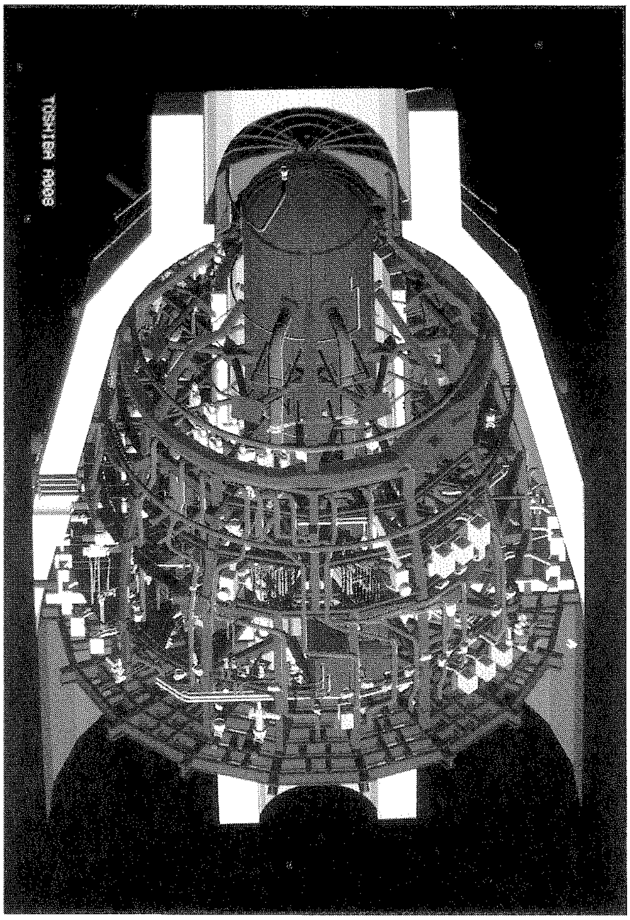
The 21st JAIF ANNUAL CONFERENCE

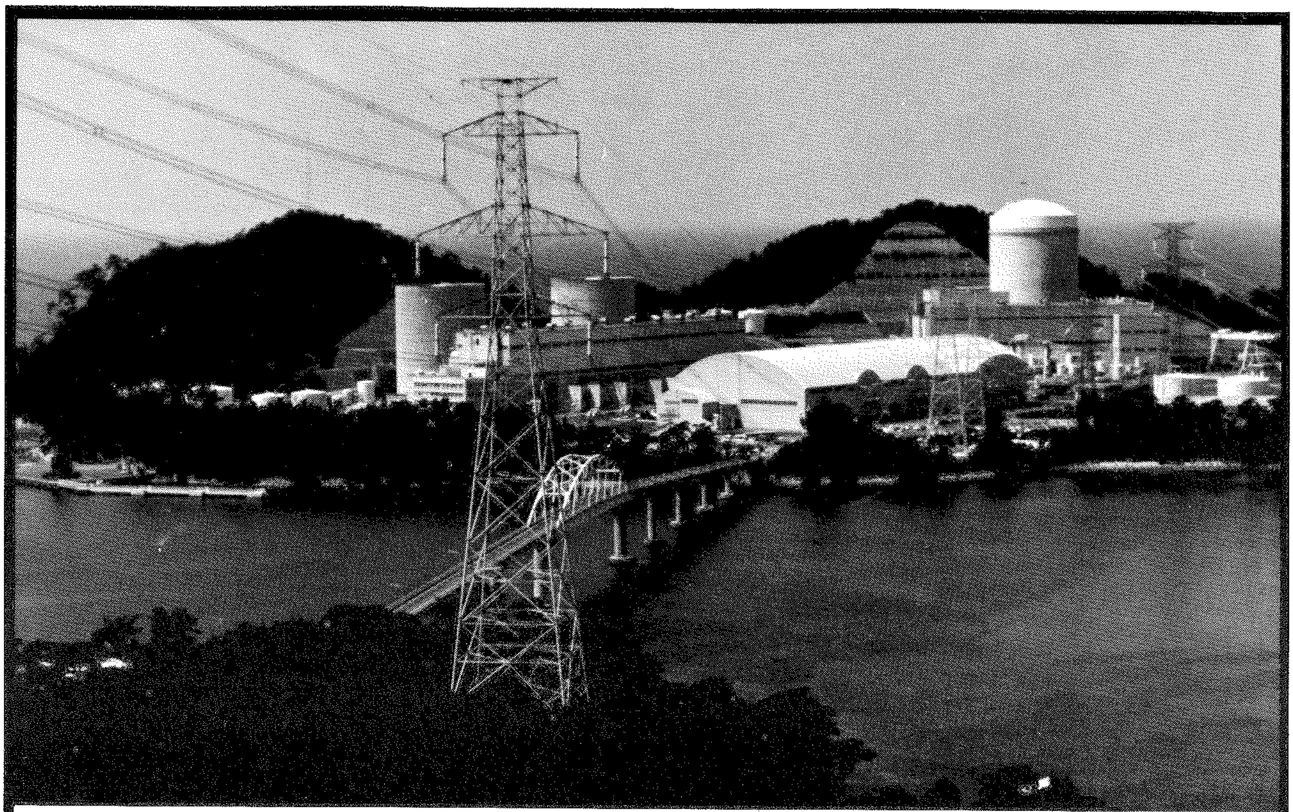
ABSTRACTS

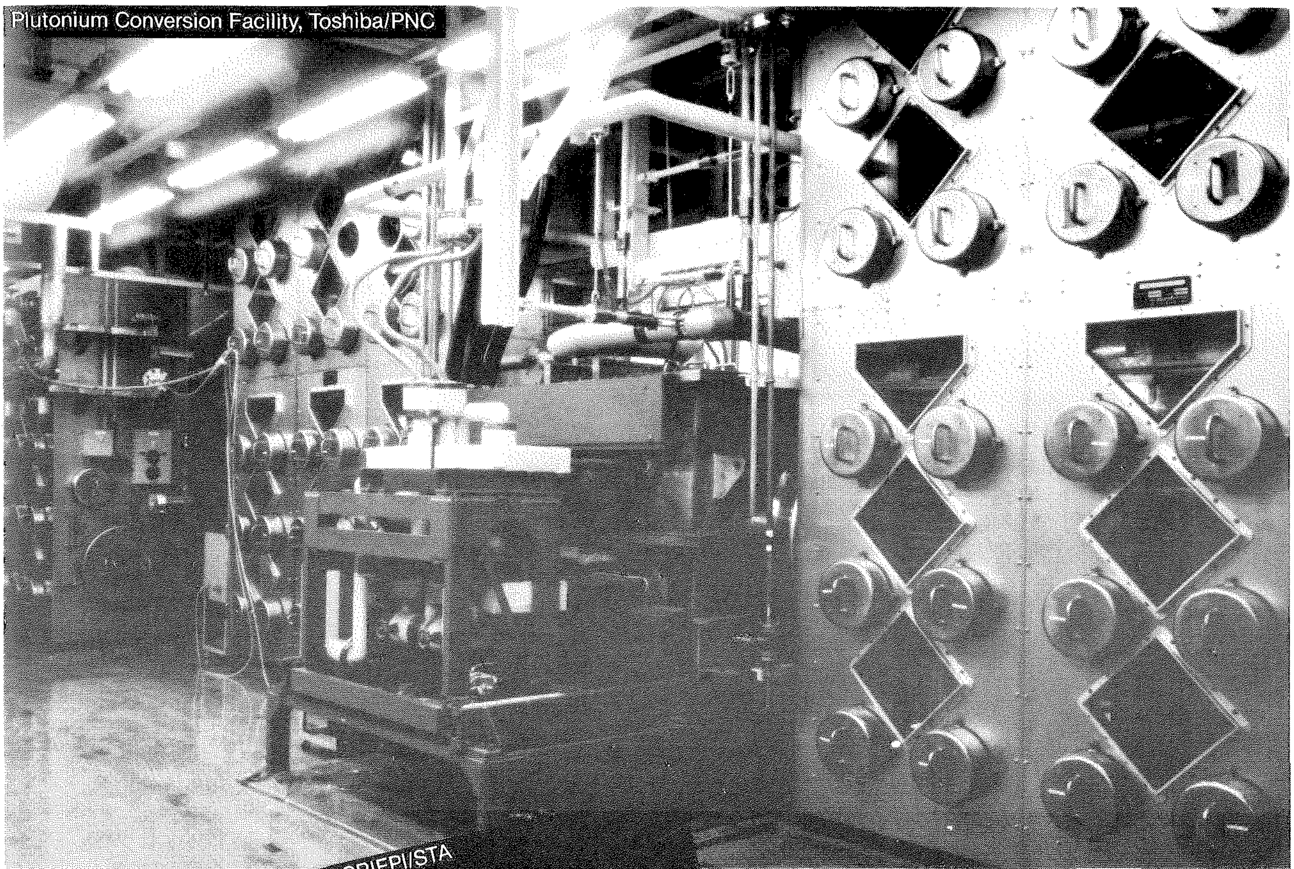
13–15 April 1988

Tokyo Yubinchokin Hall

JAPAN ATOMIC INDUSTRIAL FORUM, INC.



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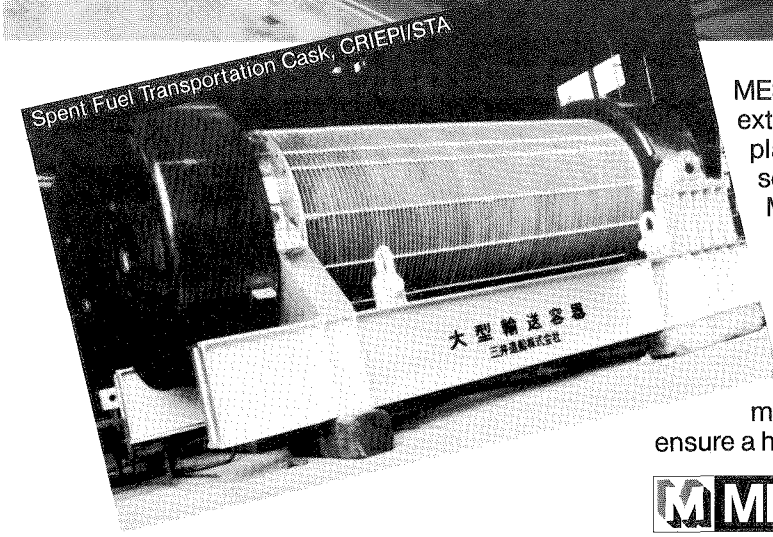
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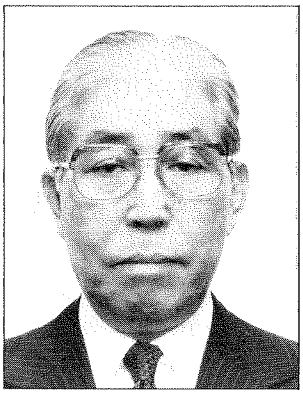


Jiro Enjoji
Acting Chairman, JAIF

Shoh Nasu
Chairman, Program Committee

Basic Theme — Nuclear Power: Assessment for World Energy Option

Installed nuclear generating capacity has world-wide been increased to 400 units with a total capacity of 300 GWe, a great contribution to the progress of the world economy and society by the steady supply of energy. The role and responsibility of nuclear power is growing bigger and heavier year by year.

On the other hand, some countries seem to be slowing down nuclear power development because of the Chernobyl accident the year before last, and the recent slackening of demand and supply of oil. The environment surrounding nuclear power development is very fluid.

At the 21st JAIF Annual Conference, based on this situation, energy problems will be examined from the global long-term viewpoint, and the significance and role of nuclear power development will be evaluated from the socio-economic, industrial and technical, environmental and resources aspects.

In the situation of competitiveness among the various forms of energy becoming increasingly sharp, Japan has various subjects to be taken up so that nuclear power can fill the role of a major source of electricity.

It is our sincere hope that this year's conference will provide a valuable opportunity for all participants from the various countries to engage in full discussions on the future of nuclear power development and the present developmental policy in each country, ways of international cooperation, and efforts to further improve reliability and confidence in the "Light Water Reactor Age," which is expected to last longer than previously thought; at the same time the firm attitude towards nuclear development in Japan will be clarified.

21ST JAIF ANNUAL CONFERENCE

PROGRAM

WEDNESDAY, APRIL 13

9:30 am — 12:20 pm
OPENING SESSION

Chairman:

Yutaka Takeda	Representative Director and Chairman Nippon Steel Corporation

Remarks by Chairman of Program Committee

Shoh Nasu	President Tokyo Electric Power Co., Inc.

JAIF Chairman's Address

Jiro Enjoji	Acting Chairman Japan Atomic Industrial Forum

Remarks by Chairman of Atomic Energy Commission

Soichiro Ito	Chairman, Atomic Energy Commission Minister of State for Science and Technology

SPECIAL LECTURES

Chairman:

Kamesaburo Matsunaga	President and Director Chubu Electric Power Co., Inc.

Mid and Long Term World Energy Strategy

Helga Steeg	Executive Director OECD International Energy Agency

Energy Systems in the 21st Century and the Significant Role of Nuclear Energy

Wolf Häfele	Director General Jülich Nuclear Research Center Federal Republic of Germany

World Energy Problems and Japan's Future Course

Toyoaki Ikuta	President Institute of Energy Economics, Japan

1:40 pm — 6:00 pm

SESSION 1: THE ENERGY COMPLEX AGE AND NUCLEAR POWER POLICY

Chairman:

Yoshinori Ihara	President Japan Atomic Energy Research Institute

The Development of Nuclear Energy and Safety Policies in the Federal Republic of Germany

Klaus Töpfer	Federal Minister for the Environment, Naure Conservation and Reactor Safety Federal Republic of Germany

Nuclear Electricity, the Answer to the Energy Challenges of the Century to Come

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

Prospects for Nuclear Power Development in China

Zhao-Bo Chen	Vice Minister Ministry of Nuclear Industry China

Nuclear Energy Development in Japanese Energy Policy

Keichi Oshima	Professor Emeritus University of Tokyo

Chairman:

Toshio Tamakawa	Representative Director and Chairman Tohoku Electric Power Co., Inc.

Nuclear Energy Industry in Bulgaria — Present State and Its Development

Nikola Todoriev	Minister Chairman, Energy Industry Association Bulgaria

Nuclear Power in the United States: Providing Electricity to Replace Imported Oil

Harold B. Finger	President and Chief Executive Officer U. S. Council for Energy Awareness

Nuclear Power Issues — Political and Social Implications

Ken Ohtani	Journalist

6:30 pm — 8:00 pm

JAIF Chairman's Reception

Room "HO-O"
TOKYO PRINCE HOTEL

THURSDAY, APRIL 14

9:30 am — 12:00 noon

SESSION 2: FOR COOPERATION AMONG ASIAN COUNTRIES IN UTILIZATION OF NUCLEAR ENERGY (Panel Discussion)

Chairman:

Hiroshi Murata	Vice Chairman Japan Atomic Industrial Forum

Keynote Address:

"Development of Regional Nuclear Co-operation in Asia"

Noramly bin Muslim	Deputy Director General Head, Department of Technical Co-operation International Atomic Energy Agency

"Overview of Nuclear Cooperation in Asia"

Yosuke Nakae	Commissioner Atomic Energy Commission

Panelists:

Noramly bin Muslim	Deputy Director-General International Atomic Energy Agency
Xue-Hong Liu	Deputy Director General Bureau of Foreign Affairs Ministry of Nuclear Industry China
Djali Ahimusa	Director General Badan Tenaga Atom Nasional Indonesia
Pil-Soon Han	President Korea Advanced Energy Research Institute
Quirino O. Navarro	Director Philippine Nuclear Research Institute
Katsuhisa Ida	Deputy Director-General Science and Technology Agency
Ko Takeda	Executive Managing Director Japan Electric Power Information Center, Inc.

12:20 pm — 2:30 pm
<u>LUNCHEON</u>

Room "HO-O"
TOKYO PRINCE HOTEL

Remarks: Hajime Tamura
Minister for International Trade and Industry

Special Lecture: "Interface of Eastern and Western Civilization"
Yuji Aida
Professor Emeritus
Kyoto University

1:00 pm — 2:10 pm
<u>FILMS</u>

CONFERENCE HALL
Most recent films on nuclear power development will be shown

2:45 pm — 5:45 pm
<u>SESSION 3: CURRENT ADVANCED NUCLEAR TECHNOLOGIES</u>

Chairman:

Joichi Aoi	President and Chief Executive Officer Toshiba Corporation

History and Actual Status of Dry Cask Storage Development in West Germany

Wolfgang Straßburg	Member of the Executive Board Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen mbH (DWK)

The Canadian Concept for Used Nuclear Fuel Disposal

William T. Hancox	Vice-President, Waste Management Atomic Energy of Canada Limited Research Company

Present Status of the Development of Uranium Enrichment Technology in France

Paul Rigny	Directeur Division d'Etudes de Séparation Isotopique et de Chemie Physique Commissariat à l'Energie Atomique France

Technologies for Uranium Enrichment in Japan

Yoichi Takashima	Professor Emeritus Tokyo Institute of Technology

Chairman:

Yasunobu Kishimoto — Chairman, Showa Denko K. K.

Technological Development of Fast Breeder Reactors

Sadamu Sawai — Executive Director, Power Reactor and Nuclear Fuel Development Corporation

Waty to Fusion Experimental Reactor

Ken Tomabechi — Special Researcher, Japan Atomic Energy Research Institute

High Technologies and Radiation Application

Yoneho Tabata — Professor, University of Tokyo

FRIDAY, APRIL 15

9:30 am — 12:20 pm

SESSION 4: NUCLEAR FUEL SUPPLY SYSTEM: PROSPECTS AND ISSUES

Chairman:

Takeshi Nagano	President Mitsubishi Metal Corporation

Perspective toward 21st Century on Nuclear Fuel Utilization

Masayoshi Hayashi	President Power Reactor and Nuclear Fuel Development Corporation

A Comprehensive Economic Assessment of the Fuel Cycle, with a Prospective View

Jean-Claude Guais	General Manager Marketing & Business Development COGEMA France

Nuclear Fuel Cycle Strategy andTasks

Kozo Iida	Executive Vice-President and Director Kansai Electric Power Co., Inc.

An Assessment of the Prospects for Fuel Cycle Technologies

William L. Wilkinson	Deputy Chief Executive British Nuclear Fuels plc

Moving toward New Era of Nuclear Fuels

Junnosuke Kishida	Honorary Chairman Japan Research Institute

General Comments:

Howard K. Shapar	Director General OECD Nuclear Energy Agency

1:40 pm — 5:20 pm

SESSION 5: EFFORTS FOR FURTHER ENHANCEMENT OF RELIABILITY OF LWR (Panel Discussion)

Co-Chairman:

Minoru Okabe	President Japan Atomic Power Company

Co-Chairman:

Rémy Carle	Directeur Général Adjoint Electricité de France

Panelists:

Leonid M. Voronin	Deputy Minister Ministry of Nuclear Power U.S.S.R.
Brian V. George	Director of PWR Central Electricity Generating Board United Kingdom
Herbert J. Schenk	Member of the Board Philippsburg Nuclear Power Company Federal Republic of Germany
Stanislav Havel	Chairman Czechoslovak Atomic Energy Commission
Kenneth C. Rogers	Commissioner U.S. Nuclear Regulatory Commission
Dong-Joo Kim	Director and Vice President Korea Electric Power Corporation
Ryo Ikegame	Managing Director and General Manager Nuclear Power Administration Tokyo Electric Power Co., Inc.

Comments:

Toshikazu Shibata	Professor Emeritus Kyoto University

WEDNESDAY, APRIL 13

9:30 am — 12:20 pm
OPENING SESSION

Remarks by Chairman of Program Committee
JAIF Chairman's Address
Remarks by Chairman of Atomic Energy Commission

Special Lectures
"Mid and Long Term World Energy Strategy"
"Energy Systems in the 21st Century and the Significant Role of Nuclear Energy"
"World Energy Problems and Japan's Future Course"

MID AND LONG TERM WORLD ENERGY STRATEGY

Helga Steeg
Executive Director
OECD International Energy Agency

I will address three main issues:

- the current world energy situation;
- international strategies for energy security;
- the particular circumstances of Japan's energy policies in the international context.

I will draw attention to the importance of the electricity sector in energy security, in Japan and in the rest of the world.

The energy situation is much improved compared with a decade ago. There is an improvement in structural terms and an improvement in the flexibility with which energy is used. Industrial countries use a more balanced mix of fuels, thanks to growing use of coal, gas, and nuclear power. However, oil is still the dominant fuel -- in its share of world energy and in the effect of its price in the macro-economic sphere as well as on the economics of other energies. The supply of oil is now more diversified; but oil supply is still concentrated on the Middle East, with attendant political risks. Producers of all fossil fuels -- coal and gas as well as oil -- are learning to live with lower prices. Flexibility has improved. Many consumers can today switch between fuels for economic or security reasons. Trade in energy has increased both diversity and economy of supply; and trade is being encouraged by removal of distorting price practices and other institutional barriers. More remains to be done in this area.

International strategy for energy security has three aspects. One aspect must be a constant readiness to cope with emergency in energy supply. The IEA plays its part here. The continued promotion of structural change is also important through diversification of resources and improvements in energy efficiency. Transport and electricity generation are likely to be the key areas of future growth in demand. Member countries must continue to promote technological development in these areas, and must not, as IEA Ministers have said, close off options. In particular those countries who have significant nuclear power programmes will need to continue to improve their structural energy security by this means.

Structural change on its own will not be enough. Changes in one part of the energy world have immediate implications for other parts, and there must be increased flexibility to accommodate this. This is the third aspect of energy security. Without flexibility in policy and in the supply and use of energy, irresistible pressures build up, and the eventual process of adjustment becomes more painful. This applies to national and even more to international cooperation in the IEA. Japan offers some recent examples of policy adjustment to a more flexible and more international approach. In the petroleum refining industry, Japan is now making the necessary adjustments to allow industry a more autonomous management and to adjust to world market conditions. Another example for the future will be the dismantling of barriers to trade in coal: this will mainly affect European countries but also affects Japan. It is encouraging to see the direction set by the Eighth Coal Plan. Adjustment should continue and you must be assured that this difficult process is taking place in other countries as well.

In sum, a strategy for security cannot be one-dimensional. Above all, options must be kept open, since we cannot know where new momentum for change may come from.

