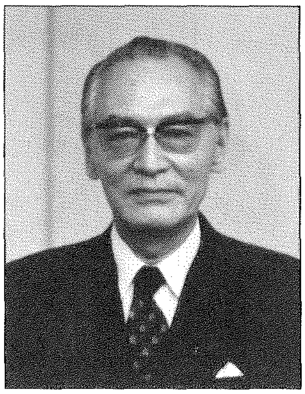
Born on May 9, 1924
1950 Graduated from Keio University, Faculty of Law
1955 Elected to the House of Representatives
1960 Parliamentary Vice-Minister, Ministry of Construction
1962 Parliamentary Vice-Minister, Ministry of Labour
1966 Chairman, Committee on Construction, House of Representatives
1968 Chairman, Committee on Finance, House of Representatives
1971 Chairman, Public Relations Committee, LDP
1972 Minister of Labour
1976 Minister of Transport
1979 Chairman, Committee on Budget, House of Representatives
1980 Chairman, National Organization Committee, LDP
1981 Chairman, Diet Policy Committee, LDP
1984 Chairman, Research Commission on the Party's Fundamental Policy and Operation, LDP
1986 Minister of Internatonal Trade and Industry



TSUNAHIDE SHIDEI

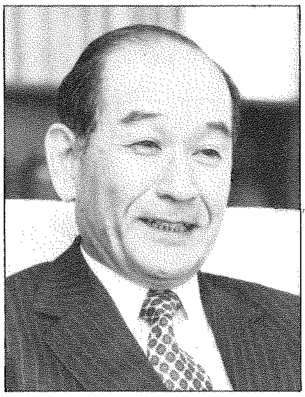
Born on Nov. 30, 1911
1937 Graduated from Kyoto Imperial University (Faculty of Agriculture)
1937 Entered Akita Regional Forestry Offices, Ministry of Agriculture and Forestry and Fisheries
1946 Engineer of the National Forest and Forest Products Research Institute
1954~1975 Professor, the Faculty of Agriculture, Kyoto University
1968 Member of the Science Council of Japan
1975~ Professor Emeritus, Kyoto University
1975~1981 Director, Japan Monkey Centre
1980~1986 Professor, Kyoto Prefectural University
1986~ Professor Emeritus, Kyoto Prefectural University

SESSION 3



HIROSHI MURATA

Born on Mar. 10, 1915
1937 Graduated of from Mechanical Course, Ryojun (Port Arthur) Institute of Technology
1958 First Secretary, Embassy of Japan in U.K.
1963 Director General, Resources Bureau, Science & Technology Agency (STA)
1964 Director General, Planning Bureau, STA
1964 Director General, Atomic Energy Bureau, STA
1967 Executive Director
Power Reactor and Nuclear Fuel Development Corporation (PNC)
1968 Vice President
Japan Atomic Energy Research Institute (JAERI)
1978 President, JAERI
1980~ Special Advisor to the President, JAERI
1981~ President, Nuclear Safety Research Association
1981~ Vice Chairman, Japan Atomic Industrial Forum (JAIF)
1983~1987 President, Japan Radiation Safety Technology Center (now Nuclear Safety Technology Center)



TSUNEO FUJINAMI

Born on Oct. 4, 1917 in Tokyo

1940 Graduated from the University of Tokyo in Electrical Engineering

1940 Entered the Agency of Electricity

1955 Director, Public Utilities Research Division, Public Utilities Bureau, the Ministry of International Trade and Industry (MITI)

1956 Director, Administration Division, Atomic Energy Bureau, Science and Technology Agency (STA)

1965 Deputy Director General, Public Utilities Bureau, MITI

1967 Director General, Atomic Energy Bureau, STA

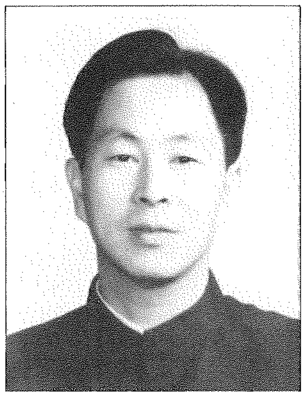
1968 Vice Minister for Science and Technology, STA

1972 Executive Director, Central Research Institute of Electric Power Industry

1976 President, Nuclear Power Engineering Test Center

1980 President, Japan Atomic Energy Research Institute

1986～Commissioner, Atomic Energy Commission



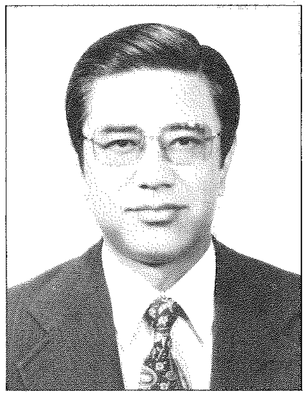
DING-FAN LI

Born on Oct. 21, 1940 in Changsha, Hunan Province

1958～1963
Studied in the Department of Radio-chemical Engineering, Huazhong Engineering College, Wuchang, Hubei Province

1963～1986
Worked in Lanzhou Nuclear/Fuel Plant, the Ministry of Nuclear Industry (MNI). Holding successivily the posts of Technical Secretary, Team leader, Deputy Section Head of Production, Head of Workshop, Deputy Chief Engineer, Deputy Plant Director, Director of Plant.

