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JPRS L/9673

20 April 1981

# Worldwide Report

## NUCLEAR DEVELOPMENT AND PROLIFERATION

(FOUO 7/81)

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## NUCLEAR DEVELOPMENT AND PROLIFERATION

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## NUCLEAR ENERGY DEVELOPMENT PROGRAMS DISCUSSED

### Nuclear Fusion Research

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 1 Jan 81 p 19

[Text] The sun continually directs light and heat to the earth. Research and development on nuclear fusion, which attempts to duplicate the sun's functions on earth, are now about to enter a new stage. Japan, along with the United States, European countries, and the Soviet Union, is constructing nuclear fusion experimental facilities and is waging a highly competitive race for "who will be first to achieve nuclear fusion." On the other hand, there is a move to avoid duplication of research and development and commitment of vast sums of capital by two or more countries joining together in cooperative efforts. On the technological front, emphasis is gradually shifting from basic research to engineering research focused on practical use. At the same time, activities of the industrial sector, which heretofore has not been much in evidence, have begun to surface. Nuclear fusion has sometimes been dubbed "the ultimate energy." The path to realization of this form of energy will be a long one, and it has been said that it will be well into the 21st century before we will begin to enjoy its benefits. The relentless efforts to attain this realization are expected to have profound effects on industrial society.

Once the narrow farm road is traversed, one comes to an open area. In the center of this cleared area, in which trees have been cut and a rough grading has been made, a square hole about 100 meters on each side and 15 meters deep has been excavated. At the bottom of the hole is a concrete caisson (box), 20 meters square and 15 meters high, which is being buried. The occasional operation of the crane and the biting cold wind which whips across the area are the only sounds. Only a handful of workers are in view.

"This caisson will rest 30 meters underground on solid rock. It will house the JT-60, which in itself weighs more than 4,000 tons," said our guide, Shinichi Fusai, representing the director of the construction department of the Japan Atomic Energy Research Institute (JAERI).

Aim of Attaining Critical Conditions

This is Naka-Machi in Ibaraki Prefecture. This is the construction site for the JAERI nuclear fusion facility located roughly 15 kilometers north of Mito. The Tokai laboratory of JAERI, where the first nuclear fire in Japan had been lit, lies some 6 kilometers to the east. The center of this approximately 1.5-million-square-meter area is where construction of this large nuclear fusion research facility "JT-60" is proceeding at a cost reputed to be 200 billion yen. The main body of the "JT-60" will be 15 meters in diameter and 13 meters high, and the experimental facility to house the main body will be 47 meters above ground when completed. This is a size comparable to the Todaiji at Nara in which the great Buddha is housed.

It is almost 25 years since nuclear fusion research was initiated in Japan. The "JT-60" is one of the breakthrough events in this research and development history. Plasma of 100 million degrees confined for the duration of one second--the so-called critical conditions--is the target of this facility. That is to say, the goal is to establish whether nuclear fusion can be achieved by human hands and to lay the groundwork for its practical use in the future.

It is now more than 2 years since construction was initiated. "Construction has progressed in a very orderly manner," according to Fusai. The greater part of this construction is expected to be completed during JFY 82. The installation of the "JT-60," which is now being fabricated by Hitachi Ltd as primary builder aided by Tokyo Shibaura Electric and Mitsubishi Electric, will start about that time. Then the experiments to attain critical conditions will finally begin in 1985.

Nuclear fusion reaction is the energy source by which the sun has been sending forth its light and heat from time immemorial. If we can reproduce this reaction, mankind will be able to assure himself of an inexhaustible ultimate energy source. At the same time, one gram of "fuel" consisting of deuterium from sea water and tritium, when used in a fusion reaction, will provide energy equivalent to that furnished by the oil in a single 80-ton tanker. A nuclear power plant burns one gram of uranium to generate energy equivalent to that present in 1.8 tons of oil, and nuclear fusion can produce far more energy per unit weight of fuel.

Nuclear fusion has already been demonstrated in practice through the hydrogen bomb. On the other hand, the reactor is not designed to discharge all its energy in a fraction of a second, but to release the energy more gradually to enable more effective utilization and set up a "sun on earth," according to the present aims of research and development. Now, there are a number of breakthroughs which are necessary before this goal can be attained. How shall we create the superhigh temperature and superhigh density conditions which are absolutely essential to attainment of a nuclear fusion reaction?

Intensifying Confrontation of Advance Guards of Various Countries

"To be honest, up to 5 years ago, I myself doubted that nuclear fusion could be achieved by human hands, but I am now convinced that we will definitely realize nuclear fusion power without fail," said Director Hidetake Kakihana of the Nagoya University Plasma Laboratory. As the result of a quarter century of research and development, we have used experimental facilities to come within a step of creating a nuclear reaction. It is only one more step until we attack the remaining barrier before practical attainment of a nuclear fusion reaction, and that will be the duplication of the critical conditions. JAERI's "JT-60" is planned to break this barrier.

At present a fierce vanguard competition is taking place worldwide between various countries intent on breaking this barrier. These include the American "TFTR," the European alliance "JET," and the Soviet "T-15." A number of these large facilities of a class comparable to the "JT-60" will be making their appearance in the next few years. Department head Yukuo Kobata of the MAERI Nuclear Fusion Research Department said: "We will be left far behind if we are too complacent. We cannot relax."

Nuclear fusion development has often been referred to as a "money-eating worm." The "JT-60," which will not produce any energy for consumption, alone will cost about 200 billion yen. The next step facility will cost several times that of the "JT-60." The Atomic Energy Commission revealed that the development funds necessary for the 10-year period from 1978 through 1987 will total roughly 670 billion yen. Since this total does not include university-related funds, the total funds required will amount to considerably more. Including university-related funds, nuclear fusion development funds, which totaled 900 million yen in 1973, increased to about 17.4 billion yen 5 years later, in 1978, and to 35.8 billion yen in JFY 80.

How do we come up with these funds, which keep on doubling? This is a common lament among the countries involved. In this situation, a movement has arisen proposing that the next step of the experimental nuclear fusion reactor development be attacked through international cooperative effort as exemplified by the IAEA (International Atomic Energy Authority) and its "INTOR" as well as two or more countries' cooperative efforts such as the Japan-U.S. nuclear fusion research cooperation and other multiple country cooperative efforts. "A country poor in resources such as Japan must not fall behind in nuclear fusion development. On the other hand, we must not only be competitive with the world but we must also have good cooperation with the rest of the world. It is important from here on that we adopt a mixed development strategy involving both competition and cooperation," said Director Kakihana.

Engineering Step Is Next

"The JT-60 will be a scientific demonstration of nuclear fusion. In other words, it will make a breakthrough in the scientific area. Next is the engineering demonstration, when we finally enter the technology stage," said permanent adviser Kenzo Yamamoto of the Japan Atomic Industrial Forum. Adviser Yamamoto was responsible for the formation of the "Nuclear Fusion Technology Roundtable" in February 1980 comprised of related industries from the forum.

After the critical conditions are attained, a second barrier lies in wait in the nature of maintenance and control of the "fire" of nuclear fusion. This barrier will involve the solution to such problems as the optimum shape of the facility,



APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000300100036-8

the materials suitable to withstand the harsh conditions involved, and the manner in which the energy is extracted. These are the engineering problems which need to be resolved. Technological developmental strength in the hands of the industrial sector is a must if this barrier is to be broken. "The breaking of this second barrier may well come near the end of the 20th century, but we must start making preparations for this breakthrough," said Mr Yamamoto. It appears that the time is approaching when the industrial world, which until now has been staying in the background, will begin to play an important role.



## Export of Nuclear Reactors

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 6 Jan 81 p 1

[Text] The Ministry of International Trade and Industry will promote the export of nuclear power plants as one phase of its promotion of the domestic nuclear power industry and information gathering related to export structures as goals for the first half of the 1980's. This situation came about because while the various domestic power companies were giving their attention to the location of power plants and the domestic nuclear reactor industry was developing to the stage that it even possessed export capability, as soon as the nuclear reactor industry saw the potential demand from the developing countries for nuclear power plants, it began to urge export to these "virgin soils." Any reactor for export at present will have to be a light water reactor, and all the nuclear reactor companies are polishing their light water reactor technology. At the same time, they have begun to seek revisions to the domestic and foreign "limiting conditions" as they relate to nuclear power and to various handling procedures, thereby removing the barriers to export.

Fierce competition is taking place in the international nuclear power plant market between Westinghouse (WH) and General Electric (GE) of the United States, West Germany's Kraut Werk Union (KWU), Sweden's Acea Atom, France's Framatom, and the Soviets. President Carter's nuclear nonproliferation policy and the U.S. Three-Mile Island incident were responsible for a number of order cancellations, and the international demand for nuclear power plants is stagnating at present. On the other hand, the sharply intensifying oil situation has made nuclear power plant revival necessary. The U.S. Government, which has great influence on the international nuclear power situation, has now come under the leadership of Reagan, who is a "nuclear power extremist," and this is interpreted to mean that the international nuclear power market will see some activity.

In Japan, the power companies introduced light water reactors manufactured by the American WH and GE companies to get their start in nuclear power generation, and the domestic nuclear reactor industry still remains under the influence of the WH and GE light water reactor technology. This industry has yet to export its first nuclear power plant.

Now, the light water reactor modification and standardization plan initiated by the Ministry of International Trade and Industry in 1980 is the wedge that has forced open the development of a Japanese type light water reactor distinct from the American technology, and it is expected that in a few years light water reactor technology of an even stronger domestic flavor will be established.

At the same time, there are movements toward utilizing the well-known light water reactor technology to develop an array of domestic light water reactors, including small and medium reactors. Even while the nuclear reactor industry was building up to this present capability, the Japanese nuclear reactor industry was pushing to export its first nuclear power plant as one phase of establishing the business foundation of each nuclear power reactor company.

The Ministry of International Trade and Industry is not only promoting nuclear reactor industry development through involvement in the new "export" concept but is also promoting removal of the various barriers which have stood in the way of export.

Japan is restricted by multiple country agreements such as the nuclear proliferation treaty (NPT) as well as bilateral agreements such as the Japan-U.S. nuclear power cooperation, and these agreements impose a number of barriers.

This situation is the result of the handicap this country received from being a defeated nation together with the fact that Japan is almost completely lacking in uranium resources to fuel its reactors, making it necessary to import the uranium needed from foreign sources, and this was accompanied by these international restrictions.

Despite these limitations, Japan has been able gradually to build up its independence and autonomy and has begun to establish its own independent fuel cycle. In the midst of these changes in the environment surrounding Japan's nuclear power situation, export of domestically produced nuclear power plants has become feasible, and the various preparations for this export are being promoted.

The ministry said: The statement that "Japan cannot export nuclear reactors" is not basically written into the various agreements and it will seek new interpretations while it aims for the mid-eighties to initiate export of domestically produced power plants.



## Types of Nuclear Reactors

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 6 Jan 81 p 6

[Text] Activity is intensifying in the nuclear power industry to enter into development of new-type power reactors. The fast breeder reactor (FBR) which is the odds-on favorite of the fission reactors, the new-type converter reactor which ties together the classic light water reactor and the FBR reactor, the multipurpose high-temperature gas reactor which not only will produce power but will be used in steelmaking and coal liquefaction and gasification, and the nuclear fusion reactor which is expected to be the energy source for the 21st century are the targets of national projects which the electric power industry and nuclear power equipment makers have been pointing toward through new promotional systems and active reinforcement of manpower training in an accelerated manner with the transition to the decade of the eighties. There is a particular desire to bring the FBR to the practical operating stage during the nineties, and in 1980 the electric power industry set up a "Fast Breeder Reactor Development Section" within the Japan Atomic Power Company along with a "Fast Breeder Reactor Promotion Council" and a "Fast Breeder Reactor Development Preparatory Section," while the electric power equipment industry established a "Fast Breeder Reactor Engineering" group. In the area of the nuclear fusion reactor, Hitachi Ltd has already set up its "JT-60" (critical plasma test facility) Promotion Headquarters, and Toshiba its "JT-60 Promotion Project Team," and the development systems are being steadily reinforced. Because of this situation, the trends in the nuclear power industry were investigated with regard to the long term development strategy of new-type power reactors.

Fast Breeder Reactor

Concerning the FBR, which has uranium utilization efficiency of 60-80 percent, far superior to the efficiencies of light water reactors, the Atomic Energy Commission in its JFY 80 Annual Report on Nuclear Power (white paper) indicated that this reactor will become practical in the decade beginning in 1995. The development promotion policy involves the experimental reactor "Joyo" (designed thermal output 100,000 kW, which went critical in April 1977), the prototype reactor "Monju" (electrical output 280,000 kW, expected to go critical in December 1987), and a 1-million-kW class demonstration reactor of the same type along about the start of the decade beginning in 1995, while the first practical reactor is targeted for criticality in the latter half of the decade beginning in 1995, according to the scenario that has been unfolded.

What has newly appeared on the scene as a problem is the line of development. The Atomic Energy Commission, the Science and Technology Agency, and the Power Reactor and Nuclear Fuel Development Corporation (DONEN) have adopted the strategy of pursuing independent technology development and have been pouring vast sums of money and huge manpower to this end, while the electric power industry, which is hoping to acquire operating experience as rapidly as possible and lay the cornerstone for a program of disengagement from light water reactor dependence, wants to look into the possible "introduction" of technology from other leading countries. In other words, the users as represented by the electric power companies are pointing toward the adoption of a two-pronged attack through independently developed technology and imported technology to hasten the day that the transition to the FBR fuel cycle can be made smoothly.