ENERGY SYSTEMS IN THE 21ST CENTURY AND THE SIGNIFICANT ROLE OF NUCLEAR ENERGY

W. Häfele
Director General
Jülich Nuclear Research Center
Federal Republic of Germany

At first, an evaluation of the present evolution and fate of nuclear power is given, both worldwide and for a number of individual countries. It becomes apparent thereby that there is a severe indication of early saturation if not stagnation of nuclear power, at least in many countries of WOCA, that is the world outside communist countries. It appears as a reasonable scenario to envisage a total of only 360 GWel for quite some time to come. Then the fuel cycle implications of such a capacity are looked into. The supply of natural uranium is not a problem for the 21st century in that case. Instead, it is the tail end of the fuel cycle. Given a stagnation of the processing capacity of WOCA, it would lead to a total of 1,000 t of Pu and more to be stored directly and this is deemed unacceptable. The problems of toxic waste that our generation has inherited from its ancestors ought not to be repeated. Therefore it is mandatory to expand the reprocessing capacity of WOCA even if the nuclear capacity stagnates.

Moreover it is the more general aspect of energy systems that is looked into. A transition from conventional to unconventional oil sources appears as forthcoming in the years 2020 — 2050. Such a transition is expected to change the whole energy picture. At the same time there would be a doubling of the CO_2 content with all the consequences of a green house effect. And this is not acceptable and thus sheds a new light on energy systems in the 21st century. It is indeed the tail end of a fossil fuel cycle that matters then.

Such considerations lead to the concept of Integrated Energy Systems which are meant to reduce emissions and to permit the eventual transition to a carbon limited energy system. Such Integrated Energy Systems are highly flexible and adaptable and this may be more important than mere economical optimality. Nuclear power assumes a more general significant and versatile role in such energy systems.

It is concluded that it is the interplay of time horizons and choices to be made that matters. And this is the context for the judgement on nuclear power in the 21st century.

WORLD ENERGY TRENDS AND JAPAN'S FUTURE COURSE

Toyoaki Ikuta
President
Institute of Energy Economics, Japan

— World oil trends
- first stage (1973 ~ 1980)
- "watershed" (1981)
- second stage (1982 ~ recently)
- "landing" (now)
- third stage (hereafter)

— Structural change of oil market
- result of energy policy
- effects of market force (mechanism) tied with the above energy policy

— Energy problems, energy policy ~ Problems of energy security (access)

— Mid and long term prospects: Two scenarios

— Super long term prospects: Problems of exhaustion of energy resources

— Importance of energy policy and recognition of energy problems as its background

WEDNESDAY, APRIL 13

1:40 pm — 6:00 pm
SESSION 1 THE ENERGY COMPLEX AGE AND NUCLEAR POWER POLICY

As we move toward the twenty-first century, it is predicted that various energy resources will compete as a result of their diversification, now making progress. In this situation, some countries look to nuclear power as their major source of electric power; others are postponing their nuclear power development due to current slow-down in energy demand and aftermath of Chernobyl accident.

In this session, the significance and role of the development of nuclear power will be generally evaluated from the socio-economic, industrial and technical as well as environmental points of view, and the future directions of such development will be considered.

The Nuclear Development and Safety Policies in the Federal Republic of Germany

Klaus Töpfer, Federal Minister for the Environment, Nature Conservation and Nuclear Safety, Bonn

Nuclear technology was born fifty years, following the discovery that nuclear fission was possible with uranium atoms. The general public was made aware of the fact when atomic bombs were dropped on Hiroshima and Nagasaki. Since then, this negative association with atomic explosions have been a serious obstacle to public confidence in the peaceful use of nuclear energy.

The Federal Republic of Germany began building up its nuclear sector in 1955 after the country was granted sovereignty and President Eisenhower's "atoms for peace" policy was proclaimed. A joint effort on the part of government, the scientific community and industry in the context of an an extended atomic energy program was needed to make good the ten-year technology gap that had formed. The developmental phase involved the creation of large nuclear research centers, cooperation in international organizations, the conclusion of bilateral cooperation agreements, and the establishment of licensing agreements with U.S. companies in the field of light water reactor technology.

After a period of about fifteen years the technology gap had been closed. The first light water reactor power plants were in operation, the world's largest nuclear power plant had been commissioned, and German industry was receiving its first orders for nuclear technology exports. As experience was accumulated in the construction and operation of nuclear power plants, an independent German LWR technology and safety philosophy developed. The commercialization of nuclear technology brought with it the need for independent government controls. At the beginning of the 1970s the responsibilities for the funding and safety of nuclear facilities were restructured. After Chernobyl the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety was created. Today nuclear safety and radiation protection form an integral part of environmental protection.

The use of nuclear energy is regulated under federal law which, in turn, is implemented by the state governments. Nuclear law consists of the Atomic Energy Act and a number of ministerial orders, supplemented by administrative regulations, guidelines, recommendations, and technical safety rules. The state government authorities call experts in connection with safety inspections. The Minister for the Environment, Nature Conservation and Nuclear Safety is advised by the nuclear safety and radiation protection commissions.

Initial euphoria was followed in the 1970s by growing skepticism towards nuclear energy. Civic initiatives sprang up in opposition to it and there was even violent resistance. In the beginning nuclear energy had received euphoric support. Now it was faced with a hostile movement against it.

The safety requirement in nuclear technology had always been very strict. However, standards are not uniform throughout the world. Today the view is uncontested that acceptance for nuclear energy can only be brought about if comparable standards of safety are established at the highest possible level. This presupposes worldwide cooperation in the field of nuclear safety. This includes close cooperation across borders as well as in the framework of international organizations. The International Atomic Energy Agency plays an important role in this context. However, general rules in the international context do not eliminate the need for national responsibility in dealing with nuclear energy. Responsibility must be taken for decisions made, both with regard to the given national public as well as with regard to world public opinion.

Even after Chernobyl the government of the Federal Republic of Germany continues to be convinced that the use of nuclear energy is a responsible choice. The safety standards imposed on nuclear power plants in the Federal Republic of Germany justify this assumption. Abandoning nuclear energy leaves no viable alternative. The response to recognized risks and negative effects of a technology should not be that of abandoning the technology, but rather of searching for an improved technology. It is our obligation to fully assess the effects of new technologies not just in terms of short and long-term economic factors, but also in terms of their social acceptance and their environmental impacts.

The government of the Federal Republic of Germany also takes the view that renunciation of the use of nuclear energy would not be a responsible choice in view of the overall energy situation and above all in view of the moral obligation the industrialized nations have to help reduce the North-South gap. All available sources of energy will be used. Obviously, a great deal of importance also needs to be attached to efficient energy use and energy savings.

As such the Bonn government pursues a strategy of

- energy savings
- use of all technically available forms of energy
- building up oil reserves, particularly for the transport sector
- substitution of coal for oil wherever this is possible, and
- substitution of nuclear energy for coal in the production of electricity.

Our common task is to make nuclear energy as safe as possible and not to relax our efforts to constantly improve the standards of nuclear safety. Achieving this, there is then a good chance we will be able to satisfy the energy needs of the entire world -- reliably and safely.

THE NUCLEAR DEVELOPMENT AND SAFETY POLICIES OF THE FEDERAL REPUBLIC OF GERMANY

Klaus Töpfer
Federal Minister for the Environment,
Nature Conservation and Reactor Safety
Federal Republic of Germany

NUCLEAR ELECTRICITY, THE ANSWER TO THE ENERGY CHALLENGES OF THE CENTURY TO COME

J. P. Capron
Chairman
Commissariat à l'Energie Atomique
France

The next decade will be characterized by a dramatic demographic evolution. World population will double more or less within half a century and its geographic distribution will be substantially modified.

While Africa, South America and South East Asia will experience a rapid demographic growth, North America, Europe and Japan will remain stable. This general trend will be associated with urban concentration and a shift from agriculture to industry in less developed countries, which will need more energy per capita in order to carry out their industrial equipment and improve their standard of living.

Even if further energy savings remain possible in industrialized countries, the decreasing share of these countries in the world population will mitigate the global impact of these savings.

All that, consequently, means that global energy requirements will increase and that more attention will have to be payed to ecological balance.

According to recent demographic and economic forecast studies, a consumption of some 20 billion tonnes oil equivalent per year is to be expected by 2050. To meet such needs, every available resource will have to be used, provided it is economically recoverable without unacceptable impacts on environment, or public health.

Nuclear energy is a right answer to such a challenge; it is readily available, at a competitive cost, and it avoids all the pollutions associated with fossil fuels.

Nuclear power generation has reached maturity in several countries, like France and Japan. Nevertheless R&D efforts are still needed to maintain its excellent record in the field of safety and improve its technical performances, and economics.

France intends to carry on with a comprehensive research and development programme in order to support its nuclear industry. This programme covers advanced technologies such as laser isotopic separation, reprocessing, disposal of radioactive waste, advanced light water reactors and fast breeders.

Japan and France follow similar routes in the industrial deployment of nuclear electricity and expect from it similar benefits in terms of energy independence, cost cutting and pollution reduction. The trust they share regarding the long term prospects of nuclear energy will certainly reinforce their mutual cooperation.

Other countries could gain as well from opting in favor of nuclear energy. Such a behavior could also ease the tensions which are to be expected on the fossil fuel markets and ensure an adequate energy supply to mankind.

THE PROSPECTS OF THE NUCLEAR POWER DEVELOPMENT IN CHINA

Chen ZhaoBo
Vice Minister
Ministry of Nuclear Industry
People's Republic of China

1. A Few Remarks on China's Energy Situation Indicating the Important Role of Developing Nuclear Power in China

China suffers energy shortage despite somewhat abundant in fossile fuel resources and hydropower potential. Due to large population, China's energy resources per capita is lower than that of the world's average. The coastal zone with major population, booming economy and priority in development is suffering energy shortage seriously as 80% of coal resources are discovered in interior of northern China and most of hydropower potential are scattered in southwest of China. As coal has been and will remain the primary energy source, large quantity coal transportation and long distance electricity transmission become very troublesome problem that constraints further economic development of China. Since the implementation of the policies of reform and of opening, booming economy turns out an ever increasing demand of energy. It is expected that the demand of energy will rise to such a level towards the middle of 1990s that no conventional energy supply can meet the requirement then. The only choice is the speeding up of developing nuclear power from now on so that an increasing proportion of nuclear energy could phase in to improve the energy pattern of China.

2. China's Nuclear Power Programme in Consideration

1) About the Reactors

No other than the common consideration of reactors development: thermal reactors — fast breeders — fusion reactors, including hybrid reactors, the future steps are still under research.

As to the thermal reactors: PWR — advanced PWR, at the same time, keep research works on high temperature gas cooled reactors and carry on technical cooperation with foreign partners.

Carry out the research and design works on low temperature nuclear heat reactors towards building it in north China.

2) About the Capacity

It is expected that: some 5,000 — 7,000 MWe would be put into operation and about 5,000 MWe would be under construction to 30,000 MWe by the year of 2015. Contribution of nuclear power could be increased to some similar degree as that of coal fired plants towards the year of 2030s.

3) About the Nuclear Fuel Cycle

In accordance with the development of nuclear power plants, the existing nuclear fuel cycle will be reformed and expanded to meet the requirements. That includes uranium prospecting and exploration, mining and processing, conversion and enrichment. Fabrication of fuel element and assembly. Reprocessing of spent fuel. Management and disposal of radioactive waste, etc.

By the way, it is clear that China is gifted with the potential to develop herself towards a regional nuclear fuel cycle center for the west Pacific.

4) About the Nuclear Safety

The principle of "safety first and quality first" has been firmly implemented in all aspects of developing nuclear power since the very beginning under the strict supervision of the National Nuclear Safety Administration. Taking IAEA/NUSS as reference, a series of urgently needed regulations has been formulated and put into effect. The government and the public, as well as nuclear industry itself, attach real importance and pay great attention to ensure nuclear safety in every consideration.

5) About the Orientation of R and D

Research and development of nuclear science and technology are orientated to facilitate the building of nuclear power plants, to cut the cost of nuclear fuel production, as well as to ensure the safety of nuclear industry as a whole.

3. Further Opening to Outside World

China has already established a series of peace nuclear cooperative relations with a lot of foreign governments and non-governmental organizations that benefits both China and the partners. Pursuant to the policy of further opening to outside world, we are ready to study, with an attitude of welcome, any possibility of foreign participation to China's nuclear power programme. Feasible cooperation patterns include "BOT (Build-Operate-Transfer)" as well as others might be suggested by industrial and commercial circles around the world.

NUCLEAR ENERGY DEVELOPMENT IN JAPANESE ENERGY POLICY

Keichi Oshima
Professor Emeritus
The University of Tokyo

The world energy situation is making a fundamental change. The worldwide shift in the energy supply and demand relationship caused by high oil price due to oil shock since 1973 has now resulted in the ambiguity and decline in the oil price, the decrease in growth rate of energy demand and dissociation of energy and GNP correlation. Furthermore, diversification of energy supply sources and rapid electrification are happening. All these facts indicate the changing role of energy as a major driving force for development of economy and society what it played for hundred years since the Industrial Revolution.

This should not be regarded simply as a change in the energy situation. It is a part of a new industrial revolution or information revolution in the industrial society, which is proceeding worldwide caused by the large-scale technological innovation started in the mid-1970s.

Japan, being a resource-scarce country, achieved its present prosperity based on plentiful and cheap energy supply of imported oil, available from the internationalized market of crude oil. Therefore, the change in the worldwide situation has naturally forced Japan to review its energy policy. Therefore, in 1987, the government has carried out "The Study of 21st Century Energy Vision" and also industry and utilities discussed new energy policy what was published as several reports. As regards to nuclear energy policy, MITI's "Nuclear Energy Vision" and Japan Atomic Energy Commission's "Long-Term Program for Development and Utilization of Nuclear Energy" are two major policy reports of the Government and also industry has discussed the nuclear energy policy under this change of energy situation as an important issue toward the 21st century.

The development of peaceful nuclear energy started more than 30 years ago as a worldwide "Atom for Peace" program. Now, nuclear power has established its economic and technical bases predominantly with light water reactor and the World is entering into a new era of nuclear energy development.

There are three main features of the development:

(1) In many advanced countries, now nuclear is becoming a main electric power source and so to say, "First Nuclear, Second Oil" period of electricity is coming.

(2) By the achievement of economy of nuclear power, nuclear policy of each country is coming diversified due to her political and social circumstances.

(3) Issues of safety, non-proliferation, and nuclear development in the developing countries, are requiring establishment of a new international relationship in the nuclear community.

Under such circumstances, in Japan, nuclear energy is defined as a "key energy source" in her energy policy. And now nuclear industry is regarded as a "full-fledged energy industry" which are guided by economic market principle, compared to its past status of "special industry" in the research and development stage.

Japan, together with France, is one of the most successful country in its nuclear development program. And the importance of nuclear power as an energy source for its future social and economic development is widely accepted by the public. However, since the establishment of light water reactor in its economic and technical bases, nuclear industry is no more to be promoted by the planning and support of the Government. Rather, it has to be developed under the leadership of private industry based on economy and harmony with the society. Namely, the future nuclear power development will be based on its optimization in comparison to the other energy sources. This is what we define the nuclear energy policy as a "key energy source" in the age of "energy complexity", where nuclear energy has to have its optimal position in relation to other energy sources in its supply.

This naturally changes the role of government from the past in nuclear development: it has to be redefined. The role of government will be shifted from promotion of nuclear development program to regulation for safety, non-proliferation etc. on the one hand and pursue of new possibilities and frontiers of nuclear energy through innovative and creative research on the other. It will be more basic and indirect compared to the past. Such a role, evidently, has to be fulfilled with close international cooperation, and Japan is now required to take a more active role in the international nuclear community.

One further important point is that the nuclear industry is a technology-intensive large-scale system playing a locomotive role in the technological innovation for the future. In order to fulfill this role, government, industry and research community in Japan have to cooperate together in development of innovative technology, cultivation of manpower and reorganization of research institutional structure to pursue new creative breakthroughs.

One of the main characters of the change in the energy situation is that in the past energy industry was strongly dependent on natural resource, namely, it was a "resource-intensive industry" and now it is changing to "knowledge-intensive industry" which is overcoming the limit of natural resources by technological breakthroughs. The nuclear development policy in the Japanese energy policy for the future has to take account the central role of nuclear industry in promoting such knowledge-intensification of energy industry by technological innovations.

NUCLEAR ENERGY INDUSTRY IN BULGARIA — PRESENT STATE AND ITS DEVELOPMENT

Nikola Todoriev
Minister
Chairman, Energy Industry Association
Bulgaria

Each nation adheres to its own energy policy as affected by the particular social, political and economic conditions and the existing labor and material resources.

Bulgaria's energy policy is wholly directed at providing the present and the future generations sufficient amounts of energy in forms meeting current standards for environmental protection.

The energy problem, irrespective of the continuously changing lifestyle of the Bulgarian people, can be resolved only by the maximum utilization of indigenous energy resources, effective energy use and further more intensive use of new energy sources.

The most characteristic and qualitatively new aspect of Bulgaria's energy development is the accelerated development of nuclear energy which makes possible a greater concentration of installed capacities and improvement of power system's technical and economic characteristics.

In 1974 was commissioned the first nuclear reactor at Kozloduy nuclear power station. Thus, Bulgaria joined the club of the first 20 nations operating nuclear power stations in the world. Kozloduy's current production exceeds over 12 thousand million kWh annually, or almost 30% of the nations total electric energy production. At the end of 1987 was commissioned reactor No 5 (VVER-1000 type) at Kozloduy thus raising its total installed capacity to 2760 MW.

Kozloduy nuclear power station is presently one of the most reliable and stable sources in Bulgaria's power system. Its average annual utilizability exceeds 7000 hours. Total electricity production in 1988, when unit No 5 will enter regular operation, is expected to exceed 16 thousand million kWh.

Irrespective of the fact that the nuclear energy sector is among the capital-intensive sectors we plan a continuous increase of its relative share in the total production of electricity. Based on governmental decisions 40% of the total electricity production in 1990 shall be covered by Kozloduy nuclear power station. The respective figure for the year 2000 shall be 45-50%. According to the program for construction of nuclear power stations and nuclear district-heating plants of the CMEA Member-nations the nuclear power stations in Bulgaria shall have a total installed capacity of 7760 MW in the year 2000, ie 4 units with VVER-440 reactors and 2 units with VVER-1000 reactors at Kozloduy site and 4 units with VVER-1000 reactors at Beléné site.

In order to meet the constantly increasing nation's demand of heat for for industries and households we plan to start after 1990 with the construction of a nuclear district-heating plant and after 1995 with the construction of a co-generation nuclear power station.

NUCLEAR POWER IN THE UNITED STATES: PROVIDING ELECTRICITY TO REPLACE IMPORTED OIL

Harold B. Finger
President and Chief Executive Officer
U.S. Council for Energy Awareness

Like other industrialized nations, the United States has faced two complex challenges in its energy policy since the oil embargo of 1973: to continue providing adequate supplies of energy during a decade of stagflation followed by a period of economic resurgence and growth, despite great uncertainties in the price and even supply of oil; and at the same time to continue to reduce the country's reliance on imported oil, so as to minimize the economic and national security risks this reliance entails.

To meet these challenges, the United States has taken action on both sides of the demand/supply equation. In large part because of higher energy costs, we are using energy more efficiently than before the oil embargo--in effect, squeezing more work out of every BTU. On the supply side, the United States has steadily been substituting other forms of energy for oil in most of its applications, other than as a fuel for transportation.

For both of these approaches, one of the keys to success has been electricity. The drive to use energy more efficiently has led industries, commercial establishments and residences to shift from the direct burning of oil in many uses, to electrification, often saving money and total energy. And the substitution of other sources of energy for oil has been led by electricity, fueled largely by coal and nuclear energy.

This paper will present details on the growing role of electricity in the U.S. economy and the special importance of the contributions made by nuclear electric power. From a trivial provider of electricity nationally at the time of the 1973 embargo, nuclear energy has become the country's second largest source of electric power. This presentation will describe and quantify the remarkable contribution that nuclear power has made to the U.S. economy and security: the amount of imported oil that it has displaced; the economic savings that it has made possible; the attention to environmental and safety issues; its historical significance as a new technology becoming available just as we needed to diversify our energy sources; and the broad public recognition of the importance of nuclear power to the national energy supply.

Despite an imminent pause in the U.S. nuclear power construction program, it is becoming more obvious that the country will turn again to nuclear electricity in the years ahead. As the U.S. economy continues to grow, so will its use of electricity. And as the total cost and availability of oil and natural gas become more apparent problems, we will be relying more and more on our two most abundant energy sources--coal and uranium. So this paper will also describe the growing role that nuclear power is likely to play in the future, and the national policy changes, combined with its drive for excellence, that the industry is now pursuing to make that expansion possible.

NUCLEAR POWER ISSUES – POLITICAL AND SOCIAL IMPLICATIONS

Ken Ohtani
Journalist

1. Discrimination of the rights and wrongs of nuclear power is now a political and social problem and is limited in technical and economical persuasion.

2. Anti-nuclear is now the symbol of the politically radical movement in democratic countries.

   – Economic growth and attainment of high income have produced a large number of teachers, scholars, writers and talents who do not concern themselves directly in production activities.

   – Along with disappointment in socialist states, anti-order and radical parties have been inclined to environmental protection and ecology, and their objectives have been changed from opposition to the cutting of forests and anti-whaling to anti-nuclear. They became the "green party" in West Germany and Italy against these backgrounds, and now have a voice in actual policy making.

3. Anti-nuclear power in Japan.

   – "Protect Green!" is now becoming a point at issue in local elections.
   (Zushi-city, Shari-town, Hachioji-city)

   – Opposition movement to the power modulation operation test of nuclear power plants — Its point of contact to the "Protect Green!" movement.

   – Nuclear power policy of the Socialist Party, the first opposition party — Why does the party have divided opinions?

   – Relation between anti-nuclear weapons and anti-nuclear power generation.

4. How to cope with this?

THURSDAY, APRIL 14

9:30 am — 12:00 noon

SESSION 2 FOR COOPERATION AMONG ASIAN COUNTRIES IN UTILIZATION OF NUCLEAR ENERGY (**Panel Discussion**)

As a result of progress made in the development of nuclear energy, it is expected that Japan will make a contribution to other countries. As an advanced nuclear energy country in Asia, Japan is required to cooperate with other Asian countries in the improvement of technologies for the use of nuclear energy and to assure its safety, as a way of contribution to economic development in the Asian region.

In this session, to seek more effective cooperation, the need for the development of nuclear energy in the region and attendant problems will be clarified, to specifically consider how regional cooperation should be developed.

THE DEVELOPMENT OF REGIONAL NUCLEAR CO-OPERATION IN ASIA

Noramly bin Muslim
Deputy Director General
Head, Department of Technical Co-operation
International Atomic Energy Agency

Co-operation in the nucler field in Asia dates back to 1962 with the development of the India-Philippines-Agency IPA project. The project involved the supply of a neutron diffractometer by India for installation in the 1 MW Philippines reactor. By the end of the project, a number of countries including India, Indonesia and the Republic of Korea were involved.

