The 22nd JAIF ANNUAL CONFERENCE

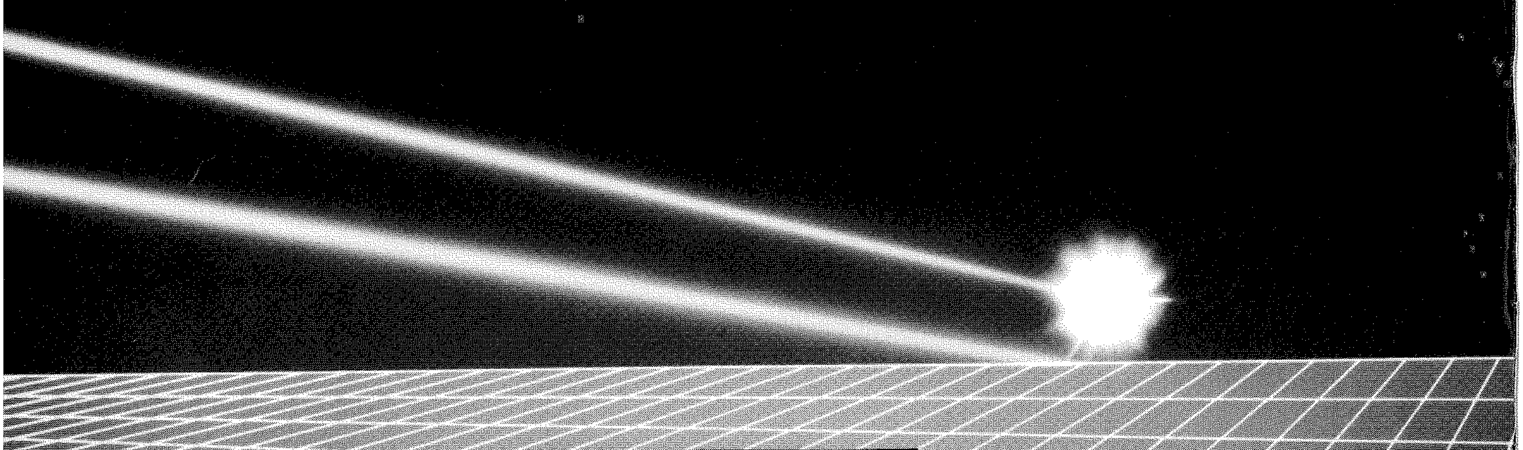
ABSTRACTS

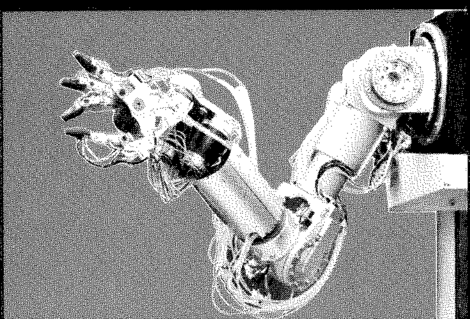
12–14 April 1989

Tokyo Yubinchokin Hall

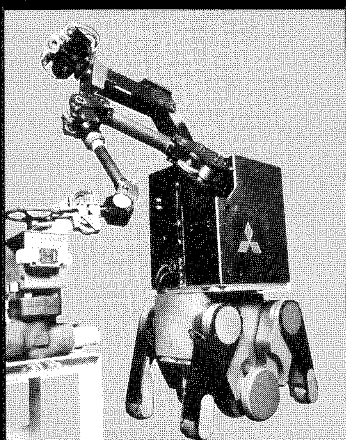
JAPAN ATOMIC INDUSTRIAL FORUM, INC.

Resourcefully Tackling the Challenges for Greater Robotic Applications in Nuclear Power Plants

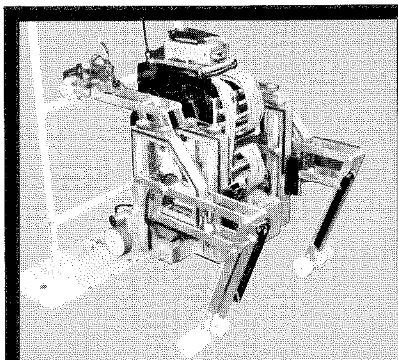




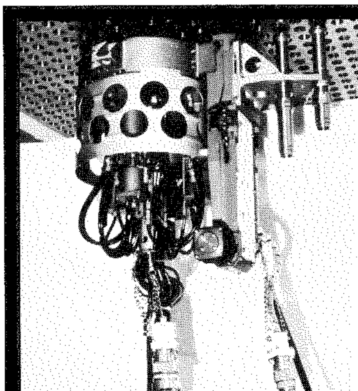
Multi Fingered Dexterous Hand for Advanced Nuclear Robot (Sponsored by MITI)



C/V Robot for multi-purpose operations in containment vessel



Wireless Monitoring Robot



S/G MR-II Walking Robot for automatic steam generator ECT system

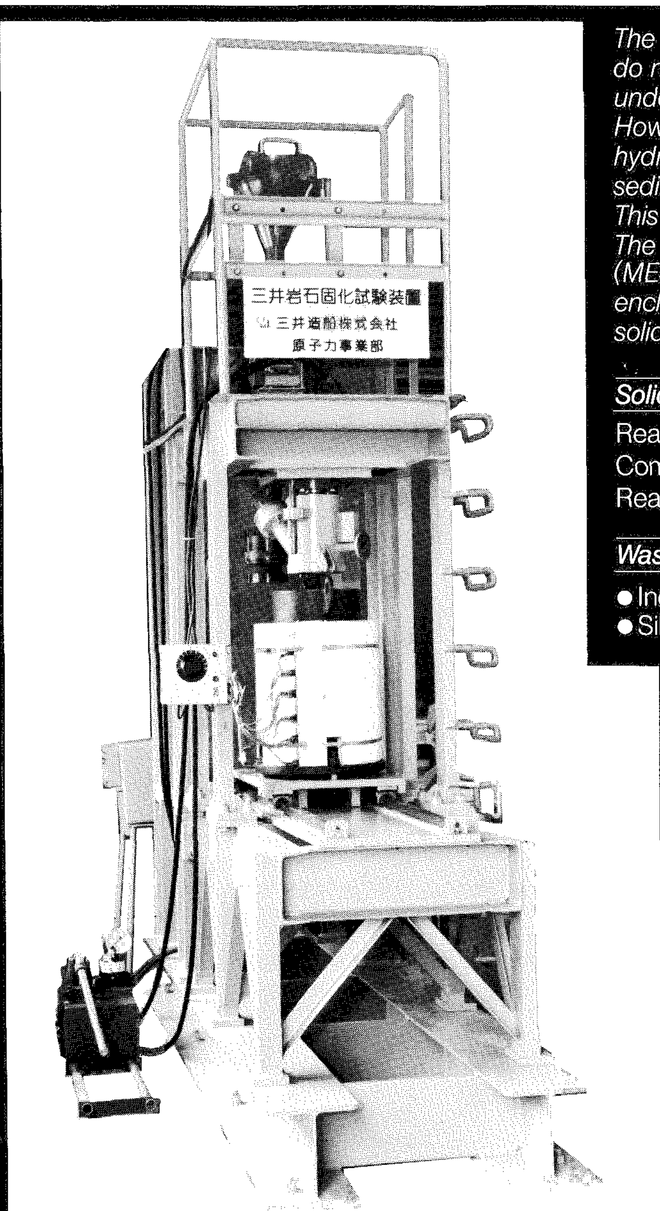
MITSUBISHI HEAVY INDUSTRIES, LTD.

Head Office
Nuclear Energy Systems Headquarters
5-1, Marunouchi 2-chome, Chiyoda-ku, Tokyo, 100 Japan
Phone: (03) 212-3111
Cable Address: HISHIJU TOKYO
Telex: J22443

the 22nd JAIF ANNUAL CONFERENCE

MES ROCK

Mitsui Hydrothermal Synthetic Rock System



The minerals such as silica (SiO_2) and alumina (Al_2O_3) do not dissolve in water at normal temperature and under normal pressure.
However, they do dissolve or precipitate in semicritical hydrothermal condition, as sand and mud form sedimentary rocks on the sea-bed or underground.
This phenomenon is known as a hydrothermal reaction.
The Mitsui Hydrothermal Synthetic Rock System (MES ROCK) utilizes this hydrothermal reaction and encloses the radioactive nuclides in stable inorganic solidified product.

Solidification Conditions

Reaction temperature — 250～350°C
Compression pressure — about 300 kg/cm^2
Reaction time — about 20 minutes

Wastes to be solidified

- Incinerator ash
- Concentrated liquid waste
- Silica-gel
- I_2 absorbent

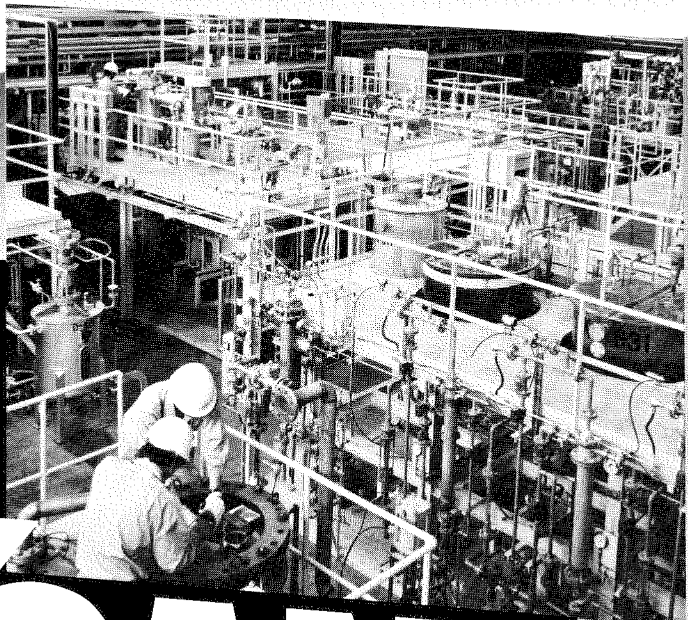
Solidified product

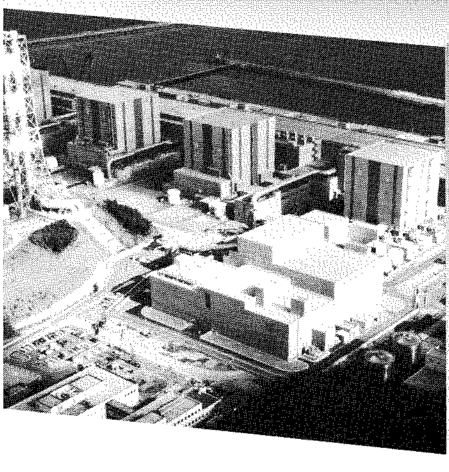
Pilot plant of MES ROCK

MES MITSUI ENGINEERING & SHIPBUILDING CO., LTD.

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

JGC, WE CAN PROVE IT





The Expert in Back-end Engineering Services

Ever since our JGC specialists were called on to design and construct Japan's first spent nuclear fuel reprocessing plant in cooperation with SGN of France, we've continued to establish ourselves as the country's leading engineer for radwaste treatment, disposal and other back-end facilities. And through our efforts and achievements, we've earned worldwide recognition for our top-quality engineering services and outstanding expertise in constructing nuclear fuel cycle facilities – particularly for radwaste management and spent nuclear fuel reprocessing.

These are not claims. These are facts. And these facts have led two major Japanese nuclear power service companies to contract us for the delivery of a fuel reprocessing plant and a low-level radwaste storage facility – two important projects which, when completed, will bring Japan a step closer to the completion of its nuclear fuel cycle. Moreover, we were awarded a contract to design and construct radwaste facilities for Virginia Power – the first time a Japanese engineering company has been contracted by a U.S. utility for the delivery of integrated radwaste facilities.

If we haven't convinced you at this point that we're the best when it comes to nuclear fuel cycle facilities, there's only one other way to prove it. Put us to work. You'll find that everything we've told you is true.

Total Engineering and Construction . . . Worldwide

JGC CORPORATION

Head Office: New Ohtemachi Bldg., 2-1, Ohtemachi 2-chome, Chiyoda-ku, Tokyo, Japan
Tel: Tokyo 03 (279) 5441 **Fax:** 81-3-273-8047 **Telex:** 0222-3096 JGCTOK J

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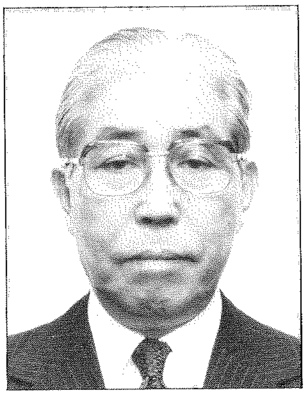

Jiro Enjoji
Chairman, JAIF

Junnosuke Kishida
Chairman, Program Committee

— BASIC THEME —

TOWARD HARMONY OF NUCLEAR ENERGY AND HUMAN SOCIETY

The social circumstances surrounding nuclear power development have become guite austere of late with an extensive anti-nuclear power movement strengthening in Japan. Some countries seem to be halting the construction of new nuclear power plants or have withdraw from nuclear power generation. Nuclear issues are now strongly argued not only on the polictical stage but also among the public at large.

At the 22nd JAIF Annual Conference, the position and role of nuclear energy will be reconsidered from the viewpoints of a stable supply of energy, the global environment and mankind, for the purpose of gaining the understanding and confidence of people, especially women and the younger generation, in the necessity and safety of nuclear power.

It is our sincere hope that this year's conference will provide a valuable opportunity for all participants from various countries to engage in full discussions on the significance and future of nuclear power development, new ropspects for nuclear technologies, the present relations between society and the nuclear fuel cycle, and ways of international cooperation, in particular keeping the harmony of between nuclear power and society in mind.

22ND JAIF ANNUAL CONFERENCE

PROGRAM

—— BASIC THEME ——

TOWARD HARMONY OF NUCLEAR ENERGY AND HUMAN SOCIETY

12-14 April 1989
Tokyo Yubinchokin Hall

WEDNESDAY, APRIL 12

9:30am - 10:20am
OPENING SESSION

Chairman:
Masayoshi Hayashi
President
Power Reactor and Nuclear Fuel Development Corporation

Remarks by Chairman of Program Committee
Junnosuke Kishida
Honorary Chairman
Japan Research Institute

JAIF Chairman's Address
Jiro Enjoji
Chairman
Japan Atomic Industrial Forum

Remarks by Chairman of Atomic Energy Commission
Moichi Miyazaki
Chairman
Atomic Energy Commission
Minister of State for Science and Technology

10:20am - 12:20pm

<u>SESSION 1: NUCLEAR ENERGY IN MODERN HISTORY: MISSIONS AND ISSUES</u>

Chairman:

Tomoo Nakano
Chairman
The Hokkaido Electric Power Co., Inc.

"The World's Needs for Nuclear Power"
Hans Blix
Director General
International Atomic Energy Agency

"Women's Entry into the Nuclear Community"
Gail de Planque
President
American Nuclear Society

"The Role of Nuclear Energy in Supplying CSSR Energy Demands"
Antonin Krumnikl
Minister of Fuel and Energy
Czechoslovakia

Chairman:

Tadahiro Sekimoto
President
NEC Corporation

"Meaning of Nuclear Power Development in Today's World : Can Nuclear Energy Contribute to Society of Mankind ? "
Shoh Nasu
Chairman
The Federation of Electric Power Companies
President
The Tokyo Electric Power Company., Inc.

"Assurance of Energy Sources and the Role of Nuclear Power for the 21st Century"
Jean- Daniel Levi
Director General
Energy and Raw Materials
Ministry of Industry
France

"The Main Guideline and Technical Measures with the Purpose of Improvement of the Safety of Nuclear Power Plants with VVER-1000 Reactors"
Alexandor L. Lapshin
Deputy Minister
Ministry of Nuclear Power
USSR

Chairman:

Yotaro Iida
President
Mitsubishi Heavy Industries, Ltd.

"Nuclear Energy Development in Pakistan -- Policy, Prospects and Problems"

Munir A. Khan
Chairman
Pakistan Atomic Energy Commission

"Starting Nuclear Power in China"

Qi-Tao Huang
Vice President
China National Nuclear Corporation

"Glasnost and Nuclear Power Development in the Soviet Union"

Vradimir S. Guvalev
Science Editor,
"PRAVDA"
USSR

6:00pm - 7:30pm

JAIF CHAIMAN'S RECEPTION

Room " HO-O "
2nd Floor, TOKYO PRINCE HOTEL,

THURSDAY, APRIL 13

9:30am - 12:30pm
SESSION 2: NUCLEAR POWER AMONG SOCIETY (Lectures and Panel)

Chairwoman:
Takeko Yanase
Journalist

Lectures:
"Nuclear Disputes in the Part One Year"
Soichiro Tahara
Critic

"Characteristics of Current Anti-Nuclear Protest Groups in Japan"
Yasumasa Tanaka
Professor
Gakushuin University

Panelists:
Yotaro Konaka
Writer

Tomoko Inukai
Critic

Takashi Ymazaki
Executive Vice President
Chubu Electric Power Co., Inc.

Soichiro Tahara
Critic

Yasumasa Tanaka
Professor
Gakushuin University

12:50pm - 2:50pm

LUNCHEON

Room "HO-O"
2nd Floor, TOKYO PRINCE HOTEL

Remarks:

Hiroshi Mitsuzuka
Minister for International Trade and Industry

Special Lecture:

"Life of Modern People"

Ayako Sono
Writer

1:30pm - 2:40pm

FILMS

CONFERNCE HALL

Most recent films on nuclear power development will be shown.

3:10pm - 6:00pm

SESSION 3: NEW PROSPECTS OF NUCLEAR TECHNOLOGIES

Chairman:

Kenko Hasegawa
Chairman
Kawasaki Heavy Industries, Ltd.

"Fuel Supply Technologies: Uranium Enrichment and Integrated Dry Route"

William L. Wilkinson
Deputy Chief Executive
British Nuclear Fuels plc

"FBR Fuel Cycle Technology "

Toshiyasu Sasaki
Executive Director
Power Reactor and Nuclear Fuel Development Corporation

"An Innovative LMR Design for the Future"

Bertram Wolfe
Vice President
Nuclear Energy Operations
General Electric Company

Chairman:

Masakazu Tamaki
President
Chiyoda

"Nuclear Materials Recycling: The Great Challenge"

Robert Lallement
Director for Nuclear R and D Programs
Commissariat a l'Energie Atomique
Jean-Pierre Rougeau
Vice President
Compagnie Generale des Matieres Nucleaires
France

"Nuclear Power Robot"

Kazuhiko Imoto
Chairman
Subcommittee on Nuclear Power Plant
Technology Committee
Advanced Robot Technology Research Association

Chairman:

Reinosuke Hara
President
Seiko Instruments Inc.

"Radiation: Creating Clean Environment"

Sueo Machi
Director General
Takasaki Radiation Chemistry Research Establishment
Japan Atomic Energy Research Institute

"Recent Trend of Medical Use of Radiation in Cancer Therapy"

Sunao Egawa
Chief
Dept. of Radiation Therapy
National Cancer Center Hospital

FRIDAY, APRIL 14

9:30am - 12:30pm

SESSION 4: ON NUCLEAR PHASE-OUT POLICY OF SWEDEN (Lectures and Panel)

Chairman:

Toyoaki Ikuta
President
Institute of Energy Economics, Japan

Lectures:

"Sweden's Energy Policy "

Hans Rode
Director General
Swedish National Energy Administration

"The Swedish Energy Policy in an Industrial and International Context"

Lennart Fogelstroem
President,
ABB Atom AB
Sweden

"Sweden's Energy Future--Pocicy vs Politics"

Tor R. Gerholm
Professor
The University of Stockholm
Sweden

Panelists: (In addition to the above Speakers)

Bill Harris
Senior Vice President
US Council for Energy Awareness

Jean- Daniel Levi
Director General
Energy and Raw Material
Ministru of Industry France

Katsuhiko Suetsugu
Editorial Writer
The Nihon Keizai Shimbun

Yoshihisa Akiyama
Senior Managing Director
The Kansai Electric Power Co., Inc.