There is considerable room for study on this problem of introduction, for Japan is already 10 years or so behind the so-called leading countries such as France and the Soviet Union, and the fulcrum of the FBR fuel cycle, the spent fuel reprocessing plant, is only now at the stage where DONEN has initiated basic research.

The electric power industry is very concerned that such problems are causing delays in the development of the FBR, and the problem FBR introduction will probably undergo during the eighties will be one of the major nuclear power policy problems.

The prototype reactor "Monju" now under construction at Tsuruga city in Fukui Prefecture, on which construction is way behind schedule, received notification of having met its first safety inspection from Governnor Nakagawa of Fukui Prefecture in December 1980, and DONEN sent an application for siting approval to the governor, indicating new movement toward development.

The construction cost of "Monju" will be 322 billion yen, and this, together with the fuel and the costs of the comprehensive functional tests following completion, will bring the total cost close to 400 billion yen. The country will bear 80 percent of this and private interests the other 20 percent. Of the share of private interests, 60 billion yen will be borne by the nine power companies along with Japan Atomic Power Company and the Electric Power Development Company for a total of 11 companies, while another 20 billion yen will be accounted for by Hitachi Ltd, Toshiba, Mitsubishi Electric Industry, and Fuji Electric groups.

The electric power industry set up a "Fast Breeder Reactor Development Section" within the Atomic Power Industry on 16 February last year, and this section will become the window through which support and cooperation on the technology front will be issued. In addition, the four companies, Hitachi Ltd, Toshiba, Mitsubishi Heavy Industries, and Fuji Electric, on 1 April of the same year reorganized and expanded the FBR engineering office they had been maintaining and established the "Fast Breeder Reactor Engineering (FBEC)" with a capitalization of 300 million yen.

The electric power industry, on the other hand, plans to start construction on the next step to the prototype reactor, which is the 1-million-kW class demonstration reactor, during the first half of the decade beginning in 1985, to go critical at the start of the decade beginning in 1995. As one phase of this development, the DENJIREN (Electric Industry Alliance) established the "Fast Breeder Reactor Promotion Council" and "FBR Development Preparation Section" to study long term basic strategy for the development system of the FBR demonstration reactor. At the same time, promotion of the conceptual design for the demonstration reactor, survey research related to this design, and information exchange with both domestic and foreign organs are being promoted.

The makers are planning to have FBEC serve not only for development of "Monju" but for the development of the post-demonstration reactors as well, and the principal functions of this facility are to have control over FBR design and engineering and onsite construction projects.

Let us next look at the FBR development strategy on the part of the electric power equipment makers.

First of all, Toshiba has set up a plan which envisages 1993-1994 as the starting time for construction of the first practical FBR reactor, and it plans to establish itself as the main contractor by setting up the "FBR Engineering Center" within the next 10 years, for which it is making plans. This company served as manager of the software area during the experimental reactor stage and was in charge of core design so that its storehouse of technological information is extensive.

It is expected to handle core upper section construction, control systems, and rotary plugs.

At the same time, Hitachi Ltd is planning reinforcement of its manpower in the soft areas, including design and inspection, and it has been increasing its manpower at the rate of about 100 people a year since 1977 at its plants, which include Hitachi Engineering, Babcock-Hitachi, and other related industries. On the experimental reactor, this company is in charge of the primary coolant system and certain equipment (such as nuclear reactor container, safety container, intermediate heat exchanger, sodium pump, electromagnetic pump) design and production. It also will handle the primary cooling system and heater for the vaporizer to be used in the prototype reactor.

The Mitsubishi group--Mitsubishi Heavy Industries, Mitsubishi Electric, and Mitsubishi Nuclear Power Industry--also has some designs in FBR development. It has set up a 3-year program for the prototype reactor and a 5-year program for the demonstration reactor and is engaged in bolstering its manpower and improving its production technology. In the area of manpower, it has put together a force of 300 design and research people and is planning annual increases of 10 percent, by which means it hopes some day to equal the 1,100-manpower force for FBR work which the U.S. Westinghouse (WH) Company has put together. Up to now it has put out a total of 6-7 billion yen for facilities, including 600 million yen in 1980. It is planning to handle the nuclear reactor container, the structures within this container, and the containment vessel for the prototype reactor.

This company is planning an information exchange program including technology with the WH company.

Nuclear Fusion Reactor

The strategy on the reactor type for the nuclear fusion reactor, which is expected to become the energy source of the 21st century, is still uncertain. The inertial confinement method is represented by the laser and ion beam modes, while the magnetic confinement method is represented by tokamak, mirror, heliotron, stellarator, and bumpy torus modes.

Both the Science and Technology Agency and JAERI are now taking the tokamak path, and the Science Council in November 1980 decided on tokamak while also conducting parallel studies on the heliotron and laser modes but emphasizing the tokamak approach in its "long term policy on nuclear fusion research for universities and other organs." In this manner, Japan has taken the step to make the tokamak mode its mainstream of developmental efforts in fusion research just as the Western countries have done.

Japan has many research results along the lines of tokamak development, and JAERI has accumulated experience in plasma heating technology and technology to operate nuclear fusion reactors, which had been operated in a pulse mode in the past by continuous operation just as a fission reactor. In the development of the international cooperative power experimental, reactor INTOR, in which

Japan, the Soviet Union, and the EC participated, the Japanese played an important role in the design. At the same time, studies are under way to construct a Japanese type nuclear fusion reactor similar to the "Star Fire," which was designed at the Argonne National Laboratory in the United States.

Now, the nuclear fusion reactor is expected to follow the FBR and surface as a large energy source of commercial nature, and the five industrial groups--which are the group headed by Hitachi Ltd along with Tokyo Atomic Power Company, the group of which Toshiba is the main figure along with Japan Atomic Power Company, the Mitsubishi Atomic Power Group headed by Mitsubishi Electric and Mitsubishi Heavy Industries, the First Atomic Power Industry whose main companies are Fuji Electric and Kawasaki Heavy Industries, and the Sumitomo Atomic Power Group--are participating and conducting vigorous research and development.

Hitachi Ltd and Toshiba are planning to set up their intracompany structure as rapidly as possible, and in April 1978 Hitachi was successful in obtaining an order of 38.7 billion yen from JAERI for parts for the "JT-60" including the main body of the reactor, and this acquisition was the occasion for establishing its "JT-60 promotion headquarters" (present director, Takio Iwano) in August of the same year.

These two companies have already accumulated 20 years' experience in fusion development, and some of their orders include the Osaka University DCX; Hitachi-Central Research Laboratory's IBIC; Nagoya University Plasma Laboratory's TPD and BSG; Kyushu University Applied Dynamics Laboratory's sphenoid coil; Nagoya University Plasma Laboratory's TPD2; Kyoto University's solenoid coil; JAERI's JFT2 and improved JFT2a; Kyushu University's Applied Dynamics Laboratory's TRIAMI; Hitachi Energy Laboratory's noncircular plasma experimental facility; JAERI's JT-60; Nagoya University Plasma Laboratory's JIPP-I and JIPP-II; Kyoto University Heliotron Nuclear Research Center's Heliotron D, DM, and E; and Tohoku University's Aspirator NP, for a total of 20 or so projects.

In addition, participation in these big projects is being planned by a Hitachi group headed by Hitachi Ltd, including Hitachi Cables, Hitachi Kasei Kogyo, and Hitachi Plant Construction.

At the same time, Toshiba established its "JT-60 promotion projects" in May 1979 (present project manager, Junichi Nagamura) and has been sponsoring an annual nuclear fusion equipment exhibition since 1977; it is projecting its involvement in nuclear fusion. This company has a record of a large number of orders for nuclear fusion equipment and has supplied experimental equipment to the Doublet III power source under construction by GA Company of the United States, and the power supply to the poloidal magnetic field coils of the JT-60, which make up part of the 20 or so orders it has handled. It has produced heating equipment such as the neutral particles injection device for the JFT2 and the LCT superconducting coils for domestic research facilities as well as 20 other items. It has also participated in the INTOR conceptual design and blanket design methods.

In another direction, an innovational development to the tokamak concept was proposed by JAERI which envisages the placing of the reactor main body in a pool

pool of water, and Mitsubishi is engaged with JAERI in exploring the feasibility of this.

### Multipurpose High-Temperature Gas Reactor

The multipurpose high-temperature gas reactor has been tabbed as the ticket which will enable the shift from oil to nuclear heat to provide the nonelectrical energy which accounts for two-thirds of the total primary energy consumption. Research and development on this reactor is being conducted by JAERI, which contracted out the detailed design for a thermal output 50,000-kW experimental reactor in 1980 with the hope it will go critical in 1987, and this contract was issued to the four nuclear power groups, Fuji Electric, Hitachi Ltd, Mitsubishi Heavy Industries, and Japan Atomic Power Industry. In charge of this design will be Fuji Electric, which has ties with Kawasaki Heavy Industries, making it a very powerful force in the atomic energy field.

Since these two companies were somewhat behind other companies in the matter of light water reactor development, they put their main developmental efforts in the direction of new-type power reactors. One of their first moves was the establishment of a nuclear power promotion headquarters within the confines of Fuji Electric. The main function of this headquarters is to serve as a cooperative outlet with the national projects in which DONEN and JAERI are engaged. Ten years later, in April 1979, the name of this organ was changed ot "Fuji-Kawasaki Heavy Industries Nuclear Power Promotion Headquarters" to play up their joint participation, and President Fukushige Shishido was made headquarters director while President Zenshi Umeda of Kawasaki Heavy Industries was appointed assistant director, and the board of directors was set at 28 members, of which Kawasaki supplied 10.

In addition to its engagement in multipurpose high-temperature gas reactor development, Fuji Electric is also involved in fuel handling facilities for the FBR experimental reactor and the ATR prototype reactor "Fugen" along with radioactive waste treatment equipment and engineering safety protection equipment. It expects to handle the same line of equipment for the FBR prototype reactor. At the same time, Kawasaki Heavy Industries is conducting research and development on the soft and hard issues of the three main pillars of new-type nuclear reactors, which are the multipurpose high-temperature gas reactor, the FBR, and the nuclear fusion reactor. This company entered into a technology cooperation agreement with the U.S. General Atomics (GA) Company in September last year on matters pertaining to the multipurpose high-temperature gas reactor.

The top problem faced by this company is personnel. This company has available a total of close to 500 people in the software end, and it plans to increase this number by 10 percent a year. Fuji Electric has a 3-year program which it plans to initiate in 1981 which will be centered on the new energy area and electronics to develop new technology, and one phase of this new development has been the acquisition of 40 college graduate technologists who will be engaged in intermediate operations. This company hired 170 college and specialty school graduates for regular service last spring and plans to hire another 250 this spring.

At the same time, Mitsubishi Heavy Industries also has considerable experience in multipurpose high temperature gas reactors. It has a high-temperature helium loop installed at its Nagasaki Laboratory equipped with various test loops for high-temperature high-pressure, materials, and helium purification use. This setup is available because this company had once intended to become involved in the power gas reactor, as a result of which it has abundant test equipment and personnel, and the spinoff to the multipurpose high-temperature gas reactor development is large. In addition, Hitachi Ltd has been participating in development of the multipurpose high-temperature gas reactor since 1973, and it has been promoting mainly development of the nuclear reactor pressure vessel, intermediate heat exchanger, and high-temperature distribution line type primary cooling equipment.

Development of New-Type Power Reactors (1980)

21 Jan--Sixth Japan-United Kingdom FBR Conference convenes
14 " --Ion temperature of 6.4 million degrees (later 7 million degrees) attained by the turbulent flow type tokamak nuclear fusion facility of the Applied Dynamics Laboratory of Kyushu University
29 Jan--Atomic Energy Commission establishes the ATR Demonstration Reactor Evaluation Study Special Committee
1 Feb--First inspection of ATR prototype reactor
--FBR experimental reactor boosted from 50,000 kW thermal output to 70,000 kWt
16 Feb--Japan Atomic Power Development Company establishes its Fast Breeder Reactor Development Section
28 Feb--INFCE ends, utilization of plutonium as espoused by Japan and Europe opens up
1 Apr--Fast Breeder engineering (FBEC) organ established
11 " --4th IAEA Larbe Tokamak Facility Technology Committee convenes in Tokyo
18 " --Toshiba sponsors fourth Nuclear Fusion Equipment Exhibition
24 " --Federation of electric power companies presidents' meeting decides to host FBR promotion conference and FBR development preparatory section
4 Jun--JFT2 of JAERI attains plasma beta value of maximum 10 percent (later 11 percent), which is tops in the world
16 Jun--Toshiba receives order for 525,000-kBA vertical type pulse generator for the Doublet III nuclear fusion experimental facility from the American GA company
19 Jun--Osaka University Laser Nuclear Fusion Research Center completes Japan's largest glass laser generating facility Gekko XII module
--Electric Power Producers Association establishes 10-year plan for promoting technological development strategy concepts concerning FBR and related items.
8 Aug--DONEN starts plutonium mixture conversion plant
1 Sep--JAERI sends out orders for detailed design of multipurpose high temperature gas reactor to four atomic power groups such as Fuji Electric
8 Sep--Kawasaki Heavy Industries enters into technological cooperation with American GA company on high-temperature gas reactor
18 Jan--Institute of Physical and Chemical Research succeeds in separating tritium fuel for nuclear fusion reactors by infrared pulse laser method
9 Oct--JAERI attains magnetic field of 6 tesla with superconducting magnet

(niobium-titanium) for nuclear fusion use
30 Oct--DONEN purchases 2 tons of heavy water from China through commercial companies
10 Nov--Science Council proposes long term nuclear fusion research promotion plan for universities and similar organs
14 Nov--DONEN sends Japan's first plutonium fuel to ATR
14 " --JAERI operates electron cyclotron resonance heating experiment with JFT2 and succeeds in elevating plasma electron temperature to 12.8 million degrees
9 Dec--Minister of Education Tanaka is in agreement with promotion of nuclear fusion by industrial and academic worlds and industry-academia cooperative system
10 " --DONEN submits application for location of prototype reactor of FBR to Prime Minister Suzuki



## Nuclear Training Center

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 8 Jan 81 p 3

[Text] Kansai Electric Power has revealed its policy of engaging in earnest construction of a "Nuclear Power Repair Training Center" aimed at strengthening repair and control capabilities of nuclear power plants, setting a target date of 7 October 1983. This type of facility has already been established by American power companies and Tokyo Electric in Japan, but Kansai Electric plans to build on a much greater scale than the preceding facilities, with the thought that this will improve the repair and control system which is vital to nuclear power development.