In view of the success of the IPA project, the IAEA decided to extend the scope, and include more countries in a wider set of projects. The Regional Co-operative Agreement (RCA) came into force on 12 June 1972. Projects incorporated within RCA were very diverse and included (a) Neutron Scattering, (b) Food Irradiation, (c) Nuclear Instrument Maintenance, (d) Improvement of Domestic Buffalo Production.

An important initiative was taken in 1976, when RCA Member States requested the IAEA to seek support from UNDP for a large project on the applications of radiation and radioisotopes to industry. This project which was initiated in 1982, after an extensive pre-project planning stage, has now entered a second phase. It has played a very significant role in the development of RCA, at one time accounting for over 70 percent of the budget.

Within RCA maximum use is made of regional resources. From about 1979, Japan and Australia have been funding a range of project activities as a tangible evidence of their commitment to regional development. In a farsighted move, India began supporting RCA as a donor in 1983. This was followed in 1986 by the Republic of Korea.

The willingness of developing countries to accept responsibilities as donors provides a sound basis for the promotion of Technical Co-operation between Developing Countries (TCDC) within RCA. Increasing use will be made of the excellent institutes and facilities within the region as co-operation enters a more mature phase. Centres of excellence, in part supported by RCA project activities are evolving and will continue to be supported. Such centres hosting for instance secondary standard dosimetry laboratories, nitrogen-15 measurement equipment, or isotope hydrology facilities should be encouraged to serve countries still lacking these capabilities. A number of such offers have been received through RCA. Still more can be done to further the local production of radioisotopes and radiopharmaceuticals.

Concurrent with these practical moves towards regional self-sufficiency is a broadening and refining of the programme. Member States, through their Meetings of Representatives are acutely aware that needs and priorities change. For instance, in the 1988 TC component of the RCA programme are projects in the fields of the "Radioimmunoassay of Thyroid Related Hormones," "Energy and Nuclear Power Planning" and the "Radiation Sterilization of Human Tissue Grafts." In addition, a Japanese initiative has led to the major new project "Strengthening of Radiation Infrastructure."

RCA is widely regarded as one of the few successful examples of regional technical co-operation. To some extent it has influenced the development of the ARCAL co-operative programme in Latin America, and possible future arrangements in Africa.

OVERVIEW OF NUCLEAR COOPERATION IN ASIA

Yosuke Nakae
Commissioner
Atomic Energy Commission

1. Japan's basic foreign policy toward Asia is the Fukuda doctorine made public in 1976. It advocates the following three principles; "not become military power," "much importance attached to meeting of minds," and "peaceful coexistance," which are also reflected in nuclear cooperation in Asia.
2. The Atomic Energy Commission, in June last year, drew up the new version of the Long-Term Program for Development and Utilization of Nuclear Energy, based upon the recent changes of the environment surrounding nuclear energy, such as alleviation of world energy supply and demand and the Chernobyl accident. It defines the outline of the philosophy and the scheme for promoting the basic measures related to the research, development and utilization of nuclear energy up to the year 2000.
3. The new Long-Term Program consists of three basic objectives, i.e. "establishment of the position of nuclear power as key energy source," "development of innovative science and technology," and "contribution to international society."
4. In order to fulfil the "contribution to international society," the Atomic Energy Commission decided to promote responsible and active international relations, taking necessary measures in the domestic context to realize the three basic objectives, i.e. "the pursuit of benefits common to the world," "the efficient utilization of R&D resources of each country," and "the active contribution to improvement of the international environment."
5. As for cooperation with developing countries, it is important to promote bilatelal cooperation and strengthen relation with neighboring area.

   It is the basic philosophy of bilateral cooperation that cooperation will be promoted starting from the earliest stage of counterpart countries program for development and utilization of nuclear energy, by taking into consideration the state of affairs of the counterpart country and by attaching importance to the consolidation of its research and technological foundations, tailoring to the degree of nuclear energy development of each country, so as to realize its smooth grade-up. In its implementation, it is important that the framework of the cooperation will be duly arranged, keeping nuclear non-proliferation and safety secured, from the stand-point of facilitating cooperation, and that in the counterpart country efforts suited to her national power will be made. Furthermore, special attention will be paid to the aftercare or follow-up, such as advice to utilization program and implementation of training, after transfer of materials and equipments, so that the results of the cooperation will take sound root in the counterpart country.

The Asian region adjacent to Japan has close relations with our country in geographic and economic terms, and have many common subjects to be undertaken related to the field of nuclear energy, such as utilization of radiation, utilization of research reactors, introduction of nuclear power generation systems, and measures for safety assurance and emergency preparedness. Under these circumstances, the implementation of region-wide cooperative programs involving Japan is thought to be advantageous for the most effective and efficient use of the limited R&D resources, such as financial and human available in the region for progress in those subjects. By gaining region-wide concensus as to subjects to be resolved and share in the cooperation, Japan will endeavor to make positive contributions to upgrading nuclear technology in the region based upon her share and to improving its economy and welfare.

For these implementation, the Japanese Government has now made necessary measures in the budget for the fiscal year 1988.

6. In implementing international cooperation in development and utilization of nuclear energy, understanding and cooperation in each nation as well as mutual understanding and cooperation among nations are indispensable. Fruitful exchange of views and consultation among the parties concerned are expected to be made.

[KEYNOTE]

Liu XueHong
Deputy Director General
Bureau of Foreign Affairs
Ministry of Nuclear Industry, China

As is known to all, Asia, compared with other regions in the world, has been witnessed with greater achievements in the rapid development of its economy and in nuclear field as well in this decade. The Asian region commands experiences, technologies and capabilities in nuclear power, nuclear fuel cycle, application of nuclear technology and research and development on nuclear science. However, unbalanced development exists in various countries and areas of the region, where the cooperation among the Asian countries to fill the gap in economy and technology thus appears to be of greater importance. Our cooperation is imbued with better adaptability and acceptability, due to the approximation in geography, history and culture. We hope that such a cooperation could promote the development of nuclear power in China. We are ready to share knowledges and experiences with our neibouring countries so as to develop an even closer Asian-wide cooperation in the area of peaceful uses of nuclear energy, bringing its benefit to the Asian peoples.

Possible areas of cooperation between China and Asian countries:

- quality control and management in design, construction and commissioning of nuclear power plant.
- training of operators and service personnel for nuclear power plant.
- treatment and disposal of radioactive wastes.
- construction of nuclear power plant in the form of BOT.

China could contribute its bit in the following areas, sharing experiences with other countries in the region:

- exploration in uranium geology.
- usage of research reactor.
- research on particle accelerator technology.
- application of isotope, radiation processing technique and nuclear technology.

In line with the principle of equality and mutual benefit and by various forms, China could, for instance:

- accept training of personnel and send experts abroad for lecturing.
- hold bilateral and regional seminars.
- use our research facilities to carry out joint research projects.
- provide expert service.
- work jointly on certain projects such as exploration in uranium geology, utilization of radiation facilities, etc.

Taking into account the current situation of cooperation in the Asian region, we propose to further such a cooperation on the existing bases as.

- enlarging cooperation areas of RCA under the auspices of IAEA.
- that Japan would make greater contribution to cooperation in the area of peaceful uses of nuclear energy in Asia.
- drawing up joint programme of experiment in Asia in light of situations and requirements of the Asian countries.
- strengthenging the further cooperation in nuclear power.

[KEYNOTE]

ENHANCING COOPERATIVE RESEARCH PRODUCTIVITY IN THE PEACEFUL UTILIZATION OF NUCLEAR ENERGY

Djali Ahimsa
Director General
National Atomic Energy Agency of Indonesia (BATAN)

During the past 30 years the world has witnessed convincing progress in the development and utilization of nuclear energy both in the developed and developing nations. Nuclear energy is now inevitable for the prosperity of humankind. Indonesian nuclear energy plan is based upon the state constitution. Its main aim is to realize a just and prosperous society and to contribute to the strengthening of world's peace. The effective utilization of nuclear energy and the enhancement of cooperation in its peaceful utilization among all nations should be persistently pursued in order to increase human welfare and to preserve world's peace. Various barriers toward the cooperative efforts among the nations must be reduced and removed. The National Atomic Energy Agency of Indonesia — BATAN has invested quite substantial amount of fund for research and development infrastructure in the nuclear field at Serpong Nuclear Complex near Jakarta. One of the main infrastructure is a 30 MW (th) Multipurpose Research Reactor (Reaktor Serba Guna — G.A. Siwabessy/RSG-GAS) well equipped with testing rigs such as In-pile-loop, In-pile capsules, Power Ramp Test Facility (PRTF) and Dynamic Neutron Radiography Facility. Outside the reactor building various facilities are also available such as Radiometallurgy Installation (RMI) for post irradiation examination, Experimental Fuel Installation to produce experimental fuel for testing purposes and Out-pile-loop for thermohydraulic studies. It would be advisable for developing countries to complement the research equipment of others, not to duplicate them, in order to reach efficiency in conducting research and development.

Consequently, all resources available for nuclear energy research and development in one country should be made open and available to all interested nations wishing to cooperate. Plans for joint projects should be laid down, coordinated and executed earnestly. It should also be stressed that the results of such a cooperation can not be obtained in a short time. A long term commitment to joint research programs must be preserved if fruitful and mutually beneficial results are to be expected.

[KEYNOTE]

SIGNIFICANCE OF THE DEVELOPMENT OF NUCLEAR POWER TECHNOLOGY IN KOREA

Pil-Soon Han
President
Korea Advanced Energy Research Institute

As of the end of 1987, there are seven nuclear power plants in operation in Korea with an installed capacity reaching 5,716 MWe, which shares over 50% of electricity generation. In addition, two 950 MWe nuclear power plants are under construction and will be commissioned in 1988 and 1989, respectively. Through the implementation of these 9 nuclear units (8 PWRs and 1 CANDU), local A/E and hardware manufacturing capabilities have been gradually upgraded. Nevertheless, they only reach a certain level, say 40%, even though most civil and erection work have been done by domestic construction companies. Moreover, such software technologies as the NSSS system design technology have wholly been dependent on foreign vendors.

As KAERI (Korea Advanced Energy Research Institute) had success in the development of the CANDU fuel design and the manufacturing technologies in the early 1980s, confidence on indigenous development of nuclear power technologies has been strongly built up. And joint system design concept with foreign suppliers has also been applied. KAERI currently performs joint reload fuel design with KWU, of which about 200 tons of fuel will be domestically fabricated from January 1989 through the fabrication plant of KNFC (Korea Nuclear Fuel Co.). KAERI also carries out the NSSS system design work jointly with CE for two 1,000 MWe PWR units that will be in operation by 1995 and 1996, respectively. For these two units, the so-called Yonggwang 3 and 4, KOPEC (Korea Power Engineering Co.) is performing A/E works with Sargent and Lundy while KHIC (Korea Heavy Industry and Construction Co.) is the main hardware manufacturer with support of foreign vendors. The overall project management of the projects has been carried out by KEPCO (Korea Electric Power Corporation). Through these two nuclear projects, self-reliance in nuclear power technology has been aimed to be achieved by the mid of 1990s.

Such high technologies as micro-electronics, robotics, remote handling, computerized I & C and human engineering are now taken priority for development and will eventually be integrated with conventional nuclear power technologies. This will eventually lead to and be linked with the technology development of advanced PWR and/or advanced CANDU in the future.

For the improvement and development of such nuclear power technologies, Korea has received extensive foreign technological support and maintained strong ties of international cooperation. Furthermore, Korea is ready and willing to share her experiences in nuclear power technology development with newly developing nuclear countries. With growing economic trade, particularly in Asian countries, the technology exchange should also be activated in this region. And I am sure that nuclear power technology will be one way to achieve this goal.

[KEYNOTE]

COOPERATION AMONG ASIAN COUNTRIES IN THE UTILIZATION OF NUCLEAR ENERGY

Quirino O. Navarro
Director
Philippine Nuclear Research Institute

During the panel discussion on regional cooperation at the 15th Japan Conference on Radioisotopes, it was my privilege to speak on a number of factors which influence the extent of cooperation among countries in the region. These included: national priorities, culture of the people, stage of a country's development, existence and identification of centers of excellence, fields of interest of local scientists, management of contributed resources, commitments of donors, and the role of the IAEA and multilateral agreements in promoting, cooperative programs. These factors still remain valid.

The success of the first phase of the UNDP/RCA Industrial Projects augur well for expansion into other projects along industrial, agricultural, medical and even business applications. Cooperation can be enhanced further through the strengthening of bilateral and multilateral agreements which are facilitative of the transfer of relevant technologies and supportive of exchanges of information, expertise and scholars.

In the last few years, significant events occurred in the field of nuclear energy which will significantly have an impact on areas of common interest and the people's perception of nuclear energy applications which should form bases for collaborative efforts within the Asian region. These are: the Chernobyl accident, the agreement between the superpowers on partial reduction of nuclear armaments; and on the part of the Philippines, the government's decision to "mothball" the first Philippine Nuclear Power Plant and the ratification of the Philippine Constitution which has a provision for a "nuclear weapon free" policy.

The countries of the region, although distant from the site of the Chernobyl accident, were recipients of radioactive contaminants in varying intensities through trade activities and atmospheric movements. These transboundary effects point to the need for information and laboratory networks for early detection, mitigation and mutual assistance in cases of major nuclear incidents which may occur in the future. The non-operation of the nuclear power plant in the Philippines resulted in a temporary "excess" of nuclear expertise which could be shared with other countries, and the requisite preservation program for this plant provides valuable insights into nuclear power programs and energy planning of Third World countries. Currently proposed national legislation which are aimed at supporting a nuclear-weapon free policy would be of interest to neighboring countries.

The experiences gained in several decades of cooperation among countries in Asia, through bilateral and multilateral arrangements, if properly evaluated, could provide a consensus on the best approach to enhancing co-operation among these countries with the end in view of an Asian nuclear community attuned to the needs of the twenty-first century.

[KEYNOTE]

ATOMIC ENERGY COOPERATION WITH NEIGHBORS IN THE ASIAN REGION

Katsuhisa Ida
Deputy Director-General
Science and Technology Agency

1. In the Asian region, research, development and utilization of atomic energy has been advancing in a broad range, including radiation utilization, research reactor utilization, and introduction of nuclear power generation. It is playing a major role in such areas as agriculture, industry and electric power. With the progress in such research, development and utilization, the necessity for international cooperation is being widely recognized.

2. As an advanced nation in the Asian region in the field of atomic energy, Japan has been engaged in international cooperation activities with the utmost purpose of supporting the laying down of the foundation of atomic energy development and utilization in the Asian countries.

   In other words, it has been conducting the training of personnel in the countries concerned, dispatching of specialists, or supporting of research activities through equipment provision, both in the framework of multilateral cooperation of IAEA's Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science (RCA), and in that of bilateral cooperation based on the activities of the Japan International Cooperation Agency (JICA) and the Scientists Exchange Program of the Science and Technology Agency.

3. Moreover, according to the Long-Term Program for Development and Utilization of Nuclear Energy formulated by the Atomic Energy Commission in June 1987, Japan is to promote even more positive development of international cooperation in the Asian region. In the peaceful use of atomic energy, safe and efficient development and utilization is secured only when it is based on a solid technical foundation, and only then can the fruits of such efforts be enjoyed. From this point of view, we think that further strengthening of cooperation activities for reinforcing the technical foundations of the countries in the region is most important.

4. On the other hand, due to the accumulation of efforts of the countries in the region over the years, a considerable number of nuclear facilities have been built in the respective countries, and a lot of knowledge has been accumulated. And in order to expand the range of research and development activities by the use of such facilities and knowledge, more personnel and

funds, as well as more knowledge, is needed. The securing of these elements is becoming a major barrier for further development. From such viewpoint, the interconnecting of these countries' accumulations and experiences, in other words, regional cooperation for pioneering the way to development is a major issue in the future.

Needless to say, since the development stage of atomic energy development and the degree of interest differ from nation to nation even within the region, it is quite difficult to find an area of cooperation which is common to all the countries of the region. Therefore, if there is some area for which some countries show common interest, starting cooperation activities with that area, then gradually enlarging the circle could be a practicable approach. Fields for this type of cooperation include radiation utilization, research reactor utilization, atomic energy safety, radiation protection as well as operation and management of power-generation plants. Exchanging experiences on public acceptance related to the development and exploitation of atomic energy is also an issue of major importance.

We think that such regional cooperation will acquire an increasingly greater importance, in order for the peaceful use of atomic energy to take root in the countries of the region as a truly meaningful subject. We also consider it extremely important that Japan exchanges views with these countries and offers positive assistance, to ensure a fruitful result of regional cooperation.

[KEYNOTE]

Katsuhisa Ida
Deputy Director-General
Science and Technology Agency

[KEYNOTE]

Ko Takeda
Executive Managing Director
Japan Electric Power Information Center, Inc.

Cooperation with Neighbouring Countries in the field of Nuclear Power Generation
(Keynote)

Ko Takeda
Executive Managing Director
Japan Electric Power Information Center, Inc.

1. Nuclear Power Development in the Neighbouring Countries and the Needs for International Cooperation

In our neighbouring countries, there has been remarkable increase of electric power demand, as a result of recent effort for industrial development and improvement of living standard. Each of the neighbouring countries has established long-term rolling-plan on power resources development, taking into account its own national enegy policy, available resources and estimated future power demand. And nuclear power generation seems one of the most important concern in their future development plans.

In order to proceed the development of nuclear power generation, it will become necessary to promote man-power development, to master sophisticated nucliar technology, and to provide enough ammount of funds and adequate industrial infra-structure, based on self effort and through international cooporation.

These challenging problems, our electric power supply industry has been trying to overcome them with long range view-point recent 30 years.

2. Japan's Approach toward International Cooperation

Jpanese electric power industry introduced nuclear power technology from U.K. and U.S. at the initial stage of its nuclear business, and the joint effort of the government and the private sector since those days, particularly that of improvement of safety and reliability, has enabled us to take an higher place among the advanced nuclear countries in terms of operating plant capacity and the level of technology.

This 30 years experience of our nuclear power development, from initial introduction through nowadays, would be full of valuable lessons for those countries intending to introduce nuclear power generation and proceed its development program.

Our electricity supply industry is ready to respond to the needs of neighbouring countries in the field of nuclear power development through an effective transfer of those lessons.

Taking into acount the fact that each of neighbouring countries are in the different stage of nuclear power development and they have respective needs for corporation, we like to proceed our corporative activities, so as to enable them to promote their nuclear power development in an efficient and timely way.

3. Role of the Government and Private Sector in Japan

In March 1986, the Sub-Committee on Nuclear Energy of the Advisory Committee for Energy published it's report on the technical cooperation in the field of nuclear power generation with neighbouring countries. The report provide guidelines to various sectors relating international cooperation.

The report recommends to the government to act as overall liaison agent to foreign countries concerned, to take over the cordinative management of every cooperative activities by domestic parties, and to establish the scheme for proceeding international cooperation, so as to secure the steady progress of cooperative activity.

Regarding to the private sector, the report recommends to set up a proper liaison agent, to which every foreign parties may feel easy to make contact, The report also recommends the liaison agent shall be capable to collect various needs of foreign parties and to take countermeasures to those needs with the full support by domestic parties concerned.

Following this recommendation, Jpapn Electric Power Information Center Inc. (JEPIC) has been acting as a liaison agent representing Japanese electric power companies.

4. Cooperative Activities of Japanese Electric Power Companies

Nuclear power development in Japan has been carried out mainly by the electric utilities, under national basic policy to promote peaceful use of nuclear energy and with close collaboration with plant manufacturers and general contractors.

And we tried to promote the self-reliant technology as well as higher level plant safety and reliability.

In this respect, the electric utilities have been trying to have enough qualified man-power and necessary technology and experiences covering every stage of nuclear power development including planning, construction and operaion stage.

Using this man-power, technology and experiences, our electric utilities are proceeding their cooperation with neighbouring countries. placing major emphasis on the support to their effort for establishment and enhancement of technical and human resources.

The measures for cooperation are as follows:
(1) JICA's Training Course on Nuclear Power Generation (Since 1986)
(2) Support for manpower deveropment through dispaching of experts and accepting of experts and trainees. in the field of planning, construction, operation and maintenance stage.
(3) Other measures such as dispaching experts to seminars held in neibouring countries

Following figures are the result of cooperation by our electric power utilities for the period of these two and a half years.
(1) JICA Training Cource: 3 times, total 18 trainees
(2) Dispaching of experts: twelve times, total 33 experts
(3) Accepting of experts: twelve times, total 41 experts

(note) Adding to these figures above, dozens of experts were sent to neighbouring countries under schemes of JAIF and other organization.

5. The structure of the cooperation activities by electric utilities

International cooperation in the field of nuclear power generation has been proceeded by 9 electric power companies and Japan Atomic Power Co. Inc. with their highly established technology and qualified manpower.

In order to promote the cooperative works effectively, the Cooperation Committee for Nuclear Technology (Mr.Oishi,Managing Director of Kansai Electric Power Company, Inc. as Chairman and Mr.Sasaki, General manager, Nuclear Power Administration Department, Tokyo Electric Power Company,Inc. as Vice-Chairman) was organized in JEPIC in August 1986. With consultation of this Committee, JEPIC, the liaison organization, set up corporative program and carried out it's program.

The Comittee consists of members from eleven major electric companies and governmental sectors and associate members from relating organizations such as JAIF and manufacturers, and has a part of coordinative function among various sectors relating international cooperation.

6.Conclusion

This paper briefly describes current status of international cooperation activities by our electric power utilities. To make cooperative work more effective and fruitful, it is important to establish more close bilateral relationship based on mutual understanding and reliance..

As the liaison agent, JEPIC will contribute for more effective transfer of our experiences to neighbouring countries, with better understandings on our measures and schemes of cooperation by all of parties

(End)

2:45 pm — 5:45 pm

SESSION 3 CURRENT ADVANCED NUCLEAR TECHNOLOGIES

Nuclear power means high technology. It is expected that it will play a major role in the supply of energy if research and development are promoted. Such an energy supply is expected to have a considerable spin-off effect on technological innovations, and on science and technology in general.

In this session, current technologies for nuclear power, now at the stage of research and development, or in practical use, will be introduced by audio visual method, and new applications of nuclear energy will be sought in combination with relevant advanced technologies.