General Comments by Chairman

2:00pm - 5:00pm

SESSION 5: TOWARD NEW ERA OF NUCLEAR FUEL

Chairman:

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

Lectures:

"The Nuclear Fuel Cycle and Global Technological Change"
John N. Yochelson
Vice President
Center for Strategic & International Studies
USA

"Environmental Issues of the Nuclear Industry"
Dennis B. Cearlock
Director
Battele Pacific Northwest Laboratories
USA

"Nuclear Fuel Seen from the Aspect of Scientific Technology"
Atsuyuki Suzuki
Professor
The University of Tokyo

"Atomic Energy in an Anthropological Perspective:
Towards an Evaluative Uderstanding of the Place of Nuclear
Technology"
Klaus Riesenhuber
Director
Institute of Medieval Thought
Professor
Dept. of Philosophy
Sophia University

General Comments by Chairman

CLOSING REMARKS:

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

WEDNESDAY, APRIL 12

10:20 am — 12:20 pm
SESSION 1 NUCLEAR ENERGY IN MODERN HISTORY: MISSION AND ISSUES

Under current conditions, with the world wide energy balance easing, public understanding of energy issues have been gradually moving away from the days of the two oil crises of the past. The population increase and the wish for improved living standards in underdeveloped countries are expected to result in rising growth of energy demand. The greenhouse effects is becoming a critical issue for the world environment.

The session will seek new meaning in essential energy for economic, social and cultual development. It will also discuss trends in demand and supply for energy, security, and the significance and role of nuclear power among energy resources.

THE WORLD'S NEEDS FOR NUCLEAR POWER

H. Blix
Director General
International Atomic Energy Agency

There are widely varying opinions on whether the world's population will need more or less energy in the future. Some scenarios for future energy demand are highly optimistic about the potential for conservation while authoritative organizations forecast increasing demand for energy, and especially electricity. It is considered that developing countries in particular will need substantially more energy to support their development.

Electricity will become increasingly important as a secondary energy form with a high level of efficiency and safety in end use. Its use has already contributed to primary energy savings in industrialized countries. The options for producing more electricity will, however, be progressively more limited in the future by environmental considerations which will call for less use of fossil fuels to limit the emission of gases which contribute to the greenhouse effect (CO_2) and cause acid rain (SO_2 and NOx). The renewable alternative energy sources are not able to meet the increase in demand which must be expected and nuclear power, together with hydro power, will remain the two alternative sources which do not give rise to such emissions.

Objections to nuclear power focus on its safety, the disposal of radioactive waste, and the risk of proliferation of nuclear weapons. Experience has shown that risks are never zero for any kind of energy production. The risks associated with nuclear power are now often exaggerated. They should, however, be seen in the context not only of the risks of other energy production methods and the environmental protection priorities which must now be set, but also of the actions taken and under way both nationally and internationally — not least through the IAEA — to further improve safety and radiation protection. Following the Chernobyl accident, a wide range of such activities are now being undertaken which constitute essential elements in an international nuclear safety regime.

WOMEN'S ENTRY INTO THE NUCLEAR COMMUNITY

Dr. Gail de Planque
President
American Nuclear Society

Today, almost 40 percent of the Japanese workforce is made up of women. However, women hold only 5.3 percent of Japanese managerial positions. A similar situation existed in the United States in the past.

Since then, American women have made great strides in education, opened up new employment possibilities, and gained a new image. Due to a declining birth rate and the increasing need for highly skilled workers, the demand for women in the labor market, especially in science and engineering, is expected to escalate dramatically in the next decade. Therefore, the American Nuclear Society is working to encourage more students, especially women, to enter the nuclear field. In addition, the society actively promotes the educational and public relations activities of its women members.

There is a general sense that broader participation by women in science and engineering, especially in the nuclear field where the percentage of women is extremely low, will lead to an increased acceptance of nuclear energy by this group. Whether or not this theory is valid for the United States, and whether or not it is applicable to other countries, only time and experience will tell. But the evidence accumulated thus far indicates that the concept has merit.

THE ROLE OF NUCLEAR ENERGY IN SUPPLYING CSSR ENERGY DEMANDS

Prof. Ing. DrSc. Antonin Krumniki
Minister of Fuel and Energy
Czechoslovakia

The reason for Czechoslovakia to develop, improve and attain a stable position for nuclear power is to be found in the following advantageous features of nuclear power itself: environmental safety /nuclear power is one large-scale source of energy which does not give rise to acid rain or any of the greenhouse gases/, economic efficiency /in terms of generating cost over the entire plant life, nuclear power is the most economical source of power in Czechoslovakia/, supply stability /nuclear power can operate for one year on a single loading of fuel, it is easy to transport nuclear fuel for a nuclear power plants, uranium ore is a domestic energy resource/. Nuclear power status /to 31 December 1987/ in Czechoslovakia can be described as follows: 8 units /on two sties/ with VVER-440 reactor system in operation. Nuclear power plants produced about 22 TWh electricity in 1987 /it accounted for 26% of the CSSR electric energy/.

Total operating experience are about 42 years. The nuclear power plants registered a 76% factor in 1987. Economic advantages of nuclear power over other thermal power sources are at present obvious.

There has been no accident in which radioactive substances have affected people in the vicinity of a nuclear power plant. Efforts to maintain the possible lower level of radioactive substances emitted from nuclear power plants during normal operation have held such emissions to levels well below those permitted by the regulations. In the nuclear fuel cycle Czechoslovakia closely cooperates with the Soviet organizations. The spent fuel is transported back to the USSR.

Efforts to gain public acceptance for the nuclear power have resulted in a relative smooth licensing process of the new nuclear power plants in the country.

At present the resources for the financing of the nuclear power plant projects are shrinking. There are two main reasons for this fact: the rising investment costs of the nuclear power plants and the changing overall investment policy /as a result of the intention to change the structure of a national economy system/.

The next development of nuclear energy in Czechoslovakia is based on the long-term outlook on energy supply and demand.

The estimated primary energy demand for 2000 /2005/ is expected 100, 9 /108/ million tons in coal equivalent. In this content, the outlook for installed nuclear capacity is expected 10,000 MW /14,000 MW/.

At present about 5,800 MW in VVER 400 and VVER 1,000 are under construction. It is expected the share of nuclear power generated electricity accounts for 40% by 1995. To reach the target figures for 2000 /2005/ year it is necessary to prepare the nuclear development plans for three new sites during the next 5 years.

As far as the reactor strategy is concerned, the advanced VVER-1000 reactor systems will be the workhorses of the Czechoslovak nuclear programme. It is expected the advanced VVER-1000 can reduce the exposure doses of operational personnel and the quantity of low-level wastes, save the uranium ore, improve the availability factor and reduce KWh cost. Czechoslovakia is also deeply interested in the deployment of easy — to operate, easy-to maintain medium and small size reactors of the so called "second nuclear era" for steam and hot water supply, electricity generation, coal gasification, chemical industry, etc. Studies are conducted by national institutions on the technological and economic feasibility of such reactors.

R & D nuclear activities in CSSR are implemented in the joint technological development on a international scale within the CMEA countries.

MEANING OF NUCLEAR POWER DEVELOPMENT IN TODAY'S WORLD

— Can Nuclear Energy Contribute to Society of Mankind? —

Sho Nasu
President
Tokyo Electric Power Company
Chairman
The Federation of Electric Power Companies

Use of energy resources produced from the realm of nature offers a number of advantages to mankind. Good as it is, however, it has significant counterbalancing disadvantages, such as depletion of resources, wastes and other unwelcome influences on the environment.

It goes without saying, therefore, that technologies for using natural resources should essentially be aimed at "maximizing benefits that can be derived from natural resources in the form of energy while minimizing the resultant cost of energy usage or losses to the natural environment encompassing human beings."

We human beings have at one time in the past been so much preoccupied with acquisition of merits and so less concerned about demerits that wastes, industrial or otherwise, have been dumped in too large a quantity for environmental assimilating capacity to take care, and new chemical substances never occurring naturally have been released without any reasonable control, only to destroy and degenerate the natural environment and hence man's living environment. Worse still, the practice is still going on. The human race should renounce it once and for all.

Man's existence depends on his environment. Self-contradiction here is that the very existence and prosperity of human beings change and ultimately disrupt the environment. The principal and underlying cause of it is attributed simply to the fact that we use energy. To maintain our existence and prosperity, we should use our own wisdom to hold back the ineviable degeneration of the environment.

A look at the environment surrounding human beings now reveals that two of the most serious problems are in progress:

(1) Degeneration of the natural environment on a global scale; and

(2) Destruction of the natural environment resulting from population explosion, as well as the aggravated social environment associated with influx of the farming population into cities, in less developed countries.

These tendencies are not just confined to any specific localities but should be perceived as problems highly likely to spread over other parts of the world and jeopardize the very existence of mankind in due course of time.

Behind the development of these problems lie a number of complexities. One such factor, it may well be said, is that advanced countries which account for no more than 25 percent of the world's population, yet consume as much as 75 percent of global energy supplies, are passing the cost of affluence they enjoy on to less developed nations in the world.

If that is the case, what is most needed to stem the ongoing tendency toward environmental degeneration is the awareness and commitment of advanced and industrialized members of the international community. There are two important points that demand immediate attention in this regard.

First, the industrial nations should take the lead energetically and earnestly in implementing a set of measures, including transformation of their own life-styles, to solve global-scale environmental problems while giving full consideration to social and economic problems facing less developed countries.

Secondly, science and technology the industrial nations have should provide the best possible solutions. The key to success in this direction is the development and use of energy-related technologies. What the world needs now is science and technology that is friendly to the natural environment.

Science and technology has originally developed as a means of man's survival in the natural environment. In the process of its development, while interacting with natural resources man harnesses for his own purposes as mentioned earlier, science and technology has always produced things new, unknown or unexperienced one after another before man, driven by his innate pursuit of improvement, as well as economic and social needs of his society.

How have we human beings reacted to these new technologies? Technologies that have been accepted by our society to a certain extent can be categorized into two broad types. In their initial stage,

a. Some technologies have been accepted unresistedly or even favorably with great hopes of their merits and, conversely, little understanding of their demerits;

b. Others have met with significant rejection because of concern about demerits, if some promise of merits.

But the fates of these technologies vary. For example, dichlorodiphenyletrichloroethane or an agricultural chemical known as DDT, and polychlorinated biphenyls or PCB were two of the technological products in the first category. Because of their toxicity proved later, however, both chemicals died out and were replaced by their substitutes. Science and technology has proved the chemicals to be harmful and developed their replacements. Electricity, steam locomotives, and aircraft came under the second category but have slowly gained acceptance with man's society.

Why and how have public apprehensions been driven away with the products in the second category? There are many factors that can be conceived as reasons to explain this. Ostensible as it may be, one of the most important reasons is of course that improvements after improvements have been made with the progress of science and technology to help emphasize the advantages of these products while overcoming their disadvantages.

Nevertheless, that may not be the sole factor that has driven a sense of unease out of people's minds. Rather, it may be that any product of science and technology will not come to stay in man's society until all members of this society respond more to the merits and less to the demerits of that product to have a 'sense of reliability' and that sense of reliability evolves into a 'sense of security' to accpet something new.

When we look at nuclear power known as 'giant' technology in the modern society of ours in this perspective, the following observations can be made.

a. Unfortunate enough, the atomic bomb was the first nuclear energy ever harnessed by mankind. As a natural consequence of this, peaceful uses of nuclear energy began with conviction and determination to ensure that "radioactive substances as leftovers from the use of nuclear energy in no case degenerate the environment."

b. To achieve this, all technical means available are provided in nuclear energy production. A prudent policy is adopted to keep radioactive material under perfect control through nearly flawless machinery and equipment, as well as safety concepts to use them unerringly. As part of that policy, any nuclear power project pays the closest possible attention to environmental protection right from the start by incorporating such approaches as:
   — Total emission control of radioactive material contained in gaseous and liquid wastes; and
   — Environmental impact assessment of radioactive material releases in case of accident or during normal operation of nuclear reactor.

c. Compared with resources-dependent and resources-consuming energy such as from fossil fuels, nuclear energy is a technology-dependent form of energy in that uses of natural resources can be expanded and resultant waste controlled by technology. Since essentially only a small quantity of uranium is required to obtain large quantities of energy, nuclear waste is relatively small in quantity and controllable. On top of that, it is expected that some transuranic particles found in nuclear waste can be annihilated some time in the future — that is, through technology that will change transuranic elements with long half-lives found in nuclear waste into ones with shorter half-lives. Therefore, it is essentially possible to keep nuclear waste from having adverse effects on the natural environment. Being technology-dependent means that nuclear energy has another important socioeconomic benefit as it is relatively invulnerable to finite availability and fluctuating prices of natural resources.

Considering these advantages of nuclear energy, it is one of the most important responsibilities the nuclear advanced countries should assume from now on to increase their commitment to nuclear power at a reasonable rate to meet energy requirements for their own existence and growth and thereby decrease their dependence on less developed nations for supplies of natural resources while extending a strong, helping hand to these developing countries in improving their living environment.

By taking this approach, we firmly believe, the industrial nations are certain to make a successful start to solve environmental problems facing the Earth.

What was the reaction of human beings to the introduction of nuclear power technology into human society? When the atoms-for-peace program got under way 35 years ago, nuclear power was hailed by human beings with ardent hopes of extracting vast amounts of energy, though there was much argument about it. As nuclear energy practically came into use for commercial purposes in earnest, however, strong rejection stemming chiefly from a feeling of uneasiness set in to take hold on people's mind. This is a typical example of the pattern that has been followed by the aforementioned second-category products of science and technology. Later on up to the present day, this popular rejection has set in over and over again, eventually developing into social movements.

Admittedly, there is popular "sentiment" against nuclear power, originating basically from a feeling of uneasiness. And when people are forced to follow the dictates of "reason" and say yes to, for example, the necessity of nuclear power as an alternative source of energy following the oil crises and more recently, to argument for nuclear power as a best solution to the greenhouse effect being accelerated by rising atmospheric carbon dioxide levels, there is a conflict between "reason" and "sentiment" in their mind. Triggered by minor trouble, this conflict comes to the fore easily and unexpectedly. Contrary to "rational" understanding, a nuclear power plant accident like the TMI and Chernobyl rubs people the wrong way to whip up anti-nuclear "feeling," making them bereft of "reason."

In the field of nuclear energy, therefore, there is a conflict of "reason" and "sentiment" in terms of man's attitude toward science and technology. And this conflict exists between nuclear energy suppliers and consumers.

To resolve this confrontation and deepen public under standing of nuclear energy, the proponents must revive people's hopes and confidence in nuclear power by changing the current approaches appealing to receivers' "reason" to ones appealing to their "sentiment." To this end, all the people in the nuclear power industry are required, before anything else, to gain and accumulate experience in the safe operation of nuclear power plants and take an open and straightforward attitude toward the general public, and, in so doing, regain and build up public confidence. This is a task that may require many years of patience and endurance, just as nuclear energy must be seen in a much longer perspective than conventional sources of energy.

ASSURANCE OF ENERGY SOURCES AND THE ROLE OF NUCLEAR POWER FOR THE 21ST CENTURY

Jean-Daniel LEVI

Immediately after the first oil shock in 1973, the French energy policy had two main targets:

— development of the independence as regards the energy supply,

— availability of cheap energy supplies.

With these purposes in mind, three main lines were defined:

— diversification of the energy supplies,

— reduction of the energy bill,

— energy saving.

These principles ahve led France to develop an important nuclear program.

Today, it makes available a cheap electricity production, relying on diversified supplies, and lightly dependent on importation.

In 1989, two additional structural data must be considered:

— the opening of the frontiers in Europe in 1993:

Europe should pursue the same objectives of energetic independence and reduced supply costs. This will be made possible only if a free market of energy is progressively established.

These targets lead to the adapted use of the own resources of each country, and the definition of the best adapted electric energy supply.

— the environmental concern about the risk of global change:

as for the production of carbon dioxide, we can already observe a significant reduction of emission in France (in 1987, 350 millions tons have been produced due to fossil fuel consumption versus 610 millions tons that would have been produced without our nuclear program).

Moreover, we have to take into account the presently increasing cost of oil.

When the 21st century comes, the targets which are now leading the French policy will still be valid, and even made more crucial as far as the greenhouse effect is concerned. Moreover, these aims might become worldwide issues.

Thus, one can expect a further development of nuclear energy in the future, provided:

— a reasonable public acceptance,

— a rationalization of its worldwide development,

— and the pursuit of efforts in the field of safety.

THE MAIN GUIDELINES AND TECHNICAL MEASURES WITH THE PURPOSE OF IMPROVEMENT THE SAFETY OF NUCLEAR POWER PLANTS WITH VVER-1000 REACTORS

Alexandor L. Lapshin
Deputy Minister
USSR Ministry of Nuclear Power

1. INTRODUCTION

The actuality of problems of the safety of the NPPs with VVER reactors, their broad spreading and application uptil the year 2000.

The analyses of the safety of NPPs with VVER reactors performs by different countries.

The ways of further improvement of reliability and safety of NPPs with VVER reactors.

2. BRIEF TECHNICAL DATA ON VVER-1000 REACTOR

The thermal arrangement of the reactor, reactor type, main reactor characteristics, safeguards system structure, main features of the containment design etc.

3. THE MAIN TRENDS OF IMPROVEMENT OF RELIABILITY AND SAFETY OF NPPs WITH VVER - 1000 REACTORS

— improvement of reactor nuclear physical characteristics;
— implementation of safeguards system based on passive principle;
— implementation of diagnostics systems of metal, piping and safeguards system preparedness;
— perfection of automized system of technological processes control and information supply;
— implementation of operator support systems, of "emergency control" principle;
— perfection of safeguards-localisation system.

4. ADDITIONAL MEASURES TO IMPROVE RELIABILITY AND SAFETY OF NPPs WITH VVER-1000 REACTORS

— reactor advancement;
— passive heat transfer system;
— emergency boric injection system;
— metal and piping diagnostics system;
— control system of safeguards preparedness (discrete performance control of the safeguards system elements);
— perfection of automized system of technological processes control;
— localisation system of leakage from the primary into the secondary circuit;
— system of pressure reduction and filtration of emergency released.

— system of pressure reduction and filtration of emergency release from under the containment;

— system of catching and cooling of welted core outside the reactor vessel.

5. CONCLUSION

Effectiveness estimation of introduction at NPPs of additional systems using probabilistic analysis methods. Different initial incidents share of the core welt probability and different systems influence. The introduction of these additional systems enables reduction of core welt probability approximately 40 fold, while the irradiation overdose probability approximately 100 fold resulting the core welt probability approximately 10^{-6} times a year.

The problems presented in this report, the ways offered for their solution with the purpose of further development of nuclear power require profound scientific, research and experimental design activities, as well as the assimilation by the industry of newly borne equipment, technology etc. In this connection the Soviet Union would be interested in cooperation in different fields aimed at joint solution of these problems.

NUCLEAR ENERGY DEVELOPMENT IN PAKISTAN
POLICY, PROSPECTS AND PROBLEMS

Munir Ahmad Khan
Chairman
Pakistan Atomic Energy Commission

Pakistan's Nuclear Energy Programme aims at economic, scientific and industrial development of the country. It concentrates on using nuclear technology for development of nuclear power and application of nuclear techniques in agriculture, medicine and industry. Pakistan is among the poorly endowed countries in indigenous energy resources both in absolute and relative terms. The total per capita annual consumption of electricity is only about 300 kWh which is one-seventh of the world average. The proven reserves of fossil fuel correspond to 4 toe per capita compared to world average of 130 toe. Hydro potential is also limited. Hence the justification for introduction of nuclear power.

The present installed capacity in the country is about 7,000 MW and is expected to grow to over 22,000 MW by the year 2000. The maximum contribution from hydro will not exceed 9,000 MW leaving a gap of 13,000 MW to be met by conventional thermal or nuclear plants. Pakistan is importing 75% of its oil needs from abroad which is a major drain on its limited foreign exchange earnings. Local supplies of coal, mostly lignite, are limited and have high content of sulphur which inhibits the construction of coal-fired plants based on indigenous coal for reasons of pollution and high cost. The gas reserves amounting to a mere 350 M toe are too limited to be dedicated for power production. It is estimated that of the total gap of 13,000 MW by the year 2000, at least 5,000 MW should be nuclear. Pakistan, therefore, has a strong economic and technical incentive to build more nuclear power stations during 1990's.