Apr. 1986～
Vice Minister, MNI



YONG-KYU LIM

Born on Aug. 23, 1933

Educational Background:

1952～56 B.Sc., Electrical Eng., Seoul National University

1957～58 International School of Nuclear Science & Eng., Argonne National Lab., U.S.A.

1958～59 Graduate School, University of Michigan, U.S.A.

1967～68 Research Fellow, Argonne National Lab., U.S.A.

1971 Ph.D. in Nuclear Engineering, Seoul National University

Professional Career:

1960 Senior Research Staff, Atomic Energy Research Institute

1972 Research Coordinator, Ministry of Science and Technology (MOST)

1973 Scientific Attache, Embassy of Korea, Washington D.C., U.S.A.

1976 Director-General, Technical Cooperation Bureau, MOST

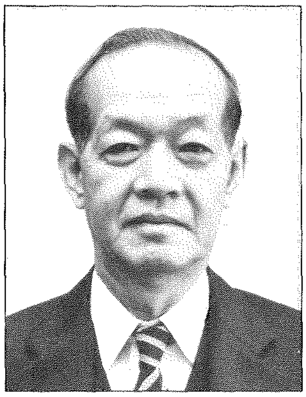
1979 Secretary-General (Concurrent Position) Korea Science and Engineering Foundation

1979 Director-General, Science Promotion Bureau, MOST

1980 Director-General, National Science Museum, MOST

1981 Commissioner, Atomic Energy Commission, MOST

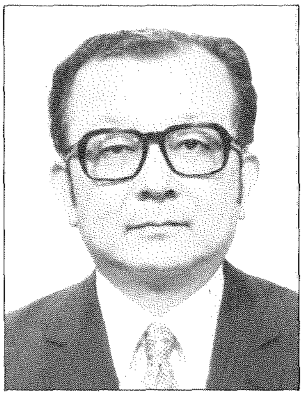
1985 Auditor-General, Concurrent Professor, Korea Advanced Institute of Science and Technology



MICHIO MUTAGUCHI

Born on March 31, 1918

1946 Graduated from Tohoku Imperial University (Department of Sociology)
1947 Entered Ministry of International Trade and Industry
1972 Director of Research and Statistics Dept., Minister's Secretariat
1973 Director of Secretariat, Science and Technology Agency
1974 Director of Atomic Energy Bureau, STA
1974 Entered IBM Japan, Ltd.
1978～80 Managing Director of IBM Japan, Ltd.
1981～85 Executive Vice President of Arctic Petroleum Corporation Japan, Ltd.
1985～ Vice-President of Japan International Cooperation Agency (JICA)



TOYOAKI IKUTA

Date of Birth: July 16, 1925

Present Titles:
President, The Institute of Energy Economics, Japan

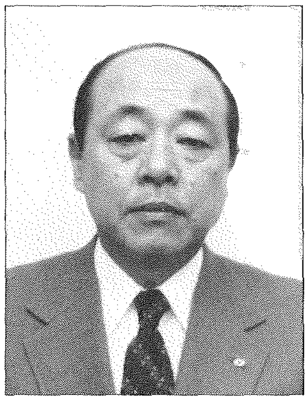
Member of some governmental councils, such
Industrial Structure Council, Industrial Technology Council, Advisory Committee for Energy (Chairman of Energy Demand and Supply Committee), Petroleum Council, Electric Utility Council

Educational Qualification:
B. A. (Economics) 1948 University of Tokyo, Japan

Previous Occupation:
After graduation from University of Tokyo, joined Ministry of International Trade and Industry (MITI) and served in various positions in planning and served in various positions planning and conducting trade-industrial policy, not only in MITI, but in other governmental agencies such as the Economic Planning Agency, Defense Agency, Science & Technology Agency and the Embassy of Japan in the Philippines.

Last governmental post was Director General of Atomic Energy Bureau, STA for almost two years.

In January 1976, retired from government service and was appointed to the present post of the Institute.