HISTORY AND ACTUAL STATUS OF DRY CASK STORAGE DEVELOPMENT IN WEST GERMANY

Wolfgang Straßburg
Member of the Executive Board
Deutsche Gesellschaft für Wiederaufarbeitung von
Kernbrennstoffen mbH (DWK)

In the Federal Republic of German the nuclear fuel cycle is definitely established in an industrial scale. By this the provisions of the German Atomic Law demanding evidence for a proper and complete nuclear fuel cycle are met. One very important part of the necessary development to reach this status was the establishment of double purpose casks for transport and storage, which is due to a DWK initiative dating back to 1977.

At that time the main idea was to make storage capacity available as fast as possible in order to cope with possible storage bottle-necks within the reactor pools. Two development lines were launched which were both based on the casting technology in order to avoid welds: one was based on cast nodular or ductile iron, the other one on cast steel.

Due to developmental and economical draw-backs the cast-steel version was abandoned in early 1980.

The success of the ductile iron based CASTOR-line led to a shift of the interim storage option from a 1.500 t U pool at the Ahaus site in favour of the more flexible cask solution.

However, construction of the 1.500 t U dry cask storage facility at Gorleben was finished earlier than Ahaus, due to less disputes in court.

Today, this storage mode can be called "state-of-the-art" not only for Germany, but also for Switzerland and the US. Even in France, it is an emergency option for the Super-Phenix reactor.

The reasons for this reactor short-term success are due to the following fact:

- double-purpose transport and storage capability
- modal increase of the required storage capacity thus negligible interests during construction
- no secondary wastes during operation
- completely passive cooling by natural convection
- zero-release due to the no-weld, double-lid system
- optimum resistance even to air-craft impact
- no technical limitation of the life-time
- the casting process allows high serial production rates
- easy decommissioning .

All these facts lead to an additional, very convincing one: lower cost.

Therefore, DWK, as a reprocessing company, has as well decided for dry cask storage at the Wackersdorf site.

The completeness in this context the development of a different type of cask for dry transport, storage and ultimate disposal of used fuel should be elucidated. There will be in future used fuel elements which are not to be reprocessed either for technical or economical reasons so that a once through cycle has to be envisaged (e.g. high temperature gas cooled used fuel). DWK has taken up the development for such type of cask and applied for the necessary licences.

THE CANADIAN CONCEPT FOR USED NUCLEAR FUEL DISPOSAL

W. T. Hancox
Vice-President, Waste Management
Atomic Energy of Canada Limited Research Company

Canadian research is well advanced toward ensuring safe disposal of used nuclear fuel deep in the stable granite of the Precambrian Canadian Shield. A multi-barrier concept has been adopted to ensure long-term containment. It includes the following:

The UO_2 fuel. Our research demonstrates that there are three principal mechanisms by which radionuclides are released: first, about 2% of the iodine and cesium are released rapidly once the zirconium alloy fuel sheath is breached; second, the remaining iodine and cesium are slowly released by preferential dissolution at the grain boundaries; third, the remaining fission products and actinides trapped within the UO_2 grains are released extremely slowly by congruent dissolution. Under the reducing conditions expected deep in the rock, congruent dissolution is highly unlikely.

The stability of UO_2 in groundwater has been confirmed by studies at the Cigar Lake uranium deposit in Northern Saskatchewan. The ore body consists mainly of individual grains of uraninite (UO_2) mixed with clay minerals; the average concentration of uraninite is 14%, with local concentrations as high as 60%. Since the ore body was formed about 1.3 billion years ago, there have been several episodes of groundwater interaction with the ore body. Despite this interaction, there has been no significant movement of uranium. Water samples taken only 5 m from the ore body have such a low uranium concentration (1 microgram/litre) that they are suitable for drinking.

Although the groundwater flowing toward the deposit is oxidizing in nature, oxygen is removed by iron minerals and organic materials within the ore body and the surrounding clay layer. The iron is oxidized more easily than uranium and acts as a scavenger for oxidizing species.

The hermetically sealed used-fuel container. Prototype containers with a titanium alloy outer shell, have withstood external pressures up to 10 MPa, at 150 C. Thus, they meet the primary structural requirements for disposal in a vault at a depth of 1000 m. Our corrosion research shows that outer shells made from titanium (5mm thick) and copper (25 mm thick) would retain their integrity for at least 500 years, the time period when the hazard is greatest. In the case of titanium, the mechanism by which crevice corrosion initiates and then becomes passive is now well understood.

The bentonite-clay buffer surrounding each container. The principal function of the buffer is to inhibit the movement of radionuclides away from the container. Our research shows that radionuclide movement in compacted bentonite-sand mixtures occurs only by diffusion. Buffer thicknesses of 250 mm yield breakthrough times of 500 to 1,000 years, providing a containment time comparable to that of the used-fuel container.

The granite rock mass. Our field research in the Canadian Shield indicates that the large granite plutons of interest consist of relatively large rock volumes with low permeability separated by relatively thin planar fracture zones. The fracture zones are much more conductive than the background rock, and control the groundwater flow. Groundwater movement within the fracture zones is slow because topographic gradients, which drive the movement, are small. Vaults excavated in the background rock could provide a very high level of containment.

Field research areas have been established at three locations in the Precambrian Canadian Shield and, since 1978, these areas have been extensively characterized from a geotechnical perspective. Monitoring of the groundwater flow system in each area is continuing via instrumented networks of boreholes.

An underground research laboratory is being excavated in a previously undisturbed granite rock mass. The rock mass was thoroughly studied prior to excavation and its geologic and hydrologic characteristics determined to a depth of about 500 m. The excavations comprise vertical access and ventilation shafts 255 m deep and laboratory rooms at a depth of 240 m. Excavation is underway to extend the access shaft to a depth of 455 m as part of an agreement with the U.S. Department of Energy.

To date, work at the laboratory has provided unique information on the response of the rock mass and its groundwater flow system. Construction of the laboratory has also allowed us to test excavation techniques that could be used to construct a disposal vault. Once the shaft extension is completed in 1988, experiments will be initiated to study how the rock mass responds to heating, how contaminants and groundwater move through the rock mass, how container and sealing materials interact with granite and groundwater, and how various backfilling and sealing methods perform.

PRESENT STATUS OF THE DEVELOPMENT OF URANIUM ENRICHMENT TECHNOLOGY IN FRANCE

Paul Rigny
Directeur
Division d'Etudes de Séparation Isotopique et de Chemie Physique
Commissariat à l'Energie Atomique, France
(and J. H. Coates and G. Sauzay)

EURODIF has been under full operation since 1982 in accordance with the market demand. Costs have been optimized in particular by taking advantage of power consumption seasonnal modulation. No future need is foreseen before the eve of the next century. During the past years, the CEA has evaluated a number of different processes which could have been in competition for the next isotope separation plant. Experimental studies have been carried on on the plasma separation process as well as on the molecular laser isotope separation and discontinued after a first step of evaluation. Likewise R and D on Chemex is to be closed by the end of 1988 after successful operation of a full length pilot plant.

Simultaneously a large scale R and D effort has been started on SILVA, and has produced evidence of the technical ability of the process to enrich uranium. Separation results obtained on process pilots show that commercial assays can be attained in single step operations. Metal vapor production systems have been started up and tested. Laser systems under development achieve better results than planned. Plans for construction and operation of installations of increasing sizes leading to an industrial demonstration unit are under elaboration. Industrial cooperation is being assessed.

TECHNOLOGIES FOR URANIUM ENRICHMENT IN JAPAN

Yoichi Takashima
Professor Emeritus
Tokyo Institute of Technology

Japan is still actively doing R&D on four processes for uranium enrichment and has spent a considerable amount of money and held a high level of man power for each R&D. Those processes are(1) Gas Centrifuge Process,GCP (2) Atomic Vapor Laser Isotope Separation,AVLIS (3) Molecular Laser Isotope Separation,MLIS and (4) Chemical Enrichment Process, CHEP.

As a matter of fact,the Japanese domestic uranium enrichment business is in a severe situation against its international competition. Therefore, it needs for the business survival to continue improvement to the successively building enrichment plant every year such as the GCP plants and on the other hand,it needs to look for the chance when a new process should be adopted into the next plant instead of GCP, if it has been techniclly well established and evaluated as being more economical.

Only GCP is commercially available at the moment and in fact,the commercial plants by GCP will have the capacity of 600tswu/y in 1995,then may further expand by more advanced GCP up to1500tswu/y at Rokkasho-mura.

As the degree of technical maturity, CHEP developed by ACHI is next to GCP, but it may still need a few years for fully confirming its reliability.

R&D on AVLIS and MLIS have just recently started in Japan and both laser processes are thought to be very prospective in the future, although they may take 10 years or more, before their technogies have become sufficiently matured.

Then, it is so decided in Japan that four processes above mentioned will be comparatively checked and reviewed in their technical and economical feasibilities in 3 years from now. It, therefore, should be required for going on the R&D work more that its merit can be proved by some valuable results at the C&R committee.

TECHNOLOGICAL DEVELOPMENT OF FAST BREEDER REACTORS

Sadamu Sawai
Executive Director
Power Reactor and Nuclear Fuel Development Corporation

Thirty-seven years have already passed since the U.S. experimental fast breeder reactor (FBR) EBR-I achieved the first nuclear power generation in the world. At present, FBRs are operated in seven countries and its development has progressed up to the stage that French Superphenix-1 with an electrical output of 1,200 MW started operation.

Levels of technology, economy and reliability required for commercial FBRs, however, are now getting higher and higher due to stable uranium supply anticipated in the near future, low increasing rate of power demand in the world, and remarkable progress made in light water reactors.

In order to achieve commercialization under such present conditions, FBR R&D is now being carried out in Japan on the basis of the following principles:

1) Improve technologies based on experiences and achievements accumulated through the development up to the prototype FBR "Monju".

2) Develop innovative technologies to attain a technical breakthrough.

3) Promote FBR development under close coordination with its fuel cycle development including FBR fuel fabrication and reprocessing.

FBR commercialization is expected to be attained in a period between 2020 and 2030. If it is taken into account that demonstration must be experienced before it, basic technologies necessary for commercial reactors should be established in the period between 2000 and 2010.

Consequently, in order to establish safety and economy necessary for commercialization before this period, we should simplify plant systems, reduce plant materials, introduce high-performance components, develop long-lived reactor core and fuel, and develop automated and self-reliant plant.

The details are itemized as follows:

(1) Simplification and Reliability Improvement of Plant Systems:

- Simplify decay heat removal system by natural convection.
- Adopt rectangular-shaped reactor building.
- Simplify spent fuel storage system by high decay heat fuel transport, etc.
- Eliminate steel liner used in piping room by adopting high temperature sodium resistant ceramics.
- Eliminate secondary sodium loops by using steam generator with double-walled tubes.

(2) Reduction of Plant Materials

- Reduce plant structure materials by seismic isolation technique.

- Shorten pipe length by bellows expansion joint, floating support, etc.

(3) Introduction of high-performance components

- Introduce once-through steam generator.

- Introduce inducer pump and superconducting electromagnetic pump.

(4) Development of Long-lived Reactor Core and Fuel

- Develop long-lived fuel.

- Optimize core arrangement for high-burnup, large-scale reactor cores.

- Develop new shielding assembly to decrease weight and volume of reactor.

(5) Development of automated and self-reliant Plant

- Automate plant to the highest possible degree with artificial intelligence technology.

In addition to the above items, plant safety design based on "defence in depth" is performed to prevent and mitigate accidents, taking FBR safety characteristics and technological progress into account.

FBR R&D programs including the above items are coordinated by an FBR R&D steering committee organized by Japan Atomic Power Company (JAPCO), Central Research Institute of Electric Power Industry (CRIEPI), Japan Atomic Energy Research Institute

(JAERI) and Power Reactor and Nuclear Fuel Development Corporation (PNC). Under this coordination, cooperation system is well organized in Japan to promote FBR R&D efficiently and effectively.

For the future FBR development, it is important to internationally utilize technologies ever accumulated in every country. Japan wishes to promote bilateral and multilateral cooperations as well as cooperation through international organizations not only to complement its own development but also to contribute to the world.

MAJOR EFFORTS TOWARDS NUCLEAR FUSION EXPERIMENTAL REACTOR

Ken Tomabechi
Senior Researcher
Japan Atomic Energy Rsearch Institute

Nuclear fusion research for utilizing energy produced by fusion of light nuclei such as hydrogen's have progressed significantly in recent years, and reached a stage where it should be advanced from scientific research of fusion plasma towards realization of a fusion experimental reactor which will produce energy by fusion.

Present status of fusion research as well as trends in development towards fusion experimental reactor are described below.

In Europe, US and Japan, there have been built and operated for experiment large tokamak machines aiming at production of plasmas of tens of million degrees in temperature. Those are TFTR at Priceton, USA, JET at Culham, Europe, and JT-60 at Naka-Machi, Japan, and called three large tokamaks.

Characteristics of plasmas produced already in the large tokamaks are of tens of million degrees in temperature and of the order of $10^{19}m^{3}s$ in product of density and confinement time. Those are close to the so-called break-even conditions, which mean heating input and fusion output are balanced, if deuterium and tritium were reacted. In JT-60, such plasmas were produced last fall.

Since good results have been oblained in the large tokamaks, fusion research is advancing towards a fusion experimental reactor. In parallel to physics research, engineering development necessary for constructing fusion experimental reactor is underway. Examples of the engineering development in Japan are given below on super-conducting coils and tritium handling equipment.

International collaboration under the IEA, called Large Coil Task, has been successfully completed last fall, and the NbTi coil supplied by Japan produced excellent results as expected.

Tritium Process Laboratory, TPL, constructed at the Tokai Research Establishment of JEARI has started experiment using tritium in the present fiscal year. Extensive experiments are planned for various types of tritium handling equipment at the facility, which has 10 g of tritium inventory.

In addition, tests on the equipment developed and fabricated in Japan are underway at a tritium flow rate of hundred g per day at the TSTA in US as US-

Japan fusion cooperation. In the future, tests will be made at a flow rate of approximately one kg per day which is close to the actual flow rate in a fusion experimental reactor.

As described above, fusion research has reached a stage to advance the programme aiming at an experimental reactor, and concepts of such experimental reactor are being considered under the conditions of various countries.

In Europe, deuterium and tritium experiment in JET is planned for 1992, and based on the results, the programme is planned to be advanced to start in 1993 or thereabout construction of a fusion experimental reactor called NET.

In USSR, an ambitious large takamak of super-conducting coil type, called T-15, is under construction. Next to the machine, an experimental reactor called OTR is considered to be built.

US plans to build a small machine called CIT, by utilizing the facilities of the large tokamak, TFTR. CIT will produce fusion reaction for a few seconds in about 1993.

Japan should advance development of a fusion experimental reactor aiming at experiment at around year 2000, according to the long range programme for development and utilization of atomic energy, developed by the Japanese AEC last year. The plan looks similar to the European's programme.

There are differences as such, but it is the present status that each nation is aiming at advancement of fusion research programme towards an experimental reactor.

In coincidence with the trends, a new international collaboration starts soon for implementing joint design of a fusion experimental reactor. It is a collaboration to conduct a conceptual design of a machine called International Thermonuclear Experimetal Reactor, ITER, by four parties of EC, Japan, USSR, and USA, until the end of 1990.

The collaborative activities will be conducted under the auspices of the IAEA, and ITER Council and ITER Management Committee will be established for implementing the activities, while ITER Scientific and Technical Advisory Committee will be set up for advising the ITER Council. The ITER project is a unique international collaboration towards fusion experimental reactor.

It is hoped that fusion research will enter into a new stage of starting construction of a fusion experimental reactor by, at least, some of the parties, by utilizing the good design produced as a crystal of knowledge of world fusion scientists, although follow-on commencement of joint construction by the four parties immediately after the conceptual design may be seen as difficut, if one extrapolates existing international situation.

HIGH TECHNOLOGIES AND RADIATION APPLICATION

Yoneho Tabata
Professor
The University of Tokyo

First, a general review - on use and application of radioisotopes and radiation will be made. In the review, it will be emphasized that radiation is being widely used in almost all fields and is profitable for human life.

Second, some of radiation processings which are already in practical use will be briefly introduced.

Crosslinking of wire and cable.
Heat shrinkable film and tubing
Rubber valcanization
Foamed polymer
Modification of material
Semi-conductor, other electronics elements
Radiation curing
γ-Sterilization of medical supplies

Third, a series of rather big projects of radiation processings for near future will be explained. That is:

Electron beam sterilization
Food preservation
Treatment of either waste water or drinking water
Stag gas treatment

Fourth, it will be mentioned that newly developed radiation sources are contributed greatly to advanced technologies.

At the same time, it will be pointed out that radiation source technology, mainly beam technology, has been very much developed by introducing advanced technologies.

Ion-beam facility
Photon factory
Meson factory

Finally, research and development of new radiation sources such as a positron factory, and a high quality electron beam facility will be discussed in conjunction with advanced tecnologies.

FRIDAY, APRIL 15

9:30 am — 12:20 pm
SESSION 4 NUCLEAR FUEL SUPPLY SYSTEM: PROSPECTS AND ISSUES

In order to make nuclear energy a promising relief for human beings, freeing them from the restraints attendant to energy issues, it is imperative that the nuclear fuel cycle should be firmly established viewing from the total nuclear fuel utilization system. Research and development necessary for this must be carried out steadily from now on. In promoting the development as effectively as possible, this must be considered from the international viewpoint as to ideally sharing the roles involved, because each field in this cycle is closely interrelated through all stages, from uranium mining to radioactive waste treatment and disposal. Efforts should be concentrated also on the subjective and positive aspects of dealing with the issues on nuclear non-proliferation and nuclear weapons disarmament.

In this session, problems to be addressed include the significance of the establishment of nuclear fuel cycle, its comprehensive economics, high level radioactive waste management, and preparation of the environment for plutonium uses. The possible way to build up the nuclear fuel supply system will thus be sought.

PERSPECTIVE TOWARD 21ST CENTURY ON NUCLEAR FUEL UTILIZATION

Masayoshi Hayashi
President
Power Reactor and Nuclear Fuel Development Corporation

1. Establishment of Nuclear Fuel Cycle in Japan

Japan wishes to survive as an industrial nation. Regrettably, however, it is short of natural resources such as oil, coal, and uranium ore. This is why energy problem becomes most important for Japan to attain national security.

From a long-term viewpoint, nuclear energy will be a principal energy source for Japan. In order to secure long-term stable nuclear energy supply, Japan has a basic policy to complete nuclear fuel cycle which covers from uranium exploration to radioactive waste disposal.

The world uranium market price remains still low. Uranium exploration is made at a low pace. More than 90 percent of uranium resources of which existence has been confirmed belong to only eight countries. These countries might change their energy policies in future. Discoveries of uranium deposits have been decreasing since 1980.

In these circumstances, it is important for Japan to increase import of uranium ores exploited by itself for a long-term stable supply of uranium. Japan's uranium exploration efforts would be internationally demanded as a duty of a nation which consumes large quantity of uranium.

Japan reconfirmed to pursue its principle to reprocess spent fuel and utilize plutonium. This has a great importance for Japan, which has a share of more than 10 percent of the world economy, not only to secure its own energy but also to contribute to international society by plutonium utilization.

Japan is preparing for a commercial scale plutonium utilization. For this, many technical problems must be solved and confidence must be obtained from international society.

2. Peaceful Utilization of Nuclear Energy and Nuclear Non-Proliferation

The Power Reactor and Nuclear Fuel Development Corporation (PNC) has steadily pursued research and development for plutonium utilization at the reprocessing plant, plutonium fuel fabrication facilities, experimental fast reactor "Joyo" and advanced thermal reactor "Fugen". Substantial achievements have been obtained so far. PNC should fully recognize its important role and responsibility to prepare for future plutonium utilization.

Concerning a problem of peaceful utilization of nuclear energy and nuclear non-proliferation, serious discussions were internationally made at the occasion of Japan-U.S. reprocessing negotiations held about ten years ago. At present, hot discussions are being made at the U.S. Congress on the revision of the Japan-U.S. Atomic Energy Cooperation Agreement. Discussions are focused on important subjects including nuclear non-proliferation in plutonium utilization, safety assurance, and environmental impact.

Japan promotes nuclear energy utilization only for a peaceful purpose. Based on this policy, Japan should energetically pursue research and development for establishing efficient nuclear utilization systems. We believe it is the best way to contribute to the establishment of an international consensus for plutonium utilization that a total system including safeguards, physical protection, and transport is established to demonstrate the effectiveness of nuclear non-proliferation.

3. Radioactive waste and human life

It is important to solve waste management problems inevitably arising from human life. This is also important in nuclear field.

Our generation which is favored with benefits from nuclear energy has a responsibility to properly dispose of radioactive waste and minimize burden of our posterity.

Especially, it is very important to establish high level radioactive waste treatment and disposal system in full consideration of radioactivity and half-life decay time. Long-term safety must be maintained without damaging human life.

For this purpose, it is essential to clarify without delay the target and methodology of geologic disposal and promote the research and development with social consensus.

It is especially noted that high-level radioactive waste includes many precious metals useful for human life. Technology development will promise us an attractive future for the utilization.

4. Role of Nucler Energy toward 21st Century

Fossil fuels such as oil and coal are valuable resources limited in quantity. This charges us a responsibility to minimize the consumption, limit them to value-added use only and keep them for our posterity. It should be noted that fossil fuels are objects of environmental problems covering the whole area of the earth.

Nuclear energy has superior features as an energy source. It is an energy utilizable by integration of high technologies. Nuclear Energy possesses very extensive technological potentialities.

In developing nuclear technologies, however, everyone should frankly acknowledge that recognition on the importance of safety problems is prevailing inside and outside of Japan after Chernobyl nuclear power plant accident.

We should frankly recognize these situations, but not forget advantageous features of nuclear energy. We should challenge toward 21st century confidently, extensively, and elastically.

From these viewpoints, I wish to point out several objectives which should be pursued hereafter:

Firstly, we should have an international and global view on the future of nuclear energy. We must observe peaceful utilization of nuclear energy under non-proliferation and solve safety, environment and resource problems. We should energetically promote international cooperation in this field and extensively contribute to international society making most use of Japan's unique security measures and original technical features.

Secondly, we must promote implementation of plutonium utilization centering on the technological development of fast breeder reactors. Uranium resources are, of course, limited in quantity. This will make it inevitable to enter an era of FBR which can efficiently utilize the resource with integrated high technologies. In order to support it, establishement of plutonium utilization system is not only domestically but also internationally important.

Thirdly, we should establish base technologies, promote innovative research and development, improve and diversify present nuclear energy utilization systems. We should also make utmost efforts to work out and utilize technological potentialities which nuclear energy possesses in unexploited areas of space, geo-space and ocean. We should diversify their utilization and contribute to the development of science and technology.