The Kansai Electric concept envisions the use of the major equipment found at a nuclear power plant along with some simulated equipment and various instructional facilities at this training center. There will be a regular complement of 40 people, and training will be provided to bring a novice up to the level of an experienced operator. Some specific duties to be learned are the disassembly and assembly of the nuclear reactor container, spot inspection of the steam generator, and fuel rod installation, which are all necessary to periodic inspection and on which there will be drills to the point that actual onsite experience can be obtained.

This center will cover a ground area of 158,000 square meters, of which 5,000 square meters will be taken up by buildings, and the cost is expected to be 6 billion yen. Construction is expected to begin in the early part of 1982 and to be completed in October 1983. Kansai Electric says that the site is still undetermined, but since all of this company's seven reactors are in Fukui Prefecture, it is expected that this center will also be located in Fukui Prefecture.

Kansai Electric operates pressurized water reactors, and this center is designed to provide training in repair of this type reactor; however, it plans to make this facility available to other companies should they request its use.

Kansai Electric obtains 25 percent of its power from nuclear sources, and it is engaged in all-out efforts to acquire nuclear power as an oil substitute. It affirms that the construction of an actual training center will serve to guard beforehand against equipment trouble and improve the operating rate of nuclear power production.



Cleaning Workers' Clothing

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 9 Jan 81 p 7

[Text] Hitachi Ltd has set up a policy of emphasizing dry cleaning of clothing and other articles workers wear close to their bodies as one means of lowering the release of radioactive materials from nuclear power plants. Tokyo Shibaura has established a system which concentrates and solidifies liquid wastes from the washing processes at nuclear power plants so that the radioactive material is not released outside the confines of the power plant, and this company has received orders for such a system from Tokyo Electric's Fukushima No 1 and No 2 nuclear power plants and Tohoku Electric's Onnagawa nuclear power plant (to go into operation 1982-1984). In contrast to this system, the Hitachi concept involves dry cleaning of the clothing so as to avoid the use of water and thereby eliminate this wash water problem, and there is a growing competition between these two companies in the area of "cleaning systems."

The Hitachi dry cleaning system is basically the same system as that used by a general dry cleaning establishment. The only difference is that if there should be some radioactive contaminant adhering to a worker's clothing, gloves or socks, a process is introduced which prevents the release of any of the radioactive material to outside the plant. This company says: "We are already at a stage at which we can develop an order receiving activity" (Yoshiro Tsutsui, head of Nuclear Power Industry Department), indicating the degree to which this system has been developed.

The problem with laundry effluent from nuclear power facilities is said to be the damage caused by the concentration of the radioactive products by the foam produced by the cleansing agent, and the system presently in use at the various power plants is to dilute this waste water with sea water before disposal into the sea. There is, however, the ALP (as low as practical) principle which proposes "every effort to minimize any release of radioactive materials from the confines of a nuclear power plant" which pervades the thinking of the concerned people in the nuclear power field so that there is consensus on the idea that "even wastes from laundry procedures will not leave a plant" which is expected to be put into effect in the next couple of years.

Toshiba developed a low foaming washing agent in establishing a cleaning method along the lines of the former water wash involving washing, waste liquid concentration, solidification, and storage, quite unlike the dry cleaning approach. This company pointed out that "dry cleaning is rather ineffective in removing perspiration residues from underwear, and this is a point of particular concern to Japanese workers' feelings, so that there is no choice but to go to a water wash."

Toshiba admits dry cleaning may be possible for outer wear and has purchased dry cleaning equipment from the Allied Nuclear Company of the United States, which is a radioactive waste treatment service company. A hot test using clothing actually used in radioactive material handling is at present under way.



### Increased Plant Operating Time

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 10 Jan 81 p 3

[Text] Last year the facilities utilization rate (operating rate) of nuclear power plants (for the whole country) averaged above the 6-year plateau of 60 percent, and not only is the power industry happy at these results but the supervisory government organs such as the Ministry of International Trade and Industry and the Resources and Energy Agency are delighted. The facilities utilization rate, which barely broke the 50 percent mark in 1979 in line with the U.S. Three-Mile Island incident, was turned around in one swoop by an increase of more than 10 percent in the course of a year, and the concerned people cannot be faulted for their elation.

Increased Performance of 11.9 Percent in One Step

What is giving the concerned people cause for this elation is the complete absence of any form of structural damage such as stress corrosion cracking or leaks in the small pipes of the steam generator during the entire last year's operation. This is why each power company has increased its watchfulness for the coming year, the the Ministry of International Trade and Industry said: "We hope to guide the industry to a better than 65 percent operating rate as an average for the whole country" (Shigeo Suehiro, head of Nuclear Power Operation Supervisory Department, Resources and Energy Agency), revealing its optimism.

The average for the year from January through December 1980 for all nuclear power plants in the country was 61.1 percent, which represented an improvement of 11.9 percent over the 49.3 percent for 1979.

When classified according to reactor type, Tokyo Electric Power, Chubu Electric Power, Chugoku Electric Power, and Japan Atomic Power Company which operate BWR (boiling water type light water reactor, total of 11 reactors) averaged 63.4 percent, which represented continuation of the better than 60 percent level from last year's 62.0 percent.

On the other hand, Kansai Electric Power, Shikoku Electric Power, and Kyushu Electric Power which use the PWR (pressurized light water reactor) experienced the very low operating rate of 32.1 percent in 1979 as a result of the Three-Mile Island incident, but rebounded in one year to the good level of 58.3 percent, and the difference in their operating rate compared to the BWR was cut down to 5.1 percent. The GCR (gas cooled reactor, 166,000 kW output) which Japan Atomic Power Company has been operating since 1966, displayed the very high operating rate of 69.7 percent, possibly a reflection of 15 years' operating experience.

Nuclear power plants are required by law to undergo periodic inspection once every 13 months. On the other hand, the actual situation is that "an overhaul after every 9 months of operation prevents trouble before it occurs" (section head Suehior), which represents the judgment of the Energy Agency, and the present practice is to operate for 9 months and undergo periodic inspection for 3 months during the course of a year.

## The Upper Limit Is About 73 Percent

This is why the facility utilization rate of 75 percent represents full operation by desk-top calculation, but the actual situation is that a reactor requires considerable time to start and stop so that 73 percent represents the more realistic limit. Accepting this 73 percent as the upper limit value, the facilities' utilization rate for 1980 will be 83.8 percent, and this is called a "superior performance." When the different power companies and the Energy Agency hold their heads high, it is because they can take pride in this accomplishment in view of the somewhat miserable 40-percent level performances of the past.

The reason the concerned people were so elated at this utilization rate exceeding 61 percent is that there was virtually no incidence of new trouble. The BWR plants of JAERI's Tokai No 2; Tsuruga No 2; Tokyo Electric's Fukushima Nos 1, 3, 4, and 5; Chubu Electric's Hamaoka Nos 1 and 2; and Chugoku Electric's Shimane power plant were subjected to "periodic inspections every 3-4 months at the outset according to plan, and the results of these inspections revealed no new need for repair (Resources and Energy Agency), and this reflected the rather satisfactory state even when viewed by the supervisory organ.

There was, however, the incident of stress corrosion cracking at Tokyo Electric's Fukushima Nos 1, 2, and 3 in 1974, at which time it was decided to make the repairs during the periodic repair periods for the next few years, as a result of which the periodic inspection periods were extended to 7-8 months or roughly twice the regular periodic inspection period. The repair of this corrosion cracking will probably require until about 1983, but "the worst is over" (Nuclear Power Development Headquarters of Tokyo Electric) according to informed sources so that the periodic inspection periods hereafter will be reduced considerably, and the facility utilization rates are also expected to rise.

Excluding the small incident of the electrical system which required about 10 days to repair, the troubles which were of concern to the operators were all limited to those developed at the PWR of Kansai Electric. These were the Takahama No 1 (826,000 kW output, initiated operation in November 1974) and the Oii No 1 (1.175 million kW, started operation in March 1979).

During the periodic inspection of Takahama No 1 in May, cracks were discovered in the splitter attached to the distribution line at the inlet to the primary coolant inlet of the coolant pump, which was followed by the discovery of stress corrosion cracking in the small distribution pipes of the steam generator in July and primary coolant leak at the welded section of the air bleed to the pressure accumulation injection system in October. This extended the periodic inspection duration from 4 to 8 months.

Damage to the support pin of the control rod cluster guide tube was discovered during the periodic inspection of Osaka No 1, and the end result was that the inspection period was extended to 10 months. These two trouble incidents served to pull down the utilization rates of PWR greatly, but these troubles were repaired satisfactorily, and there seems little possibility of repeated troubles from these sources.

In this manner, the events of 1980 reversed the situation that resulted after the Three-Mile Island incident, but there is still another reason why the industry and the Energy Agency have high hopes for 1981 and that is that the many efforts which were put forth in the past are finally coming to fruition.

Prevent Troubles Before They Occur

With the aid and guidance of the Energy Agency, the power companies were able to expand the space within the nuclear reactor containment vessel and use robots (automated equipment) to automate inspections and thereby advance improvements and standardization to nuclear power plants. At the same time, the control rod pattern altering system was improved, and the fuel rod replacement ratio was increased. This has opened the way for a change from the 9-month periodic inspection to a 13-month periodic inspection as prescribed by law. It is thought that in 1981 these improvements and standardizations will "begin to pay off to a considerable extent" (Nuclear Power Operation Control Department).

The control system of the Ministry of International Trade and Industry has been undergoing reinforcement since April of last year, and this is also thought to aid the situation. Because of the reaction to the Three-Mile incident, the Ministry o International Trade and Industry installed local agencies at 15 sites nuclear power plants are located to serve as special offices to supervise operations. The officer at each of these offices was assigned to be in close touch with the operation and safety situation of the power plant, and it has been said that "this system should be very effective in preventing trouble before it starts" (section head Suehiro).

Improvement in the operating rate of a nuclear power plant, with its low power cost, will play a large role in keeping electric power costs low and in aiding the disengagement from oil. It would be great if it were possible in 1981 to top the highest operation rate achieved in the past, 64.8 percent (1971 by four plants), to, say, 65 percent.