HIROSHI OISHI

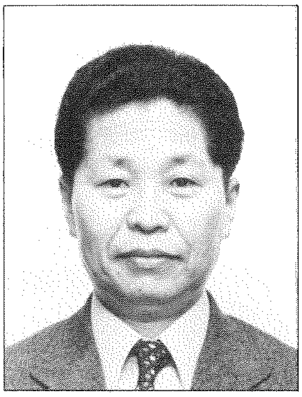
Born on October 8, 1928 in Fukuoka

1951 Bachelor of Electrical Engineering, Kyushu University, School of Engineering
1951 Joined Nihon Electric Power Generation and Distribution Co., Ltd.
1951 The Kansai Electric Power Co., Inc.
1973 Manager, Thermal Power Dept.
1978 Chief, Himeji District Office
1979 General Manager in charge of nuclear power operations
1983 Elected to the member of the Board of Directors with the same office responsibility
1986 Managing Director

SESSION 4

L. M. PANGGABEAN

Born on 1933, in Turutung, Sumatra
1972 PhD
1972~79 Lecturer at the University Malaya, Kualalumpur, Malaysia
1979~Now Director, Energy Conversion and Conservation Technology, BPPT, Jakarta

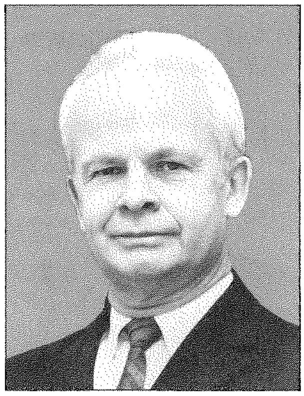


MASAO NAKAMURA

Born in 1933
1955 Graduate from Kyoshu Institute of Technology
1955 Engineer of Tokyo Metoropolitan Office
1959 Entered the Yomiuri Shimbun
City desk writer, Science writer, Staff writer
Now: Editorial writer (since 1983)

Author of books:
- Nuclear and Its Environment,
- Climate Resource, Metrological Economy
- Science Story for Junior, etc.

Other Position:
- Member of Industrial Technology Council
- Member of Advisory Committee on climate, etc.



JEAN-PAUL CRETTE

Born on April 17, 1929, in Paris

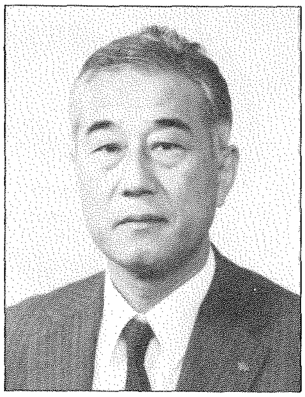
Education:
- Diplômé de l'Ecole Polytechnique
- Diplômé du Génie Atomique
- Diplômé de l'International School of Nuclear Science and Engineering of Argonne, U.S.A.

Professional Carrier:
- Beginning in nuclear engineering in 1954: has participated in studies and constructions of many reactors in Europe, both experimental and power reactors of different types: gas graphite, heavy water, LWR
- Completely devoted to LMFBR engineering since 1967:

1967~1974
Responsible for the design and construction of PHENIX plant

1975~1986
Technical Director of NOVATOME, and responsible for the design and construction of SPX1, and the design of SPX2

- Presently: Technical Adviser at NOVATOME



MICHIO ISHIKAWA

Born on March 2, 1934

Education:

1956 Graduate from the Department of Mechanical Engineering, The Faculty of Technology, The University of Tokyo

1966~67 Study in the U.S. Idaho National Engineering Laboratory as Government student

1972 Doctor of Engineering (The University of Tokyo)

Occupational Career:

1957 Enter the Japan Atomic Energy Research Institute

1969 Senior Engineer

1972 General Manager, Reactivity Accident Laboratory, Department of Reactor Safety Research

1974 Principal Engineer

1980 Deputy Director, Department of Reactor Safety Research

1983 Director, Department of Nuclear Safety Evaluation

1985~ Director, Department of JPDR

Public Positions:

1974 Research Member, Committee on Nuclear Power Safety Examination

1979 Nuclear Safety Technology Advisor, Science and Technology Agency
Special Member, Nuclear Safety Commission
Nuclear Power Generation Technology Advisor, Ministry of International Trade and Industry

REIJIRO AOKI

Born on January 30, 1926

1949 Graduated from the Technology Department of Kyushu University

1949 Joined Mitsubishi Heavy Industries, Ltd.

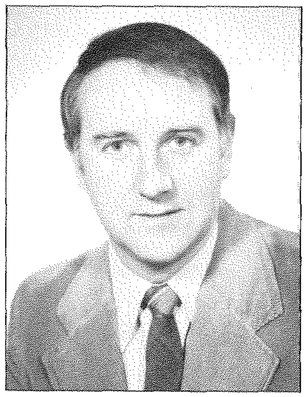
1978 Deputy General Manager of Kobe Shipyard & Engine Works