Over the years, Pakistan has developed some indigenous capability in certain areas of nuclear power technology. It has been operating a 137 MW CANDU nuclear power reactor at Karachi since 1972. This has helped train a substantial number of nuclear power engineers and operators. No outside help has been received in the operation of this plant in terms of fuel, materials or spare parts and Pakistan has been compelled to develop indigenous capability in these areas. Several institutes and facilities for research and development in relevant nuclear fields are now functioning. Exploration, mining and refining of uranium has been undertaken and a nuclear fuel fabrication plant has been in operation to meet local requirements. Research and development work in uranium enrichment has been initiated to meet a part of the requirements for future nuclear power plants. Research and development has also been undertaken on the testing of spent fuel to ensure its safety.

Apart from nuclear power, Pakistan Atomic Energy Commission is promoting nuclear and other advanced techniques in agriculture and medicine. A major breakthrough has been achieved in the evolution of superior variety of cotton through induced mutation which gives an average of 30% more yield than comparative varieties and has helped Pakistan become the third largest exporter of cotton.

Considerable emphasis has been placed on the development of manpower including training of nuclear engineers, nuclear power plant operators and technicians. The commission has also established nuclear design and engineering groups for enhancing the indigenous capability.

Pakistan faces several problems in the implementation of its nuclear programme which are both technical and financial. It plans to overcome them by increasing indigenous effort and investment and seeking maximum support through international collaboration.

As recently stated by the prime minister, Pakistan's nuclear policy is to use technology for peaceful purposes only. Pakistan has no intention to develop or acquire nuclear weapons. It strongly supports nuclear disarmament and complete ban on all nuclear tests. It also has consistently advocated the establishment of a nuclear free zone in South Asia in the U.N. and other international fora. In addition, it has made a number of concrete proposals for strengthening the non-proliferation regime in South Asia which include simultaneous accesion to NPT or acceptance of full-scope safeguards. Recently India and Pakistan have signed an agreement that they will not attack each other's nuclear facilities which is a step in the right direction.

STARTING NUCLEAR POWER IN CHINA

HUANG QI-TAO
Vice President of CNNC
Beijing, China

Due to the low average possession rate of the resources and the geographical distribution of the resources being far from energy consuming center, the scarcity of energy becomes an important factor restricting the development of China's national economy. So the development of nuclear power is the only realistic way to make up this short of supplies.

The first nuclear power plants (NPPs) under construction — Qinshan NPP and Guangdong Daya Bay NPP will be connected with grid at the end of 1990 and in Oct. 1992 respectively. In this century, China will continue to develop the nuclear power in a planned way according to the guiding priciple and "relying on our own efforts and through the cooperation with overseas. At the same time, we will still insist on the principle of putting the quality and the safety on a first priority.

The 600 MW PWR is our main reactor model of NPP development. We will make efforts to achieve the standardization, in batches and local supplies of NPP. When the conditions are suitable, we do not exclude the possibility building the 1,000 MW PWR NPP and other kinds of NPP to increase our generation of electricity capacity.

It's estimated that the total capacity of operating NPPs will amount to 6,000 MW by the end of this century.

The resources of Uranium which have been verified can satisfy the needs of nuclear power development in near future and mid term in China. For more fully utilizing the resources of Uranium, not only will we build the 600 MW NPPs, but also pay close attention to the research and development of High Temperature Gas Cooled Reactor, Fast Neutron Breeder Reactor, and Hybrid Fusion-fission Reactor etc. as a new generation of nuclear energy.

Glasnost and Nuclear Power Program in the Soviet Union

Vradimir S. Guvalev
Science Editor
"PRAVDA"
U.S.S.R.

What was the Soviet nuclear power development program for year 2000 before the Chernobyl accident? Prominent scholars, government authorities and party documents agreed that the number of nuclear power plants would increase significantly, to account for than half of the country's electricity generation before the turn of the century.

More than 100 nuclear reactors were to be constructed in addition to the 41 reactors in operation as of April 25, 1986. The planned power output of each nuclear power station was large, at between 8,000 MW and 12,000 MW.

The construction of large nuclear power plants had started in many areas including the basin of the Volga and the Dnepr, North Caucasus, Crimean and the coastal areas along the Baltic Sea.

The Primary task was to make nuclear power generation more economical than hydropower or thermal power generation. Safety was only a secondary consideration.

Then came the night of April 26, 1986: accident at the No. 4 reactor at the Chernobyl Nuclear Power Plant.

I was the first journalist to reach the site. Let me stress some points: I had the opportunity to see many things in the past, including launching of the space rocket on numerous occasions from cosmonaut Gagarin to the present. I have witnessed nuclear explosion for peaceful purposes; I have visited nuclear facilities and nuclear power plants. And I have been in meetings with leading scholars of the world. But in the two weeks following the Chernobyl accident, I experienced far more things than I had in my whole life.

The Chernobyl served as a turning point for the development of Glasnost (publicity of information) in the Soviet Union.

What caused the "week of silence" after the accident? When all the world was writing about the disaster at Chernobyl, why did the Soviet press give no more than brief and contradictory reports? There may be many answers to this question.

One thing is clear. The Chernobyl started off the extensive and diverse process called the Glasnost. Moreover, the Chernobyl was not just a domestic problem - it became the focus of worldwide attention.

The accident forced the Soviet people to reassess the principle concerning the development of nuclear power plants and the radiation safety in the Soviet Union. The authorities began to incorporate the views of the public. Environmental conservation efforts also made a great progress.

Following the Chernobyl accident, environmental conservation movements unfolded in local cities and nationwide, including the preservation of Lake Baikal, Yasnaya-Palyana (home of the great author Tolstoi) and Ladoga Lake (a lake near Leningrad). The successful election of People's Representatives (equivalent to Members of the Diet in Japan) depends on whether the candidate has a nature preservation program.

The accident at Chernobyl, the fire at the Ignalina Nuclear Power Plant and the Armenian earthquake touched off a storm of disputes over nuclear power program.

The Pravda editorial office alone received more than 60,000 letters from all over the Soviet Union.

As a result, construction of the North Caucasus Nuclear Power Plant was called off. Several units of the nuclear power plants in the Baltic Republics and the Ukraine were frozen. The power plant in Armenia underwent a re-examination while the design of nuclear power plants in Minsk and the Volga basin was changed. The construction of the Crimea Nuclear Power Plant was cancelled.

What is the present status?

The opinion of scholars and experts can be summarized as follows:

-- expand the output of power plants.
-- construct nuclear power plants underground (suggestion by Dr. Sakharov, a member of the Science Academy).
-- change the structure of reactor on the safty-first basis.
-- improve the reliability of nuclear power plant equipment and facilities.
-- establish training centers to improve the training of personnel.
-- review nuclear power plants siting, and locate plants away from large cities, for instance.

The opinion of the public and environmentalists, on the other hand, can be summarized as follows:

-- completely stop the construction of nuclear power plants.
-- look for a new source of energy (including energy generation in space)
-- develop energy-saving technologies.
-- increased use of alternative energies.
-- place the design and construction of nuclear power plants under the control of the society (public opinion). Put each case through a referendum.

As we can see, the views of the two parties are mutually exclusive. What can be done about it? A compromise is necessary to fill the gap. I would like to suggest ways to "unite the ununited". I say this because nuclear energy is vital to the development of the European region of the Soviet Union (the scale is another question). Without nuclear energy, the progress of science and technology would come to standstill. The measures I suggest will include the relationship between experts and ordinary people, and the social status of persons engaged in nuclear power and education.

Lessons of Chernobyl are valuable not only to the Soviet people but to the whole world. If we will learn from the tragedy, we will be accountable to the posterity. If not, we may well condemn mankind to extinction.

We must bear in mind that the new civilization is a matter of 25 years ago in the long history of mankind. Tomorrow may be too late: for man could find himself in Sarcophagus (stone coffin) as the one that was constructed to contain the Chernobyl reactor No. 4.

(Translated from Russian)

THURSDAY, APRIL 13

9:30 am — 12:30 pm
SESSION 2 NUCLEAR POWER AMONG SOCIETY (Lectures and Panel)

In Japan, the anti-nuclear movement, especially involving women and youth, has spread widely. It can be seen that nuclear energy development has come to be part of public concern related to the people's living. However, discussions between the nuclear industry and nuclear opponents have not yet found points of agreement.

The session will review the nuclear opposition movement and public awareness, and discuss problems in the nuclear controversy.

CHARACTERISTICS OF CURRENT ANTI-NUCLEAR PROTEST GROUPS IN JAPAN

Yasumasa Tanaka
Department of Political Science
Gakushuin University, Tokyo

Nuclear Power As Seen By the "Silent Majority"

Immediately after the fatal Chernobyl accident which occurred on April 26, 1986, public opinion in major nuclear countries turned strongly against a continuing use of nuclear power. The Japanese did not change their overall pro-nuclear attitude until the spring of 1988. One reason for the sudden outburst of anti-nuclear protests was the import of radioactivity-contaminated foods (mostly spices and nuts) from Europe. This caused a panic among Japanese housewives. As the demand for " *safety to the mouth*" was becoming commonplace among the worried housewives, opposition to nuclear power gained an unprecedented momentum for actions.

The current anti-nuclear protest campaign in this country can be characterized by participation of an increasing number of men and women on the street, who had been hardly interested in the techology and the social consequences of nuclear power prior to Chernobyl. They are named " *new-wave*" anti-nuclear protesters, in contrast to the " *old-wave*" who consisted mainly of people living in the localities near to nuclear facilities. At the present, a combined force of both " *new-wave* " and " *old-wave*" groups aim at what is called "*datsu-genpatsu*", or getting rid of nuclear power plants. At book-stores, there is a special corner where best-selling "*datsu-genpatsu*" books are sold. As nuclear power is becoming a "popular" topic, the " silent majority" is beginning to break their silence. In the summer of 1988, one million signatures were obtained in Hokkaido, demonstrating that nearly a quarter of the eligible voters of Hokkaido oppose the presence of nuclear facilities in Hokkaido. In January of 1989, there began a new nation-wide "*datsu-genpatsu*" campaign to collect ten million signatures before October.

The "Silent Majority" and Mass Media

Generally, Japanese mass media are not very friendly to nuclear power. Because their emphasis is on the side of the worried "silent majority", Japanese mass media are keen to cover even minor incidents at the nuclear facilities. They also cover anti-nuclear or " *datsu-genpatsu* " campaigns. In constrast, government agencies and utility companies often fail to convey to mass media full information on important nuclear matters, such as a major trouble at the nuclear power plant, and sufficient explanations easy enough for laymen to understand. The most serious problem for government and utilities currently is that the " silent majority" are now beginning to be inclined more toward " *datsu-genpatsu* " much popularized by nuclear opposition, mainly because the government and utilities lack enough ability to communicate with the "silent majority" effectively. In addition to the potential risk of radiation hazard which they do not want to accept, the " silent majority" are starting to entertain doubts about the credibility of government and utilities, feel their "right to know" and "right to choose" often disregarded, and oppose the nuclear facilities forced on them by government and utilities.

"Risk" vs. "Benefit" of Nuclear Power

Despite all this, the "silent majority" do not totally reject nuclear power as unnecessary. A recent national opinion poll clearly showed that, while nearly 70% of the respondents hold anxiety toward nuclear power, 60% support continuing nuclear power as acceptable. The result seems to indicate that the perceived benefit of nuclear power exceeded its perceived risk in a great majority of the repondents.

Democracy and Nuclear Power

In this country, democracy has been growing to its maturity in a forty-five-year period after World War II. In contemporary Japanese society, post-war generations have already become a majority. With it "the right to know" and "the right to choose" have become the spirit of the time, along with diversification of social and cultural values. The case of nuclear power is no exception. The choice of nuclear power may be considered legitimate only if the understanding and consent can be obtained from a majority of the people. Nuclear power has long ceased to be a technological problem, but it has apparently become an important social issue of the day. For the first time in Japanese political history, nuclear power became a democratic issue, requiring a rational dialogue between the government and utilities and the "silent majority" half of whom are women--a dialogue in that the supporters are to convince the "silent majority" of the ultimate safety and the invaluable benefit of nuclear power for resource-poor Japan, not by words alone but by actual deeds.

THURSDAY, APRIL 13

3:10 pm — 6:00 pm
SESSION 3 NEW PROSPECTS OF NUCLEAR TECHNOLOGIES

The progress of nuclear technology is the base for the advancement of utilization of nuclear energy and a key to the further development of the nuclear industry. It is also expected to fill the role of driving force to raise the levels of science and technology, as well as other industries.

The session will make an overview, by audio visual method, of specific items of nuclear technologies now at the commercialization and R and D stages, and basic and underlying research for future development.

FUEL SUPPLY TECHNOLOGIES: URANIUM ENRICHMENT AND INTEGRATED DRY ROUTE

William L. Wilkinson
Deputy Chief Executive
British Nuclear Fuels plc

BNFL's presentation will consist of a video entitled "Advance Technology in Action" which will be supported by a talk from Dr. Bill Wilkinson, Deputy Chairman of BNFL.

The presentation provides a brief introduction to the scope of BNFL's activities in the nuclear fuel cycle before examining two outstanding and unique technologies developed by BNFL for use in the front end of the fuel cycle.

These are the use of advanced centrifuge technology in the enrichment of uranium hexafluoride and the use of a single stage integrated dry route for the conversion of enriched uranium hexafluoride to ceramic grade uranium dioxide powder.

The development of each technology is traced and a comparison is made with alternative competing technologies. The many technical, operational and economic benefits of BNFL's processes are explained. An outline of continuing BNFL process development is given together with an indication of future BNFL plans for the deployment of further advanced technology.

In addition to detailed consideration of the two chosen advanced technologies, the BNFL presentation will also show various advanced technologies developed and employed by BNFL in other areas of its activities.

The video duration is less than fifteen minutes.

FBR Fuel Cycle Technology

Toshiyasu Sasaki
Executive Director
Power Reactor and Nuclear
Fuel Development Corporation

For the commercialization of FBRs, it is indispensable to make the most use of the breeding function that enables effective use of uranium resources. For the efficient recycling of plutonium, proper breeding ratio and out-of-reactor time of plutonium is indispensable. In the initial stage for introducing FBRs into nuclear power systems, supply of plutonium from LWRs is necessary. As the commercialization advances, however, this will become insufficient and plutonium from FBRs will be required. Therefore, plutonium recycling technology must be developed in parallel with the reactor technology before the commercialization of FBRs.

In order to establish economically competitive FBR fuel recycling technology, PNC is pursuing R & D on technologies for FBR MOX fuel reprocessing and fabrication, high-level radioactive waste treatment and disposal as well as transportation and safeguards of nuclear material.

The R & D objectives, themes and overview of FBR fuel recycling technology and the perspective of the future FBR fuel cycle making the most use of the distinctive features of FBRs are as follows:

1. Economic Targets

From economic viewpoints, it is important to reduce costs of fuel cycle and reactor construction for FBRs so as to be competitive with LWRs. If the ratio of FBR/LWR reprocessing cost is lower than 2.5 and that of fabrication unit cost is lower than 3 in terms of fuel on condition that the ratio of FBR/LWR construction cost is lower than 1.1 and the FBR fuel burn-up of 150,000 to 200,000 MWD/t is attained, it is estimated that FBRs will be competitive with the next generation LWRs in power generating cost at the current uranium prices.

2. R & D Themes and Overview of FBR Fuel Cycle Technology

2.1 Fuel Reprocessing Techniques

FBR fuel reprocessing techniques are being developed using Purex method with chop and leach processes based on LWR fuel reprocessing experiences.

FBR fuels are different from LWR fuels in fuel assembly structure and material, and in higher burn-up and plutonium concentration. For this reason, R & D for the rationalization and the improvement of the processes for disassembling and shearing of fuel assemblies, dissolution of fuel, clarification and separation of fuel solution as well as that for assurance of criticality safety, analysis methods and maintenance techniques.

Fuel reprocessing process can be rationalized by taking the advantage of features specific to FBRs to which fuels less purified in FP and TRU elements are acceptable. It will enable further cost reduction.

The quantity of TRU elements and platinum group metals contained in FBR spent fuel are larger than those in LWR spent fuel. Therefore, it is useful in reducing TRU elements in waste to burn and also to recover valuable nuclides such as platinum group metals for use. This is why it is important to develop nuclides partition techniques.

2.2 Fuel Fabrication Techniques

Large quantity of plutonium is processed in a FBR fuel fabrication facility. This makes it important to confine plutonium, assure sub-criticality, control the exposure to radiation and control nuclear materials. For this reason, equipment automation and remote control techniques as well as radiation shielding and safeguards techniques are being developed as the basis of handling plutonium within gloveboxes.

Improvement of the process efficiency are also being pursued to overcome the restriction of fuel material to small quantity due to criticality control. Important future R & D themes are the reduction of the size of facilties, the improvement of fuel powder handling processes, the reduction of sintering time and the remote maintenance, and containment methods other than gloveboxes such as cells.

2.3 Waste Treatment and Disposal Techniques

The same techniques with LWRs are to be used basically for FBRs.

3. Perspective of Future FBR Fuel Cycle

The above-mentioned techniques for fuel fabrication and reprocessing are being developed for the commercialization of FBR fuel cycle. In order to recycle recovered plutonium in FBR fuels, however, it is not always necessary to divide the fuel cycle process to a fuel fabrication process and a reprocessing process, but possible to make it a process embodying both of them. This would be more advantageous for the rationalization of the process and for the transport, the safeguards and the physical protection of nuclear materials because reactors and fuel cycle facilities are collocated. Therefore, it is worth studying these processes.

ABSTRACT

AN INNOVATIVE LIQUID METAL DESIGN WITH WORLDWIDE APPLICATION POTENTIAL

AUTHORS

B. WOLFE

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The nuclear program in the United States has been faced with major political, economic and technical challenges in recent years. One element of the U.S. program, the Liquid Metal Reactor, has addressed these challenges in a systemmatic, focused manner. This has led to an innovative modular design which incorporates many inherent, passive safety features, and has evolved from the PRISM design, originated by the General Electric Company.

In July of 1988, the GE team was selected by the U.S. Department of Energy to further develop this design as the reference U.S. LMR. This paper will describe the reactor concept, the program status, and the future plans.

This design is extremely responsive to the aforementioned U.S. political, economic, and technical challenges. It should also be attractive on a world-wide basis because these same factors exist, with varying intensity, in other developed countries that have, and are, deploying nuclear power. The PRISM concept incorporates many inherent, passive safety features, with the objective of achieving neutronic shutdown and decay heat removal without relying on operator action or engineered active safety features. The approach utilizes many innovations, including a reactor vessel air cooling system, the use of a sealed reactor assembly (during normal operation), seismic isolation (required in the horizontal direction only), passive neutronic shutdown (for loss of flow and transient over-power events), electromagnetic primary pumps, and an in-vessel fuel transfer machine.

The U.S ALMR design incorporates a metal fuel core as its reference, however, the safety performance can also be achieved with an oxide core having similar inherent, passive features. This flexibility is particularly important when addressing the viability of world wide applications of this ALMR concept.

The reference ALMR reactor module, of which there are nine in a typical 1395 MW_e plant, is a ~6 meter by ~20 meter vessel of 471 MW thermal, with a reactor outlet temperature of 485°C, and an overall conversion efficiency of 33%. This plant uses a saturated steam cycle and also utilizes a non-safety grade secondary sodium system. Each reactor is coupled to its own steam generator for maximum flexibility. Three sections of steam generators are coupled to a single turbine generator to make up a basic "power block" of 465 MW_e. The modular approach extends throughout the plant such that the site fabrication is a small fraction of that in current nuclear plant practice in the United States.

The challenges in this design approach are to achieve the inherent, passive safety performance while remaining economically competitive with alternative nuclear and non-nuclear energy supplies. Based upon the extensive cost evaluations performed by the experienced GE team, which contains the major nuclear vendors in the U.S., the ALMR design approach has the potential to achieve capital costs that are competitive, and busbar costs that are lower than the competition. The modular, factory fabricated approach addresses the economic risks that inhibit the current generation of nuclear power plants from being further deployed in the United States.

The ALMR design is based upon key features tests, and the existing LMR technology data base, The design has also been extensively reviewed by many independent teams, including representatives of utilities and independent consultants. However, in order to truly establish the viability - technically and economically - and also to determine the public acceptability of this passively safe design, the GE team is recommending a full-scale prototype test of this reactor concept which could be completed, with subsequent design certification by the U.S NRC, by the year 2003. This time frame, however, reflects the long-term application nature of the LMR. The R&D program required to support this development is also relatively modest, reflecting the decision to utilize established technology wherever possible. The R&D program is primarily focused on establishing the feasibility of, and qualifying, the innovative features of this ALMR design concept. The U.S ALMR program is attempting to establish collaborative approaches with other international LMR entities to achieve a synergistic approach to future LMR's in the world.