A COMPREHENSIVE ECONOMIC ASSESSMENT OF THE FUEL CYCLE, WITH A PROSPECTIVE VIEW

J. C. Guais
General Manager
Marketing & Business Development
COGEMA

In order to assess the future economic value of nuclear energy through LWRs up to and after the year 2000, it is necessary to make a prospective evaluation on the technological progress and associated cost trends, in the nuclear fuel supply system.

From uranium mining, enrichment and cost fabrication, to the back-end operations, whether through reprocessing/recycling or through direct disposal, an overview of the future technological evolution of the fuel cycle will be presented, together with reasonable cost trends, as seen by a major producer in this industry.

In particular the alternative solutions for the back-end will be examined in terms of their respective merits for the overall fuel economy and the nuclear waste management, which are two key points for the prospect of nuclear energy in the beginning of the next century.

NUCLEAR FUEL CYCLE STRATEGY AND TASKS

Kozo Iida
Executive Vice President
The Kansai Electric Power Co., Inc.

I. Keynote

It is only natural that the developmental approach of nuclear power will sharply differ among nations on account of their national strength in terms of natural resources at command, and technological and industrial potentialities. For certain countries in Europe as well as Japan who heavily rely on overseas energy resources and are urgently required for maintaining the energy security, it would be undoubtedly one of the most important tasks for them to make an effective use of uranium resources by developing nuclear power which may be termed a "High-tech Energy Source." Accordingly, it may be safely said that those energy-intensive countries are obligated to exert every effort for alleviation of global energy demand-supply situation, control of energy price, and encouragement of highly value-added usage of oil and LNG. Moreover, they have to play a central role in tackling with such global problems as the control of carbonic acid gas generation and acid rain pollution resulting from fossil fuel consumption.

Since the supply source of uranium to be used in LWRs is limited as is so with oil resources, our effort should be directed toward the ultimate objective of clearing away an obstacle in effectively utilizing nuclear fuel on FBRs: however, in the light of the difficulties in establishing a cost-effective FBR technology, the commercial use of FBRs seems to come around the year 2030. In this connection, it would become necessary for us, the parties concerned, to establish a technology designed for effectively utilizing plutonium for the time being, with the aim of building up a system for putting FBRs into the nuclear fuel cycle.

In line with such an idea, we, the utilities in Japan are planning to recycle plutonium into LWRs. As for such a uranium/plutonium recycling plan, we, the utilities in Japan will strain our utmost efforts for building up the public acceptance of the people here in Japan and abroad.

II. Strategy and major tasks

In the light of the foregoing considerations, we at the utilities in Japan are contemplating to construct a flexible, resilient nucler fuel cycle strategy based upon three schemes, i.e. the prolongation of the era of LWRs playing the leading role in energy supply, the streamlining of a transient period from LWRs to FBRs, and the furtherance of our energy security.

In order for us to cope with such eventual global market situations as the interruption and/or cessation of uranium supply and escalation of uranium price, it would be our short-term approach to make an active use of fuel stockpile in every stage of the nuclear fuel cycle. In the mid-term scheme, it would be our plan to lay great stress on diversified supply sources of uranium, increased share to be given to domestic uranium enrichment service, and decreasing dependence on uranium resources by use of reprocessed uranium and pultonium. The future full-scale approach would be designed to build up the self-reliant nuclear fuel cycle with FBRs as its core.

While the foregoing three programs should, we believe, be carried out in paralell to a certain extent, all-important immediate tasks by which our nation is confronted at present, is to establish the technological and social bases for our energy security by the construction of commercial nuclear fuel cycle facilities as well as to try to improve the fuel cycle economy. Moreover, in order for us, the utilities in Japan to develop a better understanding of the people on the nuclear fuel cycle, we believe it supremely important to structure a disposal system for high-level radioactive wastes that have long been left undecided.

In the nuclear fuel cycle, there are three key components, i.e. uranium enrichment, spent fuel reprocessing, and treatment and disposal of radioactive wastes (high-level wastes in particular), on which our basic thoughts are given in the following:

First, with respect to uranium enrichment project, it is our present plan to initiate in 1991 the commercial service of a centrifugal enrichment plant in the Rokkasho-mura on the Shimokita peninsular at the northern tip of our main land as well as to try to enhance the economic efficiency of such enrichment service undertaking with high-performance centrifuges to be placed into commercial service at an early date. In addition, a project for developing such advanced enrichment technologies as laser process will be energetically pursued, with our eyes on the next century.

Secondly, as for the spent fuel reprocessing, it is our basic policy to ultimately reprocess all the spent fuel assemblies for the purpose of recycling recorvered plutonium and uranium into the fuel cycle. In this connection, we are going to build with foreign assistance a reprocessing plant whose capacity is 800 tons HM/yr. It is our plan to utilize the reprocessed plutonium not only for R&D programs (namely, a prototype FBR "Monju," a demonstration ATR "Ohma," a demonstration FBR, etc.), but also for the fabrication of MOX fuel to be fed into LWRs.

The reprocessing plant will enable us to establish a system for filling a half of the domestic demand around the year 2000. As for those spent fuel assemblies exceeding the said reprocessing capacity, we are going to work out a flexible scheme, inclusive of an option of temporarily stockpiling them at the plant site. With respect to a long-range reprocessing program on and after the Shimokita project, our keynote is to devise a practical scheme to be flexible in meeting ever changing plutonium demand by gaining a proper perspective of such factors as accumulating spent fuel assemblies, global uranium market price trends, improving reprocessing economic efficiency, and elevating fuel burn-up.

Third, as for the treatment and disposal of radioactive wastes, it is scheduled on our part to start a shallow land disposal of low-level wastes at the said Rokkasho-mura site in 1991. It is our basic scenario to vitrify high-level wastes for tentatively storing them for a period of 30 ~ 50 years, and thereafter to start the geological disposal. Henceforth, we, the utilities with the support from the public sector, are going to tackle with such important tasks as the development of solidification system, stockpiling and disposal systems, review of other prospective scenarios, survey of disposal sites, and establishment of financing and institutional measures. Furthermore, other prospective scenarios will be reviewed in the future.

III. Significance of international cooperation

It seems to us that such uranium/plutonium recycling program would be promoted only by a limited number of countries for the present; therefore, such nations should draw on their resources in the fields of the required technological development as well as the enhanced practice of nuclear non-proliferation: otherwise, the regular nuclear power development could be jeopardized. In this field, the importance of international cooperation should be reemphasized. Accordingly, we, the utilities in Japan will proceed with the furtherance of nuclear power development program and the establishment of nuclear fuel cycle on a major premise that the securing of safety be positively maintained, and also we do commit ourselves to fulfill responsibility as a member of international society in developing such recycling technologies and strengthening the nuclear non-proliferation practice.

AN ASSESSMENT OF THE PROSPECTS FOR FUEL CYCLE TECHNOLOGIES

W. L. Wilkinson
Deputy Chief Executive
British Nuclear Fuels plc

Technological developments and progress in the pre-reactor fuel cycle, which encompasses enrichment, fuel manufacture, recycled reprocessed uranium, mixed oxide fuel, have extensive interactions with the post-reactor cycle operations of reprocessing and waste management.

Prospects for new technology are also heavily dependent upon total fuel cycle economics in comparison with the once-through, direct disposal case.

For such reasons therefore, the fuel cycle must be considered as an integrated whole in order to assess technological trends which will be of overall benefit. In essence, it is suggested that fuel cycle technologies will be driven by economics towards optimised solutions of improved fuel economy, satisfactory waste management and public and regulatory acceptance.

The major technological trends and targets resulting from these considerations will be examined from the viewpoints of practical feasibility and timely acceptability.

MOVING TOWARD NEW ERA OF NUCLEAR FUELS

Junnosuke Kishida
Honorary Chairman
Japan Research Institute

Nuclear power in 1987 accounted for 31.7% of Japan's total generated electricity and showed a capacity factor of 79.2%, to hit an all-time high for both generation and availability in this country. The development of nuclear energy in Japan has come to the point where new steps should be taken toward higher degree of maturity. These achievements provide a backdrop for the position that nuclear power holds as a key energy source in the Long-Term Program for Development and Utilization of Nuclear Energy worked out in 1987. The program points out that Japan has an important role to play in this field of international society.

In this respect, I think any concrete measures to be taken in the years ahead should be considered from the following five viewpoints.

The first viewpoint is one expected from all advanced technology states devoted to the cause of peaceful use. They must always be prepared to check up on the ways of nuclear technology from considerations of peaceful use.

Nuclear energy has already been developed for nearly half of a century. But advanced nations began their research and development projects with the development of nuclear weapons for military purposes. Technologies have been developed for peaceful uses, too, but the entire system of such technologies is apparently not free of the "trail" of what has been left with it for military use. This impression is felt particularly at the back-end of the nuclear fuel cycle. For one thing, it finds expression in the U.S. policy of restricting late-comers in much of their efforts to promote spent fuel reprocessing.

Waste liquids from reprocessing are known as "high level wastes." I suspect that this name was given because users of plutonium for military purposes thought what remained after its extraction should be disposed of as waste. But were they really right?

Besides, I wonder if an equal, well-balanced amount of research and development efforts has been assigned, for the purposes of peaceful use, to each of the tasks in the development of nuclear technologies including waste treatment and disposal.

The second view point is based on the reality that the "LWR era" is likely to last longer than originally had been forecast. For the tasks that follow, namely the back-end technologies, the need is arising to work out more realistic plans of development and push them on a more carefully laid out timetable than ever.

Nuclear technologies have so far been developed by two different stages. The first stage is the commercialization of reactors with emphasis on the use of uranium 235. The second is the perfection of a nuclear fuel cycle including the development of fast breeder reactors. For maturity to settle in for the second stage, it now seems to take a long time. Among the reasons for this are the change in estimated uranium resources, the difficulty about FBR technology and the advanced nations' strong fear as to the possibility of nuclear proliferation.

Japan is in the position, as an advanced technology state with limited resources, to regard the FBR as the mainstay in the utilization of nuclear energy. That is why this country is active in promoting commercial reprocessing.

But, now that it is obvious that the FBR era will come much later than had been expected, the necessity exists to review details of the technology development program that is to be carried out in the meantime.

The third viewpoint is that, in connection with the first and second viewpoints, reconsideration should be given, taking into account the element of time, to all conceivable variations of the flow of work at the second stage, namely the back-end including reprocessing. Reprocessing has so far been established in advanced nuclear weapon states, starting with techniques designed to extract weapons-grade plutonium. From the standpoint of peaceful use, it may well be doubted if there has not been a better approach. It would not be meaningless to explore the possibility of incorporating the reprocessing process, at a small additional cost, with "group separation."

The fourth viewpoint is one which, taking the element of time into account, should consider technological progress that may be advanced in the meantime. Constant efforts should be made to improve the system of technology for the nuclear fuel cycle.

From considerations of time, it should be noted, for one thing, that LWRs are thought to last longer. For another, there is long interval between vitrification of high level radioactive wastes and their burial in geologic formations.

Hopes of continuous improvement are held out for technology in any section of the project. Of course, this could make it hard for a system of technology to be established as a whole. But if some time is allowed for the project, it should be made to have enough flexibility for system design to take in technical achievements that may be obtained in the meantime.

The fifth viewpoint is the premise on which to incorporate such technical achievements as mentioned in the fourth place. New techniques must be added to the existing system, whenever they are developed, in ways that will certainly keep them compatible with it.

Many engineers and interests have been using their utmost efforts over the years. Care should be taken to make full use of what they have achieved.

FRIDAY, APRIL 15

1:40 pm — 5:20 pm
SESSION 5 EFFORTS FOR FURTHER ENHANCEMENT OF RELIABILITY OF LWR (Panel Discussion)

The age of the light water reactor is lasting longer than had initially been expected. Further extension of the age requires the LWRs maintain their superiority over other sources of electricity, and that their quality be improved to enable them to be a major source of electric power. Great efforts should be made to enhance the overall reliability of LWRs in terms of safety, operability and economic efficiency, and those efforts could lead to deepen the public understanding of nuclear power.

In this session, the present situation of LWRs will be reviewed in terms of strategies for the technical development for higher reliability with the prospect of their long-term use, and existing issues including international cooperation will be clarified. From these, the future of the age will be projected.

[KEYNOTE]

LONG RANGE PROSPECTS FOR THE LWR REACTORS IN FRANCE

Rémy Carle
Directeur Général Adjoint
Electricité de France

The french nuclear program is based on LWRs. At the beginning of 1988, 34 units of 900 MW and 12 of 1300 MW were operating on the network. 8 units of 1300 MW and 2 of 1400 MW (N4) were under construction. The first N4 unit will be put into operation in 1991.

The nuclear production in 1987 was of 251 billion kWh, that means 70 % of the french electricity. With an availability of 80 % the current plants appear to be perfectly safe, reliable and economical. The same résult is observed in most of the big nuclear countries. Nevertheless all these countries try to improve them and to prepare more performing units for the future - France is involved in the same process - .

For the short term the N4 model represents a great advance for all the important points of technology. For example, the fabrication of the vessels have been improved, a new steam generator with an axial economizer and use of inconel 690 has been developed, a new turbogenerator has been tested, the control system will make use of the most modern achievements in electronics and computers. Generally speaking N4 takes into account all the learning of the TMI accident, particularly regarding the man-machine interface.

So it is anticipated that the orders during the nineties will concern this model.

Another field for better performances is the fuel cycle. EDF has adopted a reloading procedure by quarters of the core permitting a higher burn-up with the AFA fuel elements. EDF has also adapted the recycling of plutonium ; the first MOX load was put into a LWR in 1987 ; during the next decade about 100 tons of MOX fuel will be loaded each year. The use of reprocessed uranium will also be tested during the next years. These improvements must be compatible with the load following necessary in a production system having a great proportion of nuclear units.

What will be the reactors of the future ?

It is not yet clear if the better use of uranium by undermoderated or spectral shift reactors will be adopted. A three years period (1985-1987) was devoted to fundamental studies in order to know better the characteristics of the corresponding cores and to assure the stability of those reactors. It is clear that the gain in the use of uranium shall be low and that the increase of the investment cost has to be low too. Engineering studies could be made during the next months to optimize these concepts.

The study called REP 2000 intends to precise more generally the specifications of the reactors we would like to dispose of after the year 2000.

Of course, EDF continues its R and D effort to get breeders available, both technically and economically, at the time the present units will have to be replaced. But LWRs will still remain part of the production system for many decades ahead.

[KEYNOTE]

MEASURES FOR FURTHER IMPROVEMENT OF SAFETY AND RELIABILITY OF VVER-TYPE (PWR) NUCLEAR POWER PLANTS AND TASKS FOR FURTHER PROMOTION OF INTERNATIONAL COOPERATION IN THIS FIELD

L. Voronin
Deputy Minister
Ministry of Nuclear Power
U S.S.R.

На I января 1988 г. установленная мощность АЭС в СССР составила 34,4 ГВт, из них примерно 50% - это АЭС с легководными реакторами типа ВВЭР. К 2000 г. намечается увеличить суммарную мощность АЭС в несколько раз.(при этом доля энергоблоков с легководными реакторами будет более 85%).

В перспективном плане развития атомной энергетики в СССР предпочтение отдается атомным электростанциям с реакторными установками типа ВВЭР (PWR).

Основной модификацией реактора ВВЭР в настоящее время является ВВЭР-1000. На основе этой реакторной установки создан унифицированный проект АЭС с блоками электрической мощностью I млн.кВт. В проекте АЭС с ВВЭР-1000 используются наиболее прогрессивные современные решения в части обеспечения безопасности АЭС: две независимые системы воздействия на реактивность, защитные герметичные оболочки, обеспечивающие удержание (локализацию) радиоактивных продуктов при максимальной аварии, сейсмостойкое оборудование и другие современные решения, принятые в большинстве стран.

Энергоблоки АЭС с реакторами ВВЭР-1000 рассчитаны на преодоление последствий различных аварий, в том числе максимальной проектной аварии - мгновенный поперечный разрыв главного циркуляционного трубопровода диаметром 850 мм контура охлаждения реактора с двусторонним истечением теплоносителя в условиях полного обесточивания энергосистемы и при наличии сейсмических воздействий. АЭС с ВВЭР-1000 имеют системы безопасности, построенные по принципу трех полностью независимых систем, или каналов, каждый из которых способен полностью выполнить функции защиты (т.е. используется структура 3х100%). Каналы системы безопасности имеют независимые источники энергоснабжения - дизельгенераторы мощностью по 5600 кВт и независимые источники охлаждающей воды - брызгальные бассейны производительностью, обеспечивающей длительный отвод остаточных тепловыделений реактора.

Системы безопасности АЭС с ВВЭР-1000 имеют резервный щит управления, с которого возможен контроль и поддержание реактора и энергоблока в целом в безопасном состоянии даже в случае выхода из строя основного щита управления АЭС. Основные решения по безопасности на энергоблоках АЭС с реакторами ВВЭР-1000 соответствуют или подобны аналогичным решениям принятым, например в ФРГ, США, Франции, Японии.

Анализ аварии на Чернобыльской АЭС не дает оснований для пересмотра принципиальных технических решений принятых в проектах АЭС с ВВЭР. Тем не менее все решения,обеспечивающие безопасность действующих, проектируемых и строящихся АЭС с реакторами ВВЭР, были подвергнуты строгому критическому анализу, в результате которого определен ряд мер по дополнительному повышению безопасности.

Так намечается дальнейшее совершенствование ядерно-физических характеристик активной зоны реактора ВВЭР-1000 и переход на более высокое обогащение до 4,4%, вместо 3,3%,что обеспечивает во всех режимах отсутствие положительных эффектов реактивности.

Признано целесообразным также увеличить эффективность механических органов воздействий на реактивность (для гарантированного подавления температурного эффекта реактивности органами СУЗ при охлаждении теплоносителя до температур ниже 100°С);

Начато внедрение замкнутых пассивных систем отвода остаточных энерговыделений от активной зоны, надежно предотвращающих на время не менее 24 часов повреждение ядерного топлива при длительном отсутствии всех источников энергоснабжения на АЭС.

Все атомные электростанции оснащаются диагностическими системами контроля за исправным состоянием оборудования, трубопроводов и готовности к работе механизмов систем важных для безопасности.

Планируется внедрение систем высокоэффективной фильтрации газовоздушной среды защитной оболочки при авариях.

СССР, являясь одним из учредителей МАГАТЭ, принимает постоянное и активное участие в широкой и полезной деятельности, включая реализацию мероприятия по созданию международного режима безопасного развития ядерной энергетики. СССР в числе первых ратифицировал Конвенцию об оперативном оповещении о ядерных авариях и Конвенцию о помощи в случае ядерной аварии или радиационной аварийной ситуации на АЭС.

Советский Союз участвует в международной системе ядерной информации. Его представители работают в группе экспертов по выработке концептуальных положений безопасности, а также участвуют в информационной системе об инцидентах на АЭС. Принято решение о вступлении СССР во всемирную ассоциацию организаций, производителей ядерной энергии.

СССР на двусторонней основе сотрудничает с 34 странами, включая США (вопросы вероятностного анализа безопасности), ФРГ (прочность конструкций, системы контроля, дезактивация оборудования а также с рядом фирм и организаций Великобритании, Франции и других западных стран.

Тесное и плодотворное сотрудничество в области развития и безопасности атомной энергетики установилось между всеми странами-членами СЭВ.

Для создания нового поколения атомных станций повышенной безопасности необходимо и целесообразно дальнейшее развитие международного сотрудничества с использованием накопленного разными странами опыта исследований и создания оборудования для АЭС. В первую очередь представляется целесообразным объединить усилия стран по изучению процессов протекания тяжелых аварий на АЭС с легководными реакторами и выработки на этой основе международных рекомендаций направленных на совершенствование технических решений и систем, обеспечивающих максимальную безопасность АЭС.

[KEYNOTE]

LWR PROGRAMME OF THE U.K.

Brian V. George
Director of PWR
Central Electricity Generating Board
United Kingdom

Introduction (Brief)

Sizewell 'B'

The development of the design, is described. Changes include those due to the use of UK turbines, the different frequency (50Hz) of the UK system, and the very stringent UK safety criteria. Some of the specific features resulting from these points are addressed.

The layout and programme of construction of the station are discussed. Objectives for protecting the programme (and therefore cost) of the station include early solution of design and safety issues, the use of test rigs and an engineering model of the station and careful contract strategy.

Follow on Stations

The need for new capacity in the remainder of this century is considered along with the factors influencing the choice of new plant. It is concluded that there is a need for 5000-6000 MW of new nuclear capacity on a relatively tight timescale.

Because of this and the obvious cost saving it has been decided to replicate Sizewell 'B' as far as is reasonably possible. The advantages of these policies are discussed along with some of the areas where replication may not be possible. These include site specific aspects, commercial aspects and fuel optimisation. In addition the allocation of 2 identical PWRs to one site would offer further advantages.

Second Generation PWR

The incentives for further development of the design are discussed. These include generating costs, operating flexibility and safety.

The likely UK approach is then described including possible changes, as follows:

- NSSS	Increase in power output, extension of fuel cycle, instrumentation changes, extension of vessel life.
- Turbine	A single turbine may be adopted.
- Layout	To improve segregation, with due regard for constructability.
- Design	System simplification, piping improvements including integrity and support simplification.
- Operating Flexibility	Control rod changes
- Safety	Larger pressuriser, larger steam generator, passive safeguards features, additional mitigation for "beyond the design basis" events, improved containment integrity.

International Cooperation

Suggestions are made for areas which might benefit from international cooperation. These include an exchange of information on the consequences of low level exposure and computer code development.

[KEYNOTE]

PRESENT AND FUTURE ENDEAVOURS IN GERMANY TO IMPROVE THE SAFETY AND RELIABILITY OF LWRS

Herbert J. Schenk
Member of the Board
Philippsburg Nuclear Power Company
Federal Republic of Germany

On April 1st, 1988, there were 7 BWRs and 12 PWRs in operation in the Federal Republic of Germany with a total output rating of about 21,000 MWe. The installed nuclear power plant capacity has doubled since 1984. The first of the three units of the so-called Konvoi series has already started power operation after a construction period of 64 months, including 3 months of interruption by an administrative court. Nuclear power currently accounts for about 36% of overall electric power generation; in the south and north of Germany, this figure is in the range of 55% to 75%. Some units are already being employed in load follow operation. The possibility of frequency control has also been successfully demonstrated.

The availability of German nuclear power plants continues to be very high at about 86%. About 13% of down times are accounted for by refuelling and annual inspection, and less than 1% is due to malfunctions. The release of radioactivity to the environment is very low (currently about 200 Ci noble gases per year with the exhaust air): the annual radiation exposure of the operating personnel has been drastically reduced to about 50 manrem in newer plants by optimization of water chemistry, employment of low-Co alloys and special design of the plants for case of maintenance and repair. The number of fault-induced shutdowns is on average 2 per plant and year. And finally, there have been only a small number of reportable incidents, none of them of major significance to safety. All these highly satisfactory results reflect the high reliability and safety of our nuclear power plants. This has been achieved thanks to the stringent quality requirements made of well to all essential plant components and of to the operating personnel and because of consistent follow-up of operating experience, in other plants also.