1982 General Manager of Nuclear Systems Engineerng Department of Power Systems Headquarters

1983 Assistant General Manager of Power Systems Headquarters

1984 Deputy General Manager of Power Systems Headquarters

1985 Director, Deputy General Manager of Power Systems Headquarters



GERARD F. LYNCH

Born on October 10, 1945

Education

1967 B.Sc. (Physics) – Glasgow University, Scotland

1971 Ph.D. (Physics) – Queen's University, Ontario

Professional experience

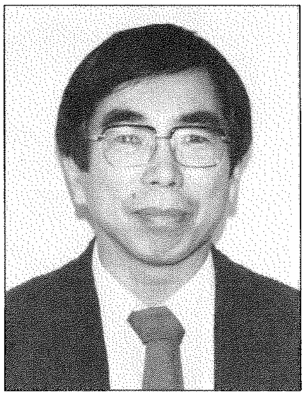
1972~72 Lecturer in Applied Physics at Queen's University

1972~84 Staff Scientist at AECL's Chalk River Nuclear Laboratories

1981~84 Head of the Electronics Branch at the Chalk River Nuclear Laboratories of AECL.

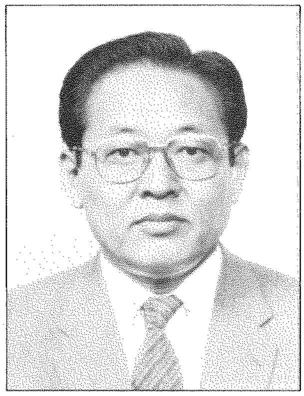
1984~85 Executive Assistant to Mr. James Donnelly, President and Chief Executive Officer of AECL.

1985~Present General Manager of the Local Energy Systems Business Unit of Atomic Energy of Canada Limited (AECL). In this capacity, Dr. Lynch has the overall management responsibility for the commercial development of small reactors for community heat and electricity production. These responsibilities include market and product development as well as establishing the necessary business arrangements to facilitate the adoption of the technology on an international basis.



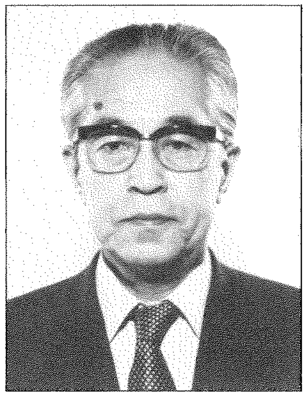
YOICHI KAYA

Born on May 18, 1934
Education and degrees:
from the University of Tokyo
1957 B.A. (Engineering)
1959 M.A. (Engineering)
1962 Doctor of Engineering
Teaching and research:
in the University of Tokyo
1962 Lecturer, Department of Electrical Engineering
1963 Associate Professor
1974 Associate Professor, Engineering Research Institute
1978~ Professor, Department of Electrical Engineering,
1963~64 Instructor, Department of Aeronautics and Astronautics, MIT (USA)
1971~72 Visiting Research Fellow, in Battlle Memorial Institute
Research activities:
1957~70 Mainly control theory and applications, especially on the methodology of process identification
1970~ System analysis and modeling of energy systems and social systems
Present activities in the government
- Project leader, energy system study, Ministry of Education, Science and Culture
- Advisor, Science and Technology Agency
- Member of the transportation policy committee, Ministry of Transportation
- He chairs several governmental committees in MITI and STA



KUNIHIKO UEMATSU

Born on May, 4, 1931
1954 Graduated from Kyoto Univ.
1956 Master of Science from Kyoto Univ.
1961 Doctor of Philosophy from MIT, USA
1961 Lecturer of Kyoto Univ.
1964 Joined Atomic Fuel Corporation
1968 Senior Research Engineer FBR Project, PNC (Power Reactor and Nuclear Fuel Development Corporation)
1982 Director of Fuels Development Division, PNC
1983~ Executive Director, PNC



KENZO YAMAMOTO

Dr. Yamamoto, Professor Emeritus of Nagoya University, is Senior Advisor to Japan Atomic Industrial Forum Inc. and Expert Advisor of Japan Atomic Energy Research Institute.

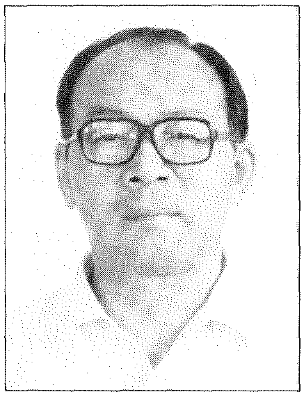
As a key member of the Nuclear Fusion Council of the Atomic Energy Commission, he has been engaged in making and promoting the Japan's national program on nuclear fusion development. Dr. Yamamoto also serves as Vice Chairman of the Fusion Power Coordinating Committee of the IEA. At JAIF he serves as chairman of the Committee on Nuclear Fusion, which was established in 1980.