NUCLEAR MATERIALS RECYCLING, THE GREAT CHALLENGE

R. LALLEMENT, Director for Nuclear R and D Programs CEA

JP. ROUGEAU, Vice Président, COGEMA

Summary

Nuclear energy is the basic choice for nations having no oil and coal national resources. It has been demonstrated that this choice is economic and safe. However natural fissile material resources are limited. It is mandatory to optimise fissile material consumption. This implies plutonium production and plutonium recycling in thermal reactors, plutonium utilisation in breeders and maximum use of uranium coming from reprocessing.

The great challenge for the next century is to define the best strategy for uranium and plutonium utilisation leading to the lowest cost of energy and the optimum safety of our facilities. This is a multiparameter question, which implies the development of low cost enrichment, reprocessing, fuel fabrication and waste treatment, as well as easy to build, safe, easy to operate, simple and cheap reactors.

The paper will present the French approach for plutonium and uranium utilisation in the short term as well as in the long term.

NUCLER POWER ROBOT

Kazuhiko Imoto

Chairman of Subcommitee on Nuclear Power Plant,
Technology Committe, Advanced Robot Technology
Research Association

1. General

The nuclear power generation in Japan tends to share increasingly higher percentages in the future of the total Japanese power generation, so that the enhancement of its safety, reliability and availability factor, and reduction of radiation exposure for human operators and reduction of plant outage duration are looming as major issues.

At nuclear power stations, in order to achieve safety plant operation, various kinds of safety features, and equipment are provided. These safety equipment must meet the daily and anual periodical inspection.

However, for some of these equipments inspection, there are some difficult cases for the human operators to access to the equipments naturaly. On the other hand, inspection work and maintenance work to the equipments require a lot of complieated and skilful works which are carried out by human operators at present time.

It is now necessary to develop a robot capable of performing these complicated and skilful tasks at various places of the nuclear power station.

In the past, many automated machine for maintenance work or inspection purpose have been developed and utilized for actual plant work. And also, improvement or actual use of inspection or survey robots and maintenance robots are being undertaken.

In Japan, the development effort of nuclear robots has started in the 1970's.

It has started from mechanized specific works such as exchanging of simple parts, simple maintenance works or inspection which are represented by in-service inspection. These machines were mostly manually operated at early stage. However, coincident with small size computer development, many of the machines have been computerized.

Proceeding to computerization, recent development effort is being focused to multipurpose robots which can access to various places. Example of the multipurpose mobile robots application are represented by TMI-2 robots for decontamination and other works.

However, robots based on current technology, has become increasing difficult to expand further remote mechanization of work tasks in nuclear power station, since it requires more advanced technology, such as high-performance intelligency, maneuverability, delicacy and dexterity as mankind.

In order to meet this necessity, the R&D of Advanced Robot for Nuclear Power Plant are being carried and promoted by the large-scale national R&D project system of AIST (Agency of Industrial Science and Technology, MITI).

2. R&D Plan for Advanced Robot for Nuclear Power Plant

This project aims to develop the robot which has following work tasks features.

- Inspection, monitoring and repair works at areas of high level radioactivity, high temperature and/or high humidity at where human operators are not accessible.
- Access to various and complicated work places.

- Maneuverability and multi-purpose capability by autonomous or tele-operational control.
- In addition to establish the each elementary technologies to meet above mentioned three requirements, by conducting the overall evaluation of combined system of the elementary technologies, useful technologies for robotics will be established.

At present, almost all of elementary technologies R&D works have been finished, and designing and manufacturing total system of a robot which will be assembled with completed elementary technologies and combined with current technologies, have started.

2.1 R&D Plan and Schedule

Figure 1 shows R&D schedule of the nuclear robot. Figure 2 shows image of the nuclear robot.

2.2 Total System

In environmental conditions involving high level radoiactivity, high temperature and high humidity, the robot should be able to arrive at a job site by walking over uneven floors, climbing up and down stairs, passing over or under an obstacle as required, making turns at right angles, and so on, and should be able to inspect, repair, or otherwise handle valves, pumps, heatexchangers, and other equipment or instruments in the power station.

Table 1 shows outline of total system.

Fig.1. R&D Schedule of Nuclear Robot

Fiscal Year / Research Theme	1984	1985	1986	1987	1988	1989	1990
Specialized Elementary Technologies	Conceptual and Basic Design	Trial Production and Experiments		*1	Trial Production and Experiments		*2
Total System			Concept	Conceptual Design	Detailed Design	Manufacture and Experiments	

*1 ; Interim Evaluation, *2 ; Overall Evaluation

Fig.2. Image of Nuclear Robot

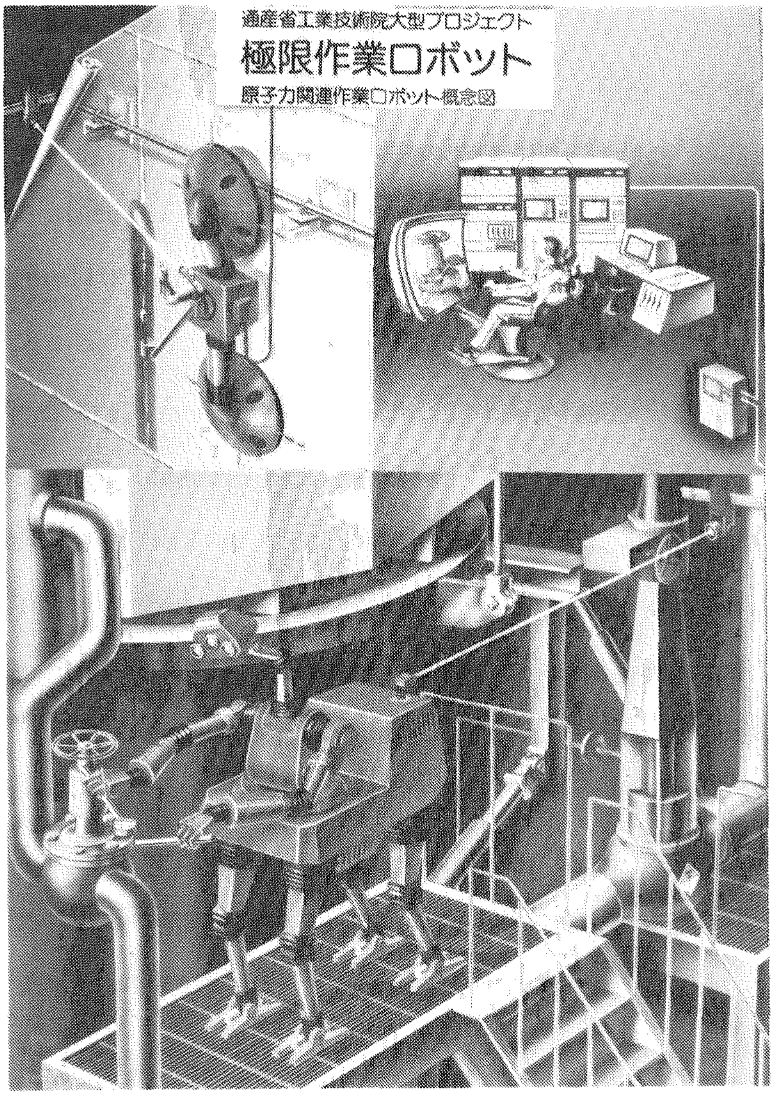
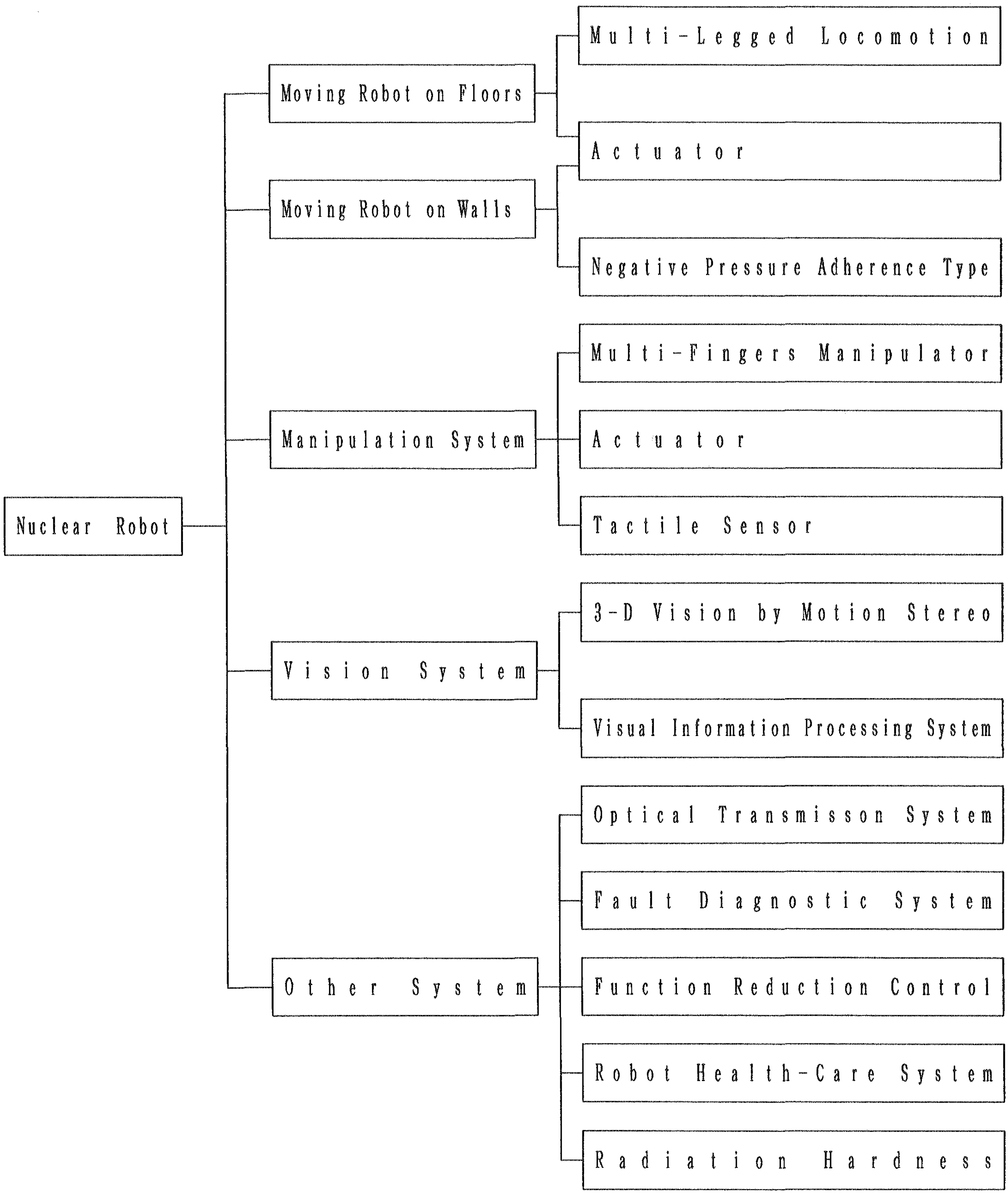


Table 1 Outline of Total System



Radiation Technology for Clean Environment

Sueo MACHI, Japan Atomic Energy Research Institute
Takasaki, 370-12, Japan

Environmental conservation is very important task, which will be discussed at Summit Meeting in Paris in July this year. Radiation is efficient tool to remove various pollutants. Treatment of waste water, sewage sludge and stack gases by radiation has been extensively conducted.

1. Clean up of Combustion Flue Gases

Acid rain due to sulfur dioxide and nitrogen oxides causes environmental problem, such as damage of forests, lakes and concrete buildings. JAERI and Ebara invented method to remove SO_2 and NOx simultaneously from flue gases by electron beams. The pilot scale experiments have been conducted in Japan, USA and FRG to show this technology is feasible for commercial use. Next mile stone is to build full commercial plant to prove industrial feasibility by one year continuous operation. For this demonstration project, internationl cooperation will be desirable to avoid the duplication of investment.

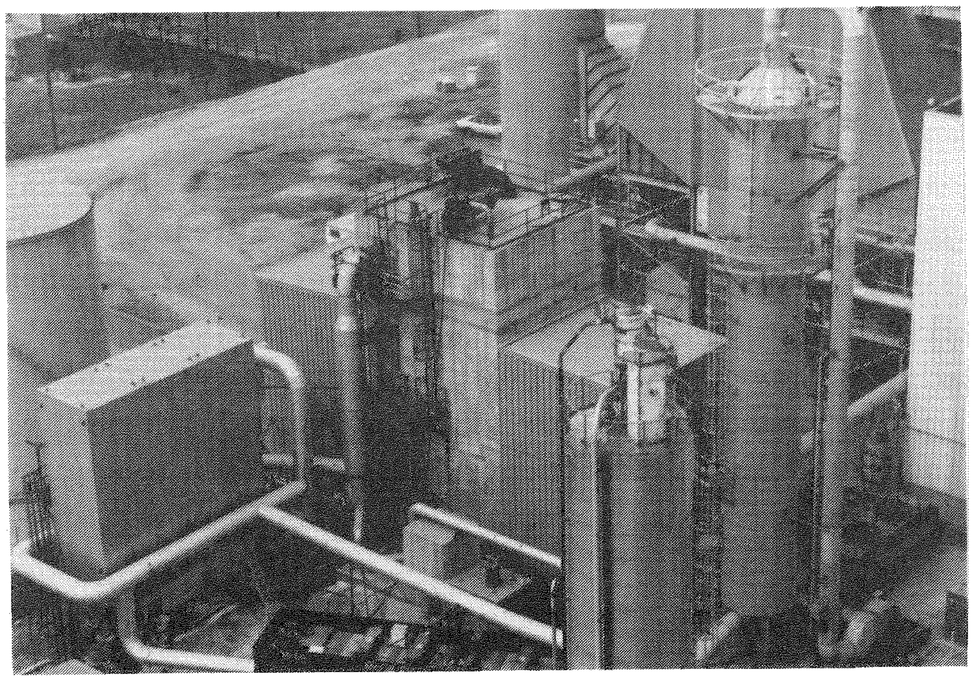
2. Waste Water Treatment

Waste water is contaminated by various kinds of pollutants, some of which are not bio-degradable but radiation-degradable. In this respect, radiation treatment is efficient technology. Effuluent from sewage treatment plant is disinfected by chlorine injection which forms toxic organic chlorine compounds. Radiation disinfection is alternative technology. In Japan and USA this technology developments are in progress using electron beams. The task is engineering design of facilities to irradiate large amounts of water at high rate and efficiency.

To avoid the formation of trihalomethane, radiation treatment of raw drinking water to decompose humic acid has been found to be efficient method.

3. Disinfection and Use of Sewage Sludge

Sewage sludge of more than 2 million tons per year is formed from sewage treatment plant in Japan. In order to use the sludge as a fertilizer, radiation sterilization has been used in commercial scale in Federal Republic of Germany. JAERI is developing new technology to disinfect sludge by electron beams followed by composting to produce organic fertilizer. This technology is very promissing in terms of economics, saving space and good quality of composts. Pilot scale experiments are being carried out by the plant attached to municipal waste water treatment plant.



PILOT SCALE PLANT OF COMBUSTION GAS TREATMENT BY ELECTRON BEAMS
(CAPACITY: 24,000 cubic meter/hr)

RECENT TREND IN MEDICAL USE OF RADIATION IN CANCER THERAPY

Sunao Egawa, M.D.
Chief
Department of Radiotherapy
National Cancer Center Hospital

The incidence rates of cancer in Japan per 100,000 people are estimated at 260.8 in males and 199.6 in females. From these figures, it can be estimated that the number of new cancer patient per year is as follows: both sexes 270×10^3; males 150×10^3; females 120×10^3. The highest incidence is stomach cancer in both sexes, but cancers of the liver, lungs, rectum and mammary glands and others are increasing.

Radiotherapy is an important form of cancer therapy, along with surgery and chemotherapy. In Japan, some 30% of cancer patients are treated by radiotherapy both for radical and palliative treatment. Radiotherapy is planned and performed in a single mode or combined with surgery and / or chemotherapy, the choice being made according to the location and extent of the cancer. As a result of technical improvement, a high radiation dose to the tumor and a low dose to normal tissue is possible. This increased local treatment will result in longer survival of cancer patients.

Source of Radiation for Cancer Therapy and Recent Trend in Radiotherapy

The main telepherapeutic apparatuses are linear accelerators, betatrons, microtrons and telecobalt or telecesium. In "Statistics on the use of radiation in Japan 1988" the number of radiation generators and telecurie units for medical use are respectively 441 and 440. Hospitals and clinics equipped with teletherapeutic apparatus number 683. Only a small number of apparatuses are used in clinics. About 7% of all hospitals are equipped with some kind of radiotherapy unit; in big hospitals, including university and cancer hospitals, usually several equipments are provided and many external cases of irradiation and brachytherapy are carried out. By simple calculation, about 100 patients receive treatment per unit, the total number of irradiations being estimated at 2,500 to 3,000. In the biggest radiotherapy center, nearby 800 patients have been treated, and the number of irradiations per year will be about 20,000.

In external radiotherapy, by the use of megavoltage radiation, homogenous dose distribution on the tumor is readily possible. Each radiation dose should be given within $\pm 5\%$ accuracy. Quality control of dosimetry and reproducibility of the treatment field during a treatment session are most important. Technical improvement to avoid excess radiation to normal tissue is still an important problem although many refinements have been made by isocentric irradiation and conformation radiotherapy. Radiotherapy should be considered a system in itself, and treatment by planned use of X-ray CT is most important and still making technical progress.

Remote after-loading high dose rate intracavitary radiotherapy units (RALS) with ^{60}Co or ^{137}Cs are very useful for treatment of cancer of the uterus. The number of intracavitary low dose rate radiotherapy cases with a low radioactive source has decreased. Because treatment results by the two modes did not positively differ, short treatment time and low radiation exposure to operators in RALS are superior.

The number of treatments using ^{226}Ra needles or tubes as low radioactive source has decreased. Needles with ^{60}Co, ^{137}Cs are used for interstitial radiotherapy, but the recent trend is the use of ^{192}Ir wire or a hairpin source. Treatment results are encouraging. In many hospitals, ^{226}Ra sources are stored without clinical use. Contamination with Rn leaking from damaged capsules or needles will be a major future problem. In Japan, ^{125}I or other new sources are still not used, but because of their important physical characteristics, many clinicians now desire to use them.

New Approach to Radiotherapy

Neutron radiotherapy is carried out in two facilities in Japan. The biological effect is superior to photon radiotherapy, the main indications being directed to refractory cancers. Clinical research is going on and the real indications will be decided in the near future.

Radiotherapy with proton beams has prominent characteristics in the avoidance of excess irradiation to normal tissues. Clinical research is now being conducted in 2 facilities in Japan. Small tumors and also large tumors are being treated by this mode.

Heavy ion radiotherapy is a big challenge. This project in the National Institute of Radiological Sciences in Chiba is the first in the world in being a facility devoted to radiotherapy. Several heavy ions from ^{4}He to ^{40}Ar can be used. Clinical work is to begin from 1993.

Neutron capture therapy is being used for brain tumors and malignant melanoma of the skin, considered to be a big challenge in the field of radiotherapy.

FRIDAY, APRIL 14

9:30 am — 12:30 pm
SESSION 4 ON NUCLEAR PHASE-OUT POLICY OF SWEDEN (Lectures and Panel)

There are some countries taking political action to shut nuclear power plants down or to retire from the nuclear power option, although the circumstances of each differ. The case of Sweden will be discussed in the session, from the aspects of whether it is really possible or not to abandon nuclear power from energy sources, what are the economic and social impacts, and what is the assessment of alternative energy sources. The direction after the country's nuclear phase-out policy will also be considered.

SWEDEN'S ENERGY POLICY

Hans Rode
Director General
National Energy Administration
Sweden

The total amount of energy supplied is today at approximately the same level as in 1970, that is about 450 TWh/year.

Oil continues to lose ground in this perspective of the future, even though it is assumed to account for just under half the total energy supply until the turn of the century.