Facility Utilization Rates of Nuclear Power Plants (%)

| 1 | 昭和44年 | 45年 | 46年 | 47年 | 48年 | 49年 | 50年 | 51年 | 52年 | 53年 | 54年 | 55年 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BWR | — | 76.2 | 63.5 | 67.7 | 66.1 | 65.0 | 26.6 | 64.0 | 26.3 | 53.7 | 62.0 | 63.4 |
| | | (1) | (2) | (2) | (2) | (4) | (4) | (6) | (6) | (10) | (11) | (11) |
| PWR | — | 91.1 | 65.6 | 50.8 | 50.1 | 56.5 | 45.9 | 53.6 | 48.8 | 55.2 | 32.1 | 58.3 |
| | | (1) | (1) | (2) | (2) | (3) | (5) | (6) | (7) | (7) | (9) | (9) |
| GCR | 62.0 | 59.3 | 68.5 | 67.2 | 70.3 | 67.2 | 69.0 | 69.8 | 67.6 | 69.9 | 70.6 | 69.7 |
| | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) |
| 2 合計 | 62.0 | 71.2 | 64.8 | 61.6 | 59.1 | 62.0 | 37.3 | 59.1 | 39.2 | 54.8 | 49.3 | 61.2 |
| | (1) | (3) | (4) | (5) | (5) | (8) | (10) | (13) | (14) | (18) | (21) | (21) |

(注)設備利用率＝発電電力量＋（認可出力×暦時間数）×100(%)、カッコ内は基数、B
3 WRは沸騰水型軽水炉、PWRは加圧水型軽水炉、GCRは日本原子力発電の東海ガス冷却炉

KEY:
1. 1969 [the next figures are years running consecutively from 1970 through 1980]
2. total
3. Note: Facility utilization rate = power produced ÷ (permissible output x time function x 100 (%). The number in parenthesis is the number of plants, BWR is boiling water type light water reactor, PWR is pressurized water type light water reactor and GCR is Japan Atomic Power Company's Tokai gas cooled reactor



## Robots for Nuclear Plants

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 12 Jan 81 p 5

[Text] There has been a sudden rise in activity using the industrial robot, about which Japan can boast the world's top-level product for mastering the so-called three major problems in the nuclear power industry: assurance of safety, minimization of human exposure, and improvement of utilization rate of facility. In its studies related to the future vision of nuclear power generation technology (contracted to the Industrial Development Laboratory) the Ministry of International Trade and Industry is urging all-out promotion of robot utilization, and it proposed a "nuclear power generation supporting system" be developed over a 5-year period starting in JFY 80 to develop operational control systems and automated inspection systems for the containment vessel. On the receiving end of this proposal are the six companies—Hitachi Ltd, Toshiba, Mitsubishi Heavy Industries, Mitsubishi Atomic Power Industry, Mitsubishi Electric, and Japan Atomic Power Industry--which formed a system development group. At the same time, each maker is developing its independent robot technology, and Kawasaki already has at hand its in-service inspection robot (IS, inspection while in operation), Mitsubishi Heavy Industries has its eddy current detection robot for steam generator use, Toshiba has its automated fuel exchanger and remote-controlled control rod drive mechanism (CRD), and Hitachi Ltd has its automated robot for welding nuclear power distribution lines, which are all about to become practical. Furthermore, the use of these robots will not end at power generation, but they will be used in spent fuel reprocessing plants and high-level radioactive waste disposal operations and the decontamination of nuclear power plants which have come to the end of their days. The need for robots in the nuclear power field is increasing, and there is an increasing pattern of their use about the major equipment of nuclear power facilities.

The "robot for welding nuclear power distribution lines" developed by Hitachi Ltd and used at the No 4 reactor of Fukushima No 1 power plant is a robot which looks most like a robot. This robot has visual and feel capabilities and can detect from a considerable distance away any breaks in the weld or the condition of the weld, and if necessary it can correct the welding condition, thereby displaying its great flexibility in capabilities. Repair operations of distribution lines at atomic power plants are beset with the problem of lack of operating space as well as the presence of a radiation field. This radiation level becomes more intense the closer the site of operation is to the reactor core, and the time the welder is present has to be limited to a very short period in order to keep his exposure within permissible limits. This is why the practice in the past was to use a number of welders who successively spelled each other.

The welding robot for nuclear reactor distribution lines was developed to resolve this problem and to enable welding the distribution lines within the containment vessel by remote control from a safe site outside. First, a guide ring is attached to the distribution pipe, and the welding unit, sensory unit, and drive unit are placed on the three carriers on this ring. There is a visual device attached to this welding unit.

The carriers with these units are linked together and travel around the circumferential by action of the drive unit over the guide ring. It feels for the open break with the touch unit while a complete pass is made around the distribution line, and the point of the break is kept in memory. Next, all information about this site is progressively extracted, and the welding torch is positioned in line with the information, after which the weld is made automatically. During this time, the spread of the welding pool and the aim on the center line are monitored with the visual unit and displayed on a screen. The welder views this screen and manipulates knobs on the control panel whenever the welding conditions become inappropriate to correct the situation.

When the welding operation is completed, the welding unit is replaced by a grinding unit, and this unit together with the touch sensory unit are used to remove the unevenness on the bead by grinding. By replacing this grinding unit with an ultrasonic flaw detection unit, the weld can also be examined for defects.

Effective in Lowering Exposure to Radiation; Toshiba Develops Mechanism To Replace Fuel Rods

The occasions of periodic parts replacement and repair opertations at a power plant are numerous, and more often than not these operations are performed under condition of high radiation. This is why remote-controlled operations have long been the rule, but there has always been the hope of introducing robots to enable greater automation.

The "automated fuel exchanger" developed by Toshiba is a type of robot equipped with manipulators to remove and handle fuel rods, and it has already been put to practical use. The fuel exchange operation of a BWR is performed during the periodic inspection of a nuclear reactor which is made annually, and the spent fuel from the core is removed during this rest period of the reactor and new fuel rods are inserted or fuel rods are redistributed throughout the core. In these operations, performed in the past by a team of experienced workers and many assistants, the fuel rods in water were removed while sighting from above. This routine was conducted by teams of four men each in a three-shift rotation over a period of 15 days.

Because of the type of operation involved, the automated fuel exchanger was developed in order to reduce the radiation exposure, shorten the work duration, and improve reliability. This unit is comprised of an exchange unit main body, fuel handling tool, mast and control and drive equipment, and a computing system to serve as judgment device and issue commands to the control and drive equipment. With the development of this unit, the operating time for fuel replacement has been reduced 15 percent from what was required before, and one operator working by remote control can do the work formerly required by four workers, thereby effecting conservation of labor. At the same time, the exposure has been reduced to one-fifth, and this unit is already being used at the No 5 reactor of Tokyo Electric's Fukushima No 1 plant.

In addition, there is a "remote-control control-rod drive mechanism" (CDR), also developed by Toshiba, which is a maintenance robot. The exchange of control rods is also performed during the periodic inspection, and roughly 25 percent (35-50 rods) are removed from the lower reaches of the pressure vessel, inspected carefully, and reinserted once more into the reactor pressure container.

The CRD is long--4.7 meters long overall--so that its removal and reinsertion is a formidable task. At the same time, this work has to be performed in a high radiation field and in a very limited space, making this operation a classic example of worst possible working conditions. The actual operation involves the use of an electrically operated winch and a sliding mechanism. A team of five men stand on a platform to do the work (there are five shifts, for a total of 25 men), and they do most of the work manually. The performance of this routine by mechanized remote control is the work of the remote-control CRD unit. This mechanism has made it possible to replace the control rods from a control panel located in a safe environment.

Automated Inspection System Within the Containment Vessel

There have been intensified efforts during the past few years to introduce automation and remote control to handle routine operations in high radiation fields of nuclear power plants such as fuel exchange. On the other hand, the capabilities of these units are fairly limited, and the development of robots with much higher capabilities has become necessary in order to make safety at a nuclear power plant more reliable.

For example, located in the control room from which a nuclear power plant is operated is an operating crew of five or six people who look over a battery of 300-400 instruments and 1,000 or so alarm devices from which they receive information on the status of the reactor and select the necessary switches from the array of 500-600 switches to adjust the operation. In this manner, a tremendous burden is placed on these operating personnel. In addition, the containment vessel which houses a large number of the measuring devices is an area of very high radiation, making it impossible for a worker to enter the area when the reactor is in operation and some of the equipment is not functioning properly.

If a supporting system to lighten the burden on the operators or a robot which can be moved about the containment vessel while the reactor is in operation to check the situation within the vessel were introduced, the reliability of the reactor would be enhanced one step further, exposure in the event of trouble or accident could be minimized, and the worker's safety could be enhanced, which should contribute greatly to improved safety and increased utilization rate of nuclear power plants.

The "nuclear power generation support system," which is the target of a 5-year program initiated in 1980 by the Ministry of International Trade and Industry, is this ministry's answer to this need, and the development can be divided into the instruction system and the automated point inspection system for use within the containment vessel. The first mentioned member uses a computer to grasp the operating status of the power plant through the various pieces of equipment and summarize the information, transmit the status of the system to the appropriate terminals, and make the appropriate operational directions. The automated point inspection system for use within the containment vessel runs on a rail installed within the high radiation level interior of the containment vessel or on the floor of this vessel interior and examines the condition of the various pieces of equipment within.

The point inspection system as it operates within the containment vessel includes a point inspection dolley which runs on the floor, a space scanning type inspection vehicle, and a manipulator and detectors for this vehicle. The space scanning unit checks pumps and valves from above; the floor traversing dolley checks the various parts from below for air, water, and oil leaks; while the manipulator observes the equipment through a television camera and performs whatever operations can be performed by remote control.

The responsibilities have been divided up between the various companies so that Hitachi Ltd is in charge of the space scanning equipment, Toshiba the floor traversing dolley, and Mitsubishi Heavy Industries the manipulators. The private interests' nuclear power generation support system development group which was formed last summer by the six companies sent a survey group at the end of last year to the United States and Europe, where it minutely surveyed robot technology development and the status of its introduction. The results of this survey have not been compiled as yet, but it has been said that the situation with respect to robots for observing and operating within a containment vessel is virtually undeveloped. In light of this, the development and introduction of this type of robot in Japan should draw international attention, and the robot may become a future export item.

Robot for Spot Inspection

The point inspection robot is used mainly with ISI. ISI is the periodic inspection which is conducted once a year with the reactor shut down in order to check the safety aspects of the nuclear power plant. Fuel bodies are removed from the core, and the distribution lines inside and outside the core, valves, pumps, and their support members, are given a thorough examination. The inspection of the welds of and to the containment vessel and the weld sections of the distribution lines are the main focus of these examinations, and the inspection methods include ultrasonic testing and visual inspection.

Even when ultrasonic testing is used, the equipment has to be operated by human hands, and the time any worker can spend on the job is limited by the amount of radiation he receives, making for low efficiency. At the same time, the working quarters are so narrow that the worker often cannot come close to the working site.

The answer to this problem is the "ISI Robot System" developed by Ishikawajima-Harima Heavy Industries. This system was developed in a cooperative effort with the comprehensive research laboratory, Southwest Research Institute (SWRI) of the United States, and the system consists of an ultrasonic flaw detector, liquid damage seeking device, remote control and automated transport device to carry the above detection units, and automated recording and processing units for recording and processing the data accumulated.

Another point inspection robot is the "Steam Generator Eddy Current Detection Robot" developed by Mitsubishi Heavy Industries. The PWR steam generator consists of several thousand small heat transfer pipes where the heat from the primary coolant water is transferred to the secondary line, which is then used to generate steam to operate a turbine. When viewed from the standpoint of radiation control, this section serves as the "breastworks" which shields the radiation from the primary side. This is why these heat transfer tubes must always be in good shape, and the point inspection of these tubes is given particular attention during each periodic inspection. The robot developed by Mitsubishi Heavy Industries can cover these fine tubes completely for a given inspection and has the merit of lowering the worker's exposure to radiation and conserving labor.



## Inspection Systems

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 12 Jan 81 p 3

[Text] Japan's energy strategy, which is focused on promotion of nuclear energy as the main force to effect disengagement from oil, involves increasing the scale of power production from nuclear sources to 53 million kW by 1990, according to the cabinet decision adopted during the oil substitute energy deliberations of November last year. In other words, there must be local preparation and site selection for new plants to generate 23-25 million kW (23-25 reactors of the 1-million-kW class) over the next 10 years. This is why greater emphasis is being placed on assurance of nuclear safety and greater utilization rates of facilities, and improvement in observation systems which can spot an abnormal operation of a reactor at an early stage has become a pressing problem.

Nuclear power generating systems which are constantly increasing in size and capacity are designed from the outset with safety in mind, and great weight is placed on safety protection measures. This is why a pressurized light water reactor (PWR) operated by Kansai Electric at Takahama No 2 power plant (820,000 kW output) recorded 320 days continuous operation (from 21 November 1979 to 6 November 1980) and a boiling water type reactor (BWR) of Tokyo Electric, the No 4 reactor of its Fukushima No 1 plant, recorded 283 days continuous operation (from 22 November 1978 to 31 October 1979), thereby establishing new records.

On the other hand, Kansai Electric's Mihama No 1 (340,000 kW) suffered from an error in the selection of coolant, which resulted in corrosion of the fine tubes of the steam generator, as a result of which the reactor has not been operating for 6 years. It is an example of an extreme case in the other direction. Delay in detecting minor troubles and lack of proper treatment can effectively stop operation of a nuclear power generator plant, which is a product of massive science and technology efforts.

The reduction of radiation exposure to maintenance workers and repairmen during the periodic inspections is also considered an important objective in establishing industrial safety in nuclear power generation. One step in this direction is the recent activity in developing and introducing remotely operated observation equipment. This introduction is not complete, and the present situation is that the exposure suffered by the workers has emerged as a major social problem.

In another direction, the improvement in utilization rate of nuclear power generation facilities is considered very important from the standpoint of plant locations and stabilized supply of electric power. The utilization rate during the past few years has run the course of 41.8 percent in 1977, 56.7 percent in 1978, 54.6 percent in 1979, and 61.2 percent in 1980, showing an improving trend to a higher rate.

Facility utilization rate is directly tied in with power generation cost. If a 1-million-kW class reactor should suspend operation for a day, the loss would total 100 million yen, while a 10-percent reduction for the entire electric power industry would cost 30 billion yen. The high-performance fuel rods that can be used for high burnup and for long periods before replacement which the power industry is energetically promoting or the development of load pursuing type fuel rods are attempts by the power industry to increase the utilization efficiency.

The greatest factor responsible for lowering facility utilization rate is the so-called ISI or periodic inspection. This periodic inspection usually requires 90 days including the replacement of fuel rods. In other words, the reactor is idle at least one-fouth of the time even when it is trouble-free. Robot technology has recently has been coming to the fore as a possible solution to this situation.