Dr. Yamamoto was with the Japan Atomic Energy Research Institute from 1971 to 80; for first seven years as Director responsible for nuclear fusion development and for another two years as Vice President. He also served as President, the Atomic Energy Society of Japan, 1977~80, and is President of the Japan Society of Plasma Sciences and Nuclear Fusion Research, established April 1983.

After graduation from the Department of Electrical Engineering, University of Tokyo, he joined Fujitsu Co. as an engineer in 1937. From 1940, he became associate professor of the Nagoya University and from 1952 to 1971 professor.

HIROSHI TAKUMA

Born on June 8, 1930, in Tokyo
1953 Graduated from Department of Physics, University of Tokyo
1962 Doctor of Science (University of Tokyo)
1953 Researcher at the Central Technical Laboratory, Nippon Oil Co.
1956 Research Associate, University of Tokyo
1959 Lecturer, University of Tokyo
1963 ~ 1964 Physicist, Boulder Laboratory, Department of Commerce, National Bureau of Standards
1965 Associate Professor, University of Tokyo
1967 Professor, University of Tokyo
1970 R&D Director, JEOL
1974 Professor, University of Electro-Communications
1974 ~ 1977 Professor Adjoint, Osaka University
1980 ~ Professor and Director, Institute for Laser Science, University of Electro-Communications



KEN KIKUCHI

Born on Oct. 4, 1929
Education:
1953 Bachelor of Science (University of Osaka)
1958 Doctor of Science (University of Osaka)
History of Employment:
1956 Research Associate of Institute of Nuclear Science, Univ. of Tokyo
1958 Lecturer of University of Minnesota (USA)
1960 Associate Professor of Dept. of Physics, Univ. of Nagoya
1972 Professor of Accelerator Dept., National Laboratory for High Energy Physics
1978 ditto and Director of Engineering Research & Scientific Support Dept., National Laboratory for High Energy Physics
1982 ditto and General Director of TRISTAN Project
1983 ~ General Research Coordinator for High Energy Physics

TADAO OHGAKI

Born on July 13, 1918
1941 Graduate from the Faculty of Law, the University of Tokyo
1975 Director and General Manager of Siting Dept., the Tokyo Electric Power Co., Inc.
1977 Managing Director, TEPCO
1980' Director, TEPCO
Vice Chairman, the Federation of Electric Power Companies
1985 ~ President, Japan Nuclear Fuel Co., Inc.

KENZABURO KOBAYASHI

Born on Dec. 8, 1912 in Kouchi Pref.

1935 Graduated from the Department of Civil Engineering, Faculty of Engineering, Kyoto University

1935 Entered Kobe Municipal Office

1953 Entered the Tokyo Electric Power Co., Inc. (TEPCO)

1970 Director and Deputy General Manager, Environmental Pollution Administration, TEPCO

1977 Managing Director and General Manager, Transmission & Transformation Facilities Construction Administration, TEPCO

1980 Vice President, the Japan Nuclear Fuel Service Co. (JNFS)

1984~President, JNFS

MASATOSHI TOYOTA

Born on June 28, 1923

1945 Graduated from the Electrical Engineering Division, Engineering Department of the Imperial University of Tokyo. Joined Japan Electric Generation and Transmission Co.

1951 Joined the Tokyo Electric Power Co.

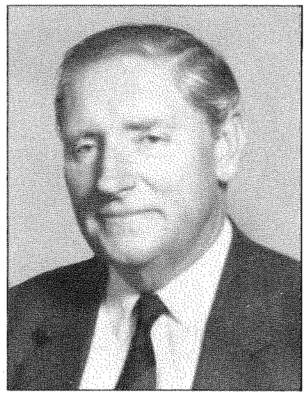
1974 General Manager of Nuclear Safety Dept.

1977 Director, Deputy Executive Chief of Nuclear Power Development Center

1979 Managing Director, General Manager of Nuclear Power Development Center

1985 Executive Vice President, General Manager of Nuclear Power Center

1986 Executive Vice President



JEAN-HUBERT COATES

Born in 1930, Mr. Jean-Hubert COATES graduated as a Grenoble chemical engineer in 1954.

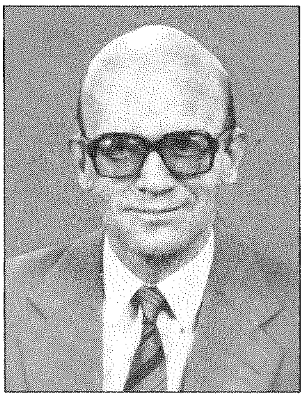
After having worked five years in a small private company already involved in enrichment, he entered the French Atomic Energy Commission (CEA) in 1962 with the specific task of starting up and optimizing the Pierrelatte diffusion plant.