Natural gas and indigenous fuels are expected to gain in significance, mainly in combined heat and power stations and in industry.

Electricity is today generated chiefly in hydroelectric and nuclear power stations. These account for about 65 TWh each per annum. Apart from this, there is also electricity generated by fuel combustion, mainly through backpressure. In 1988 we had a total capacity of just over 140 TWh and a consumption of about 133 TWh. A first evaluation of this plan is to be made in 1990.

This plan of action will be carried out on an economically correct basis. This means that the demand for new electricity-generation capacity will entail increased costs to society and that these will be allowed to affect the price level.

One characteristic of the Swedish electricity market is the absence of government price regulations. This Swedish model is to continue, and no regulation or interventions are at present expected from the government.

Within this distribution of tasks and responsibilities, the power companies, local authorities, firms and individuals are given the responsibility of finding a solution which harmonizes with their demands and needs and with the local situation.

In this work, the changeover will, undoubtedly and unavoidably, affect large sectors of society and it is, to some extent, measures at local and regional level that can create scope for new production facilities.

Naturally, it is primarily the more efficient use of energy that we are now engaged in, both through government inputs and through changes in attitude and organization on the part of our energy companies.

Low running costs of hydro- and nuclear power, combined with a certain overcapacity have kept electricity prices low. As far as electricity consumption over the next ten years is concerned, there are too many unknowns to make numerical examples worthwhile. It is, however, clear that more expensive power production will play an increased role, and that differentiated tariffs and a higher electricity price will have effects on the electricity market.

In the spring of 1988, the government presented its proposals as to the main tasks of our energy policy for the nineties. The resulting energy Bill was passed by Parliament on the seventh of June 1988.

The main task of the energy policy of the Nineties is the creation of the preconditions necessary to achieve the adjustments in the energy system prescribed in the energy-policy decisions of 1985, that is, nuclear power is to be phased out by the year 2010 and the targets set up in relation to issues such as the environment, our emergency capacity and our security should be reached at the lowest possible cost to society.

A first reactor is to be closed down in 1995 and a second in 1996 — both of them on the west coast of Sweden. The selection of reactor and of the order of closure is to be made in 1990.

Environmental controls on heating and electricity generation plants are to be tightened successively during the nineties.

Suplphur emissions are to be reduced by 80% from 1980 to the year 2000, and must not increase thereafter.

Similarly, the emission of nitrogen oxides is to be reduced by 30% from 1980 to 1995, and must not increase thereafter.

Emissions of carbon dioxide must not increase in a long term period.

Electricity conservation programmes have started. The necessary resources are estimated to be around SEK 400 million over a five-year period.

The programme aims to:

— utilize the potential for greater electricity efficiency and electricity substitution that is economically feasible from now until 1997.

The government is of the opinion that a functioning electricity market would facilitate a phase-out. It is important that increased production costs are gradually allowed to affect electricity prices. Only then can the necessary adjustments be made by households, business and other electricity users.

Combined heat and power plants and industrial back-pressure are to be expanded as much as is economically reasonable.

Hydroelectric power is to be expanded from 64.5 TWh to 66 TWh, with attention paid to environmental aspects.

Alternative forms of electricity generation are to be developed, such as:

fuel cells

wind power

Fuel-based electricity-generation techniques satisfying high environmental standards should be developed, especially with natural gas.

An energy-technology fund has been set up to encourage the development and demonstration of new energy technology with high environmental standards.

The electricity-distribution system is to be further developed.

The government is to follow trends in electricity demand, electricity prices and the investment plans of the power companies. Electricity consumption is to be monitored continuously and conservation programmes, as well as supply-planning measures, are to be followed and revised as necessary.

Our work is both stimulating and a challenge to us in Sweden. However, at the same time we know that neither environmental nor energy issues are merely national ones. They are global, and co-operation between countries is therefore essential if together we are to succeed in attaining our goals.

Our goals are both national and global and co-operation between countries is the only way to attain those goals.

Lennart Fogelström:

The Swedish energy policy in an industrial and international context.

The Swedish nuclear programme is a success excepting public acceptance. However, there are reasons to believe that the public opinion will change and with the opinion eventually the energy policy.

Nuclear power was developed to complement hydro power. Several goals were set up. Nuclear energy had to be economically competitive, safe, environmentally benign and a low burden for the trade balance. Looking at the result nuclear energy has fulfilled most, if not all, of these demands.

The Swedish technology has never depended on foreign licenses. Safety has been kept in the forefront. All Swedish plants have filters which make the use of surrounding land possible even after an unlikely core melt accident. Sweden also has a very comprehensive programme for the final treatment of nuclear waste. This makes nuclear power basically a closed system and thus nuclear energy from environmental and safety point of view is matching hydro power.

Further, plant construction schedules have been short, operational reliability is excellent and the average radiation dose to nuclear plant personnel is very low. Together these factors make the Swedish nuclear power programme a formidable economical success.

The development of nuclear power hasn't stopped neither in Sweden nor abroad. As a matter of fact Sweden was pioneering the development of inherently safe reactors in the 1970ies which since then have gained an increasing international interest. Decisions taken ten years ago have little to do with the current and even less with the technology of the coming decades.

The Swedish industry is concerned not only over the future cost of electricity. The current energy policy also creates a lack of confidence in the future production capacity. The alternatives for producing electricity have one by one been politically eliminated, hydro, nuclear, coal and, as the parliament in 1988 set a limit for the release of carbondioxide, even natural gas can be looked upon with doubt.

The energy consuming industries contribute strongly to an improvement of the balance of trade. The net export income from the pulp&paper industry is thus three times that of the automotive industry. The population trend is towards an increasing number of retirees and a decreasing number of active employees. The percentage in non-industrial work has been increasing over the years. It is of strategic importance for the industry in the coming decades to get qualified personnel in sufficient numbers. The current energy policy makes this problem more difficult on a national basis. The Swedish labour unions are becoming more and more concerned over these related problems.

There are further objections against the current energy policy. How does it comply with the ambition to have a close relation to the inner European market after 1992? Should developed nations choose an energy policy which increases their dependence on fossil fuels which should be saved for lesser developed countries? Should nations with an advanced technological infrastructure make an energy choice which will increase the burden on the global environment?

SWEDEN'S ENERGY FUTURE
Policy vs. politics

Tor Ragnar Gerholm
Professor, University of Stockholm
Sweden

Hydroelectric power played a major role in the industrialization of Sweden. But by the late 50s environmental resistance essentially foreclosed further hydroelectric development projects. Nuclear power was therefore enthusiastically seized upon as a viable new alternative. Sweden embarked upon an ambitions nuclear effort which finally met with striking success. Half of the electricity now generated in Sweden comes from our 12 nuclear power reactors. Of these 10 have been made by ASEA-ATOM (now ABB-ATOM).

But in the 60s nuclear power was not yet ready for use. Petroleum served as a bridge to the nuclear future. Oil was imported to Sweden in ever increasing amounts, not only for power production, but also for industrial and domestic heat and for the fueling of a rapidly growing fleet of motor vehicles. In the early 70s Sweden's per capita consumption of petroleum was higher than in any other industrialized country.

The oil price shock in 1973 probably hig Sweden barder than other OECD countries. Energy conservation, efficient energy use and — in particular — oil substitution became top priority goals.

Unfortunately public debate took a weird turn: energy use rather than oil substitution was seen as the main problem. Nuclear energy, just about ready to be called upon as a major means for oil substitution, was singled out as the culprit. After Three Mile Island the political parties reluctantly agreed to a nuclear referendum. The outcome of this spectacle was somehow interpreted to mean that all nuclear power plants should be phased out by the year 2010 at the latest. These events silenced the debate completely.

In the wake of the referendum and in the absence of public debate nuclear power was massively introduced as a substitute for oil.

Renewable and domestic sources of energy were supported on an ambitious RD & D level but with meagre and disappointing results. Meanwhile public opinion changed slowly but steadily towards a more pronuclear attitude.

Chernobyl called the bluff. It was felt that something had to be done to make the promised nuclear phase out appear more crediable. The Government proposed a premature decommissioning of two, out of the twelve, nuclear power reactors.

This seemed like a modest proposal in particular since the nuclear contribution to the Swedish energy balance is systematically undervalued by a deceptive accounting method used in Sweden but hardly anywhere else. But it is now becoming abundantly clear that in economic, ecological and political terms a heavy price will have to be paied for the forsaken reactors. Furthermore the immediate impact of the Chernobyl accident had already worn off and the environmental movement is now turning against all realistic alternatives to nuclear power.

Since we find ourselves caught in a blind alley the nuclear phase out is not likely to occur. However the current breed of energy politicians will certainly be phased out as time goes by.

In other words: the key to the understanding of Sweden's energy future is not to be found in policy but in politics.

FRIDAY, APRIL 14

2:00 pm — 5:00 pm
SESSION 5 TOWARD NEW ERA OF NUCLEAR FUEL

Japan's nuclear development is reaching a new era for nuclear fuel through plutonium recycling. A way of recycling must be considered timely for the fuel cycle to be accepted by the people. The session will discuss such issues as whether the fuel cycle can be accepted in modern society, considering also relations between humanity and scientific technologies, the significance of closing the fuel cycle from the international standpoint, and the total assessment of risks and environmental effects of the fuel cycle.

THE NUCLEAR FUEL CYCLE AND GLOBAL TECHNOLOGICAL CHANGE

John Yochelson
Vice President for Corporate Affairs
Center for Strategic and International Affairs
U.S.A.

The nuclear fuel cycle is almost always analyzed from the perspective of the global supply-demand energy equation. This dominant perspective highlights both the interrelationship among various energy sources and the wide ranging factors which determine their development. It points to the reality that nuclear power will remain an alternative rather than a primary energy source throughout the 1990s and for decades beyond.

Although there is no substitute for examining the nuclear fuel cycle in the light of other energy sources, it is useful to seek to develop supplemental perspectives for analysis. One such perspective is to view nuclear power in the context of profound structural changes in the world economy that are being driven by new technologies.

Four such changes in the new technological era can be identified: (1) the compression of time; (2) closer global economic integration; (3) a sharpening of competitiveness among companies and national governments; and (4) pressure on multilateral institutions. Fresh insights can be gained by considering what measure of nuclear fuel cycles reflects or contributes to these far-reaching changes.

Compression of time. The advances that are taking place in informatics, computer integrated design, and computer integrated manufacturing have shortened time holizons in many important ways. The compression of time is reflected both in the operation of global financial markets (most recently illustrated by the shocks of October 1987) and in the continually reduced life cycle of many manufactured products. Whereas the compression of time has deeply affected economic as well as political decision-making, it does not seem to be reflected in the development of nuclear power. On the contrary, the constraints on nuclear power have resulted in continually extended lead times in the installation of current systems and the development of new generations of reactors.

Global Integration. Transfers of capital and know-how are tying national economies more closely together than ever. It is becoming increasingly routine for large companies to have global strategies for manufacturing and the provision of services. The nuclear fuel cycle reflects and reinforces this basic trend. Although the pace of nuclear power development varies among the advanced industrial economies, the challenges posed by the nuclear fuel cycle are ultimately global in character and require an integrated strategy of collaboration.

Increased competitiveness. The knowledge-driven technologies have altered traditional concepts of comparative advantage, which put a premium on natural resources. There is an increasing belief that the companies or nations which dominate the new technologies will gain a major competitive edge. During the 1970s this sharpening of competitiveness was mainfested in the nuclear power sector in competition for export markets. In the 1980s, however, there are indicators that these competitive pressures have become less intense as initial prospects for developing the nuclear industry on a global basis have declined. Moreover, the lag of the U.S. industry behind Japan and Europe has been insulated from the internal U.S. debate over competitiveness.

Pressure on institutions. New technologies multiply the demands on the multilateral institutions that have helped bind the global economy. The compression of time, the redistribution of global economic power, and the preoccupation of national governments to maintain their sovereignty in the face of sweeping change have all contributed to the erosion of the multilateral trading system, and the weakening of the IMF and the World Bank. The erosion of multilateral structures has been reflected in the nuclear power arena. New mechanisms to facilitate collaboration will be required to meet the challenges of the 1990s.

The task of shaping a collaborative agenda to develop the nuclear fuel cycle will be made easier if due account is taken of its relationship with transformation of the global economy.

ENVIRONMENTAL ISSUES OF THE NUCLEAR INDUSTRY

Dennis B. Cearlock, Associate Director
Pacific Northwest Laboratory

Perhaps no other environmental issue has caught worldwide public attention like that of global environmental change--the "greenhouse" effect, acid rain, ozone depletion. It is well established that carbon dioxide and other greenhouse gases have substantially increased since the industrial revolution. Although the relationship between these gases and climate has not been quantified, four of the last eight years have been the warmest since global surface measurements were initiated in the 1880s. Last summer's drought heightened concern in the United States. Long-term changes in the global environment could significantly impact the environmental health and economic well-being of nations. Because the combustion of fossil fuels contributes significantly to the greenhouse gases, the role of nuclear power in the United States is being reconsidered.

As a result of intense public concern of nuclear issues, U.S. scientists and engineers have had to emphasize environmental issues while developing the knowledge and technology for handling radioactive waste associated with nuclear weapons production. For example, for more than 20 years the U.S. Department of Energy's Pacific Northwest Laboratory has been studying the environmental impacts of nuclear waste--from creation to disposal. The U.S. commercial nuclear industry is benefitting from this experience and expertise.

By contrast, hazardous waste disposal has not received the same level of public scrutiny. This has resulted in national problems and the proliferation of environmental regulations. Assessment and remediation technology developed for the nuclear industry is now being used to help clean up hazardous waste sites in the United States.

Historically, public demands for environmental responsibility have been much greater for the nuclear industry than any other. After the Three Mile Island and Chernobyl accidents, public concern increased dramatically and demands became even more stringent. To meet these demands, we must understand how wastes behave in the environment at a fundamental level. This understanding is being developed through basic and applied research efforts such as the Environmental Center of Excellence recently established by the Department of Energy.

Although we cannot yet address all the issues associated with nuclear waste, we now have a sound basis for future research to solve environmental problems. I am confident that Japan and the United States, working together, will be able to develop the scientific knowledge and technology to safely address radioactive waste management and other environmental issues facing the nuclear power industry.

NUCLEAR FUEL SEEN FROM THE ASPECT OF SCIENTIFIC TECHNOLOGY

Atsuyuki Suzuki
Professor
Department of Engineering
University of Tokyo

"Why nuclear power?" This simple question remains unanswered even today, 90 years after the discovery of radioactivity by Madame Curie, and 50 years after the discovery of nuclear fission by Hahn and Strassman. Unless the question is answered, it would be difficult for nuclear power to be widely accepted in the society. The answer may take various forms: some may talk of an alternative energy, saying that fossil fuels, such as petroleum, coal and natural gas, are destined to be depleted and nuclear power is needed as an alternative energy source; other may refer to the security considerations, saying that fossil fuels are generally unevenly distributed and dependence on such resources is not favorable from the viewpoint of national security, and that the nuclear power is needed to diversify supply sources. Others bring out global environment logic, saying that nuclear power is needed to solve the problem of carbon dioxide which has been particularly known to the people in recent years. It is needless to say that they are all legitimate answers. The more intrinsic and more essential answer would be that nuclear power is a microscopic energy and that it is a natural consequence that we arrive at nuclear power, in the histrory of scientific technologies, which have moved from macroscopic to microscopic world.

Fossil fuel energy, which is obtained by the bonding of carbon and oxygen, produces 4 electron volts per atom, whereas nuclear fuel energy, generated through the nuclear fission of uranium produces 200 million electron volts per atom. This is because the reaction of carbon and oxygen is one in which electrons, traveling rapidly in curved paths about the nucleus, are bonded. On the other hand, the fission of uranium is a reaction of nucleus itself, producing energy in supermicroscopic world. Energy in general is in inverse proportion to the size of space or substance. The size of nucleus is millions times smaller than the space, in which electrons are traveling. This is the scientific evidence to support that the energy productivity of fossil fuels and that of nuclear power are poles apart. The 4 electron volts of fossil fuel energy is tantamount to the energy of ultraviolet ray, which is the limit of visible level. The 200 million electron volts of nuclear power energy is in the orders of supermicrons, completely invisible to the eye, in the realm of X rays. Though invisible, uranium is widely existing in the world, and when fissioned, it will generate enormous amount of energy. That is a scientific fact no one can deny. It is suggestive that the technological shift from fossil fuel to nuclear fuel is a transfer from visible world to invisible world. This seems to have some relevance to the fact that though ultraviolet rays and X rays are both electromagnetic waves X ray has a particularly frightening image. The conservatism concerning safety issue of nuclear power may be attributable to this discontinuous shift. Heisenberg's theory states that anything smaller than submicrons are blurred and cannot be observed, as long as one relies only upon visible light. Our world, then, will be restricted to that theoretical limit. The use of X ray and electronic microscope, however, will enable us to observe microscopic worlds in their submicron dimensions.

It is known that when Isaac Newton presented "Principia" and proposed the Newton dynamics 300 years ago, the Cartesians did not necessarily accept it. The acceptance of the concept of absolute space in Newton dynamics is to recognize the existence of void, which at that time was impossible in the world created by God. Today, it is known that there is quantum mechanics, transcending Newton's dynamics. The history of scientific technologies has revealed that the technologies of the future will be dependent on the quantum mechanics. This, however, will only hold for a handful of people, called scientists. It will still be some time before that is widely accepted by the society at large. Though it is not yet known what the universal gravitation is derived from, the world of Newton is now believed by many and is accepted to be part of common sense. The quantum mechanics will, some day, reach that point. It is our responsibility to make visible the benefit of the technology, based on the understanding that nuclear fuel is the mainstream fuel in the historical trend of scientific technologies, directed towards microscopic quantum mechanics. Only when we have realized this, will we see people readily accept nuclear fuel as a fuel of common sense. The examples of visible benefit are already seen in information science and materials science, where microscopic quantum mechanics is being introduced and new paradigms are being created. In the field of energy sicence, further efforts are needed to change the current approach towards the creation of new paradigm for nuclear power.

ATOMIC ENERGY IN AN ANTHROPOLOGICAL PERSPECTIVE

Towards an evaluative understanding of the place of nuclear technology

Klaus Riesenhuber
Director, Institute of Medieval Thought
Professor, Dept. of Philosophy
Sophia University

The industrial use of atomic energy involves not only technological, economic or political aspects, but raises, on account of its far-reaching impacts and its symbolic function, fundamental questions concerning the justification, meaning and limits of modern technology as such and of man's role in relation to the natural world and to the future of mankind. In order to detect the hidden anthropological aspects of atomic energy, one has, therefore, first to reflect on man's relation to nature, as it has been conceived in the history of thought, and, then, to try to develop some normative principles for an appreciation and responsible use of modern technology in general and nuclear technology in particular.

I. The historical perspective and its implications for an appraisal of atomic energy

1. At the roots of modern natural science as they can be traced back to ancient Greek thought, lies the conception of nature as an intelligible, meaningful order of being, built according to general laws from simple elements or "atoms." This view of the natural world did not, however, lead to technological development since the order of being was considered as static and complete, even divine, in itself, and since man's destiny was seen to consist in the contemplation of eternal spiritual truth rather than in active labor in the 'lower' or even 'evil' material world.

2. Christianity, as the second determinant of Western thought, has transformed man's attitude toward the material world to a creative engagement which corresponds, according to the doctrine of creation, to God's own creativity. The material universe, thus, is seen as revelation of God's providence, but, at the same time, becomes demythologized and is regarded as the place given to man as his home, entrusted to his responsible use and development. Since man's harmonious relation to nature and to his fellow men became distorted by sin, man's domination of the earth became ambiguous, wavering between egoistic abuse and justified utilization for the common good of mankind. Finally, the eschatological outlook emphasizes the limits inherent in the power of man and his world, even the possibility of a final disaster, and promises, on the other hand, a final fulfillment also of the natural world.

3. Since early modern time technological development came into being through the change from a holistic, finalistic, metaphysical conception of the world to an analytic, quantifying,

empirical world view, and through the utilization of the natural sciences for technological and economic purposes. During the last decades, however, the trust in unlimited progress, characteristic for the last century, has given way to an awareness of the limitations of the earth and its possibilities. Moreover, in a paradigm change, the hitherto analytic and mechanic approach to nature is at present being deepened to a more organic and synthetic understanding of nature as a precondition and part of human existence which has to be respected in its own structure and meaning.