The Chernobyl accident led to further intensification of the already standard plant reviews. Even these more stringent reviews confirmed the very high standard of safety engineering embodied in our plants.

Chernobyl also had the effect of accelerating ongoing work on accident management measures. These measures, in particular the use of available operating systems in the event of a serious accident, significantly reduces still further the already low residual risk.

At present, the following accident management measures have been implemented or are being considered for implementation, e.g. by means of provision of additional equipment:

— filtered depressurization of the containment for PWR and BWR
— inertization of the BWR containment
— additional back-up for emergency power supply
— filtering of the supply air to the control room
— rapid depressurization of the primary system in the PWR
— burning off of hydrogen in the PWR containment
— preparation of the use of normal operating systems to achieve the safety objectives

The following items are worthy of special emphasis as objectives for future development:

— development and improvement of fault-tolerant systems
— more effective employment of computers, including "intelligent" computers
— further development of high-burnup fuel
— reduction of radioactive waste
— and the development of heater reactors and high conversion reactors.

Finally, work is underway on the construction of a nuclear fuel reprocessing plant and of an ultimate storage repository for radioactive waste.

[KEYNOTE]

SOME ASPECTS OF CONTINUED INCREASE OF RELIABILITY OF THE CZECHOSLOVAK NUCLEAR POWER PLANTS

Stanislav Havel
Chairman
Czechoslovak Atomic Energy Commission

There are steadily growing demands on effective, reliable and safe operation of the nuclear power plants (NPPs). The increase of the NPP reliability is therefore a continued process, in which not only the operators, but also the designers and manufacturers of NPP components must participate. As a basic assumption of effectivity of this effort, there must be a continuous monitoring and thorough analysis of the NPP operation and effective feedback ensuring the transfer of information to the designers, manufacturers and vendors of NPP components, who are, on the basis of operational experience, improving the designs and structures of the individual parts of NPPs, or the NPP as a whole.

In the paper some practical methods of continued increase of the Czechoslovak NPPs reliability through

- Improved prophylactic inspections, maintenance and repairs during overhauls and routine repairs,
- Permanent analysis of failures and incidents at NPPs with proposals of engineering and organizational measures preventing their repeated occurrence,
- Purposeful reduction of reactor scrams,
- Effective national and international information system embodying the NPP component designers, manufacturers and vendors,
- Probabilistic reliability analyses of the safety significant systems as a prospective modern complex theoretical tool of the NPP reliability evaluation are outlined.

[KEYNOTE]

Stanislav Havel
Chairman
Czechoslovak Atomic Energy Commission

[KEYNOTE]

LONG RANGE PROSPECTS AND SHORT RANGE OPPORTUNITIES

Kenneth C. Rogers
Commissioner
U.S. Nuclear Regulatory Commission

In the US, as elsewhere in the world, the emphasis in the near term will be on maintaining and improving current light water reactor technology. In some respects, the pressure to improve current technology is even greater in the US than in a number of other countries. There are several major reasons for this. First, there are currently very few commercial power reactors remaining under construction and none awaiting start of construction. Secondly, a number of the existing reactors are over twenty years old. The potential for operational problems due to the aging of reactor components is an issue of growing concern. Further, within the next few years, the utilities must begin to plan for the period beyond the expiration of their present 40 year licenses from the NRC. Thirdly, for a variety of reasons, our recent operating experience, as compared to that of other nations, suggests that the performance of US reactors can be improved.

Both industry and the NRC will need to make some significant changes in the coming years to adjust to the changing environment and prospects for LWRs. It is my view that the most significant adjustments include: the need for industry to devote more attention to maintenance to improve the availability and safety of nuclear power plants; the need for industry to apply greater management effort to operations to assure that attention to detail, to quality, and to conformance to rules and procedures is achieved and sustained; the need for the NRC to maintain a strong oversight role of the industry while modifying its regulations to be less prescriptive and more results oriented; the need for the NRC to establish the criteria and requirements for renewal of licenses and for decommissioning for existing LWRs; and the need for the NRC to begin to address the regulatory requirements for the next generation of reactor designs.

One interesting opportunity is for NRC and the industry to adapt as much as possible to existing reactors the lessons we have learned and are learning in designing the next generation of nuclear power plants. This can allow us to realize the benefits of our research even before the new technology comes to total fruition. Of course, an existing power plant imposes certain intrinsic constraints on the changes which can be made, and not all the lessons of advanced technology can be backfitted to existing systems. However, significant adaptations may be possible, particularly when existing plants are refurbished and existing components replaced. This is a concept that has possible worldwide application as well.

The US nuclear power program is at a critical crossroads. There are presently 109 licensed power plants supplying 17% of US electrical power. Thus, despite the continuing hiatus in new plant orders, nuclear power is an important component of the present US energy mix. Because the US has substantial indigenous fossil fuel resources, its near term needs have not been as acute as those of some other countries, and there has not been the same pressure to develop nuclear power as a matter of national policy. However, the needs that have led to the development of nuclear power in the US will continue to make nuclear power a desirable option. The measures outlined here should help improve the safety and viability of the present commercial nuclear capacity for the near term, and provide a solid regulatory and operational environment for the future.

[KEYNOTE]

ENDEAVORS TO IMPROVE THE SAFETY AND RELIABILITY OF KOREAN NUCLEAR UNITS

Dong Joo Kim
Vice President, Technology Development
Korea Electric Power Corporation

Growth of Korean nuclear industry is remarkable enough to supply 53.1 % of electricity in 1987. Completion of new units will fortify the role of nuclear energy. The accident of Chernobyl, however, has boosted the public concern on reactor safety than ever before. And introduction of breeder technology is delayed than expected earlier. Thus, present LWR technology, though well-proven to extract fission energy, must enhance its reliability and safety to remain superior to other energy options.

Worldwide efforts to enhance LWR reliability are sought through plant standardization , optimization of regulatory terms on reactor safety, and provision of more safety margin.

Korean efforts to upgrade LWR technology are based on the recognition of domestic situations; co-existence of PWRs and a CANDU and diversified reactor supply brought hardship in establishment of her own regulations, manpower training, systematic buildup of domestic capability; whole dependency on foreign fuel may lead to serious energy shortage in case of an energy crisis; and public acceptance is critical to sound development of nuclear option. Therefore, in order to pursue energy independence, Korean strategy aims not only to absorb advanced reactor and associated technology but to obtain public acceptance.

Several improvements are made for the existing units to upgrade their safety and reliability; refueling interval is extended to 15 months to raise capacity factor; optimized fuel assembly is loaded to save uranium requirements; most of TMI action items are accommodated; methodologies of PRA are set up to analyze major safety systems; while reactor internal of Kori # 1 was modified to protect fuel rods from flow-induced vibration, retubing of condenser and sleeving of plugged S/G tubes will rehabilitate its performance.

Although about 80 % of Koreans acknowledge neccessity of nuclear power, mass media are critical to nuclear safety and tend to degrade public acceptance. Thus, an master plan is being prepared to establish the confidence on nuclear energy.

As an effort to improve the performance of future units, a project is underway to standardize 1,000 MWe PWR for KNU 13 & 14. Because small domestic market and limited capacity provide relatively small incentives for innovative development, this project emphasizes economic improvement over the old units.

[KEYNOTE]

PRESENT AND FUTURE ENDEAVOURS IN JAPAN TO IMPROVE THE SAFETY AND RELIABILITY OF LWRS

Ryo Ikegame
Managing Director and General Manager
Nuclear Power Administration
Tokyo Electric Power Co., Inc.

I. Development of Advanced Light Water Reactors

Japanese reactor vendors and utilities have developed Advanced Light Water Reactors (ABWR and APWR) aiming at higher reliability, a better capacity factor, lower radiation exposure, and construction cost reduction. They are based upon our operational experience and technologies accumulated in Japan, supported by international cooperation.

They are also included in the Third Improvement and Standardization Program which was promoted under the cooperation of Japanese Government and nuclear industry.

Decision has been made to build ABWRs in Kashiwazaki Kariwa Nuclear Power Station as its 6th and 7th units. The capacity factor and the radiation exposure are expected to be more than 86% and less than 50 manrem/yr respectively and the construction cost (dollar per kW) is expected to be 20% less than the conventional BWRs.

II. Operation, Maintenance, and Safety of Nuclear Power Stations

1. Securing Steady Operation

Efforts will be continuously made to attain a higher capacity factor by various measures including the extension of operating cycles, reduction of refueling outage, improvement of fuel, reduction of forced outage, extensive education and training of operators and maintenance staff, and countermeasures against aging.

2. Load Following Operation

It is expected that flexibility in the operation of nuclear power plants will be needed in future because of larger day and night or seasonal differences in demand. Load following tests have been made on both BWR and PWR, and successfully demonstrated the capability. Movements against such operations, however, have been seen recently and larger efforts is required in the area of public acceptance.

3. Man Machine Interface

It is necessary to continue the study of user oriented system design, to make clear definition of the roles of man and machine, and the importance of human factors in maintenance not only in operation.

4. Education and Training

Operators are given various training at operation training centers, and by small simulators for education in basic operation. Maintenance staff is trained in study courses at technical training centers.

5. Radiation Exposure Reduction

Measures to reduce the radiation exposure is being taken by the introduction of materials with less cobalt content, decreasing the crud, adopting various automation equipment, giving assistance to subcontractors in regard to radiation protection, and training with mock-ups.

6. Solid Radioactive Waste Management (Drum Can Management)

We have reduced the number of drum cans at nuclear power stations by the introduction of non-precoated type filters, incineration treatment, plastic solidification and other volume reduction measures.

Also it is planned to build a low level waste storage facility at Shimokita district in Aomori Prefecture, which is expected to start operation in April 1991.

7. Life Extension of Nuclear Power Stations

In 1985, an 8-year plan started to study the life extension of nuclear power stations. Items now being studied include classification of equipment and parts, clear definition of equipment which should be put under surveillance, establishing evaluation methodologies of life extension, development of surveillance equipment, and economic evaluation.

III. Improvement of Fuel

1. High Burnup Fuel

In BWRs, we started to load high burnup fuel with a maximum assembly burnup of 40,000 MWD/T in the fall of 1987. Further, it is planned to load high burnup fuel with a maximum exposure of 50,000 MWD/T around late 1991.

In PWRs, there is a plan to increase maximum burnup from current 39,000 MWD/T to 48,000 MWD/T in late 1989.

2. Utilization of Pu in Light Water Reactors

In BWRs, two mixed-oxide fuel assemblies were loaded in Tsuruga-1 in 1986 in order to verify the characteristics. In PWRs, four mixed-oxide fuel assemblies are scheduled to be loaded in Mihama-1.

Further there is a plan for a large scale demonstration targeted to start in the early 90's, which will be followed by actual utilization in the late 90's.

IV. International Cooperation

Japanese utilities support the idea of Regional Center of the World Association of Nuclear Operators proposed by Chairman, Lord Marshall, of CEGB, and the first meeting to exchange views on establishing and operating the Asia Regional Center of the World Association of Nuclear Operators was already held in Tokyo.

Besides Japanese utilities, the Korea Electric Power Corporation, the Pakistan Atomic Energy Commission, and the Taiwan Power Company attended the meeting and recognized that efforts will be made towards the establishment of the organization.

BRIEF PERSONAL HISTORY

OF

CHAIRMEN, SPEAKERS AND PANELISTS

MEMBERS OF THE PROGRAM COMMITTEE FOR THE 21ST JAIF ANNUAL CONFERENCE

(in Alphabetical Order)

Chairman	Shoh Nasu	President The Tokyo Electric Power Co., Inc.
Members	Kohei Abe	Executive Director The Federation of Eiectric Power Companies
	Etsuro Ashihara	Senior Vice President Toshiba Corporation
	Yoichi Fujiie	Professor Tokyo Institute of Technology
	Kiyoshi Fushiya	Executive Vice President Japan Nuclear Fuel Service Co., Ltd.
	Tetsuo Hineno	Managing Director Mitsubishi Heavy Industries, Ltd.
	Kozo Iida	Executive Vice President The Kansai Electric Power Co., Inc.
	Ryo Ikegame	Managing Director The Tokyo Electric Power Co., Inc.
	Ryuichi Ishida	Senior Managing Director Nuclear Fuel Industries, Ltd.
	Takao Ishiwatari	Executive Vice President Power Reactor and Nuclear Fuel Development Corporation
	Shigeru Mori	Vice President Japan Atomic Energy Research Institute
	Masataka Nishi	Executive Vice President Hitachi, Ltd.
	Keiji Naito	Professor Nagoya University
	Yoshihiko Nakazato	Executive Vice President Fuji Electric Co., Ltd.
	Kazuyuki Ohama	Deputy Science News Editor The Yomiuri Shimbun
	Ken Ohtani	Stuff Writer Asahi Shimbun
	Ariyoshi Okumura	Managing Director The Industrial Bank of Japan
	Toshikazu Shibata	Professor Emeritus Kyoto University
	Shoichi Shiraishi	Executive Vice President The Kyushu Electric Power Co., Inc.
	Mamoru Sueda	Executive Director The Committee for Energy Policy Promotion
	Atsuyuki Suzuki	Professor The University of Tokyo
	Takashi Yamazaki	Executive Vice President Chubu Electric Power Co., Inc.
	Yoshio Tanaka	Executive Vice President The Japan Atomic Power Company
Observers	Kunikazu Aisaka	Deputy Director-General Agency of Natural Resources and Energy Ministry of International Trade and Industry
	Kensaku Hogen	Deputy Director-General United Nations Bureau Ministry of Foreign Affairs
	Katsuhisa Ida	Deputy Director-General Science and Technology Agency

(As of September 1987)

OPENING SESSION

Chairman

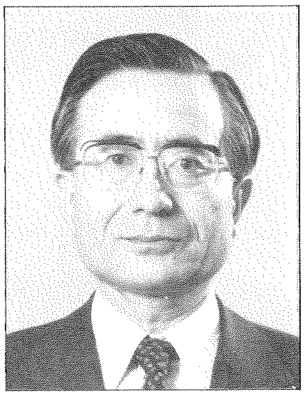
YUTAKA TAKEDA

Date of Birth: January 6, 1914

Education: Graduated from Department of Political Science, Faculty of Law, the University of Tokyo

Professional Career:
1939 Joined Japan Iron & Steel Co., Ltd.
At Fuji Iron & Steel Co., Ltd.
1955 General Manager, Secretariat
1965 Director and General Manager, Personnel Dept.
At Nippon Steel Corporation (organized by the merger of Fuji Iron & Steel Co., Ltd. and Yawata Iron & Steel Co., Ltd.)
1977 Executive Vice President
1981 Representative Director and President
1987~ Representative Director and Chairman

Ex-officio Positions:
1974~ Trustee, Japan Committee for Economic Development (Keizai Doyukai)
1984~ Chairman, The Japan Iron & Steel Federation
1982~ Chairman, Japan-Brazil Economic Committee, Japan Federation of Economic Organization (Keidanren)
1986~ Vice Chairman, Keidanren
1986~ Vice Chairman, Federation of Employers' Associations
1985~ Vice Chairman, International Iron and Steel Institute (1983-1985 Chairman, IISI)
1982~ President, Japan Amateur Baseball Association



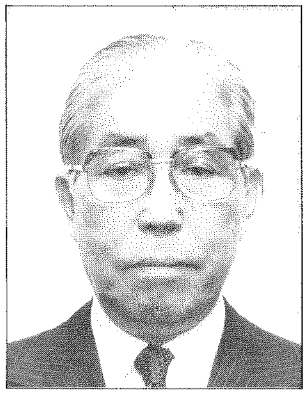
SHOH NASU

Date of Birth: September 19, 1924

Academic career:
1948 Graduated from Political Science Course of Law Department, the University of Tokyo

Professional career:
1948 Entered Kanto Electric Power Distribution Co.
1951 Entered the Tokyo Electric Power Co., Inc. (through the reorganization of the electric power industry)
1964 Manager, Research Sec., General Planning Dept.
1966 Manager, General Affairs Sec., General Affairs Dept.
1971 Acting General Manager, General Affairs Dept.
1974 General Manager, General Affairs Dept.
1977 Director (in charge of General Affairs Dept.)
1979 Managing Director
1982 Executive Vice President
1984~ President

Other major posts:
1985~ Vice-Chairman, Keizai Doyukai
1980~ Chairman, the Federation of Electric Power Companies



JIRO ENJOJI

Born on Apr. 3, 1907

Present Titles:
- Senior Counsellor, Nihon Keizai Shimbun
- Acting Chairman, Japan Atomic Industrial Forum

Education:
1933 Graduated from Waseda University (Department of Political Economy)

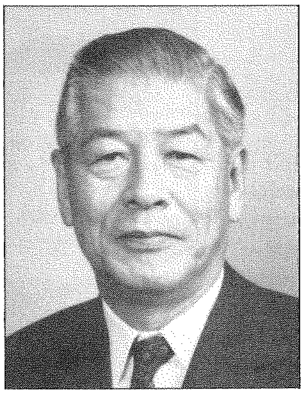
Professional Career:
1933 Joined Nihon Keizai Shimbun, Inc., publisher of the nation's foremost economic daily newspaper (then called The Chugai Shogyo Shimpo and later renamed The Nihon Keizai Shimbun), as a reporter
1942 Economic and political news editor
1946 Managing editor
1947 Director and managing editor
1954 Managing director and editor-in-chief
1965 Executive director and editor-in-chief
1968 President and Cheif Executive Officer
1976 Chairman of the board
1980~ Senior Counsellor

Current Government Posts:
- Member of Advisory Committee for Energy
- Chairman of Petroleum Council
- Chairman of Central Social Insurance Medical Council
- Member of Industrial Structural Council

SOICHIRO ITO

Born on March 21, 1924
1947 Graduated from Tohoku University, Faculty of Law
1948 Political Reporter for the Yomiuri Shimbun
1957 Private Secretary to the Minister for Construction
1960 Elected to the House of Representatives (HR)
1971 Parliamentary Vice-Minister for Agriculture, Forestry and Fisheries
1972 Parliamentary Vice-Minister for Science and Technology
1974 Representative Manager, Union of Parliamentarians for Promotion of Nuclear Power Development
1976 Chairman, Committee on Communications, HR
1979 Vice-Chairman, Policy Affairs Research Council Liberal-Democratic Party (LDP)
1980 Chairman, Public Relations Committee, LDP
1981 Minister of State, Director-General of the Defence Agency
1982 Chairman, Special Committee on Military Bases, LDP
1982 Member, Executive Council, LDP
1985 President, Judges Impeachment Court, HR
1986 Chairman, Special Committee on Disasters, HR
1987~ Minister of State for Science and Technology
Chairman, Atomic Energy Commission

Chairman



KAMESABURO MATSUNAGA

Born on March 2, 1915 in Nagasaki Pref.

Present Title:
President & Director, Chubu Electric Power Co., Inc.

Education:
1936 Graduated from Kansai Gakuin Commercial College

Occupation:
1936 Joined Godo Electric Power Co. (current Chubu Electric Power Company)
1963 Deputy General Manager of Finance Dept.
1966 General Manager of Finance Dept.
1971 Director
1977 Managing Director
1981 Executive Vice President & Director
1985~ President & Director

Official Positions:
- Vice President, Chubu Employers' Association
- Director, Japan Federation of Employers' Associations
- Counselor, Federation of Economic Organizations
- Executive Member, Chubu Committee for Economic Development
- Vice President, Chubu Region Development Research Center
- President, Chubu Electric Association
- Vice Chairman, Nagoya Chamber of Commerce & Industry

HELGA STEEG

Mrs. Helga Steeg was appointed Executive Director of the International Energy Agency (IEA) in May 1984. She came to the Agency from the German Economics Ministry where, as a senior official, she dealt with trade and energy issues, foreign investment, and relations between industrialised and developing countries.

At the IEA, Mrs. Steeg has supported moves by Member governments to reduce barriers to trade in energy and to encourage competition between energy sources. Under her leadership, the IEA has improved and expanded its system for gathering and evaluating data on energy markets.

From 1973 until she joined the IEA, Mrs. Steeg was Director-General for External Economic Policy at the Economics Ministry in Bonn.

As a member of her country's delegation to the OECD, Mrs. Steeg was chairman of the Trade Committee, for more than eight years. Before that she was chairman of the OECD committee on International Investment and Multinational Enterprises. During the 1960s, she was Alternate Executive Director of the World Bank.

Mrs. Steeg was born in Bonn on June 8, 1927. She studied law and economics at Bonn and Lausanne Universities.

SESSION 1

Chairman

WOLF HÄFELE

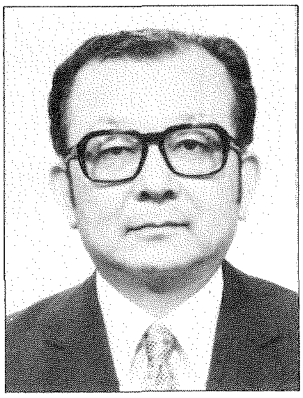
Born on 15, April 1927 in Freiburg/Breisgau.

University education as technical and theoretical physicist in Munich, graduation there in 1950. Thesis on instationary shock waves at the Max-Planck-Institute for Physics in Göttingen, Ph.D. in Theoretical Physics from the University of Göttingen in 1955.

1960 Head of the Fast Breeder Project in Karlsruhe; 1963 Director of the Institute for Applied Reactor Physics at the Kernforschungszentrum Karlsruhe; 1964 Honorary Professor at the Technical University of Karlsruhe; from 1967 Head of the Nuclear Safeguards Project and scientific advisor to the government of the Federal Republic of Germany on the Non-Proliferation Treaty.

1973 Head of the Energy Systems Research Project at the International Institute for Applied System Analysis (IIASA), Laxenburg/Vienna; 1974 Deputy Director of IIASA, Laxenburg; 1975 External member of the Royal Swedish Academy of Engineering Sciences; 1976 Honorar Professor at the Technical University of Vienna; 1977 Foreign Associate of the National Academy of Engineering in Washington.

1981 Director General of the Kernforschungsanlage Jülich/FRG. In 1986 he also became Honorary Fellow of the European Nuclear Society.



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:

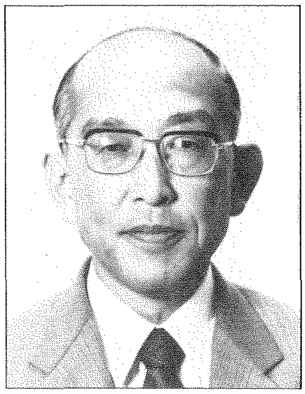
B. A. (Economics) 1948 University of Tokyo, Japan

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.