In 1970 he was called to CEA's head office in Paris as special assistant for enrichment to Michel PECQUEUR who was to become Chairman of the CEA in 1978. Since 1971, Mr. COATES has been deeply involved in French uranium enrichment policy.

He headed with Mr. Akio Nomura the Franco-Japanese group on enrichment in 1971 and was Eurodif's board secretary from creation until 1979.

He shared the "Grand Prix de l'Energie" awarded by French Banks (Société Générale) in 1982 for work on chemical enrichment.

He is presently Deputy Director of CEA's Isotope Separation Division with special implication in laser isotope separation.



JUERGEN ALFRED PALEIT

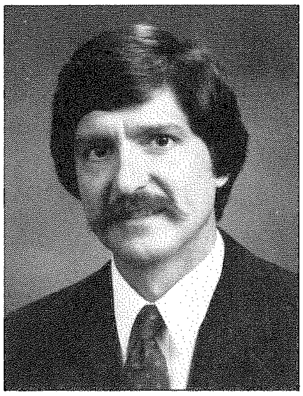
Born on July 12, 1944, in Poland Mr. Paleit studied at the Universities of Koln (Cologne) in West Germany, the Technical University of Aachen, West Germany (aix-la-chapelle). He received his Bachelor Degree in Economics from London University and Master Degree in Business Administration from Koln University.

Mr. Paleit joined Uranit GmbH (German Shareholder of Urenco Ltd.) in 1971 and was mainly involved in the setting up of the British, Dutch, German central Urenco companies.

In early 1973 he was transferred from Uranit to Urenco Ltd. in Marlow where he became, after some initial involvement in the enrichment plant build-up activities, primarily concerned with the marketing and sales of long term enrichment services to utilities in many countries. He was appointed Commercial Manager and subsequently Deputy Commercial Director of Urenco Ltd. in which capacity he negotiated many of the long term enrichment contracts in Urenco's order portfolio.

In 1984 he was promoted to Finance and Planning Director of Urenco Ltd. and Commercial Director of Centec GmbH

In 1985 Mr. Paleit became Finance and Commercial Director of Urenco Ltd. in charge of all marketing and sales and financial activities of Urenco Ltd.



JOHN R. LONGENECKER

John R. Longenecker is the Deputy Assistant Secretary for Uranium Enrichment, Office of Nuclear Energy, U.S. Department of Energy (DOE). In this position he is responsible for overall management and execution of the Uranium Enrichment Program including gaseous diffusion, atomic vapor laser isotope separation, and enrichment business operations.

Prior to this assignment, Mr. Longenecker served as Director of the Office of Breeder Demonstration Projects, where he was responsible for program management of the Clinch River Breeder Reactor Plant (CRBRP) Project, licensing of breeder demonstration projects, and conceptual design of the Liquid Metal Fast Breeder Reactor (LMFBR) Large Scale Prototype Breeder.

Previously, Mr. Longenecker served as Director, Plant Development Division; and in other positions in DOE and its predecessor agencies since 1973.

Mr. Longenecker received both his B.S. and M.S. degrees in engineering mechanics from Pennsylvania State University. He was born in Port Royal, Pennsylvania, on July 27, 1949, and resides in Monrovia, Maryland with his wife Bonnie and daughter Laura.

JEAN-PIERRE ROUGEAU

Graduated from Ecole des Mines de Paris in 1960 as an engineer in chemical engineering. Then he joined the ISPRA Research Center of European Economic Community to head the core components test section.

In 1967, he joined the Commissariat à l'Energie Atomique (CEA) and served in various positions. From the Fuel Elements Control Department, he moved to a supervisory position in economic and optimization studies regarding the fast breeder program.

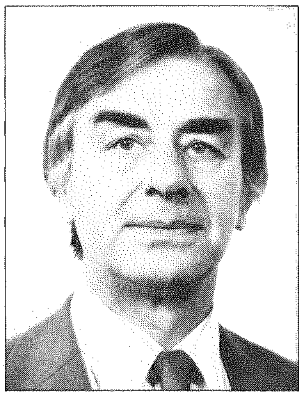
He joined the isotopic enrichment field in 1971, where he managed the economic and marketing aspect of several international feasibility studies for large uranium enrichment projects.

Responsible of EURODIF marketing activities since 1973, when the Company was established, he acted as Commercial Director of the EURODIF from 1976 to early 1983.

In March 1983, he has been appointed Vice-President, Marketing and Sales Division of COGEMA. He is President of URANEX and Chairman of the Board of COMMOX and UREP.