Japan's robot technology has advanced to such a high level that robots presently are being exported to the United States in a situation just the reverse of what used to be. According to a survey by the Japanese industrial robot industry, production for 1980 totaled roughly 65 million yen, and this is expected to increase to 240 million yen in 5 years and to 450-600 million yen in 10 years.

The atomic power world plans to transfer the world's frontrunner robot technology to the subjugation of the so-called three primary problems in nuclear power generation: assurance of safety, reduction in radiation exposure, and increase in facility utilization rate. One of the reasons robot development is being emphasized so much is that during the U.S. Three-Mile Island incident a robot named "Berman" was used with great effect. This robot has a base which runs on caterpillar treads upon which are placed manipulators and television cameras which all are operated by remote control and are used to make radiation measurements within the nuclear reactor structure and operate valves and perform similar manipulations.

The inroads of robot technology into the atomic energy industry are fairly small compared to the automobile industry, the electrical industry, and the general machine industry. On the other hand, remote-control units with handling capability or visual capability have made their appearance, and it is thought that this will be the opening by which the use of robots for atomic power requirements will henceforth see great expansion in line with increasing needs for safety and other related items.

Robots for nuclear power use can be classified under the three large categories of operational, maintenance, and spot-inspection use depending on the application at hand, and products which fulfill these ends are now making their appearance.



## Instrument Calibration Center

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 12 Jan 81 p 14

[Text] The Radiation Measurement Association Inc (director, Masahiko Murakami) will conduct calibrations of radiation measuring instruments over the entire country starting this month. The accurate measurement of radiation is a most basic and important subject from the standpoint of exposure control and nuclear power development. The practice heretofore has depended on the instrument makers to make their own uncontrolled calibrations, but the Radiation Measurement Association, making use of the standard radiation facilities of the Japan Atomic Energy Research Institute in Ibaraki Prefecture, has developed a highly reliable calibration capability and plans to serve as Japan's calibration center.

### Standard Facilities at Tokai Laboratory

When an instrument for measuring radiation is used over a long period, the measurement begins to drift as the result of radiation wihin the instrument itself and other causes. The function of calibration is to bring these errant values to their proper place. Radiation measuring instruments are used in a wide area of application, including nuclear power plants, laboratories, hospitals, and radioisotope (RI) handling establishments, and these instruments need to be calibrated on the average of once a year.

In the past, when an institution purchased radiation measurement equipment it drew up an agreement with the vendor, and a trusted worker took the instrument to a maker or at times to the Agency for Industrial Science and Technology or JAERI which has capability for the calibration. This practice resulted in considerable variation in the reliability of the calibration, while imported products were associated with the problem of a large number of handling steps.

In order to resolve these problems, the Radiation Measurement Association was established in October last year. Since all the equipment which was ordered has been accumulated, it is about to take up its appointed duties.

The calibrations will be made relying on the "Radiation Standard Facility" located within the Tokai laboratory of JAERI. Although this facility is not 100 percent complete, it is provided with a number of standard radiation "yardsticks," which can be used as standardizing equipment for the calibration and maintenance control of survey meters, environmental monitors, and neutron rem counters.

The building is a two-story structure with one underground floor, a floor area of 1,900 square meters, and it houses irradiation rooms, laboratories, and spot inspection and repair rooms. There is a very low-level radiation room for measuring x-rays and gamma rays at very low levels, rooms where low, medium, and high rates of irradiation can be performed and a neutron irradiation facility.

At present the national standards for dosimeters and sources are kept in custody at the Electrotechnical Laboratory, and this facility has standard measurement equipment and standard sources which are compared and calibrated with the national standards on hand, which can then be compared with the measurement equipment in question for the calibration.

The cost of this calibration is about 22,000 yen for a GM survey meter for gamma use (not including shipping and repair costs) which is said to be somewhat less costly than the other routes.



Research Cooperation

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 12 Jan 81 p 14

[Text] The Central Research Institute of the Electric Power Industry and JAERI have decided to enter into intimate interchanges on nuclear fusion development, including technological information exchange. The ground-breaking event for this liaison was the first "roundtable on nuclear fusion" which was cosponsored by these two organs and held in December of last year. It is planned to hold these seminars periodically to enhance this exchange.

Nuclear fusion is considered to be a very powerful energy source for the future where the electric power industry is concerned. It is said that it will be at least 2020-2030 before this type of reactor will operate on a commercial scale, and preparations for a practical reactor must be accelerated if this timetable is to be met.

Research and development on nuclear fusion is now in the stage of shifting from research centered on plasma physics to engineering research with practical adoption in mind. That is to say, research is now at a crossroads, and it is the belief of the Central Research Institute that now is the time to initiate studies on the practical reactor so that the electric power industry can make a smooth introduction of fusion power in the future. It is said that these studies will be viewed particularly from the user's standpoint, taking into account reactor economics, reliability, operation, maintenance, and environmental problems.

The Central Research Institute set up a research group on nuclear fusion within its Energy Technology Development Headquarters as one example of the manner in which studies related to the nuclear fusion reactor are being promoted, and the tieup with JAERI is planned to push this development even further.



## PWR Automatic Control System

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 13 Jan 81 p 6

[Text] Mitsubishi Electric has embarked on the development of nuclear reactor instrumentation and operation control systems to enhance safety and enable complete automation of the pressurized light water reactors (PWR). A demonstration system will be built within its Kobe plant which will serve both as an experimental facility and a demonstration facility to the consumer. It is said that the danger of radiation exposure to operators and maintenance personnel is less than that experienced with the boiling water type reactor (BWR). Demand for PWR instrumentation and control type automated systems has been weak in the past, but the trend toward increasing the size of nuclear reactors has led to increased demand so as to lower the burden on operators and increase the facility operating rate through automation, and Mitsubishi Electric is demonstrating sensitivity to these requests.

### Construction of Demonstration Facility

Control is exercised over a large number of control systems such as the reactor pressure cooling system, the output control system or water circulation system, and the control of turbine and generator systems in the operation and control room of a nuclear power generating plant. A large number of gages, meters, and operational equipment are assembled here, and there is a good possibility that a slight error might end up as a major accident. This places tremendous responsibility on the operational control personnel. In the particular case of the BWR, coolant water which passes through the core also circulates through the turbine section in the construction that has been adopted, and direct entry into the plant equipment to make inspection and measurement is very difficult because of the radiation exposure involved. This is one impetus for the installation of a central observational capability. The computerization of the operation and control systems along with the introduction of robots are being urged to attain this end, and BWR makers such as Toshiba and Hitachi have introduced systems names "Podea" and "New Cam 80" which they developed.

In contrast to the BWR, the PWR has a cooling system divided into the primary water system which circulates through the core and the secondary water system which circulates through the turbine section, and the net result is that there is less exposure of workers, making unnecessary the development of a concentrated central observation and control system such as that required by the BWR. This is the present view. On the other hand, if the premise of increased plant safety for the future location of even larger nuclear power plants is to be implemented, the PWR will undoubtedly also be made difficult to operate in an error-free manner, and demands for a reduced burden on workers are increasing. This is why the Ministry of International Trade and Industry is providing subsidies to aid the development of such systems.

Mitsubishi Electric is a member of a PWR makers group which has handled instrumentation and control systems and has compiled an impressive record, and it has decided to engage in development of systems of greater capability and conservation of power compared to previous systems, including capabilities such as color display devices and voice input-output. One phase of this development will be the establishment of a demonstration system which is a compilation of the technology to date, at a cost of several hundred million yen, which is expected to aid research and development as well as to be useful for explanations to users and actual training of technologists.



MITI's Subsidy to ABWR

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 14 Jan 81 p 1

[Text] The Ministry of International Trade and Industry has decided to aid development of the "Improved Boiling Water Type Light Water Reactor" (ABWR), which is intended to be the standard Japanese type reactor on which five companies both domestic and foreign from four nations have started work, including Toshiba, Hitachi Ltd and General Electric (GE) of the United States, as one phase of the third improvement standardization (nationalization of light water reactor) technological development which is part of a 5-year program initiated in 1981. The ABWR is an international development on a private base which was started due to demand for development of an even better BWR. Meanwhile, the Ministry of International Trade and Industry was looking at the ABWR as the next generation BWR, and it has incorporated this concept into the nucleus of the third improvement and standardization program, thereby entering into its development. The ministry informally explained its policy to GE, Toshiba, and Hitachi Ltd among others, as well as to Tokyo Electric Power as representative of influential BWR users, and the net result is that technological demonstration tests on the nuclear reactor internal circulating pump (internal pump) will begin in 1981 as the start of a "Made in Japan" ABWR.

First Internal Pump Technology

ABWR development was instigated under the leadership of GE, which solicited Toshiba, Hitachi, Sweden's Acea Atom and Italy's Ansuld Mechanico Nuclear to form a five-company, four-nation group of BWR makers, and this development was started about 2 years ago. The technological sector of each company formed teams which incorporated basic BWR concepts of the past into the conceptual design which they then subjected to new stages of development.

Tokyo Electric has maintained a forward looking attitude toward the developments being made by these five companies, but recently other companies which have introduced BWR are also displaying forward looking attitudes toward the day when the ABWR becomes practical.

In another direction, since 1975 the Ministry of International Trade and Industry has been engaged in improvement and standardization of second-generation light water reactors and has looked toward independent Japanese technology in this area, which heretofore depended on technology introduced from the United States. With the energetic cooperation of the electric power industry, the light water reactor makers such as Toshiba, Hitachi, and Mitsubishi Heavy Industries saw their technologies make great advances.

With this background, the Ministry of International Trade and Industry, in its efforts to come forward with a more nationalized light water reactor technology, emerged with a policy of improving and standardizing the third-generation reactors starting in 1981 and put forth a call for domestic technology to tackle the nuclear reactor interior, which up to now has been the most difficult to nationalize, and truly aim for a Japanese type light water reactor.

The ABWR concept fell right in line with this line of thinking, and it was decided to finalize the third-generation improvement and standardization plan in the form of ABWR development.

The idea is for the two powerful companies which are influential in ABWR development, Toshiba and Hitachi Ltd, to be the member makers for the improvement and standardization of this third-generation model to support this activity.

In the specific matter of the technological test demonstration of the internal pump which is one of the prime items in this third-generation standardization, a budget of about 480 million yen has been allocated for 1981 with a funding of 8 billion yen projected for the next 5 years for pump-related costs. The overall cost is expected to be about 20 billion yen.

It is said that the power companies are expecting 1990 to be the approximate date of ABWR introduction, and development of the Japanese label ABWR is aimed at the start of the decade beginning in 1985, with all the power companies taking forward looking attitudes toward this standardization plan.

The Ministry of International Trade and Industry further believes that once the ABWR becomes practical somewhere in the post-1990 period, that important data related to approval will turn out to be "nationalizable" from within the standardization operations, and this may prove to be another major plus.

GE believes that the advancement of research and development funds by the Japanese Government will benefit future sales, and this unusual international joint development seems to be starting off with various expectations.

## Nagoya University Fusion Research

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 14 Jan 81 p 4

[Text] The Nagoya University Plasma Laboratory (director, Hidetake Kakihana) will embark on a third 10-year plan on plasma research in which deuterium (D) and tritium will actually be burned in a DT nuclear reaction (R plan). The experimental facility in which this reaction will be conducted is a medium-class tokamak of about 15 cubic meters volume. Because this facility was trimmed to the minimum size which would still allow experiment, some of the benefits which will be realized are: 1) the experiments will be easy to conduct, 2) many experiments can be run, and 3) a small amount of tritium will suffice. The plans involve preparational research and design and fabrication of the facility up through the first period to about 1887, after which the actual facility will be set up in 1988 at Doki City in Gifu Prefecture, where actual burning experiments with the injection of DT are expected to be initiated in 1989. Nuclear fusion research to date has been involved in experiments with light hydrogen nuclear reactions, and these nuclear fusion core plasma experiments are expected to be the first in the world.

Many nations are putting forth great effort on the theory and experimentation of nuclear fusion, which is expected to become the new energy source for the 21st century. The tokamak-type plasma experimental facility, which is the mainstream of this development, is now undergoing construction as very large facilities such as the JAERI "JT-60," the American TFTR, and the European alliance JET, with the hope of attaining critical conditions in 3-5 years. These facilities will represent major advances in plasma confinement and heating, but none of them will get to the stage that an actual DT combusion will be involved, although some altogether different reactions will be achieved, so that any analysis of the actual fusion reaction will have to await later experiment.

Representative nuclear reactions include DT and DD reactions; the DT reaction has a very high reaction rate, and nuclear fusion research utilizing this reaction makes up the bulk of this type of research today. On the other hand, tritium, which is one of the reactants, does not exist in nature as a natural form, making it necessary to produce it from lithium, which has to be reacted with neutrons produced by a nuclear reaction. This is the shortcoming of this fuel.

On the other hand, deuterium, which is present in abundant quantity in the natural world, enters into a DD reaction of a low reaction rate, and a DD nuclear fusion reactor may become an eventuality because it does not require the breeding of tritium.

The plasma at the core of a fusion reactor contains an abundance of charged particles from DT and DD reactions, and their free energies are of the same level or higher than the thermal energy of fuel plasma. It is said that this free energy is responsible for various instabilities such as thermal instability of the core plasma, thermonuclear instability, or diffusion through the radially directed electric field.



APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000300100036-8

In light of this situation, the Nagoya University Plasma Laboratory is proposing its R plan, which is not limited to the DT reaction but also includes the study of nuclear reaction plasma research necessary to the DD reaction using a compact version of the DT tokamak and following the various phenomena induced into the core plasma as the result of nuclear reactions.

The experimental facility for this purpose has a 15-cubic-meter volume, a 0.6-meter minor radius and a 2.1-meter major radius, which is roughly one-fourth the size of the JT-60 which JAERI is constructing. Included in the design is a plasma current of 1.8 mega-amps, a toroidal magnetic field of 50 kilogauss, a discharge time of 1.5 seconds, a neutron particle injection heat input of 15 megawatts, and a high frequency heating of 5 megawatts or more.

Consideration has also been directed to safety measures regarding radiation, and shielding will be provided by the walls of a spherical concrete structure 15 meters in internal diameter which is to be constructed. The first wall (0.5 meters thick) will be of boron containing heavy concrete, and the second wall (1.5-meter-thick concrete) will shield the injection device and its surroundings. The ceiling of this structure will be 0.5 meters thick, and it will be located 500 meters away from the nearest building. These measures are planned to produce weekly exposures of the order of 0.1 millirem per week, which is less than one-tenth the amount occurring in nature.

The plasma which is the objective of this research wil have a temperature of more than 120 million degrees at its center, a density of $10^{14}$ per cubic centimeter, and a confinement time of 0.1 second according to the target figures.

The plans involve a new construction on a 76,000-square-meter plot in Doki city, Gifu Prefecture. The first 3 years, up to 1983, will involve control of impurities (such as oxygen, carbon), nuclear reaction plasma measurements, and safe handling of tritium and radiation-type preparatory research, after which the 4-year period starting in 1984 will be taken up by design, construction and equipping the experimental facility. The facility is expected to be completed in 1988, at which time a year and a half will be allotted to tests with injections of ordinary hydrogen, and then experiments with DT nuclear reaction plasma are expected to begin in earnest in the fall of 1989.

The construction costs include 40 billion yen for the tokamak test facility main body, and more than 50 billion for the related facility costs. There will be a complement of 60 research personnel and 90 assisting personnel, for a manpower total of 150, indicating the magnitude of this project.

At present, the American TFTR and the European alliance FET are also aimed at conducting experiments on the DT nuclear reaction plasma, but these are large-scale projects which incorporate many problems so that the plans are reportedly encountering one delay after another. This is why there are great expectations that the world's first combusion tests will be conducted at this compact facility which is part of the R plan of Nagoya University.

The promotion of the R plan is tied in with various plasma technology developments accompanying long term operation of the JT-60 which will be mutually supplemented by fuel mode front information to contribute to Japan's future reactor technology test facilities. These will also be useful in the development of the plasma technology necessary for future DD nuclear fusion. Joint research on the part of all the universities in the country is necessary if this program is to be promoted in the universities. At the same time, the training of young researchers is considered vital to long term nuclear fusion research and development.

Director Hidetake Kakihana of the Nagoya University Plasma Laboratory made the following statement: The combustion of real fuel is important to nuclear fusion development. I hope this will be done as quickly as possible. JAERI's JT-60 is a very large affair, while the R plan is only the size of an eyeball. If we succeed in tying together the results of these two projects, Japan will become a leader in the field of the practical implementation of nuclear fusion.



## Reactor Material

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 15 Jan 81 p 4

[Text] The two countries which are intensifying their unity with regard to nuclear fusion development, Japan and the United States, have decided to enter into a joint study, the "RTSN Plan," on reactor materials development using a large accelerator in the United States. According to releases from the Ministry of Education, this accelerator is the high dose damage use accelerator (RTNS) located at the Lawrence Livermore Laboratory (LLL), where irradiation experiments on reactor materials will be conducted over a 5-year period starting in 1981 by Japanese-American joint effort, and this program is expected to be continued with the next stage accelerator, RTSN2, now under construction. The Japan-U.S. nuclear fusion research cooperation agreement ratified in May 1979 was started off in the form of the Doublet III plan, from which considerable information such as that relating to plasma characteristics is being derived. This reactor materials joint development plan is the next large project involving use of experimental facilities which follows the Doublet III, and the results are being awaited with great interest.

Reactor materials is a key technology to the practical use of nuclear fusion reactors. This is why the Ministry of Education built the "Octavian" for generating 14 mega eV at Osaka University starting in 1978. At the same time, the Research Institute for Metals at Tohoku University started on the development of superconducting magnet materials in a project budgeted for about 3 billion yen (for a 3-year period starting in 1980). In addition, the University of Tokyo will work on a high irradiation research facility with 4-5 MeV capability (3-year project starting in 1981) on funding of 750 million yen.

The development of wall materials for reactors is the most important element in reactor materials, because these materials are subject to 14 MeV high energy irradiation, which is one order of magnitude highter than that received by the cladding tubes of fission reactors, and materials which can withstand such high irradiation and still not suffer volume expansion (avoid swelling) for at least 10 years are needed.

Other means to be utilized in these material developments being considered are 1) the super high voltage electron microscope (the 1 MeV electron beam which operates this electron microscope can be used as damage causing irradiation, and swelling experiments using electron microscopes is a popular subject), 2) nuclear reactors, and 3) accelerators. Japan is limited to the 1 MeV neutron facility, which is the materials testing reactor (JMTR) at JAERI, and there is no facility which can deliver heavy irradiations on the order of 14 MeV such as will be generated in a fusion reactor.

In contrast, the nuclear fusion reactor use material research in the United States is considerably advanced, with the availability of the RTSN at LLL and the large irradiation use accelerator "FMIT," construction of which at the Hanford National Laboratory is being promoted. The U.S. Department of Energy (DOE) has asked for Japanese participation in these two projects based on the Japan-U.S. nuclear fusion research cooperation agreement, as a result of which the Ministry of Education hammered out its policy for cooperation in the RTSN plan starting in JFY 81 and allotted an initial year's outlay of 350 million yen. If possible, researchers will be dispatched as early as June to start Japan-U.S. joint experiments.

If an RTNS scale accelerator facility should be constructed in Japan, the cost will be at least 4 billion yen and will require 5 years to complete, and developing nuclear materials based solely on the use of our own capabilities will greatly delay nuclear fusion reactor development. In this respect, the present Japan-U.S. agreement is thought to play the role of a primer in the advancement of nuclear fusion development.



## Plutonium Reprocessing

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 16 Jan 81 p 5

[Text] The Tokai reprocessing plant of the Power Reactor and Nuclear Fuel Development Corporation (DONEN), which is targeting a goal of reprocessing 80-120 tons (uranium conversion) this year, is gradually establishing itself as a leading plant on a worldwide basis. This is because the degree of cleanliness of its external environment and its working environment greatly surpasses that of other leading reprocessing countries. On the operating end, this plant topped the previous record of the French of 16 tons continuous operation, which had been considered almost unbeatable, by a performance of 28.5 tons continuous processing. If the goal targeted for this year should be attained, Japan will surpass the United Kingdom and West Germany and close in on France. This operating record is attracting attention both at home and in foreign circles, and there is no doubt that its success is contributing greatly to the construction of a second reprocessing plant by private effort. We asked the director of the Tokai plant, Hideo Yasukutsu, to discuss the status and prospects of reprocessing technology, including the operational plan of the Tokai plant, and he said: "The Tokai plant is just about ready to enter the stage of competing with France for top position, and the reprocessing-related technology which was nurtured as a national project should serve as the base for the immediate construction of a second reprocessing plant by domestic technology. We will certainly cooperate in such a venture," he emphasized.

The Tokai plant was constructed by technology imported from the SGN Company of France, but what made this plant a truly independent Japanese plant was the acid recovery vaporization can, which was considered to be the most formidable problem in this processing (holes had formed at weld sections in March 1978, and operation was suspended for 1 year and 3 months). This was the opportunity which enabled the Tokai plant to become autonomous, as a result of which the denitiri-fication facility which had been treated as an inferior process and in which France had no real experience registered the amazing record of 206 hours continuous operation.

The quantity of fuel processed between July 1977 and November last year totaled 79.2 tons, but the production was 60 tons for the year starting in November 1979 after the repair to the acid recovery volatilization can had been made. We were able to process 28.5 tons for the C1 campaign and 20 tons for the C2 campaign.

It is said that these operating records of the Tokai plant are even surprising the French. The track record of the French, which to date has been the leading reprocessing country in the world, has not been the best where operating efficiency is concerned. The Karlsruhe Plant in West Germany called WAK (35 ton/year reprocessing capacity, initiated operation in 1971) has only reprocessed 114 tons over the past 10 years, and it is not operating at present because of a leak in the dissolution tank. At the same time, the Windscale Plant in the United Kingdom (400 tons, started operation in 1969) has developed trouble and is not operating at the present time, and the plant has yet to hit the 100-ton mark in fuel reprocessed.

The La Arg reprocessing plant in France (400 tons, started in 1976) reprocessed a total of 250 tons for the 5-year period up to June last year. When we consider the low operating rates of these foreign reprocessing plants, it appears that problems with the shearing mechanism and the filter equipment used to filter the dissolution liquid from the dissolution of spent fuel elements in nitric acid are the major obstacles.

When plant directors of the foreign reprocessing plants including the French visited Japan, what interested them most was the blade of the shearing machine, and there was the inevitable question: "How often do you change the blade?" This is because the French use a mode in which the fuel assembly is held vertical for the shearing, whereas the Germans leave the fuel rods in scattered array while the knife suspended like a pin descends on these rods. This practice is hard on the knife blade, necessitating frequent changes.

In addition, we put great effort into minimizing radioactive discharges to the environment, and we registered the value of 26 curies discharge for the year, which is close to the limiting value in the inspectional operations preceding actual operations up to the end of last year. This is several thousandths of the 45,000 curies of the French and the 80,000 curies of the British. In this manner, despite a late start Japan's reprocessing development is compiling good results, and this is having a sharp effect on the operations of the other leading countries.

Up to 27 December last year, the Tokai plant received a total of 615 fuel rod assemblies which converts to 132 tons of uranium, of which 79.2 tons were reprocessed. From this process, 450 kg of plutonium was recovered and 74.5 kg of uranium.

Full scale production will be initiated on 17 January, and the total to be processed within a year will be a maximum of 140 tons, based on 200 days operation for the year. Since a 1-million-kW-class light water reactor will produce 30 tons of spent fuel per year, this plant will be able to handle only 4.5 million kW reactors per year. This year's operational plan calls for a division into two periods in which 50-70 tons BWR fuel will be reprocessed, while the latter period will be devoted to reprocessing PWR fuel, and a total reprocessing capability of 80-120 tons is targeted. If this goal should be realized, the total processed thus far will be more than 160 tons, including what has been reprocessed in the past, which will put us ahead of the British and West Germans and close to the French.

Now, when we come to the second reprocessing plant era, although some actual experience may be necessary, it will be necessary to reprocess fuels of high burnup of as much as 40,000-50,000 megawatt days/ton. This high burnup fuel will not dissolve completely in nitric acid, resulting in the formation of insoluble residue (dregs), thereby creating uncertainty regarding the solvent extractions which follow.

The Tokai plant has reprocessed 28,000 megawatt-day/ton fuel from the Genkai power plant of Kyushu Electric and we had considerable anxiety over this insoluble residue although there were no serious consequences. We are preparing for the coming days when we will be involved in the reprocessing of these high burnup fuels through the solution of these problems.



## MITI's Budget for FBR

Tokyo NIKKAN KOGYO SHIMBUN, in Japanese 19 Jan 81 p 1

[Text] Taking aim at the period from the latter half of the decade beginning in 1986 to the 21st century as the period for the practical implementation of the fast breeded reactor (FBR), the Ministry of International Trade and Industry (MITI) will engage in development surveys of both the technology front and the economic front starting in 1981. The FBR is being promoted by various countries throughout the world as a "miracle nuclear reactor," but MITI is preparing itself for the day when the FBR will actually become practical by setting up the necessary preparations such as siting systems, power transport systems, establishment of nuclear fuel cycle, and setting up nuclear nonproliferation safeguards and is making all possible preparations in order to create a vision of a practical FBR. Research and development on the FBR is now taking place centered on the Science and Technology Agency and DONEN, but it will come under the administrative umbrella of MITI once it becomes practical, as a result of which MITI will be handling a new area. This is the first case in which MITI has considered FBR-related items in the budget.

Focus on Location and Nuclear Fuel Cycle

The FBR is a reactor which can utilize uranium extremely efficiently, and its appearance is awaited with great expectations by the various countries of the world as the powerful successor to the light water reactor.

France has been the most active in promoting development of the FBR, and developmental efforts in Japan have been spearheaded by the Science and Technology Agency and DONEN, which have centered their efforts on self-developed technology. Regarding actual construction, the experimental reactor "Joyo" (thermal design output 280,000 kW, went critical in April 1977) is being followed by the prototype reactor "Monju" (280,000 kW electrical output) which is targeted to go critical in December 1987, and research and development is gradually being advanced.

The plans for demonstration reactors of the 1-million-kW class to follow "Monju" are gradually assuming concrete form, and MITI believes that the FBR will make the transition from the research and development stage to the practical stage sometime in the latter half of the decade beginning in 1985.

MITI initially placed a 20-million-yen item for FBR development in the budget for 1981, and it may be said that behind the vision created from the technological and economic fronts, including practical implementation of the FBR, is the situation that the initial schedule has been followed by and large, and the self-developed FBR development is gradually taking shape.