YOSHINORI IHARA

Date of Birth: April 24, 1924

1947 Graduated from Tokyo Institute of Technology (Electrical Engineering)
1947 Ministry of International Trade and Industry
1955 International School of Nuclear Science and Engineering, U.S.A.E.C.
1956 Atomic Energy Bureau, Science and Technology Agency (STA)
1964 Scientific Attaché, Japanese Embassy, London, STA
1967 Director, Power Reactor Development Division, STA
1970 Minister's Secretariat, STA
1973 Deputy Director General, Atomic Energy Bureau, STA
1974 Director General, Research Coordination Bureau, STA
1976 Director General, Nuclear Safety Bureau, STA
1977 Vice Minster, STA
1980 Secretary General, Japan Association for the International Exposition, Tsukuba, 1985
1986~ President, Japan Atomic Energy Research Institute (JAERI)

KLAUS TÖPFER

Born on July 29, 1938 in Waldenburg, Silesia;

1960～64 Studied political economy at universities of Mainz, Frankfurt-on-Main and Munster

1968 Ph. D.

1970 Head of the political economy department of the Institute of Development Planning in Munster

1971 Head of the planning and information section of the Saarland state chancellory in Saarbrucken

1972 Joined Christian Democratic Union (CDU)

1978 Professor ordinarius at Hanover University. Director of the Institute of Environmental Research and Regional Planning (Hanover University)

1978～85 State Secretary in Rhineland Palatinate Ministry of Social Affairs, Health and Environment in Mainz

1983 Appointed deputy chairman of the CDU's federal committee of experts on the environment

1985～Honorary Professor at Mainz University

1985 Minister of Environment and Health in Rhineland Palatinate

1987～CDU district chairman in Rhein-Hunsrük

1987～Federal Minister of the Environment, Nature Conservation and Reactor Safety

JEAN-PIERRE CAPRON

1943 Born in Paris

— Graduated from Ecole Polytechnique and Ecole des Mines

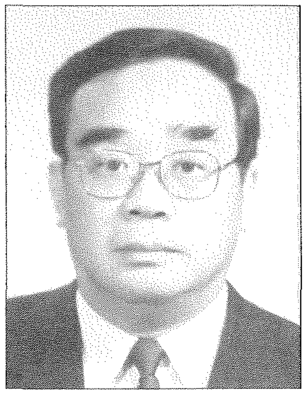
1972～1977
Joined the Ministry of Economy, Finance and National Territory

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



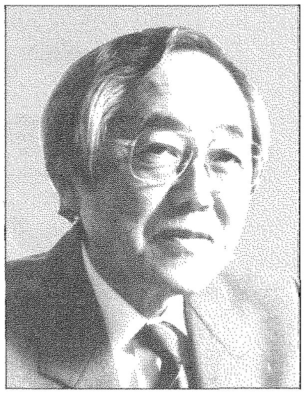
CHEN, ZHAO-BO

Mr. Chen Zhao-Bo, born in Beijing on May 11, 1937.

From 1956 to 1961, Studied at Leningrad University of USSR (Radioactive Minieral Deposit and Geochemistry)

From 1961 to 1983, Served successively as Engineer, Senior Engineer, Chief General Engineer, Deputy Director of Institute of Uranium Geology, Ministry of Nuclear Industry (MNI)

From 1983 to now, Successively serves as Vice Minister, Executive Vice Minister of MNI.



KEICHI OSHIMA

Born on Jan. 12, 1921 in Tokyo

Education:

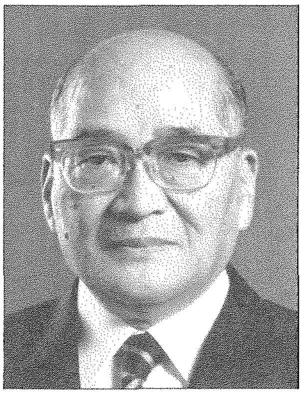
1944 Graduated from Department of Applied Chemistry, the University of Tokyo
1959 Doctor of Engineering, the University of Tokyo

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, 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
1985~ Chairman, Technova Inc.

Other Professional Activities (Government): Advisor, Science and Technology Agency/Member of Advisory Committee in Industrial Technology (MITI)/ Member of Advisory Committee for Energy (MITI)/ Member of Advisory Committee on Promotion of Underlying Technology (JAEC)

Chairman



TOSHIO TAMAKAWA

Born on Jan. 26, 1916

Education:

1938 Graduated from Waseda University (Commerce Dept.)

Business Career:

1944 Joined Tohoku Power Distribution Co.
1951 Tohoku Electric Power Co., Inc. established (Succeeded from Tohoku Power Distribution Co.)
1968 Deputy General Manager, General Affairs Dept.
1970 Officer and General Manager, Land Affairs Dept.
1974 Director and General Manager, Land Affairs Dept.
1977 Representative Managing Director
1979 Representative Director & Executive Vice President
1983 Representative Director & Executive Vice President and Head of Regional Development Cooperation Division
1983 Representative Director & President
1987 Representative Director & Chairman

Other Major Posts:

1983 Chairman of Thoku Economic Federation
1983 Chairman of Thoku Employers' Association
Chairman of Miyagi Prefectural Employers Association
1984 Chairman of Thoku Regional Development Research Center

NIKOLA TODORIEV

Prof. and Minister N. Todoriev was born on Ocober 25, 1927 in the town of Belovo.

He graduated from the Higher Institute of Mechanical and Electrical Engineering "V.I. Lenin" in Sofia as a thermal engineer.

In 1953 he joined the Steam Engines and Boilers department of the same Institute as assistant and lecturer. Later, he became assistant professor, professor and dean of the Power Machines Building Faculty and rector of the Institute. In the meantime he worked as deputy-director (1963) and director (since 1965) of the Institute for Power Research.

In 1973 he was appointed Deputy Chairman and in 1974 First Deputy Chairman of the Committee for Science, Technical Progress and Higher Education and later Chairman of the State Committee for Science and Technical Progress.

In 1976 he was appointed Minister of Energy and since 1977 he is a Member of Parliament.

Prof. Todoriev and his team has developed technologies of effective burning of indigenous lignites.

He is now Chairman of the Bulgarian Member Committee to the World Energy Conference and since 1986 he is also Deputy-Chairman of the International Executive Council of this organization.

Prof. N. Todoriev is presently President of the Energetika Association.

HAROLD B. FINGER

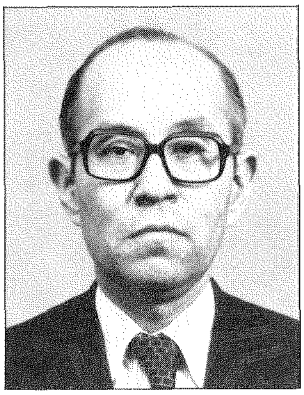
Harold B. Finger is president and chief executive officer of the U.S. Council for Energy Awareness.

He received a bachelor of science degree in mechanical engineering from City College of New York in 1944. In 1950, he was awarded a master of science degree in Aeronautical Engineering from the Case Institute of Technology.

He directed National Aeronautics and Space Administration's nuclear and space programs, and from 1960-67 Mr. Finger managed the Space Nuclear Propulsion Office, a joint office of the Atomic Energy Commission and NASA. From 1967-69, he served NASA as associate administrator for Organization and Management.

In 1969 he left NASA to become the assistant secretary for Research and Technology with the U.S. Department of Housing and Urban Development.

He left the Government at the end of 1972 when he joined the General Electric Company as general manager of its Center for Energy Systems in Washington, D. C. And in 1980, he was named staff executive for GE's Power System Strategic Planning and Development Operation at corporate headquarters in Connecticut. He came to his present position with the U.S. Council for Energy Awareness from GE in 1983.



KEN OHTANI

Mr. Ken Ohtani was born in Osaka in 1930. Graduated from Osaka City University, he entered the Asahi Shimbun. Having been in the positions of Deputy General Manager, Dept. of Economy of Nagoya Branch Office and that of Tokyo Branch Office, he is a member of the editorial committee of Tokyo Head Office (in charge of economic affairs).

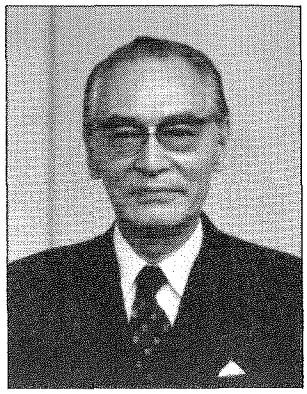
His speciality is the private business in the fields of bond, machine manufacturing, and finance. His recent interests extend to the energy issues, including nuclear energy, the management concerning public utilities, such as Japan National Railway, financial problems of local governments, and the problem of forestry and mountain villeges.

His main works are: "Can the JNR Survive?" "Vicissitudes – Politics and Economics surrounding Electric Power Industry," "Bill Charged by the 'Hanami' (Cherry Blossom-Viewing)-like Economy," "Economics on Green."

He won the Nippon Kisha Club Prize in 1987.

SESSION 2

Chairman



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

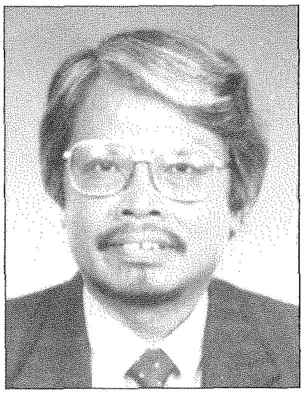
1981 President, Nuclear Safety Research Association

1983~ 1987 President, Nuclear Safety Technology Center

1987~ President, Japan Atomic Energy Relations Organization

Other Major Positions:

- Vice Chairman, JAIF
- Chairman of the Steering Committee, International Nuclear Cooperation Center, JAIF
- Special Advisor, JAERI
- Advisor, Nuclear Safety Research Association
- Advisor, Nuclear Safety Technology Center



NORAMLY BIN MUSLIM

Present Appointment:
Deputy Director General and Head of Department of Technical Co-operation, International Atomic Energy Agency

Previous Appointments:
1973 Head, Dept. of Chemistry National University of Malaysia
1974 Dean, Faculty of Science National University of Malaysia
1975 Deputy Director, Tun Ismail Atomic Research Center, Ministry of Science and Technology Malaysia
1977 Director, Tun Ismail Atomic Research Center, Ministry of Science and Technology Malaysia
1982 Deputy Vice-Chancellor, National University of Malaysia
1985 Director, Defence Science and Technology Center

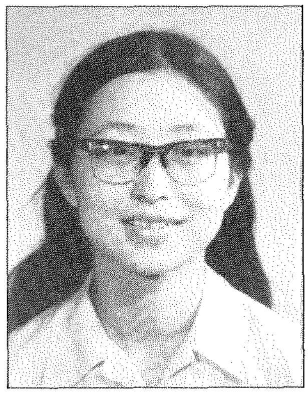
Academic Appointments:
1970 Lecturer
1973 Associate Professor
1973~74 Visting Lecturer, Dept. of Nuclear and Radiation Chemistry, University of New South Wales, Sydney, Australia
1978 to now
Professor of Chemistry

Education:
1952–61 Malay College, Kuala Kangsar, Malaysia
1962–70 University of Western Australia (B. Sc. and Ph. D.)

YOSUKE NAKAE

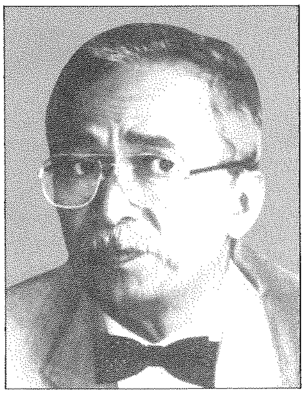
Mr. Nakae was born in Osaka in 1923, and after graduating from the Faculty of Law, Kyoto University in 1948, he entered the Ministry of Foreign Affairs. In 1975, he was appointed Director General of the Asian Affairs Bureau, and later was appointed respectively Ambassador Extraordinary and Plenipotentiary to Yugoslavia in 1978, and to Egypt in 1982. He served as Ambassador to the People's Republic of China from June 1984 through October 1987, during which time he devoted his services to the conclusion of the Japan-China atomic energy cooperation agreement.

Mr. Nakae was appointed in November, 1987, as Commissioner of the Atomic Energy Commission.



LIU, XUE-HONG

Born on December 15, 1952, Manjing City.
1977 Graduated from the French Literature Language Dept. of Beijing Foreign Languages University.
1978 Joined Institute of Atomic Energy in Beijing for International Relations Service.
1979 Joined Ministry of Nuclear Industry, Deputy Director of International Cooperation Division.
1985~Present Deputy Director General of Foreign Affairs Bureau, Ministry of Nuclear Industry.



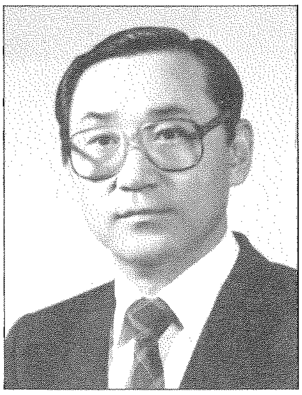
DJALI AHIMUSA

Born on 31 May 1931

Present Title:
Director General, National Atomic Energy Agency, Indonesia (BATAN)

Educations:
- Graduated from Institute of Technology, Bandung 1957 with MSC degree.
- Attended International Inst. of Nuclear Engineering Argonne Natl. Lab. USA 1958.

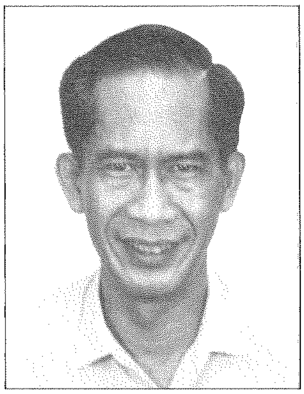
Occupational Career:
- Project Leader for Construction of Bandung Reactor Research Center 1961-1964.
- Director of Bandung Reactor Research Center 1964-1968.
- Dept. of Safeguard, IAEA, 1968-1984.
  Country Officer for Far East Area
  Later Head of Standardization Section.



PIL-SOON HAN

Education:
1957 ROKAF Academy, B.S.
1957–60 Seoul National University, Dept. of Physics (B.S. in Physics)
1962–64 University of Illionois, Dept. of Physics (M.S. in Physics)
1966–69 University of California at Riverside, Dept. of Physics (Ph.D. in Physics)

Research and Work Experience:
1960–70 Instructor of Physics at ROKAF Academy
1970–82 Chief of 3rd Research Division at ADD
1982–83 Vice President of Daeduk Engineering Center at Korea Advanced Energy Research Institute (KAERI)
1983–Present
Chairman of the Board & President to Korea Nuclear Fuel Co., Ltd.
1984–Present
President of KAERI



QUIRINO O. NAVARRO

Born on 29 March, 1936

Director, Philippine Nuclear Research Institute (formerly Philippine Atomic Energy Commission)
Academician, National Academy of Science and Technology, Philippines
Scientist IV, Science Career System

Formerly:
Associate Commissioner, Board of Commissioners, PAEC
Chief Science Research Specialist, Department of Nuclear Services, PAEC
Supervising Scientist, Department of Physics, PAEC

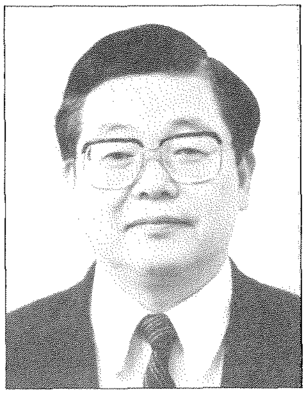
B.S. Chemistry, University of the Philippines (Quezon City, 1956)
Ph. D. (Chemistry), University of California (Berkeley, 1963)

1985 Professional Award (Chemistry), University of the Philippines Alumni Association
1984 Most Distinguished Alumnus Award, University of the Philippines Chemistry Alumni Foundation

Doctoral dissertation based on research using cryogenic and solid state spectrometry techniques for the determination of nuclear parameters of isotopes of dysprosium, californium, and einsteinium

Author/Co-author: About 70 articles and reports in solid state physics, nuclear chemistry, electronics, reactor physics, industrial applications and regional cooperation activities in Asia and the Pacific.

LUNCHEON



KATSUHISA IDA

Born on August 11, 1934

1959 Graduated from Department of Agricultural Ecoomics, Faculty of Agriculture, the University of Tokyo

1962 Entered the Science and Technology Agency (STA)

1978 Director, Research Division, Planning Bureau, STA

1980 Director, Public Relations Division, Promotion Bureau, STA

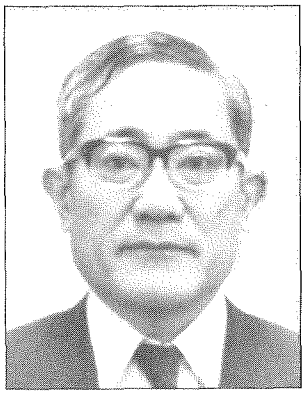
1981 Administrator of Atomic Energy Institutes, Atomic Energy Bureau, STA

1983 Science Research Officer, Planning Bureau, STA

1985 Director, Policy Division, Atomic Energy Bureau, STA

1986 Director, General Cordination Division, Minister's Secretariat, STA

1988~ Deputy Director-General (in charge of Atomic Energy Bureau), Minister's Secretariat, STA



KO TAKEDA

Born on December 11, 1922
in Tokyo

Education:

1950 Graduated from the University of Tokyo (B.E., Electrical Engineering)

Occupation:

1950 Entered the Ministry of International Trade and Industry (MITI)

1971 Director, Nuclear Power Division, Public Utilities Bureau, MITI

1973 Director, Public Utilities Division, Osaka Bureau of MITI

1974 Councillor, the Agency of Industrial Science and Technology, MITI
(in charge of Sun-Shine Project)

1976 Deputy Director General, the Agency of Natural Resources and Energy, MITI

1978 Executive Managing Director, the Institute of Applied Energy

1985~ Executive Managing Director, Japan Electric Power Information Center, Inc. (JEPIC)

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

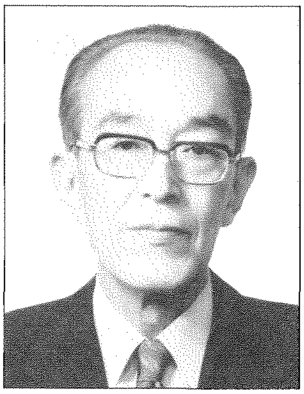
1980 Chairman, National Organization Committee, LDP

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

SESSION 3



YUJI AIDA

Professor Emeritus of Kyoto University, History Scholor, Critic

Major: History of western culture, esp. that of the Renaissance, period. Comparative culture analysis

Born in Kyoto, on March 5, 1916

1940 Graduated from Kyoto University, Dept. of History, Faculty of Literature

1943～47 Joined the 128th Infantry Division, which was sent to Burma

1949 Assistant Professor, Kobe University.

1952 Assistant Professor, Kyoto University.

1964 Professor, Kyoto University.

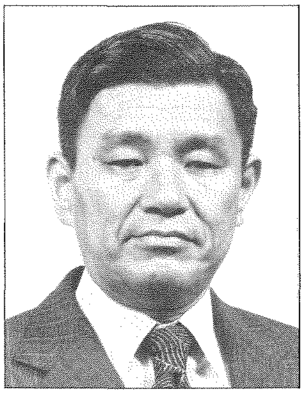
1979 Professor Emeritus, Kyoto University.

"The Aron Camp," which criticizes the western civilization through his experience as a prisoner of war in Burma, was a best seller after the World War II.

"A Manly Essay on Home," serialized on the Yomiuri Shimbun from 1963-64, was his first hit as a critic.

Other major works are: "The Renaissance Art and Society," "Michelangelo," "Structure of the Japanese way of Recognition," "Requirements of Leaders," "Requirements to Make up a Decision," "Logic of Paradox," "The Historical Moment of Decision-making."

Chairman



JOICHI AOI

Boarn on March 30, 1926

1948 Graduated from Department of Electrical Engineering, the University of Tokyo, Joined Tokyo Shibaura Electric Co., Ltd. (current Toshiba Corporation)

1978 Vice President and Director and Deputy Group Executive of Nuclear Energy Group (NEG)

1980 Vice President and Director and Group Executive of NEG

1981 Senior Vice President and Director

1982 Executive Vice President and Director

1984 Senior Executive Vice President and Director

1987～ President and Chief Executive Officer

WOLFGANG STRAßBURG

Wolfgang Straßburg was born in 1945.

He studied law at the Universities of Munich and Tübingen, obtaining his doctor's degree in 1974.

After practice as a legal council with Rheinisch-Westfälisches Electrizitätswerk AG (RWE), Essen, he became general council with Deutsche Gesellschaft für Wideraufabeitung von Kernbrennstoffen mbH (DWK), Hannover, in 1977, and director with DWK in 1982.

Today he is a member of the executive board of DWK, ressorts law, staff, basic questions, fuel services and fuel management. From 1982 to 1987 he was general manager of United Reprocessors GmbH, Karlsruhe/Hannover.

His professional memberships include the Nuclear Fuel Cycle Association, the German Nuclear Society (KTG), the International Nuclear Law Association and the Bar Association of Celle.

WILLIAM T. HANCOX

Dr. W. T. (Bill) Hancox is presently Vice-President responsible for AECL's R&D programs on the management of radioactive wastes, including research on the permanent disposal of nuclear fuel wastes produced by nuclear power plants. He has held this position since 1986 February.

Dr. Hancox grew up in Princeton, B. C. He received a diploma in Aeronautical Engineering Technology from the Southern Alberta Institute of Technology in 1961, and a B. Sc. (1966) and a M. Sc. (1967) in Mechanical Engineering from Carleton University. In 1971, he obtained a Ph.D., also in Mechanical Engineering at the University of Waterloo.

Prior to joining AECL, Dr. Hancox worked for United Aircraft in Montreal, for Orenda in Toronto, and for the Atomic Power Division of Westinghouse Canada Limited, in Hamilton. During the period 1971-73, he was also an adjunct professor in the Department of Mechanical Engineering at the University of Waterloo.

In 1973, Dr. Hancox joined AECL's Whiteshell Nuclear Research Establishment as head of the Applied Mathematics and Computing Section of the Reactor Analysis Branch. He became head of the Thermalhydraulics Research Branch in 1976, and in 1977 was appointed Director of the Applied Science Division with responsibility for research related to the safety of nuclear power plants. In 1984 May, he was appointed Director of Local Energy Systems with responsibility for the development and marketing of miniature nuclear reactors for community heat and electricity supply.