WULF BÜRKLE

Born on November 11, 1939 in Celle
Education:
1959~1966
Technical University of Braunschweig Diploma in Mechanical and Chemical Engineering
1968 Siemens AG, development of advanced reactors
1970 Siemens AG, development of heavy water reactors
1971 Siemens and Kraftwerk Union AG:
(Light water reactors: Biblis and Iran I+II nuclear power plants)
1980 INB, executive manager, Kalkar Nuclear Power Plant
1982~ Interatom GmbH, Vice President
(Breeder reactors, high temperature reactors)
1986~ Kraftwerk Union AG, Vice President
(Product Management, Nuclear Power Plants and Nuclear Fuel Reprocessing Plants)



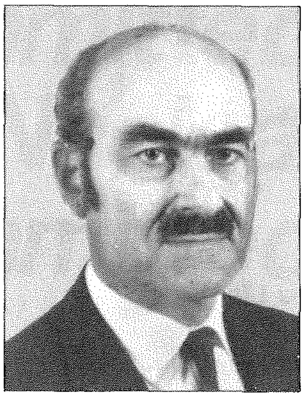
W.L. WILKINSON

Born on 16 February, 1931 in England
Education:
University of Cambridge 1950~56
Studied Mechanical Sciences & Chemical Engineering
Awarded MA degree in 1954
Awarded PhD degree in 1956
Career:
UKAEA Technical Management 1959~67
Professor, Chemical Engineering at University of Bradford, England, 1967 ~ 1979
Joined BNFL in 1979
Assistant Managing Director 1979
Director Engineering, Reprocessing Division 1982~84
Technical Director 1984~86
Director, Spent Fuel Management Services 1986
Deputy Chief Executive 1986

JEROME PELLISSIER-TANON

Born on the 7th of July, 1935 in Paris (France)
1954~ 56 Graduate of Ecole Polytechnique
1956~ 59 Graduate of the Paris School of Mines
1968 Graduate of the Harvard Business School PMD
Presently Chairman of the Board and Chief Executive Officer of Comurhex.

History of Employment:
1959~ 61 Mining geologist
1961~ 68 Aluminium smelting superintendant
1969~ 70 Aluminium smelting plant manager
1971~ 73 International business administration
1974~ 78 Assistant general manager of Pharmuka (pharmaceutical industry)
1979~ 83 Assistant general manager of Lorrilleux Lefranc International (Printing Ink Industry)
1984 Present assignment with Comurhex
Since 1961, all activities have been performed within the Pechiney Group.



HUBERT BAIRIOT

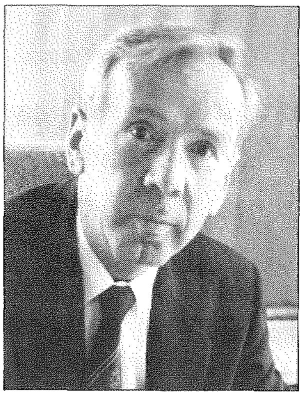
Born on April 11, 1931 at LEUVEN (Belgium)

Education:

- 1954 Metallurgical Engineer, Université de Louvain (Belgium)
- 1956 M.S. Actuary, Université de Louvain
- 1957 M.S. Nuclear Engineering, Massachusetts Inst. of Technology, Cambridge, USA

Occupation:

- 1959 Seconded to the Argonne National Lab/USA for the manufacture of Pu fuels
- 1961 In charge of Rod Manufacturing Section of the Joint Pu Group CEN/SCK-BN
- 1963 In charge of the Belgian R&D programme on Pu recycle in LWRs, HWRs and HTRs.
- 1973 In charge of LWR fuel engineering activities of BN (engineering know-how development, qualification of fuel manufacturers, supply of reload fuel & related core management studies)
- 1980 Manager, LWR fuel projects
- 1094~ Vice President, COMMOX (supply of MOX fuel fabrication and related services) and Manager Thermal Reactor Fuel BN (fuel development, fuel design, reload supply, core design, and related safety analysis)



WOLFGANG STOLL

Prof. Dr. W. Stoll was born in Austria in 1924.

After graduating from the Technical University of Vienna, he spent ten years on research and production in inorganic chemistry before moving first to Canada, where he trained in nuclear technology at AECL, and then to Hanford in the USA.

Since 1960 he has been Technical Manager in the nuclear fuel industry, and General Technical Manager of ALKEM since its foundation in 1964. He spent three years on research and development at NUKEM, and is a Board member of KTG and the Wirtschaftsverband Brennstoffkreislauf, as well as he was a member of the German Fast Breeder Parliamentary Commission.

He is Honorary Professor of Technical Radiochemistry at Karlsruhe University.