II. The ethical perspective of the utilization of atomic energy

Since science and technology are in themselves ethically indifferent, any use of them, under the condition that its execution and effects do not violate man's life and dignity, is legitimate as far as it serves the fulfillment of man in his personality and of mankind as a whole. This principle is valid also for the industrial use of atomic energy, including the nuclear fuel cycle. Since a sufficient, economic, long range energy supply is the necessary condition for economic growth, a high employment rate, social and political stability and, thus, for a humane life in the contemporary world, and since atomic energy seems to fulfill these requirements, its industrial use can be permitted under the following conditions. The use of any technology involves risks, lays some burden on the natural environment and, for the most part, uses up natural resources. It is, therefore, the task of careful common deliberation to judge which kind of energy supply deserves preference, and it is at the same time a strict obligation for technological researchers, economists, and politicians to try to reduce these dangers and negative effects as far as possible. In order to keep alternative possibilities for future development open, it is advisable to take a multiform approach to the energy problem; in this sense, any technology is provisional and can be superseded. Since energy supply is a common problem for mankind as a whole, any attempt of a solution has to take into account the needs of the third world, too, and protection of its natural resources and its economic development; in this respect, the use of atomic energy offers considerable advantages. The points that still need further clarification and development are the questions of safety and of the protection of the human environment, and these both not only for the present, but also, with regard to the disposal of radioactive waste, for a far distant future. Since these questions touch upon the common responsibility of society as a whole, the way to their democratic solution has to be achieved through wide information and sincere dialogue.

BRIEF PERSONAL HISTORY

OF

CHAIRMEN, SPEAKERS AND PANELISTS

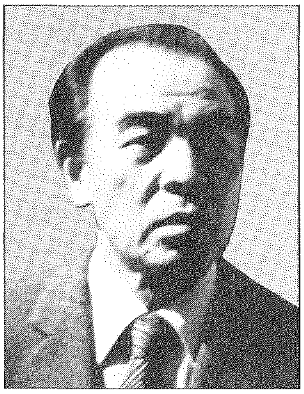
MEMBERS OF THE PROGRAM COMMITTEE FOR THE 22ND JAIF ANNUAL CONFERENCE

(in Alphabetical Order)

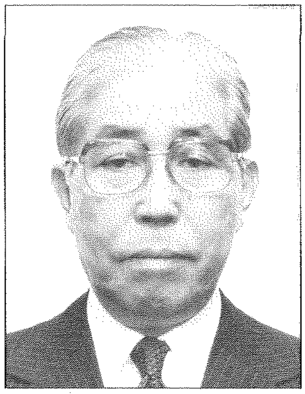
Chairman	Junnosuke Kishida	Honorary Chairman The Japan Research Institute
Members	Kohei Abe	Executive Director The Federation of Electric Power Companies
	Michiko Abe	National Institute of Radiological Sciences
	Yumi Akimoto	Senior Managing Director Mitsubishi Metal Corporation
	Akio Etori	Scientific Journalist
	Heiichi Hamaoka	Executive Director The Japan Development Bank
	Ryo Ikegame	Managing Director The Tokyo Electric Power Company
	Yoshinori Ihara	President Japan Atomic Energy Research Institute
	Mitsuru Inuta	Professor Tokai University
	Tsutomu Kanai	Chairman Committee on Nuclear Energy Policy The Japan Electric Manufacturers' Association
	Yoichi Kaya	Professor The University of Tokyo
	Fumio Kodama	Professor Saitama University
	Hiroshi Murata	President Japan Atomic Energy Relations Organization
	Masao Nakamura	Editorial Writer The Yomiuri Shimbun
	Hiroshi Ohishi	Managing Director The Kansai Electric Power Co., Inc.
	Ken Ohtani	Senior Writer Asahi Shimbun
	Toshitsugu Shibata	Professor Emeritus Kyoto University
	Atsuyuki Suzuki	Professor The University of Tokyo
	Yasumasa Tanaka	Professor Gakushuin University
	Masatoshi Toyota	President Japan Nuclear Fuel Service Co., Ltd.
	Takeko Yanase	Journalist
	Satoshi Yamori	Eexecutive Vice President Japan Nuclear Fuel Industry Co., Ltd.
Observers	Kensaku Hogen	Deputy Director General United Nations Bureau Ministry of Foreign Affairs
	Katsuhisa Ida	Deputy Director General Science and Technology Agency
	Junichiro Mukai	Deputy Director General Agency of Natural Resources and Energy

Chairman

MASAYOSHI HAYASHI



JUNNOSUKE KISHIDA



JIRO ENJOJI

Date of Birth: May 12, 1922

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

Occupation:

Nov. 1946 Chubu Electric Power Generation and Transmission Corporation, Inc.
May 1951 Chubu Electric Power Co., Inc. (due to Organization change)
Jun. 1972 General Manager of Power System Operations Department
Jun. 1975 General Manager in change of Power System Operations Department
Jul. 1977 Director
Jul. 1979 Executive Director
Jun. 1981 Executive Vice-President
Mar. 1986 President, Power Reactor and Nuclear Fuel Development Corporation (PNC)

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, informatization 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 the NIRA research projects, "Japan toward the 21st Century" and "Japan in the 1990s" In 1985, he retired from Asahi Shimbun and became chairman of JRI.

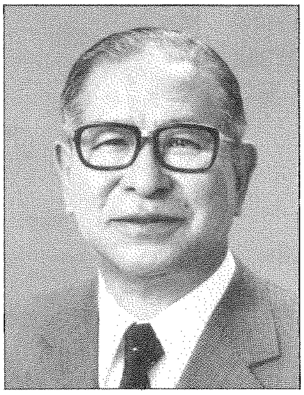
Born on Apr. 3, 1907

Present Titles:
- Senior Counsellor, Nihon Keizai Shimbun
- 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



MOICHI MIYAZAKI

Born on February 15, 1917
in Kagoshima
1939 Graduated from Tokyo Imperial University, Department of Civil Engineering, Faculty of Engineering
1939 Civil Works Bureau, Ministry of Interior
1957 Director for Planning, Planning Bureau, Economic Planning Agency
1961 Director, Planning Division, Ports and Harbors Bureau, Ministry of Transport
1967 Director-General, Ports and Harbors Bureau, Ministry of Ministry of Transport
1972 Elected to the House of Representatives
1976 Vice-Chairman, Science and Technology Committee, Policy Affairs Research Council of the LDP
1977 Parliamentary Vice-Minister of Post and Telecommunications
1979 Parliamentary Vice-Minister of Administrative Management
1983 Chairman, Committee on Judicial Affairs, House of Representative
1986 Chairman, Committee on Communications, House of Representative

Present Position
Minister of State for Science and Technology
Technology in Japan
Member of the House of Representatives (LDP)
– elected six times from Kagoshima Prefecture

Chairman

TOMOO NAKANO

1916 – Born, Shibetsu City, Hokkaido

Education:
1941 – B.S.E.E., Hokkaido University, Faculty of Engineering

Career:
1946 – Entered The Hokkaido Electric Distribution Co., Ltd.
1951 – The Hokkaido Electric Power Co., Inc.
Assistant Manager, Research Sec., Engineering Research Center
1958 – Manager, Generation and Transmission Sec., Otaru Regional Office
1959 – Manager Telecommunication Sec., 1st Engineering Works Dept., Head Office
1961 – Manager, Generation Sec., 1st Engineering Works Dept., Head Office
1964 – Deputy General Manager, Accounting and Financing Dept., Head Office
1967 – Deputy General Manager, Engineering Works Dept.
1970 – General Manager, Engineering Works Dept.
1972 – General Manager, General Planning Dept.
1974 – Managing Director
1977 – Executive Vice President
1983 – President
1988 – Chairman

Decoration:
1984 – Blue-Ribbon Medal with Ranju

HANS BLIX

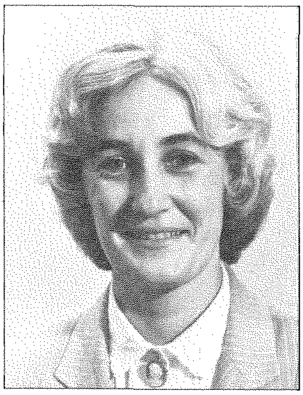
Dr. Hans Blix was born in 1928 in Uppsala. He studied at the University of Uppsala, at Columbia University and he received his Ph.D. at Cambridge.

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

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

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

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



E. GFAIL DE PLANQUE

Currently serving as Director, Gail de Planque was appointed Deputy Director of the Environmental Measurements Laboratory (EML) U. S. Department of Energy in February 1982. Prior to that appointment, Dr. de Planque was a physicist with the Radiation Physics Division, a position held since she joined the Laboratory in 1967.

EML is a Federal research and development laboratory funded primarily through the Department of Energy's office of Energy Research. EML conducts environmental research concerning pollutants associated with energy technologies and related national security activities, principally for the purpose of providing the scientific information required to determine the consequent effects on human health and the environment.

Over the years, Dr. de Planque's research efforts have been concerned with experimental and theoretical investigations involving the application of the basic physics of radiation interactions with matter to problems of radiation protection.

Dr. de Planque has published over 60 scientific journal articles, proceedings and reports, presently serves on the editorial board of the 'Radiation Protection Dosimetry' journal, has been on the scientific advisory and editorial committees of the recent International Conferences on Solid State Dosimetry, and has given numerous scientific lectures both in the U. S. and abroad.

ANTONIN KRUMNIKL

Born 11 February 1941, Plzen:

1966–71 Mining College, Ostrava; technician, Hlubina Mine, Ostrava
1966–71 Postgraduate studies, Mining Institute of the Czechoslovak Academy of Sciences
1971–76 Director, Antonin Zápotocky Mine, Ostrava
1975–88 Senior Lecturer, Mining College, Ostrava
1977–88 First deputy general director, Ostrava-Karvina Coal Mines
1982 Doctor of Mining Sciences
1988 Professor
1988– Minister of Fuel and Energy of the Czechoslovak Socialist Republics

Publications: Numerous scientific studies and publications on underground mining of coal, ore and nonferrous deposits, etc.
Distinguished by a number of Czechoslovak orders and distinctions.

Chairman

TADAHIRO SEKIMOTO

Date of Birth: November 14, 1926

Education:
Mar. 1948 Graduated from University of Tokyo (Physics Department, Faculty of Science)
Mar. 1962 Received a degree of Doctor of Engineering from University of Tokyo

Business Career:
Apr. 1948 Joined Nippon Electric Co., Ltd.
Apr. 1965 Chief, Basic Research Department, Communication Research Laboratory
Aug. 1965 Joined COMSAT on loan
Sept. 1967 Reinstated to Nippon Electric Co., Ltd.
Manager, Communication Research Laboratory, Central Research Laboratories
Aug. 1972 General Manager, Transmission Division
Nov. 1974 Elected to the Board of Directors
Jun. 1977 Senior Vice President and Director
Jun. 1978 Executive Vice Presdient and Director
Jun. 1980 President

Award:
Apr. 1982 Recipient of the Purple Ribbon Medal from His Majesty the Emperor of Japan
Dec. 1982 Recipient of the Edwin Haward Armstrong Achievement Award from the IEEE

Hobby: Igo

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

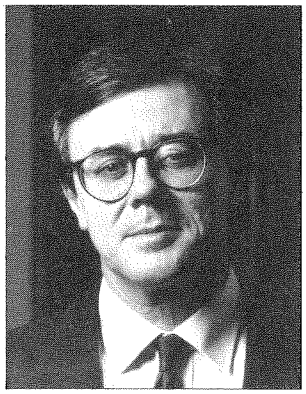
1982 Executive Vice President

1984~ President

Other major posts:

1985~ Vice-Chairman, Keizai Doyukai

1980~ Chairman, the Federation of Electric Power Companies



JEAN DANIEL LEVI

Né le 30 Mai 1940 à Marrakech (MAROC)

1960 Ecole Polytechnique

1965 Ecole Nationale de la Statistique et de l'Administration Economique

1965~1982 Economiste à Electricité de France et à Gaz de France

1982~1988 Conseiller Technique à la Présidence de la République (énergie, matières premières, nucléaire, spatial, contruction aéronautique)

depuis le 6.1.1989 ~ Directeur Général de l'Energie et des Matières Premières au Ministère de l'Industrie et de l'Aménagement du Territoire

Membre du Comité de l'Energie Atomique

Président de la Caisse Française des Matières Premières

Administrateur de l'ERAP et de PECHINEY

Alexandr L. Lapsnin

May 23, 1933 Born in Leningrad

1957 Graduated from the Leningrad Airforce Engineering Academy

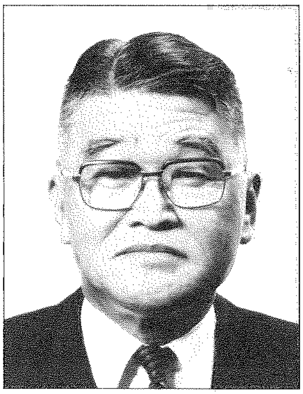
1959~77 Engineer, Chief of the Department, Deputy Chief Engineer at the Leningrad Thermo-Electric Power Stations Design Institute

1977~84 Chief Engineer at the Scientific Research Design Institute of the Power and Electrification Ministry in Moscow

1984~87 Deputy Chairman of the USSR State Committee on Supervision of Nuclear Power Safety

1987~ Deputy Minister of Atomic Power of the USSR

Chairman



YOTARO IIDA

Date of Birth: February 25, 1920

Education: 1943 Sep. Graduated from the technology department of Tokyo Imperial University

Career:

Sep. 26, 1943 Joined Mitsubishi Heavy Industries, Ltd.

May 29, 1973 General Manager of Utility Power Systems Engineering Department of Power Systems Headquarters

Jun. 29, 1976 General Manager of Utility & Industrial Power Systems Engineering Department of Power Systems Headquarters

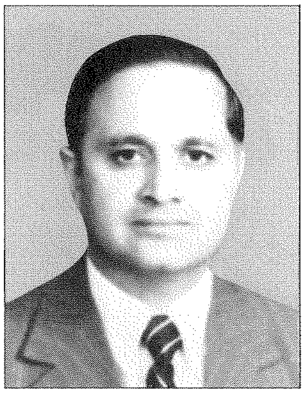
Jan. 1, 1977 General Manager of Utility Power Systems Engineering Department of Power Systems Headquarters

Jun. 28, 1977 Director, Deputy General Manager of Power Systems Headquarters

Jun. 26, 1981 Managing Director, General Manager of Power Systems Headquarters

Jun. 28, 1983 Executive Vice President, General Manager of Power Systems Headquarters

Jun. 28, 1985 President

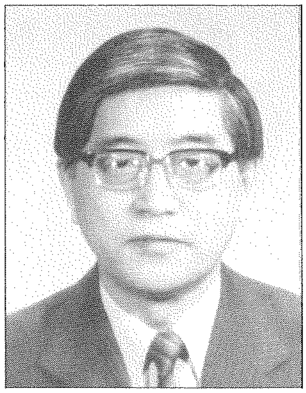


Munir Ahmad Khan

Mr. Munir Ahmad Khan is a nuclear power engineer. He worked in nuclear industry before joining the IAEA in Vienna where he served for 14 years.

In 1972, he was appointed Chairman of the Pakistan Atomic Energy Commission. He has guided the development of Pakistan's peaceful nuclear energy programme for the last 17 years. During this period, Pakistan has commissioned a nuclear power reactor, a large nuclear research and development centre, several nuclear fuel cycle facilities, two training institutes for technical manpower and a number of centres for the application of atomic energy in agriculture and medicine.

He has been taking an active part in international for a dealing with nuclear energy and worked for bringing closer understanding between the less developed and the advanced countries. He has been member of the board of governors of IAEA for eleven years and served as the Chairman of the board in 1986–87.



HUANG QI-TAO

Was Born in Ningbo City, Zhejiang Province, China on July 31, 1934.

1951–1957 Studied at Leningrad University and Moscow Chemical Engineering Institute.

1957–1960 Worked at Lanzhou Nuclear Fuel Factory of Ministry of Nuclear Industry (MNI) as Engineer.

1961–1968 Senior Engineer, Beijing Institute of Nuclear Engineering, MNI.

1969–1975 Research Professor, Institute of Atomic Energy, MNI.

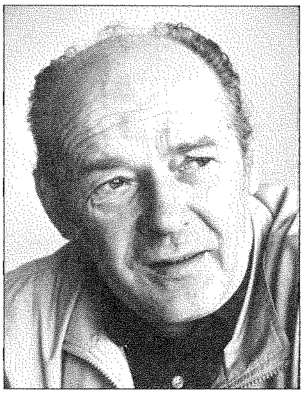
1976–1984 Chief Engineer of Lanzhou Nuclear Fuel Factory, MNI.

1984–1986 Chief Engineer, Bureau of Nuclear Fuel, MNI.

1986–1987 Director General, Bureau of Science and Technology, MNI.

1987–1988 Vice Minister, MNI.

1988– Vice President, China National Nuclear Corporation.



VRADIMIR S. GUVALEV

Born: August 26, 1938 in Mogilev (Belorussia).

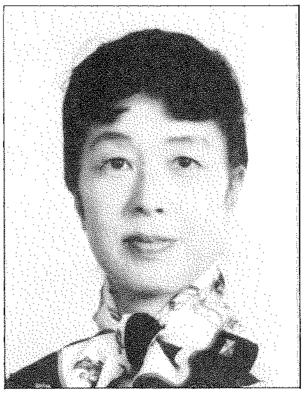
Engineer:
Manager of Department of the Komsomol Pravda since 1960.
The Science Editor, Manager of Department of the Pravda since 1976.

As a journalist:
Received the highest prize awarded to a jouranlist from the Soviet Journalist Union: first for public relations activities on space development and second for activities in the Chernobyl accident site.

As an author:
Guvalev has written more than 20 books. The include "Space Century" (2 volumes), "Thread of life" (a book of genetic science), "Two Steps Away from the Epicenter" (a book on the peaceful use of nuclear explosion and uranium industry), "Nuclear Power City" and "The Space Bridge." His latest work "Crimson over the Pripyach" deals with nuclear energy in the Soviet Union. His books have been translated into many languages. The literary activities has won him the Soviet Union State Award, the Komsomol Prize and many other international awards.

As playwright:
Guvalev has written five plays. The "Sarcophagus (stone coffin)" – the play on the Chernobyl tragedy – was shown in 40 countries including Japan. His latest play is "The grandman Stalin."

Chairman

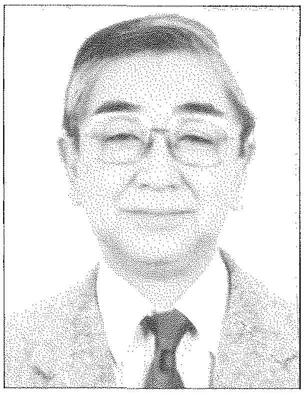


TAKEO YANASE

April 22, 1935 Born in Tokyo
Mar. 1959 Graduated from Japanese Literature Department, Waseda University
1969–72 Served as an MC in an NHK program "Konnichiwa Okusan." She then started to free lance as a TV caster and interviewer, mainly for educational and daily life related programs.
Since 1977 Special Advisor to the Science and Technology Agency. Having visited national laboratories more than 50 times in Tsukuba, wrote essays in STA's publicity magazine "Prometheus" from the viewpoint of a liberal arts major.
1980–85 Public relations officer for the Scientific Expo in Tsu kuba
Also served as a member of various councils for the government, including STA and MPT (Ministry of Post and Telecommunications). Is now a director of the Tsukuba Scientific Expo Memorial Foundation. Has been a caster of "Family Science" program, produced by Higashi Nippon Hoso (since 1986)

SOICHIRO TAWARA

Born in 1934 in Hikone City, Shiga Prefecture. Graduated from Waseda University. After Working for Iwanami Movies and Tokyo Channel 12 TV (currently TV Tokyo Channel 12), is now active as a non-fiction writer and critic.



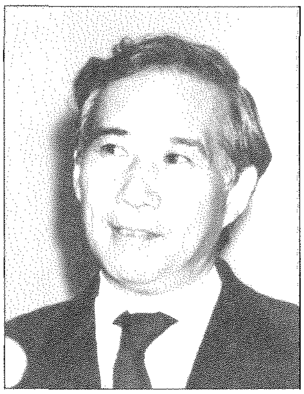
YASUMASA TANAKA

Born in Tokyo on
November 28, 1931
Litt. D. in Psychology; Ph.D. in Communications.
Professor of Social Psychology and Communications, Department of Political Science, Gakushuin University.
Chairman, Department of Political Science, Gakushuin University.
President, Japan Election Studies Association.
Specialist Member, Atomic Energy Safety Commission.