The envisaged creation of the FBR in which MITI plans to engage in this new fiscal year will be entirely directed at the practical development of the FBR, and MITI plans to take up as quickly as possible the necessary technological and economic problems which Japan will face with the practical implementation of the FBR.

It is anticipated that the problem of the location of the practical FBR will be considerably greater than what was experienced with the light water reactor. This is because there is not only the question of power output end but also the need to locate the nuclear fuel facility at the same site.

The problem of just where in Japan to locate these large energy bases will become a major economic problem of the people, and it is necessary to establish a location image and an FBR base image.

At the same time, it is expected that a network of power distribution lines throughout the nation to deliver power from the FBR bases to the power demand areas will change greatly with the advent of FBR, and early attention must be given to the technology and economics to bring this about.

In addition, we must establish technological evaluation of the practical FBR. At the same time, the positioning of the practical FBR in Japan's overall nuclear fuel cycle must take place as rapidly as possible in order to effect nonproliferation of plutonium and its regulation.

In this manner, MITI hopes to engage in development of utilization systems for the FBR from this new fiscal year. Recently, the electric power industry also appears to be moving vigorously toward a practical FBR, and it may be that the placement of FBR development on the budget by MITI will accelerate Japan's practical development of the FBR.



## Commercial Nuclear Ships

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 19 Jan 81 p 9

[Text] The research and development plan for a reactor plant for an improved ship, which is the practical goal of the nuclear powered ship for the 21st century, is undergoing renewed activity this year through a government-private industry joint effort centered on the Japan Nuclear Ship Development Agency (director, Kazuhiko Nomura). Plans call for development of a 100-150 megawatt output pressurized water reactor equivalent to 30,000-50,000 hp shaft output, to be placed aboard high-speed container ships which will be mass produced, and for establishment of technology for safe shipping. The first step will be a 5-year program starting in 1981 during which time the selection of the reactor along with conceptual and test design drafting and design evaluations will be conducted. This agency is to set up the developmental office under its technological department and to involve academic and industrial sources in coming up with preparations and procedures by March.

### Agency To Come Up with Conceptual Design in 5 Years

A nuclear powered ship has such a high output that there is no comparison with a diesel powered ship, and it is ideally suited to serve as high-speed container vessel or superlarge tanker or even an icebreaker. When viewed from the standpoint of the limits of oil energy, its development is a must where Japan is concerned. The development of nuclear powered ships in Japan has been delayed because of the radiation leak incident on the nuclear powered ship "Mutsu," but the Western countries have not neglected long-term development. The U.S. plans were delayed from the original timetable, and studies are underway to come up with a large number of nuclear powered commercial ships in the latter half of the eighties. West Germany is conducting transport tests on a completed ship and reportedly is now developing a superlarge container vessel of 240,000 hp.

It is only natural that the greatest attention be directed to safety in the development of nuclear powered commercial ships, but the economics is also important. In the case of power generation on land a higher output will provide the "scale of profit," but this is not directly applicable in the case of a ship, so that the development of small and low cost reactors or the problem of fuel must be resolved before practical realization is attained.

Research and development on nuclear powered ships was conducted centered on the "Mutsu," but the emergency parliament of last year amended a section of the law pertaining to this nuclear powered ship working group, and the way was paved for emphasis to be placed on the establishment of manpower and technology for the day when the nuclear powered ship will surely make its appearance. At the same time, the time limit for this law was extended in the past, but the limits to this working group have been abolished, and administration will be simplified by merging this group with JAERI or DONEN by the end of 1984.

In the light of this, this working group has decided to point toward research and development on reactor plants for ship use parallel with improvements to the nuclear powered ship "Mutsu" and experimental voyages. The budget in 1980 for reactors for ship use was about 20 million yen, to which will be added the 1981 research and development funds of 190 million yen, indicating the government's view of this project.

In the matter of the direction in which this project should be promoted, "the theme" for JFY 81 will be: "What kind of reactor shall attention be directed toward?" (senior managing director Masaaki Kuramoto of the working group). Preparations for making a major start will be under way for the rest of this fiscal year, and it is thought that not only will this working group be involved but a committee will be formed, including representatives from the academic world and industry, along with the establishment of working sections to work in this direction.

In the first stage starting in 1981, the core of a pressurized water type light water reactor plant, which is thought to have the potential to become the power plant for nuclear powered ships in the near future, the primary system equipment, and a number of types of the shielding structure will be test designed along with the ship body and land support facilities. These will be evaluated, and the concept will be established. Some specific research subjects are: 1) comparison and evaluation of unitized reactor and divided reactor to aid in selection of reactor type, 2) program development and analytical research that will enable evaluation of the reactor itself with respect to fuel behavior and heat transfer flow, 3) actual irradiation tests in case the fuel becomes critical using an experimental reactor, and 4) information gathering. Except for the experimental research, there will be a shift to execution starting in JFY 81.

The program after this second stage will involve checking the established concept from all angles, after which the basic design and test fabrication and testing of various items of equipment will begin. At this time, particular attention will be directed at improving the economics. There will be another check and review before the third stage is entered, after which the construction and operational tests on the improved prototupe reactor for ship use will be finally started, according to this plan.

## Import of CANDU Reactor

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 20 Jan 81 p 3

[Text] The cries for the introduction of the Canadian type heavy water reactor (CANDU reactor), which were concealed for a while, have arisen again recently. When Minister Tanaka of MITI visited Canada a while back, he told the Canadian prime minister: "Please exert all possible effort (for the introduction of this reactor to Japan)," indicating an all-out attitude for the introduction of the CANDU reactor. During the summer 2 years ago, the CANDU reactor was hit by the conclusion of the "goodby to introduction" issued by the Atomic Energy Commission, but MITI and the Electric Power Development Company still burned with the desire to acquire this reactor, and they used this recent expression on the part of Minister Tanaka to intensify their efforts.

Let us look at the past history of this so-called CANDU problem. In 1976, the Electric Power Development Company, just as former undersecretary of MITI Yoshihiko Ryosumi became president of the company, initiated a plan to introduce the CANDU reactor. The CANDU is a heavy water reactor developed by the Atomic Energy Public Corporation of Canada (AECL), and it is a self-developed Canadian reactor which burns natural uranium with good efficiency. It has one of the best operating records in the world, and for the six reactors exported to five developing countries, this reactor has had a good record. It is a strategic export item of Canada.

The question of the introduction of this reactor was initiated at the new-type power reactor development discussion sponsored by the Atomic Energy Commission in 1978. In the meeting of presidents of the electric power industry in November of the same year, the conclusion was to approve the introduction of this reactor as a "test demonstration reactor." At this time, the new power reactor introduction roundtable appeared to have a forward looking attitude. Now, along about the end of March 1979, the Three-Mile Island incident occurred, as a rsult of which the self-development principal overtook the Japanese nuclear power industry, and the Atomic Energy Commission drew the conclusion of "goodby to introduction" in August of that year.

MITI and the Electric Power Development Company reacted strongly to this situation and announced their policy of "continuing technological studies aimed at introduction," and the Electric Power Development Company even budgeted 700 million yen for developmental preparations for testing this reactor in 1981 and has decided to continue its studies along the technological front.

One reason MITI and the Electric Power Development Company are so earnestly promoting introduction of the CANDU reactor is that this reactor will complement the light water reactor as far as reactor types go. The other reason is that this introduction may serve long term stable assurance of access to the oil, natural gas, uranium, and coal of Canada. In other words, by introducing the strategic Canadian export item, the CANDU reactor, stable supply of resources will be assured. In this matter, MITI and the Electric Power Development Company claim that the Atomic Energy Commission is completely off base as far as stable energy supply is concerned.

At the same time, however, the safety of the CANDU has been suspect, as Under-Secretary Ob of MITI said: "The CANDU reactor is operating smoothly in developing countries. Is Japan a backward nation where nuclear power is concerned?", indicating that there is a conflict in technological viewpoints.

It was with such a background that Minister Tanaka of MITI made his forward looking statement with regard to the CANDU introduction. There will be a meeting of Japanese and Canadian economists in May, followed by a (summit) meeting of leaders of the leading countries in July, both in Ottawa, and the possibility that the CANDU problem will develop anew cannot be denied.



## Radiation Clean-up Technology

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 20 Jan 81 p 9

[Text] Kurita Kogyo plans to put its strength into development of radiation decontamination technology. The electric power companies have come to put efforts into safety management of workers in nuclear power plants and their decontamination, while the increasing number of years of operation of nuclear power plants will necessarily entail system decontamination and disassembly of shutdown reactors, and this company hopes to be ready for these situations. In this respect, this company is developing remote control and automation technology as well as research on volume reduction and solidification of decontamination solutions in its policy.

An installation such as a nuclear power plant undergoes periodic inspection once a year, at which time the necessary equipment is decontaminated of its radioactivity before it is used again. If this decontamination treatment should be insufficient, workers may be exposed to increased radiation, and this will mean the use of more workers and more time. In this manner, efficient and safe decontamination becomes an important problem in the operation of nuclear power plants from the standpoint of worker safety, cost, and time economy.

Kurita Kogyo has a record of having decontaminated a large number of items such as recirculating pumps, spent nuclear fuel racks (storage shelves), and waste gas treatment devices. These decontamination procedures involve both mechanical and chemical procedures, and this company has top records in both classes.

It is expected that the decontamination problems to be faced in the future will be even more formidable. When the decontamination of an entire system becomes the problem, there may be situations in which existing technology may not be able to cope with the situation, and there will be even greater developmental efforts. This company received orders to clean the nuclear power plant equipment and systems of the Japan Atomic Power Company's Tsuruga atomic power plant No 1 and the Kansai Power's Mihama atomic power plant No 1 before they went into operation and has accumulated information and experience on nuclear power plant equipment and systems which will provide it with powerful weapons for its future development. The Dow Chemical Company of the United States went through several years of preparation to decontaminate an entire nuclear power plant system in the form of the Dresden nuclear power plant No 1, but it still has not been able to complete the project. This is a technology in which there is no example anywhere else in the world, and Kurita Kogyo appears to realize it is necessary to accumulate considerably more technology in the future.

In another direction, the decontamination solutions produced by past decontamination were contracted to and processed by various power companies, and this company is studying means by which it can concentrate and solidify such wastes. This company has embarked on waste water treatment for removal of heavy metals and other contamination, and this technology will be applied together with the development of solidification in asphalt.



## Reprocessing Negotiations With U.S.

Tokyo NIHON KEIZAI SHIMBUN in Japanese 21 Jan 81 p 1

[Text] With the inauguration of the new president of the United States, Reagan, the Japanese Government has decided to strongly urge a review of the September 1977 agreement between Japan and the United States which has proved to be a crippling influence on the promotion of Japanese nuclear power policy. A government negotiating team will visit the United States in March to initiate negotiations. The joint agreement drawn up during President Carter's administration imposed limitations on the reprocessing of spent fuels, which is the key point in the establishment of an independent fuel cycle. The government claims this agreement is a major impediment to the operation of the reprocessing plant now in use at Tokaimura in Ibaraki Prefecture and the construction of the second reprocessing plant now being planned, and is asking for 1) an extension of the operating period of the reprocessing plant and 2) a large expansion of capacity of the reprocessing plant.

### Take a Second Look at the 1977 Agreement

The September 1977 agreement between Japan and the United States, which has proved to be a ball and chain to Japan, includes a basic policy of "reprocessing all spent fuel." It states "the total amount of spent fuel which can be reprocessed in Japan hereafter during a 2-year period will be 99 tons or less." Agreement was reached on this issue because Japan responded to President Carter's fierce efforts to limit nuclear proliferation.

After this joint agreement was drawn up, the operating period of 2 years for the reprocessing plant was gradually extended, and the present situation is that it can operate up to the end of May this year. In addition, the quantity handled is expected to be increased 50 tons as an emergency measure accompanying the initiation of operations of the reprocessing plant at Tokaimura, but it will still be under 149 tons.

Up to now the government has been able to cope with the provisional extension (2-year period) and expansion with respect to extension of the period of operation and expansion of the quantity reprocessed but: 1) the Tokai reprocessing started operations in January, and the limiting quantity bolstered by an increase of 50 tons (for a total of 149 tons) will be surpassed sometime this summer, and 2) a second reprocessing plant under private capital has already been initiated (Japan Nuclear Fuel Service) with the target date of 1990 to initiate operations. Thus, the need to review the joint agreement has become more pressing.

The government is of the opinion that President Reagan will be much more flexible regarding Japan's requests for the operation and construction of reprocessing plants than President Carter.

It is thought that President Reagan's nuclear power policy will be enunciated near the end of February, when he decides on the staff for nuclear power-related positions, and Japanese Government circles say: "During the presidential race Reagan's speeches and the dialog between Reagan's staff and Japan's nuclear nonproliferation principle. On the other hand, he will probably push for fast breeder reactor development and will in all likelihood push the nuclear nonproliferation demands on Japan just as President Carted did."

Because of this situation, the government views the Reagan inauguration as "a chance to eradicate the joint agreement. "A government negotiating team will be dispatched in March to renegotiate this agreement. Even before this government group makes its visit, a good will group mainly of power company people will visit the United States to discuss the expectations of the industrial world to engage in nuclear power development in a plan now under consideration.