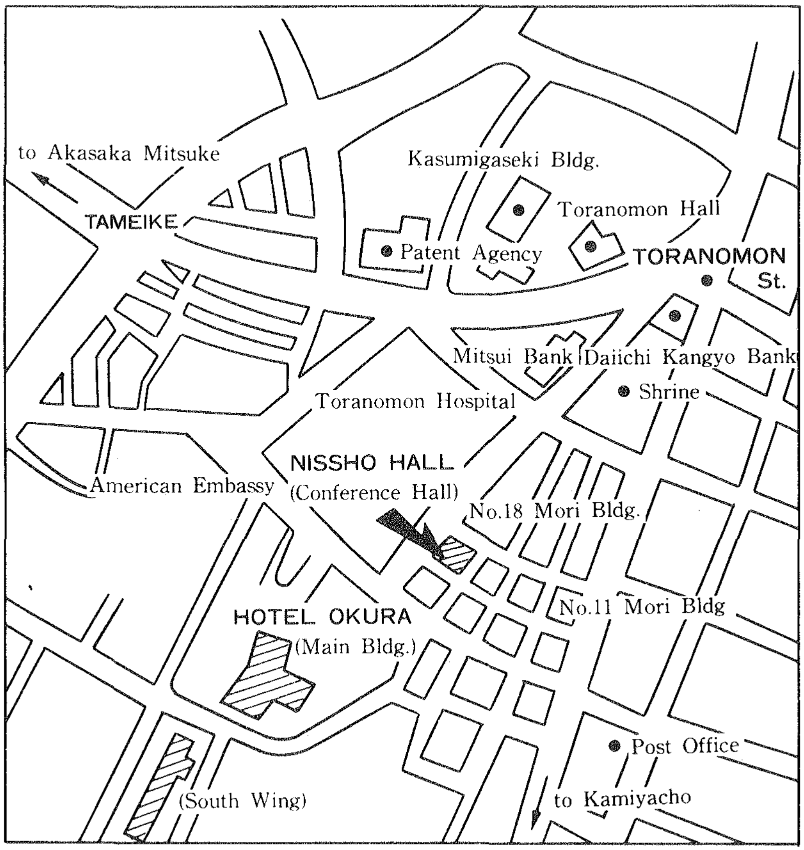
NISSHO HALL

9-16, Toranomon 2-chome, Minato-ku, Tokyo
Tel. (03) 503-1486

HOTEL OKURA

10-4, Toranomon 2-chome, Minato-ku, Tokyo
Tel. (03) 582-0111

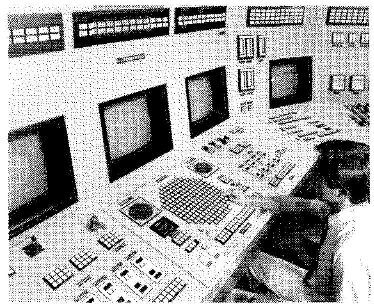
- 2 min. walk from Toranomon St. (Subway: Ginza Line)
- 5 min. by car from Shimbashi St. (Japanese National Railway, Subway; Ginza Line, Toei Asakusa Line)
- 10 min. by car from Akasaka-Mitsuke St. (Subway: Ginza Line, Marunouchi Line)
- 10 min. by car from Yotsuya St. (Japanese National Railway)



SECRETARIAT

Office of Planning and International Affairs
Japan Atomic Industrial Forum, Inc.
1-13, Shimbashi 1-chome, Minato-ku, Tokyo 105, Japan
Telex: 222-6623 JAIFRM J
Cable: JATOMFORUM TOKYO
Phone: 03-508-9056
03-508-2411, Ext. 57, 58
Fax.: 03-508-2094

TOSHIBA, Committed to Leading the Nuclear Industry, Committed to Quality.



Toshiba has made a committed effort to develop the nuclear energy industry in Japan, including the following activities:

- Toshiba has been engaged in the planning, design, manufacture, installation, and preoperation of nuclear power plants.
- Toshiba has operated a large research and development program.
- Toshiba has gained extensive nuclear steam supply system technology and nuclear fuel technology from nuclear power plants in operation or under construction.
- Further, Toshiba has trained many nuclear power station operators.

Toshiba's responsibility to provide safe, reliable, and economical nuclear energy is shared by everyone in the company.

From manufacturing, design, research and development to customer service, we are aware as both employees and citizens that progress must be coupled with a thorough and on-going commitment to quality.

Fukushima Daiichi Nuclear Power Station is the world largest Nuclear Power Station of total 4,696 MWe capacity owned by Tokyo Electric Power Co. Inc.

Toshiba has been involved in design and construction works and various kinds of maintenance works at this station in these more than 15 years.

TOSHIBA TOSHIBA CORPORATION

ENERGY SYSTEMS GROUP 1-6, Uchisaiwaicho 1-chome, Chiyoda-ku, Tokyo, 100 Japan
PHONE: (03) 597-2068 CABLE: TOSHIBA TOKYO TELEX: J22587, J24681 TOSHIBA