[Educational Background]
Gakushuin University (B.A. in Political Science)
University of Illinois (M.A. in Political Science)
University of Illinois (Ph.D. in Communications)
Kanseigakuin University (Litt. D. in Psychology)

[Career]
Visiting Professor, University of Pennsylvania
Visiting Professor, University of Saskatchewan

[Membership in Learned Societies]
President, Japan Election Studies Association
Japanese Political Science Association (Formerly, Member of the Executive Committee)
Japan Society for International Politics (Member of the Council)
Japanese Psychological Association



YOTARO KONAKA

Novelist/Critic:

Yotaro Konaka was born in Kobe City on 9 September 1934. He was graduated from University of Tokyo in 1958. For six years he worked as a drama director for NHK before turning to writing in 1964. Since 1976 he has been closely involved in the work of the Japan PEN Club.

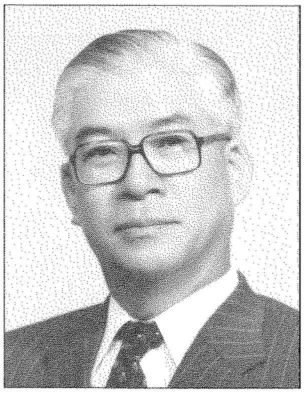
In 1970 Konaka brought out "Tenchugumi Story," a historical novel on the Meiji Restoration. This was followed in 1972 by "Artists of Kingdom," a novel recounting the story of a musicians union, and by an anti-war novel. "Nara High School" treats the topic of university entrance examinations and the intense competition involved.

1938/4, Konaka was an exchange Professor at West Virginia University and Kentuckiana Metroversity in Louisville, Ky., under the Fulbright program teaching Japanese Literature and Journalism.

As a productive free-lance writer as well as a TV commentator, Konaka published recently "TV News War" and "Hour oh History."

TOMOKO INUKAI

Born on April 18, 1931, in Tokyo. Graduated from Gakushuin University and studied journalism and mass communications at the Graduate School, University of Illinois, 1955–56, as Flubright student. After working for the Tokyo Bureau of Chicago Daily News, started her career as a critic. Her 1968 work, "Kajihiketsushu" was a national best seller. In the book, proposed housewives to try and reduce their work load, by washing potatoes in a washing machine, for example. Her other publications include essays and comments in magazines, newspapers, etc. Is now active in various fields, for example, as a member of the Economic Welfare Council, Economic Planning Agency.



TAKASHI YAMAZAKI

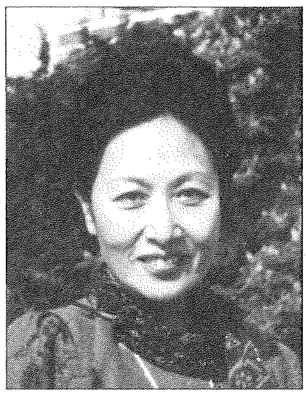
Date of Birth: November 23, 1925
Educational Background:
1949 B. Eng., Nagoya University

Career:
1949 Chubu Electric Distribution Co., Ltd.
1951 (Chubu Electric Distribution Co., Ltd. was Reorganized to Chubu Electric Power Co., Inc.)
1973 General Manager of Nagoya Thermal Power Administrative Center
1979 Senior General Manager of Hamaoka Nuclear Power Plant
1981 Director
1983 Managing Director
1987 Executive Vice President & Director

HIROSHI MITSUZUKA

Born on August 1, 1927
1951 Elected to the Miyagi Prefectural Assembly
1972 Elected to the House of Representatives
1977 Parliamentary Vice Minister for Transportation
1979 Parliamentary Vice Minister for Education
1985 Minister for Transportation
1988 Minister for International Trade and Industry

Hobbies: Reading
Japanese Martial Arts
"Kendo," "Aikido"



AYAKO SONO

1931 Born in Tokyo
1953 Married Shumon Miura
1954 Graduated from the English Literature Department, University of the Sacred Heart
1979 Awarded with Cross pro Eeclesia et Pntifire by the Apostolic See
1983 Awarded with Father Damien Award by the Korean Catholic Leprosy Workers Association
1986 Awarded with "Writing Prize" by Japan Society of Civil Engineers
1987 Awarded with Shikanai Nobutaka Seiron Taisho" by the Fuji Sankei Group

Chairman

KENKO HASEGAWA

Date of Birth: June 8, 1916

Place of Birth:
Fukushima Prefecture, Japan

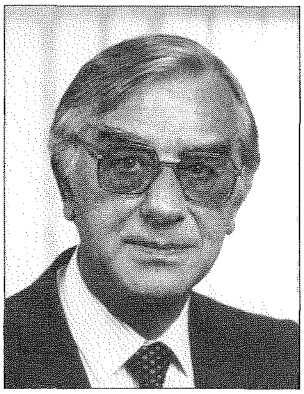
Education: Graduated from Tokyo Imperial University, Faculty of Naval Architecture (December, 1941)

Occupational Background:

1942 Joined Kawasaki Heavy Industries, Ltd.
1962 Senior Manager, Ship Designing Department Ship Group
1971 Director, Deputy General Manager of Ship Group and General Manager of Ship Sales Division
1975 Managing Director, Senior General Manager of Development Group
1978 Senior Managing Director, Senior General Manager of Marketing Group
1980 Executive Vice President
1981 President
1987 Chairman of the Board of Directors
1987 Chairman
The Shipbuilders' Association of Japan
1988 Chairman
The Society of Japanese Aerospace Companies, Inc.

Honours and Awards:

1974 Kobe Distric Maritime Bureau Award
1982 Ministry of Transportation Award
1983 Blue Ribbon Award



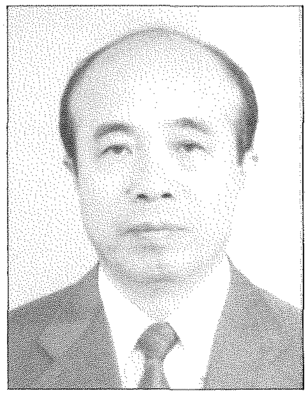
WILLIAM L. WILKINSON

Dr. William Wilkinson studied engineering at Cambridge University. He joined the UKAEA in 1959 and for the next 8 years was engaged on the development, design and operation of fuel element production plants.

In 1967 he was appointed Professor of Chemical Engineering at the University of Bradford and returned to the nuclear industry in 1979 as Assistant Director responsible for Research and Development in Reprocessing Division in BNFL.

He was appointed to the Main Board of BNFL in 1984 as Technical Director and in 1986 became Deputy Chief Executive. He is now the Chairman of the Fuel, Enrichment, Engineering and Transport Divisions.

He is a Past President of the Institution of Chemical Engineers and a Member of the Fellowship of Engineering. He was awarded the CBE in 1986.



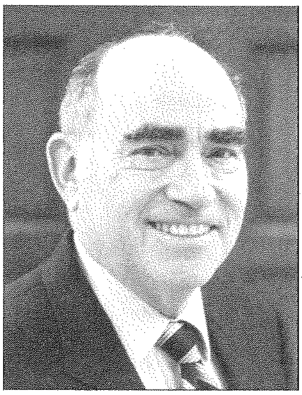
TOSHIYASU SASAKI

Date of Birth: May 6, 1934
Education: Graduated from the Department of Electric Engineering, the Faculty of Engineering, Osaka University

Careers:

1957 Heavy Industry Bureau, Ministry of International Trade and Industry
1959 Atomic Energy Bureau, Science and Technology Agency (STA)
1975 Counselor of Japanese Embassy in Austria
1979 Director, Space Planning Division, Research Coordination Bureau, STA
1982 Director, Planning Division, Planning Bureau, STA
1983 Deputy Director-General, OECD/NEA
1986 Director-General, Nuclear Safety Bureau, STA
1987 Executive Director, Power Reactor and Nuclear Fuel Development Corporation (PNC)

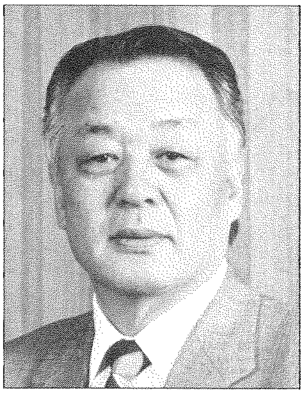
Chairman



BERTRAM WOLFE

Born on June 26, 1927 in Bronx

Dr. Wolfe received his B.A. in Physics from Princeton University in 1950 and his Ph.D. from Cornell University in 1954. He has been in the nuclear energy field since 1955, spending all but two years at General Electric. Dr. Wolfe has worked in almost all phases of nuclear energy from reactor design to fuel supply to waste management to development of new reactor concepts. He is Vice President and General Manager of GE Nuclear Energy, responsible for all GE activities in the nuclear power industry. He is a member of the Board of Directors of the Nuclear Management & Resources Council, U.S. Council for Energy Awareness, Nuclear Power Oversight Committee, and the American Nuclear Energy Council. He is a Fellow of the American Nuclear Society and in 1985 was elected Vice-President, President-Elect. He served as President for the year starting in June of 1986. Dr. Wolfe is a professional Engineer in the State of California, and is a member of the National Academy of Engineering. He holds a number of patents in the nuclear field and is the author of several dozen publications concerning nuclear technology, nuclear energy and energy in general.



MASAKAZU TAMAKI

Born on April 10, 1927

1951 Graduated from the Faculty of Law, Nihon University

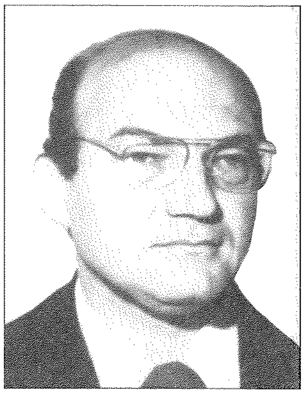
1959 – 1971 Joined Chiyoda, Sales Department

1971 – 1976 Director, Personnel and Administration and Business Development

1976 – 1979 Managing Director, Personnel and General Administration, Corporate Planning

1979 – 1981 Representative Director and Senior Managing Director

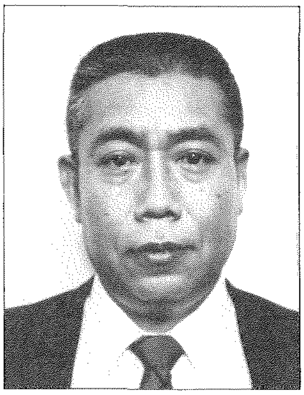
1981 to date President and Chief Executive Officer



ROBERT LALLEMENT

55 years old
Ingénieur de l'Ecole des Mines de Paris 1955
Docteur Ingénieur University of Paris
Master of Science, California Institute of Technology

Entered CEA in 1960
Head of Plutonium Fuel Department (1973)
Head of Technology Department (1976)
Head of Material and Fuel Division (1979)
Director for Nuclear Programs in CEA since 1982

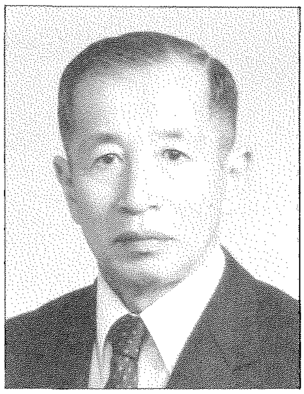


KAZUHIKO IMOTO

Born on Dec. 7, 1939

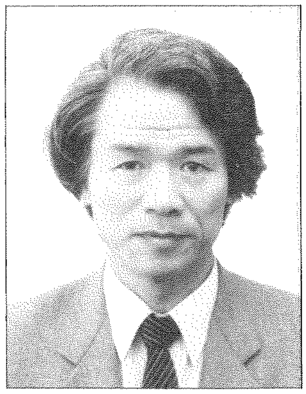
1962 Graduated from the Tokyo Institute of Technology (Mechanical Engineering)
Joined Tokyo Shibaura Electric Co., Ltd. (current Toshiba Corporation)
1966 Atomic Power Division Mechanical Engineer
1985~Chief Specialist – Nuclear System Design Engineering Department
1986 Elected as the vise-chairman of Subcommittee on Nuclear Power Plant, Technology Committee, Advanced Robot Technology Research Association
1988~Elected as the chairman of the above Subcommittee

Chairman



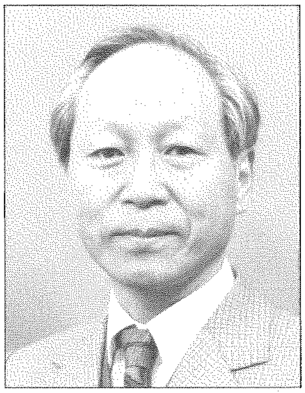
REINOSUKE HARA

Born March 1925, Tokyo
BS 1945 University of Tokyo
PhD 1952 University of Tokyo, Chemistry
1952–56 Post-doctorate research in the U.S.A.
University of Washington, Harvard University, and Louisiana State University
1956–59 Japan Atomic Energy Research Institute
1959–69 International Atomic Energy Agency
Assistant Director, Division of Research
1969 Seiko Instruments Inc.
Director in charge of R&D
Member of the management board
1976 Managing Director
1982 Executive Senior Managing Director
1985 Executive Vice President
1987–Present President
Award Award by the Ministry of Science and Technology for contribution to the nuclear safety (October 1987)
Adviser Hattori Seiko Co., Ltd.
Member Radiation Council of the Government
Member Government Committee on Nuclear Safety
Member Advisory Committee on Science and Technology, Singapore Government
Director Japan Atomic Industrial Forum
Director Japan Association of Analytical Instrument Manufacturers



SUEO MACHI

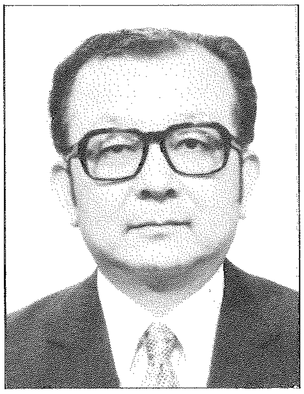
15 January 1934
Born in Shizuoka Pref.
Mar. 1959 Master of Engineering at Kyoto University
Apr. 1966 Enter to the Takasaki Radiation Chemistry Research Establishment, Japan Atomic Energy Research Institute
Jul. 1971 Senior Scientist
Jun. 1974 Head of Process Laboratory II, Pilot Scale Research Station
Jun. 1978 General Manager of Radiation Engineering Division, Pilot Scale Research Station.
Aug. 1980 Detached to the International Atomic Energy Agency
Jun. 1983 Deputy Director to the Office of Planning, JAERI
Apr. 1986 Director to the Department of Research, Takasaki Radiation Chemistry Research Establishment, JAERI
Oct. 1988 Director to the Department of Development, TRCRE
Jan. 1989 Director General of TRCRE, and Director to the Department of Development



SUNAO EGAWA

1929 Born in Tokyo
1955 Graduated Medical School of Okayama University
1956 M.D.
1960 Dr. Med. Sci., Graduate School of University of Tokyo
1961 Research stuff in University of Rochester, N.Y.
1963 Stuff in Department of Radiology, National Cancer Center Hospital
1967 Associate Professor, Department of Radiology Medical School, the University of Tokyo
1971 Professor and Chairman, Department of Radiology Medical School, Teikyo University
1984– Chief, Department of Radiation Therapy, National Cancer Center Hospital

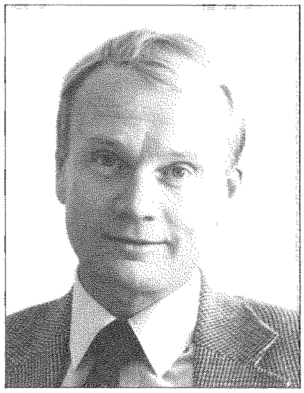
Chairman



TOYOAKI IKUTA

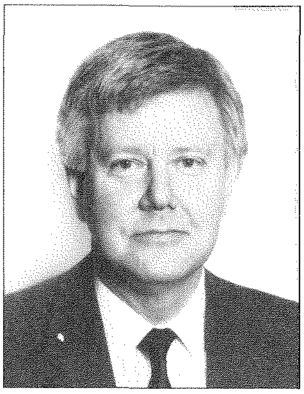
Date of Birth: July 16th, 1925
Present Titles:
President, The Institute of Energy Economics, Japan
Director, Japan Atomic Industrial Forum
Director, Japan Energy Conservation Center
Director, Research Institute for Peace and Security, Tokyo
Director, The Committee for Energy Policy Promotion (Chairman of Experts Subcommittee)
Member of some governmental councils, such as Industrial Structure Council, Industrial Technology Council, Advisory Committee for Energy (Chairman of Energy Demand and Supply Committee), Petroleum Council, Electric Utility Council
Member of some International Groups, Namely, Oxford Energy Policy Club, Group of 13, "The Group"
Educational Qualification:
B.A. (Economics) 1948
Tokyo University, Japan
Publication:
"Reserved Seats for Energies" – 1985
"OPEC" – 1980
"Energy Theory for Citizens" – 1981

and many other articles regarding energy in general, oil, gas and nuclear issue.



HANS RODE

Mr. Hans Rode, Director General of Swedish National Energy Administration since 1985. Age 45, a background as a local politician; since 1977 Mayor in Sweden's third largest town Malmoe.



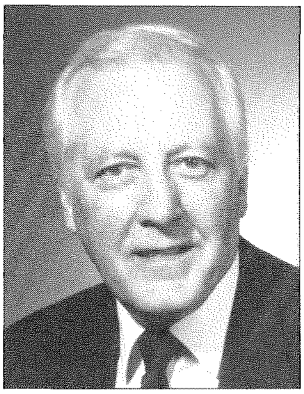
LENNART A. W. FOGELSTRÖM

Born on April 26, 1939

1962 Graduated from the Chalmers University of Technology, Gothenburg, Sweden
1970 Graduated in Business Economics at the University of Lund

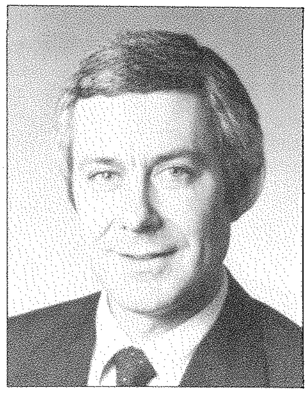
Positions held:
1963–64 Development engineer at Arenco Electronics AB, Stockholm
1965–67 Engineer, Kockums AB, Malmö
1967–72 Head of planning section, Sydkraft AB, Malmö
1972–74 Head of Distribution Department, Gullspång Utility, Örebro
1974–77 Consultant, industrial organization, at Bohlin & Strömberg Co., Stockholm
1978–80 Vice President and President at the Krångede Utility, Stockholm
1980–88 President of the OKG Utility, Stockholm
1988–President of ABB Atom AB, Västerås and Business Area Responsible for Light Water Reactors within the ABB Group

Member of the Royal Swedish Academy of Engineering Sciences
Chairman of the Swedish Atomic Forum
Board Member of Innovative Technologies Inc. Pittsburgh, ABB TRC, Sweden, EB Seatech, Norway



RAGNAR GERHOLM

Born 21 December 1925, was matriculated at Norra Latin, Stockholm, and studied at the University of Stockholm and at the University of Uppsala (1946–1956), before he was named Ph.D. in 1956 by the University of Uppsala. Now a professor of physics at the University of Stockholm, he has served as a research assistant at the Royal Institute of Technology (1951–1954) and at the Institute of Physics, University of Uppsala (1954–1956), and as an assistant professor at the University of Uppsala (1956–1962), before joining the University of Stockholm in 1962. Professor Gerholm has been Head of the department 1970–77 and again since 1988, Dean of the faculty since 1987, a member of the Board of the University of Stockholm 1981–84 and 1986–88, a member of the Swedish Physical Society, of the European Physical Society, of the American Physical Society, of the Swedish Academy of Engineering Sciences since 1976, member of the Royal Academy of Science since 1985, and a member of the Swedish Atomic Research Council (1974–1977). He has also been a member of the Board of Studsvik Energiteknik AB since 1976, of the Board of Industrifonden since 1979, of the Board of ABV (1977–87), of the Board of the Swedish Institute of Foreign Affairs since 1975, and of the International Chamber of Commerce's Commission on Energy since 1980.