PAUL RIGNY

P. Rigny is director of the Division des Etudes de Séparation Isotopique et de Chimie Physique (DESICP) of French Commissariat à l'Energie Atomique (CEA).

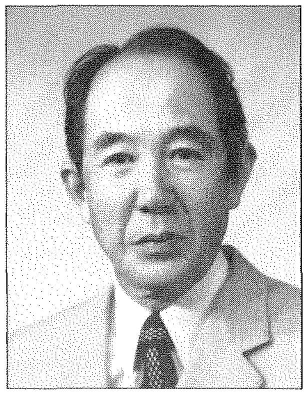
Diplomed of the PARIS Ecole Polytechnique (1958), he joined the CEA in 1963 to work on basic science in chemical physics in a group connected with the studies on UF_6 gaseous diffusion. There he obtained a Ph.D. in 1967.

As head of a chemistry section, from 1971, he directed research laboratories involved in basic studies on the CHEMEX process, and in preliminary studies on photochemical enrichment.

As head of the department of physical chemistry, from 1979, he built the effort CEA on MLIS and SILVA.

The deivision he now heads (DESICP) is in charge of all R and D programs on uranium enrichment in France, the main one being presently the SILVA program.

P. Rigny is also vice-president of the SFC, the French Chemical Society.



YOICHI TAKASHIMA

Born on Oct. 24, 1921

1945 Graduated from the Tokyo Institute of Technology (Chemical Engineering)

1946 Institute of Physical and Chemical Research

1954 Associate Professor, Tokyo Instititute of Technology

1963 Professor, TIT

1959~1961 Research Associate, Harvard University, School of Public Health

1978~1981 Director, Nuclear Reactor Research Laboratory, TIT

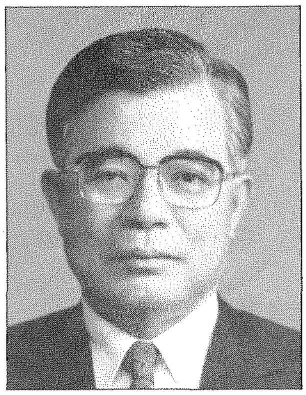
1982 Professor Emeritus, TIT
Professor, Faculty of Engineering, Saitama University

1987~ Director General, NUCEC (Nuclear Chemical Engineering Center), Industrial Research Institute, Japan

Other Posts (Government):

- Member, Committee on Examination of Nuclear Fuel Safety
- Member, Advisory Committee on Uranium Enrichment
- Member, Subcommittee on Nuclear Power, Advisory Committee for Energy

Chairman



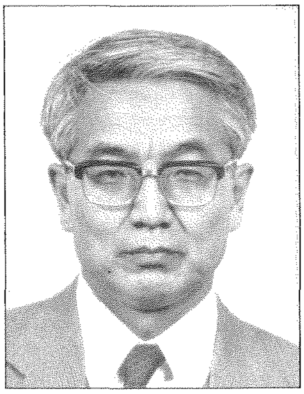
YASUNOBU KISHIMOTO

Born on July 23, 1919

Education:
1942 Graduated from Engineering Department, the University of Tokyo

Professional Career:
1942 Entered Showa Denko K.K.
1962 Works Manager, Yokohama Works (Alumina)
1967 Managing Director; Chief Manager, Petrochemical Projects Department, and General Manager, Oita Petrochemical Complex Construction Group
1976 Executive Vice President
1981 President
1987~ Chairman

Other Major Posts:
< Business organizations >
1986~ President, Japan Chemical Industry Association
1988~ President, The Society of Chemical Engineers, Japan
< Government advisory bodies >
1985~ Member, Chemical Product Council, MITI
1986~ Member, Chemical Industrial Committee, Industrial Structure Council, MITI
1986~ Member, Industrial Technology Council, MITI
1986~ Member, Export-Import Transaction Council, MITI
1986~ Member, Industrial Property Council, Patent Office, MITI
1987~ Member, Round Table Discussions on Basic Material Industries, MITI



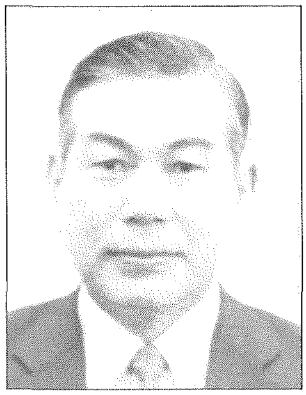
SADAMU SAWAI

Date of Birth: February 13, 1927

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

Education: Graduated in 1951 from the Department of Mechanical Engineering, Faculty of Engineering-II, The University of Tokyo

Occupation:
1953 Agency of Industrial Science and Technology, Ministry of International Trade and Industry
1956 Reactor Development Division, Japan Atomic Energy Research Institute (JAERI)
1966 Head, ATR Design Group, Power Reactor Development Division, Tokai Research Establishment, JAERI
1967 Senior Engineer, ATR Development Project, PNC
1975 Deputy Senior Director, ATR Development Project, PNC
1985~ Executive Director, PNC

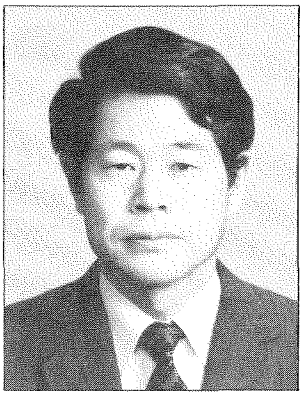


KEN TOMABECHI

Born on Apr. 20, 1929

Education:
1953 Graduated from Tohoku University (Dept. of Communication Engineering)
1961 Doctor of Engineering (Shield of reactor)
1957 Joined Japan Atomic Energy Research Institute (JAERI) (Engaged in construction & operation of JRR-1 and -4)
1966~67 Dispatched to IAEA
1968 Dispatched to Power Reactor and Nuclear Fuel Development Corporation (PNC)
Senior Scientsis at the Headquarters of FBR Development, PNC
1980 Reinstated to JAERI
Director, Department of Large Tokamak Development, JAERI
1985 Director General, Naka Fusion Research Establishment, JAERI
1988 April 1 ~
Special Researcher, JAERI
1988 April 20
Chairman Designate, Management Committee of International Thermonuclear Experimental Reactor (ITER)

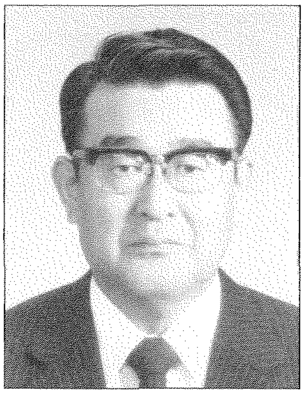
SESSION 4



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

Chairman



TAKESHI NAGANO

President of Mitsubishi Metal Corporation.

Born on March 17, 1923. In September 1945, graduated from the University of Tokyo (Mine and Metallugy Course). Obtained a Ph. D. degree in pyrometallurgy in 1962.

In 1945, joined Mitsubishi Metal Corporation. In 1969, became General Manager of Metallurgy Department, Tokyo head office. In 1970, named General Manager of Naoshima Copper Smelter. In 1971, elected a Director. In 1973, appointed Managing Director and in 1977, Senior Managing Director. In 1981, promoted to Executive Vice President and in 1982, became President.

Was in the U.S.A. from 1953 to 1955 to study metallurgy at Columbia University. From November 1979 through November 1981, served as Chairman of ILZRO. In November 1984, awarded a Medal with Blue Ribbon by H. M. the Emperor. Permanent domicile, Hirohsima Prefecture.

MASAYOSHI HAYASHI

Date of Birth: May 12, 1922

Present Title:
President, Power Reactor and Nuclear Fuel Development Corporation (PNC)

Education:
1946 Graduated from the Department of Electricity, Faculty of Engineering, University of Nagoya

Occupation:
1946 Chubu Electric Power Generation and Transmission Corporation, Inc.
1951 Chubu Electric Power Co., Inc. (due to Organization Change)
1972 General Manager of Power System Operations Department
1975 General Manager in charge of Power System Operations Department
1977 Director
1979 Executive Director
1981 Executive Vice-President
1986~ President, PNC

JEAN-CLAUDE GUAIS

Mr. Guais is the general manager of International Commercial Development for the COGEMA Company. In this position, he is responsible for prospective evaluation, commercial and business development, as well as international communicaton. Moreover, he is currently heading several consultancy studies, speciallly in the back-end of the fuel cycle.

Mr. Guais joined the Commissariat à l'Energie Atomique (CEA) in 1963, after French university studies in mathematics and physics. He was involved in CEA for 20 years in uranium enrichment and other fuel cycle activities on technical, economic, and management grounds. He was deeply associated in the realisation of the EURODIF Tricastin plant, and headed an assessment team on every enrichment technology, including the French chemical exchange process and the advanced laser technologies.

Mr. Guais joined COGEMA in 1983 to participate in the setting-up of the Marketing and Sales Division.

KOZO IIDA

Born on Apr. 23, 1923

1946 Graduated from Electrical Engineering Department, Faculty of Engineering, Tokyo University

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 Asst. Manager, Power System Engineering Dept.

1966 Chief, Hokuriku District Office

1968 Manager, Power System Engineering Dept.

1970 General Manager, Power System Engineering Dept.

1972 Director, Power System Engineering Dept.

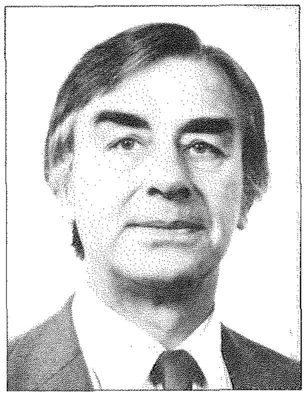
1977 Managing Director

1979 Senior Managing Director

1983~ Executive Vice President

Other Major Posts:

President,
The Foundation of Osaka Science Technology Center



WILLIAM L. WILKINSON

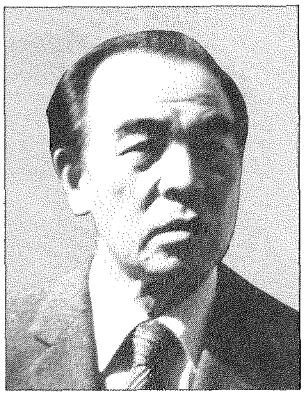
Born on 16 February, 1931 in England

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 British Nuclear Fuels plc (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



JUNNOSUKE KISHIDA

Mr. Kishida is the current chairman of the Japan Research Institute (JRI), a former chairman of the Editorial Board of the Asahi Shimbun, and the author of a number of publications in Japanese, including "Studies on Negotiations," "The New Era of Information," and "On Technological Civilization."

He was born on 1920 and graduated in 1942 from the Department of Aeronautical Engineering of the University of Tokyo.

After graduation, he worked as an aircraft designer at the Naval Institute of Aeronautical Engineering until the end of the war.

He joined the Asahi Shimbun in 1946. There, he became an editorial writer and senior staff writer specializing in science and technology, information in society, international relations, and disarmament and security issues, and went on to serve as chairman of the Editorial Board of the Asahi Shimbun from 1977 to 1983.

From 1974 to 1978, he also served as vice president of the National Institute for Research Advancement (NIRA) and as project leader of two NIRA research projects, "Japan towards the 21st Century" and "Japan in the 1990s."

In 1985, he retired from Asahi Shimbun and became chairman of JRI.

Commentator

HOWARD K. SHAPAR

Mr. Shapar is Director General, Nuclear Energy Agency, Organisation for Economic Cooperation and Development (OECD).

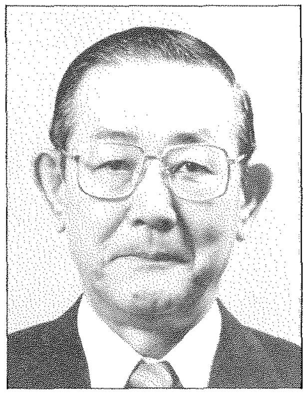
He previously served as the Executive Legal Director of the U.S. Nuclear Regulatory Commission, responsible for providing legal and policy advice to the NRC on a wide variety of activities, including licensing and regulation of nuclear power reactors and nuclear materials, enforcement, nuclear exports and imports, international agreements, nuclear insurance and indemnity. He was involved in the analysis and preparation of legislation and had extensive contacts with the U.S. Congress and federal and state governmental agencies.

Mr. Shapar has participated in a number of international nuclear activities in addition to the NEA. He is immediate past President of the International Nuclear Law Association. He has lectured and written extensively on the impact of science and technology, nuclear power and environmental law, and nuclear regulations.

Before taking up his duties at the NRC at its creation, he was Assistant General Counsel for Licensing and Regulation, U.S. Atomic Energy Committee.

SESSION 5

Co-Chairman



MINORU OKABE

Born on October 1918

1941 Graduated from the University of Tokyo (Electrical Engineering)

1941 Entered Japan Electric Generation and Transmission Company

1951 Joined Tokyo Electric Power Co., Inc., renamed from the above company

1975 Director, TEPCO

1977 Managing Director, TEPCO

1981 President, The Japan Atomic Power Co.

Co-Chairman

RÉMY CARLE

Born: March 9th, 1930 in Paris

Education:

Ecole Polytechnique and Ecole National Supérieure des Mines de Paris

Present Positions:

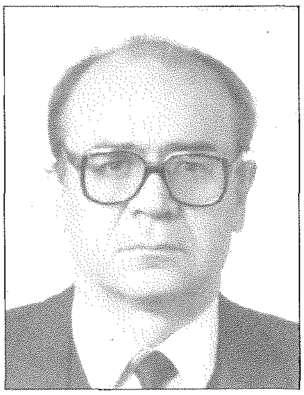
- Director of the Engineering and Construction Division of Electricité de France (EDF)
- President of Supervisory Board of the NERSA
- Member of the Board of the Commissariat à l'Energie Atomique (CEA)
- Chairman of the Nuclear Generating Study Committee of the UNIPEDE

Principal positions occupied:
Between 1957 and 1976: At the CEA

- Head of the Reactor Construction Department (1964)
- Director of the Reactor Construction Division (1971)
- Chairman of TECHNICATOME (1972 ~ 1976)
- Chairman of CIRNA (1974 ~ 1978)

From March 1976 to date: At EDF

- Assistant Director of the Generation and Transmission Division, Head of the Nuclear and Fossil Generation Department (1977 ~ 1978)
- Member of General Management (1979 ~ 1982)
- Director of the Engineering and Construction Division (1982 ~ 1987)
- Deputy General Manager (Since July 1987)



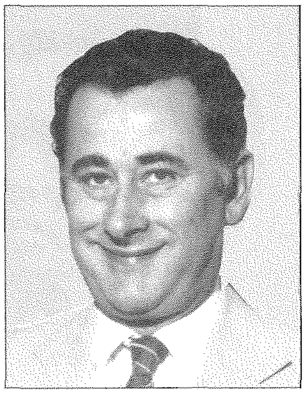
LEONID M. VORONIN

Dr. L. Voronin was born on March 4, 1929 in Voronez.

Graduated from the Institute of Thermal Energy in Moscow.

Engaged in design of nuclear power reactors.

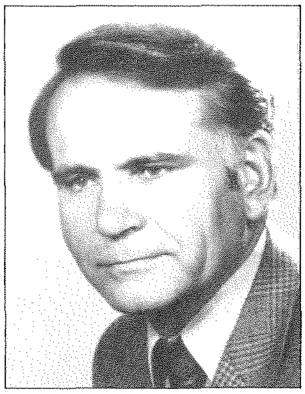
Before the present Deputy Minister, Ministry of Nuclear Power, he was deputy director of the Institute for Research into Nuclear Power Plant Operation (VNIIAES).



BRIAN V. GEORGE

Mr. B. V. George, Director of PWR, Central Electricity Generating Board, was born on February 5, 1936, and is an honours graduate of Brunel College and commenced his career with the National Nuclear Corporation, based at Whetstone, Leicester.

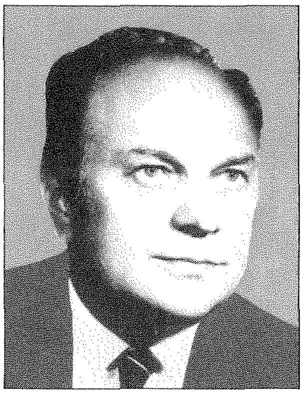
In 1979, he moved to the CEGB's Generation Development and Construction Divsion headquarters at Barnwood, Gloucester, as Head of Nuclear Plant Design Branch, where two years later he became Director of PWR. Mr. George is now the Project and Technical Director for both the on-going Sizewell 'B' Project and the new Hinkley Point 'C' Project for which the CEGB made application to build earlier this year, both based at Knutsford, Cheshire.



HERBERT J. SCHENK

Dr. Herbert J. Schenk, 60, studied physics at TH-Stuttgart, was awarded a Diploma in 1953 and graduated to Dr. rer. nat. in 1955. He is Director of the Nuclear Power Station at Philippsburg. Prior to this appointment he was Director of Obrigheim NPP for 18 years.

Dr. Schenk is a member of the Deutsches Atomforum, Kerntechnische Gesellschaft and American Nuclear Society. He is also a member of the German Reactor Safety Commission (RSK). In 1985 he was chairman of this commission. In 1980 the German Bundesverdienstkreuz was awarded to him.



STANISLAV HAVEL

Born in Plzeň, Czechoslovakia in 1930

1955 Graduated from the Faculty of Metallurgy (M. Sc.)

1978 The thesis on Nuclear Energy (Ph. D.)

1956 Started working at Škoda Concern in Plzeň in the nuclear power construction and research department.

1956 Head of Reactor Engineering Research Centre at Škoda Concern

1966~1969 Joined the International Atomic Energy Agency in Vienna, where worked in the Division of Nuclear Power.

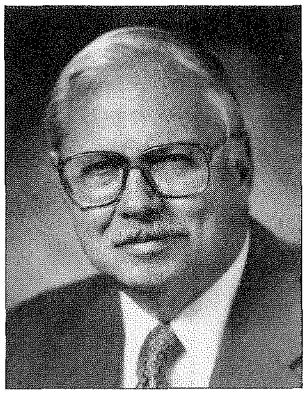
1971 Joined the Czechoslovak Atomic Energy Commission to work on the preparation of nuclear R&D programs.

1972 Director of the Nuclear Research Institute at Řež near Prague

1980 Accepted a new assignment with the IAEA, working in the Department of Nuclear Power in the Capacity of an Advisor to Deputy Director General, responsible for the fields of nuclear power, nuclear safety and scientific and technical information.

1982~ Chairman, Czechoslovak Atomic Energy Commission

Mr. Havel has been one of the founders and is a long years' member of the International Council for Pressure Vessel Technology.



KENNETH C. ROGERS

Kenneth C. Rogers was sworn in for a five-year term as a member of the Nuclear Regulatory Commission on August 7, 1987. Before then Dr. Rogers served as president of Stevens Institute of Technology for 15 years.

In 1957 he joined Stevens where he served as a professor, head of the physics department, dean of the faculty and acting provost before becoming its president in 1972.

A physicist by training, Dr. Rogers' technical areas of expertise include plasma physics, particle accelerators, optical spectroscopy and elementary particle physics. He is the author of more than 30 technical papers.

He has served as a director of the Public Service Enterprise Group (formerly Public Service Electric and Gas Company of New Jersey). In addition, he has been a trustee of the Christ Hospital, Jersey City, NJ; the Association of Independent Colleges and Universities in New Jersey; the Independent College Fund of New Jersey; and the Hoboken (NJ) Chamber Orchestra.

He received a bachelor degree in physics from St. Lawrence University (1950) and a master degree in physics (1952) and doctorate degree in physics (1956) from Columbia University. He was awarded an honorary doctorate degree by St. Lawrence University in 1983 and by Stevens Institute of Technology.

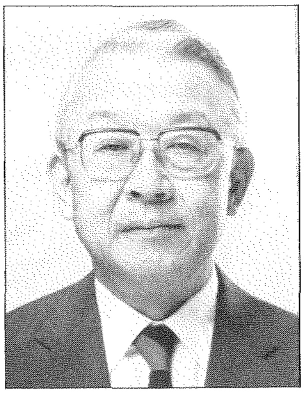
Born in 1929 in Teaneck, New Jersey.

KIM, DONG-JOO

Date of Birth: October 21, 1934

Education:
1957 Graduated from Electrical Engineering Dept. of Seoul National University (B. S.)
1987 Completed the Management course for Administrative Development, Seoul National University

Experience:
1961 Joined Korea Electric Power Corp.
1976 Deputy General Manager, Construction Dept.
1978 Site Manager, Seohae Thermal Power Plant Construction Office.
1979 Site Manager, Kori Nuclear Plant Construction Office.
1980 General Manager, Construction Dept.
1983 Plant Manager, Boryung Thermal Power Plant
1985 Director, Kori Nuclear Power Division
1986 Vice President, Power Generation Division
1987 Vice President, Technology Development Division



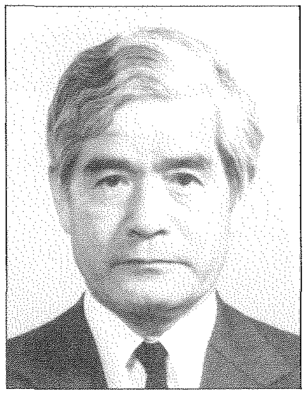
RYO IKEGAME

Date of Birth: October 3, 1927

Education:
1952, Graduated from the Electrical Engineering Department, the Univeristy of Tokyo

Occupation:
1952 Entered the Tokyo Electric Power Co., Inc.
1979 General Manager, Nuclear Power Plant Construction Department
1981 Supeintendent, Fukushima Daiichi Nuclear Power Station
1983 Director, Deputy General Manager of Nuclear Power Development Center
1985 Director, Deputy General Manager of Nuclear Power Administration
Deputy General Manager of Engineering Research & Development Administration
1986 Managing Director, General Manager of Nuclear Power Administration

Commentator



TOSHIKAZU SHIBATA

Date of Birth: March 6, 1924

1949 Graduate from Osaka University
1957 Associate Professor, Osaka University
1961～87 Professor, Kyoto University
Chief of Research Reactor KUR (Kyoto University Reactor) Construction
1973 Designed and Constructed the Kyoto University Critical Assembly (KUCA)
1972～80 Director, Research Reactor Institute, Kyoto University
1973～81 Science Adviser for Ministry of Education, Science and Culture
1987～ Professor Emeritus, Kyoto University
1987～ Director, Atomic Energy Research Institute, Kinki University
1987～ Technical Advisor, Japan Atomic Energy Research Institute

Other Positions:
Chairman, National Committee for Nuclear Energy Science, the Science Council of Japan