The specific contents of this renegotiation will be discussed between MITI, the Foreign Office, and the Science and Technology Agency, but a great extension in operating period and large increase in reprocessing volume are sure to be requested.



## Australian Talks on Reprocessing

Tokyo MAINICHI SHIMBUN in Japanese 21 Jan 81 p 9

[Text] According to a disclosure by government circles on 20 January, the Japanese and Austrialian Governments will meet in Tokyo on 21 and 22 January for the sixth Japan-Australia leaders' meeting, at which time the revision by this fall of the Japanese-Australian nuclear energy cooperation agreement will be discussed. The spent fuel reprocessing system will be handled in the rather mild form of "consensus beforehand on the contents," and this is where the modifications are to be made in which the Australian wishes for strict nonproliferation measures will be combined with Japan's desire for a stable supply of uranium. The government hopes that this new agreement will become a model of two-country agreements and is striving to draw up similar agreements with the United States and Canada.

The revision subjects in the Japanese-Australian agreement include the long-standing problem which involves the Australian proposition made in 1977 that "each time there is a reprocessing, both parties come to an agreement beforehand." This proposal is in line with U.S. President Carter's stand that reprocessing essentially will be prohibited, and the Australian Government has maintained that "as long as the agreement is not revised, there will be no new contracts for uranium export," presenting its very stern viewpoint. In answer to this stand, the Japanese Government said: "To have to come to agreement each time reprocessing is performed at any point will make the red tape unbearable."

At the preliminary negotiations last December the Australians proposed "consensus beforehand on the contents." This proposal makes it incumbent on the uranium-consuming nation to summarize its nuclear power utilization plan and submit it to the uranium-producing nation, which then determines the extent of reprocessing that should take place within such a framework.

This revisional negotiation will be pursued vigorously during the meeting of leaders of the two countries. In addition, there will be a business meeting in March with the hopes that final signing will take place in June.

The government hopes that this new agreement can, if at all possible, be presented to the emergency meeting of parliament this fall. If not, it hopes that it will be ready by the regular session of parliament which will be convened near the end of the year, after which it hopes to enter into negotiations with the United States and Canada.



## Nuclear Powered Steel Mill

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 21 Jan 81 p 4

[Text] The Nuclear Power Steelmaking Technology Research Group (director, Ichiro Fujimoto, president of Kawasaki Steel), which faces an uncertain future because of the failure of the nuclear powered steelmaking research and development project utilizing a high-temperature gas reactor sponsored by the MITI Agency for Industrial Science and Technology, will hold a meeting on 23 January to determine future operating policy. At present, the view is to somehow avoid the worst possible case--that is, dissolution--and possibly participate in the soft area of projects such as coal gasification in a sort of moonlighting effort until the promotional plan is reactivated. On the other hand, this group was subjected to a major shock when the 1.5-megawatt heat exchange capacity high-temperature helium test loop, which is indispensable to safety research on nuclear powered steelmaking and which had been requested in the 1981 promotional funds, was jeopardized by the withdrawal of some 200 million yen from the budget, and the country's nuclear policy from here on may cause withdrawals and even dissolution of the group. In any event, the multipurpose high-temperature gas reactor development, which during the past couple of years had been considered the ticket to disengagement from oil and was given increasing budgets each succeeding year, saw the principal member of its utilization system, nuclear powered steelmaking, collapse. This has rocked the long term multipurpose high-temperature gas reactor utilization plan for the use of nuclear heat to the very foundations, and a new look by the government is in order.

The Nuclear Power Steelmaking Technology Group, which was established in May 1973 on the basis of the Metal Industry Technology Research Group Law, is comprised of 15 companies, including Kawasaki Steel, Shin Nittetsu, Ishikawajima-Harima, Toshiba Ceramics and the Japan Steel Association. That year the first-stage plan was initiated, including development of constitutive element technology for high-temperature heat exchangers and reducing gas production facility for a nuclear powered steelmaking plant, and during the 8 years since then it has received about 12.35 billion yen from the Agency for Industrial Science and Technology. This sum was augmented by self-produced funds totaling 330 million yen up to the end of October last year.

Then the second stage (up to 1994) was to be entered in 1981, at which time the utilization system was to be docked to the JAERI high-temperature gas experimental reactor (50,000 kW thermal output, expected to go critical in 1988). In the previous stage (up through 1980), Ishikawajima-Harima was to install the steam reformer at the high-temperature helium test loop with inlet temperature of 1000 degrees Celsius of the primary system helium loop, which had been completed in 1978, and to check the properties of new thermal insulating materials at the helium bypass which uses two types of new alloys developed for heat exchanger use, and these efforts were to be funded by a grant of about 13 billion yen which also included improvements and safety demonstration tests of the utilization system.

The group had requested 2.2 billion yen for this project, but the Agency for Industrial Science and Technology gave the following reasons to effectively "freeze" the project by cutting its budget to zero: 1) there is excessive steel-producing capacity, 2) development of the experimental reactor at JAERI has been delayed, 3) there has been no request from the Nuclear Safety Bureau of the Science and Technology Agency for a safety demonstration test, and the Agency for Industrial Science and Technology cannot run ahead on its own, and 4) even when the safety test is not performed, the results obtained in the first-stage studies can be directly applied to the experimental plant.

As a result, the group tried to pass on these results to JAERI and requested the Science and Technology Agency and JAERI for this transfer of technology, but this effort also failed, and the requested maintenance and management funds for the high-temperature helium test loop (for one year's government agency inspection as required by the High Temperature Gas Handling Law) of 120 million yen also was slashed to zero. Conversely, the extraordinary situation resulted in that 200 million yen was allocated for the removal of this loop. In response to these actions on the part of the government, some members of the group claim that these actions do not constitute freezing of funds but a cancellation of the project, and any chance of restoration is very slim. In this manner, the future operational policy of this group is in a turbulent stage.

The group seems to be planning to participate in the coal gasification project after the end of 1981 and to participate in the survey on nuclear heat utilization by JAERI. On the other hand, the removal of the high-temperature helium test loop has severed the pathway to a safety demonstration test plan, and increasing weight is being given to the thought that the nuclear powered steelmaking project has failed.



## Nuclear Waste Disposal

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 21 Jan 81 p 1

[Text] MITI will embark on development of a "system to receive solidified material reprocessed and returned from foreign countries" with an outlay of several billion yen, according to a 3-year program starting in 1981. This system will be comprised of hard and soft technology centered on the remote-control operating technology necessary to handle safely high-level radioactive waste from reprocessing plants for spent fuels which are solidified in glass. The nine electric power companies, including Tokyo Electric and the Electric Power Development Company for a total of 10 companies, contracted back in 1977 and 1978 to have their spent fuels reprocessed in the United Kingdom and France, as a result of which high-level radioactive waste solidified in glass will be shipped back to this country starting in 1990, and there will be a need to develop domestic technology to safely receive this waste product.

### Return From France To Start in 1990

The spent fuel which the 10 power companies contracted to the British BNFL and the French COGEMA public corporations for reprocessing in 1977 and 1978 totaled 1,600 tons per year. The 1,500 tons of uranium which had been contracted to the same two companies before these 2 years was reprocessed with the agreement that the high-level radioactive wastes produced by the reprocessing would be disposed of by the respective reprocessing countries. On the other hand, the wastes from the fuel covered by the 1977 and 1978 contracts are to be solidified and sent back to Japan starting in 1990.

These solidified high-level radioactive wastes will be shipped back from these two countries, and experience in receiving such material is a first for Japan. In order to be able to receive this material safely, development of a domestic technology for the safe receipt will be needed.

The technologies for solidification of high-level radioactive wastes and their storage are being gradually developed by DONEN, which is operating Japan's first reprocessing plant for spent fuel, but the technology to safely handle radioactive waste in solidified form after its shipment from abroad is something completely missing in this country.

This ministry plans to start development on this technology over a 3-year period starting in the new year for the safety of the people of the nations, and the main attention will be directed toward remote-handling technology.

High-level radioactive wastes are products of nuclear fission and emit both heat and radiation, making their handling very important. The most common international practice is to solidify the wastes in glass, store the glass for a long period to extract most of the heat, and then subject the glass to ultimate disposal.

It is not clear in just what form the two foreign companies will ship back the wastes to Japan, but these companies are required by contract to notify Japan of the specifications as to size, form, concentration, and shape of enclosing container by 1 January 1982. Japan has up to 1 January 1984 to respond to this specifications proposal, and the system to be developed by MITI will take these specifications into account.

The ministry has budgeted about 400 million yen in JFY 81 for development of this system and is studying a contract to the Nuclear Power Environmental Control Center.



## Revision of Nuclear Programs

Tokyo NIHON KEIZAI SHIMBUN in Japanese 21 Jan 81 p 4

[Text] The Atomic Energy Commission (chairman, Ichiro Nakagawa, director of the Science and Technology Agency) announced on 20 January its policy of making an overall reassessment of the "long term plan for nuclear power research and development" which was set up in 1978, in view of the changes in the nuclear power environment during the past few years. This situation is the result of the considerable advances made over the past 3 years in the area of light water reactors, new converter reactors, the fast breeder reactor, and even the fusion reactor, as well as adverse effects brought about by the Three-Mile Island nuclear power reactor incident, which complicated nuclear reactor location problems, and the emergence of the treatment and disposal of radioactive wastes as a social problem. Thus, some major changes are taking place in the nuclear power situation, and the long term plan should be revised accordingly. The Atomic Energy Commission has plans to involve all its subsidiary organs in initiating these changes as quickly as possible and in coming up with a new long-range plan by this August.

This long-range plan will encompass the entire field of research and development over the next 10 years. It was first drawn up in September 1978 and was to be revised every 5 years. Since it is the opinion of the Atomic Energy Commission that the worldwide situation in nuclear power has changes so much over the past 3 years, a reassessment of the plan is in order. This is why the commission pushed ahead the date of review by 2 years and has listed this revision as one of the most important items for 1981.

It is expected that those areas in which changes have been most significant over the past 3 years, such as nuclear fusion, fast breeder reactor and treatment and disposal of radioactive wastes, will be given the greatest attention in this reassessment. Nuclear fusion is undergoing development through a national project involving a tokamak-type facility, but research on modes other than tokamak are taking place at Kyoto University, Osaka University, and Nagoya University, among others, with considerable success. Now, the plan of 3 years ago mentioned only the tokamak, and research at universities was considered simply for reference purposes. The Atomic Energy Commission said: "It will be too much for the budget to continue developing the modes being pursued at all the universities. The results must be reviewed and condensed quite a bit before further nuclear fusion reactor research is continued in our long term plan" (Koyonari substituting for the commission chairman). In addition, rather specific plans are in the offing for the future of the demonstration reactor, which will be the next step following the prototype reactor "Fugen" in the area of new-type converter reactor and the centrifugal separation method, the operation of which was initiated at Ningyo Toge in Okayama Prefecture.



Uranium Enrichment Model Plant

Tokyo NIHON KEIZAI SHIMBUN in Japanese 22 Jan 81 p 7

[Text] The Science and Technology Agency on 21 January issued a permit for nuclear fuel use to the Asahi Chemical Industry Company for the chemical exchange uranium enrichment model plant facility which this company is planning to construct at Himukai city in Miyazaki Prefecture. With this receipt, the company will apply for a construction permit from Miyazaki Prefecture and start construction during JFY 80 if possible. If this company should succeed with this model plant, it is believed the way will be open to the construction of a 1,000-ton year uranium enrichment plant, and Japan's domestic enrichment of uranium plan, which is based on the national project of the centrifugal separation method now being developed by DONEN, will be backed by another member.

The chemical exchange method is an epoch-making uranium enrichment method which this company has developed and is the first of its kind in the world. When tetravalent uranium and hexavalent uranium of differing chemical properties exist together, use is made of the property that the uranium-235 which is used in nuclear fission concentrates to the hexavalent side to bring about enrichment. The principle of this separation was thought of some 30 years ago, but Asahi Chemicals was able to develop high-performance ion exchange resins and developing solvents suitable for this enrichment and come up with the basic technology.

The model plant which is to be constructed to establish the technology and develop the economics to enable the next step to commercial application. Four chemical exchange towers of one-twentyfifth the practical scale of 1-meter-diameter and 1.5 meter-high will be set up to produce 3 percent enriched uranium for use as fuel in light water type reactors. When this plant goes into full operation, it will be able to produce 500 kg/year of 3 percent enriched uranium, but this product will be mixed with depleted uranium (material whose uranium-235 content is less than the natural abundance ratio) for reuse so there will be no accumulation of enriched uranium at this plant.

Ashi Chemical expects to complete this plant by the spring of 1983 and to complete operational experiments and economic evaluations by 1985. The development and research costs are expected to total 12 billion yen, but since this is an important technolgoy which is tied into Japan's energy assurance and the nuclear diffusion problem, two-thirds of the total cost will be supplied by MITI and the Science and Technology Agency as a subsidy, and development will proceed under government direction.

Plans involve the processing of 5 tons of natural uranium per year in this facility, but the Science and Technology Agency deemed that there will be no problem of waste materials countermeasures or discharge of radioactive agents to the environment so that it issued what amounts to a building permit but is actually a permit to handle nuclear materials (permit prescribed by the Nuclear Reactor Law).

There is a belief that it may require some time to receive a building permit from Himukai city where the plant is to be located.



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