BILL HARRIS

Education:

Bachelor's degree in Agricultural Business from Iowa Sate University

Low degree from Georgetown University Law Center

Experience:

Served in the U.S. Army Signal Corps.

Four years (1972 – 1976) as Counsel to Congressman Mike McCormack, who was a subcommittee Chairman on the Joint Committee on Atomic Energy and on the House Committee on Science and Technology.

Four years (1976 – 1980) at the Atomic Industrial Forum – first as Nuclear Information Services Manager, then as Staff Councel.

From late 1980 through 1982, served as Director of the Committee for Energy Awareness.

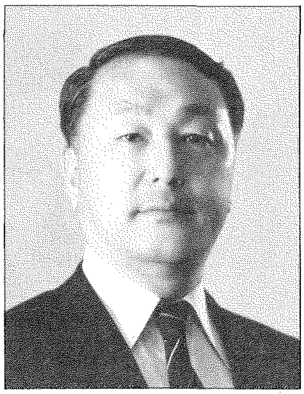
Five years (1983 – 1988) as Vice President, Program Development and Issues Management at USCEA.

Organizations:

Member of the District of Columbia Bar and the Virginia State Bar.

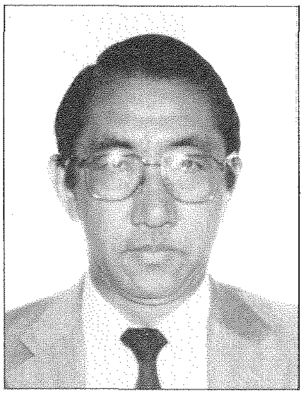
Member of the American Nuclear Society (D.C. Chapter).

Member of the Board of Directors of the Electric Information Council.



YOSHIHISA AKIYAMA

Sept. 10, 1931 Born in Yamanashi Prefecture
Mar. 1955 Graduated from School of Economics, Tokyo University
Apr. 1955 Jointed The Kansai Electric Power Co., Inc.
Jun. 1978 Manager, Corporate Planning Department
Jun. 1979 Manager, Department of Personnel Management and Secretarial Services
Jun. 1980 Deputy General Manager in charge of Personnel Management and Secretarial Services
Jun. 1982 General Manager and Executive Assistant to the President
Jun. 1985 Elected to the Member of the Board of Directors
Jun. 1987 Managing Director
Jun. 1988 Senior Managing Director

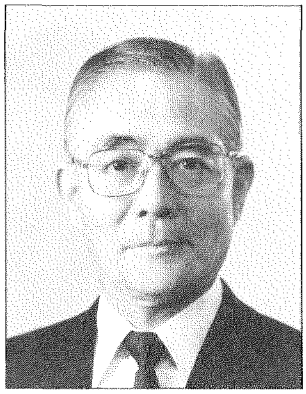


KATSUHIKO SUETSUGU

Borin in Tokyo, 1939
Graduated from Waseda University, 1964
Industrial Nes Reporter for The Nihon Keizai Shimbun (Nikkei), 1964 ~
The 1970 Annual Award of The Japan Newspaper Association for the Best News Report on the Liberalization of Automobile Industry in Japan
Research Fellow at Harvard University, 1977 ~ 1978
Editorial Writer for The Nikkei, 1979 field; International Politics/Economy
Major Basic Industries
Energy/Resources

(Current Government Post):
Members of the Council of Industrial Structure for MITI,
Member of Coal Mining Council for MITI,
Member of Petroleum Council for MITI

Chairman



SHOICHIRO KOBAYASHI

Born on July 14, 1922 in Osaka City, Osaka

Sept. 1946 Graduated from School of Economics, The University of Tokyo
Jan. 1947 Joined Kansai Elecric Supply Co., Ltd.
May 1951 The Kansai Electric Power Co., Inc.
May 1965 Manager, Power Sales Department, Office of Sales
May 1968 General Manager in charge of Office of the President and Subsidiary Business Operation
May 1970 Elected to the Member of the Board of Directors with the same office of managership
May 1972 Managing Director
May 1974 Senior Managing Director
May 1975 Executive Vice-President and Director
Jun. 1977 President and Director
Nov. 1985 – Chairman of the Board

Directorship
Jun. 1977 – Director, Japan Foundation for Promotion of Science and Technology
Nov. 1977 – Vice Chairman, Kansai Economic Federation

Publication
"Total Quality Control in the Electric Utility Industry" by Shoichiro Kobayashi et al, October 1986, Publishing Office of the Union of Japanese Scientists and Engineers

Hobby
Reading, Painting, and Golf

JOHN N. YOCHELSON

Born in 1944

EXPERIENCE:

1979 to Present
Center for Strategic & International Studies, Washington, D.C.

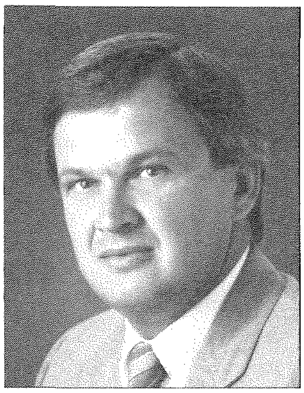
1975–78 Department of State
Political Officer; Wrote decision memoranda for the Secretary of State on U.S. policy toward Europe. Member of delegations to U.S.-European and U.S.-Soviet negotiations on worldwide arms sales. Specialized in French and German affairs.

1973–74 U.S. Congress, Joint Economic Committee
Consultant (part time);
Analyzed political and economic impact of East-West security negotiations.

1971 Atlantic Institute, Paris
Consultant (part time); Co-authored report for Jean Monnet on U.S. and European economic integration. Lectured at the French Council on Foreign Relations.

EDUCATIONAL BACKGROUND:

1972–75 Harvard University, Center for International Affairs
Research Fellow; Coordinated the Harvard/MIT faculty seminar on European Security. Lecturer at Harvard and Columbia Universities.



DENNIS B. CEARLOCK

EDUCATION

1964 B.S. Civil Engineering, Washington State University

1965 M.S. Sanitary Engineering, Washington State University

1965–68 Graduate Studies in Mathematics, Joint Center for Graduate Study, Richland, Washington

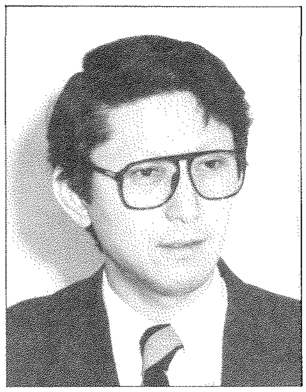
1977 Ph.D. Civil Engineering, University of Washington

EXPERIENCE

As Director of Research at Battelle, Pacific Northwest Laboratories, Dr. Cearlock is responsible for the research activities conducted by five research centers and three specialized offices, which are staffed by over 1,100 scientists, engineers and professional specialists. These research responsibilities cover the broad technical areas of materials, atmospheric, hydrologic, geochemical, radiological, chemical, environmental, biological, ecological, computer and social sciences, and manufacturing and process engineering.

Publications:

"A Systems Approach to Management of the Hanford Groundwater Basin." Groundwater, 10 (1):1-12, 1972, etc.



ATSUYUKI SUZUKI

Born on October 31, 1942

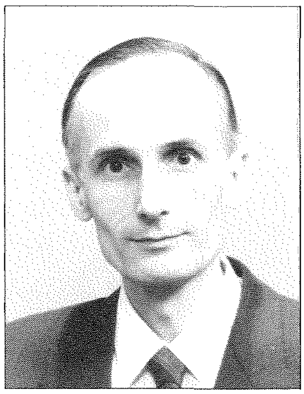
1966 Graduated from Dept. of Nuclear Engineering, Faculty of Engineering, University of Tokyo

1971 Graduated from the Doctor Course, University of Tokyo
Doctor of Engineering

1977 Assistant Professor, Faculty of Engineering, University Tokyo

1986 Professor, Ditto

Other Major Posts:
Member of the Special Committee, Atomic Energy Commission
Member of the Special Committee, Nuclear Safety Commission
Member of the Special Committee, Advisory Council on Energy, Agency of Natural Resources and Energy, MITI, etc.



KLAUS RIESENHUBER

1) Prof. Dr. Klaus Riesenhuber was born on 29 July 1938 in Frankfurt am Main, Germany
2) History of Education:
   - 1957 Studying philosophy at Philosophisch-Theologische Hochschule St. Georgen, Frankfurt am Main, West Germany
   - 1958 Entering the Society of Jesus
   - 1960 Studying philosophy at Philosophische Hochschule Berchamanskolleg, Pullach, Germany; 1962 Lic. phil. (MA)
   - 1962 Studying philosophy at the University of Munich, Germany; 1967 Dr. phil.
   - 1967 Coming to Japan; studies of Japanese language, in Kamakura
   - 1969 Studying theology at Sophia University, Tokyo; 1972 Master in theology; 1975 completion of the doctoral course in theology
3) History of Employment:
   - 1962–1967 Assistant at Philosophische Hochschule Berchmanskolleg, Pullach
   - 1967 Lecturer of philosophy at Philosophische Hochschule Berchmanskolleg
   - 1969–1974 Lecturer of philosophy at Sophia University, Tokyo
   - 1974–1981 Assistant professor of philosophy at Sophia University

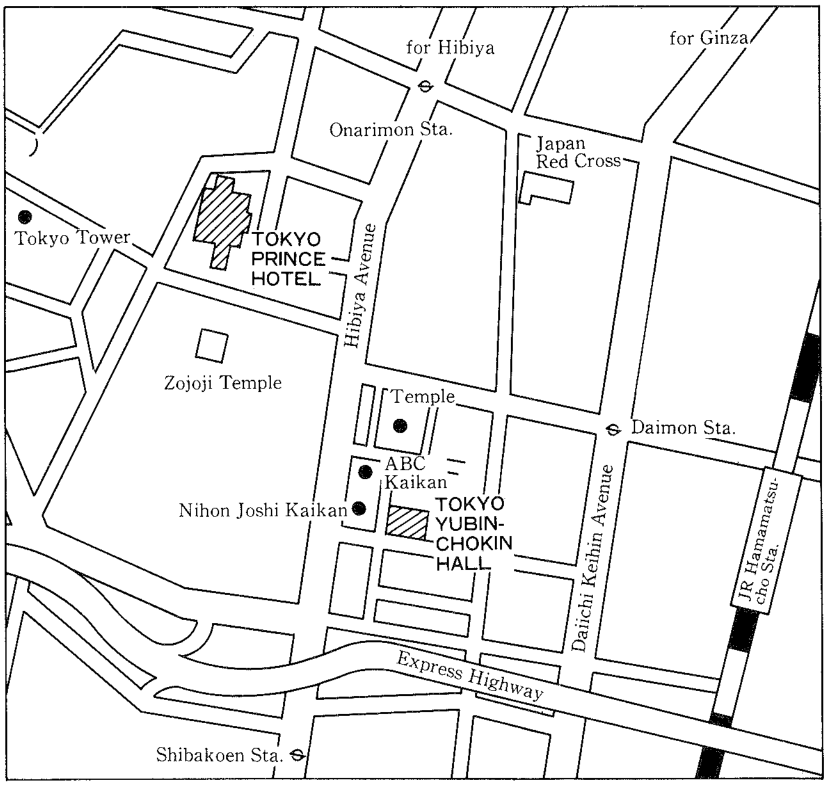
TOKYO YUBINCHOKIN HALL

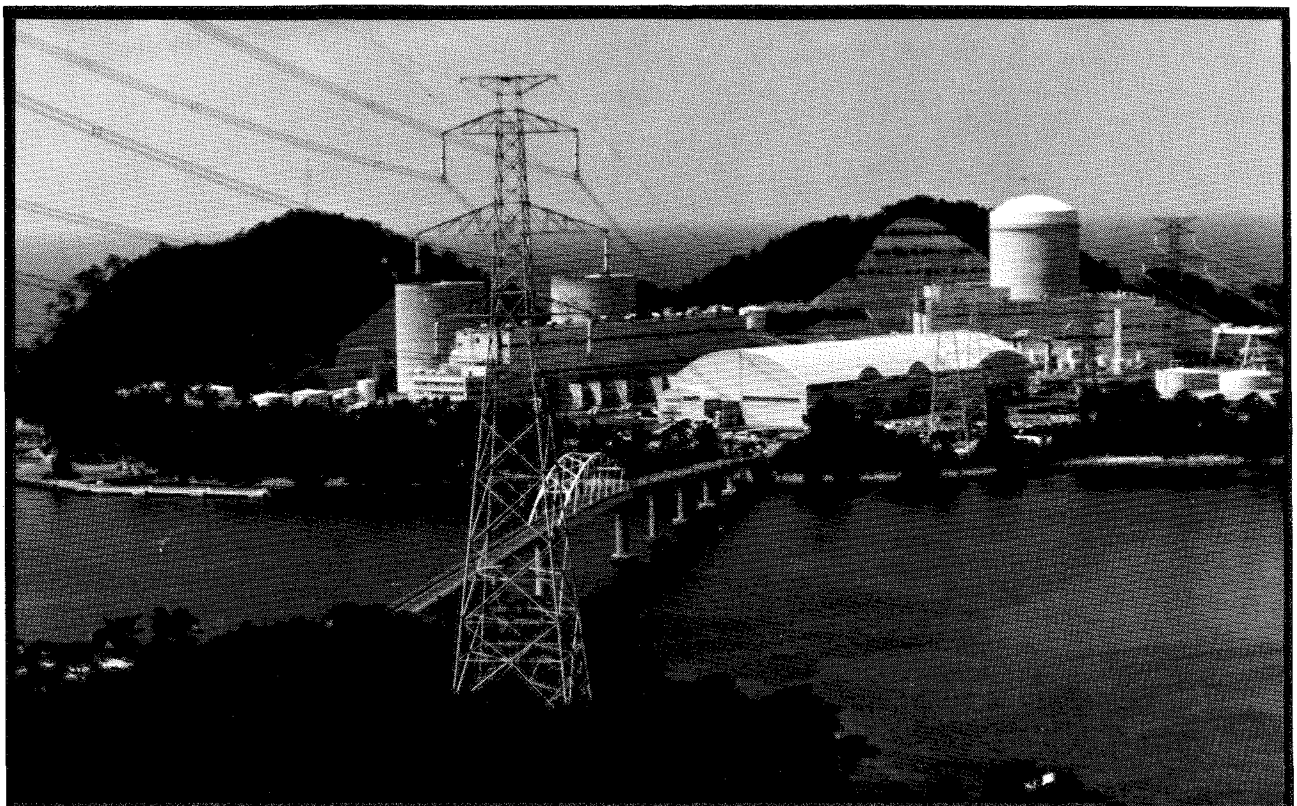
5-20, Shibakoen 2-chome, Minato-ku, Tokyo
Tel. (03) 433-7211

TOKYO PRINCE HOTEL

3-1, Shibakoen 3-chome, Minato-ku, Tokyo
Tel. (03) 432-1111

- 3 min. walk from Shibakoen Sta. (Subway: Toei Mita Line)
  10 min. walk from Onarimon Sta. (Ditto)
- 5 min. walk from Daimon Sta. (Subway: Toei Asakusa Line)
- 7 min. walk from Hamamatsucho Sta. (JR Higashi Nippon)





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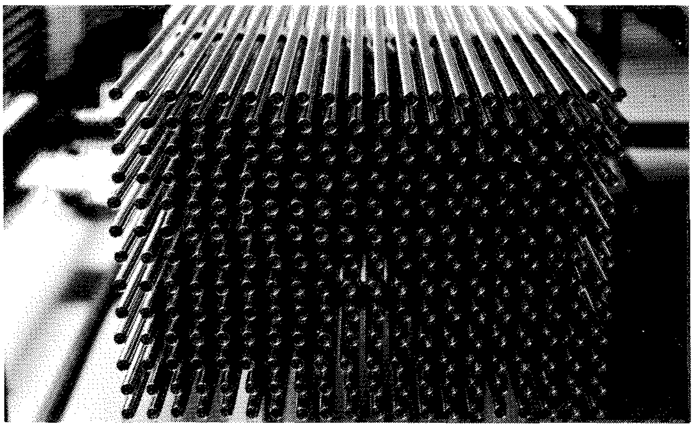
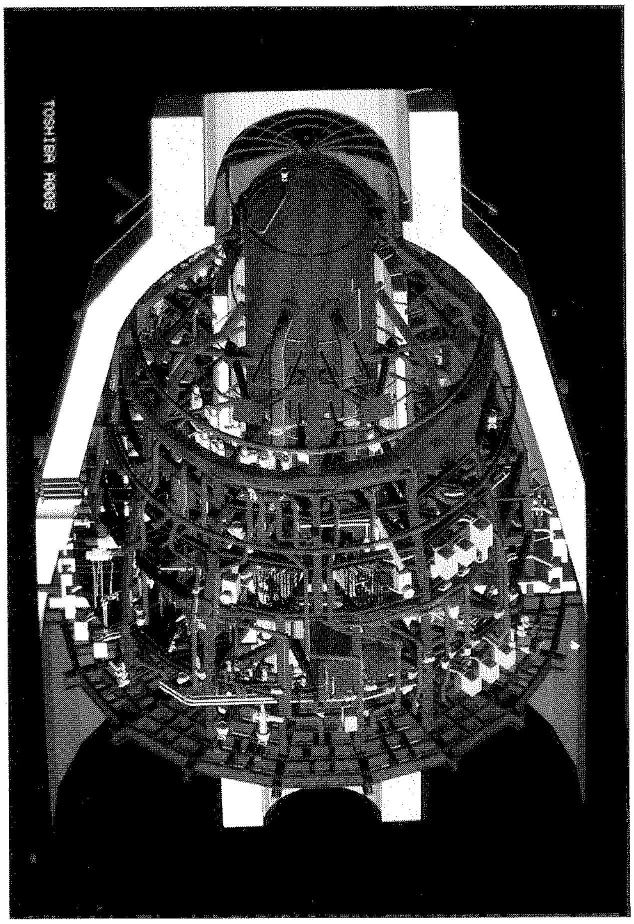


MITSUBISHI METAL CORPORATION

Tokyo Branch: 23F, World Trade Center Bldg., 4-1, Hamamatsu-cho 2-chome, Minato-ku, Tokyo 105 Tel. Tokyo (435) 4662
Nagoya Branch: Nikko Bldg., 22-18, Higashizakura 2-chome, Naka-ku, Nagoya-shi 460 Tel. Nagoya (931) 3350
Osaka Branch: Shindai Bldg., 2-6, Dojimahama 1-chome, Kita-ku, Osaka-shi 530 Tel. Osaka (346) 1841


Power from Nature



Ready for the future of nuclear energy? Toshiba's already there.

Toshiba, one of the world's largest electric and electronics manufacturers, is today also a leading supplier of nuclear energy facilities and equipment.

Nuclear technology across-the-board

Toshiba is active in *all* aspects of nuclear power generation, from the engineering, construction and maintenance of nuclear facilities, to computers, instrumentation and controls, radwaste treatment systems, and even the supply of fuel fabrication services.

Proven record in nuclear facilities

A major participant in Japan's nuclear development program for the past 30 years, Toshiba has also delivered a significant number of boiling water reactors (BWRs) that are noted throughout the world for enhanced safety, reliability, operability, availability and economy.

Experience in diverse energy fields

Toshiba's activities in nuclear energy come backed by nearly a century of experience in hydro, oil, LNG and geothermal power facilities. While continuing to lead the field in Japan, we are now also fueling advances in these and other energy projects everywhere.

Shaping the future of nuclear energy

Today, Toshiba's experience and vast, integrated technologies continue to play a vital role in Japan's nuclear energy program. And all around the world, they are contributing to new developments that will one day free our dwindling fossil fuel reserves for other, more creative uses, and secure nuclear energy as the cleanest, safest, most viable fuel alternative of all.

That, Toshiba believes, is the future of nuclear energy. And that's what we're working to realize, right now.

In Touch with Tomorrow

TOSHIBA

For further information, contact: Marketing Department, Nuclear Energy Division, Toshiba Corporation
1-6, Uchisaiwai-cho 1-chome, Chiyoda-ku, Tokyo 100, Japan Phone: (03) 597-2084, Facsimile: (03) 597-2678, Telex: J22587