224067

JPRS-JST-88-009
23 JUNE 1988

FOREIGN BROADCAST INFORMATION SERVICE

JPRS Report

DISTRIBUTION STATEMENT A
Approved for public release:
Distribution Unlimited

Science & Technology

Japan

19980612 046

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
SPRINGFIELD, VA. 22161

DTIC QUALITY INSPECTED 6

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JPRS-JST-88-009
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SCIENCE & TECHNOLOGY

JAPAN

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AIRCRAFT ACQUISITIONS, AEROSPACE DEVELOPMENTS DESCRIBED

Purchase of Aircraft

43062548 Tokyo AEROSPACE JAPAN in Japanese Dec 87 p 25

[Article: "Purchase of Aircraft by Ministries and Agencies of the Japanese Government"]

[Text] Ministries and agencies of the Japanese Government have selected the types of aircraft whose purchasing schedules were included in the supplementary budget and have entered into contracts for these aircraft with aircraft manufacturers. The contents of these contracts are shown below.

Government special-purpose aircraft. On 22 October the government announced that it had selected the Boeing 747-400 as a special-purpose government aircraft. The contents of this decision are as follows:

1. ¥387.58 billion was appropriated as the total contract authorization in the supplementary budget for fiscal 1987. Aircraft to be purchased by the government were studied by the Government Special-Purpose Aircraft Study Committee (chairman: Deputy Chief Cabinet Secretary Fujimori) and, eventually, it was decided by the committee that the Boeing 747-400 would be purchased as a special-purpose government aircraft.

2. The Boeing 747-400 was selected on the basis of a comprehensive assessment which showed that the Boeing 747-400 is a top high-performance aircraft, has excellent range, etc., and is flexible in operation because the airframe capacity is large. In addition, a sufficient support system can be expected.

3. In the future, the government intends to enter into a contract with Boeing Corporation (agent: C. Itoh & Co., Ltd.) as quickly as possible (probably in December) after it discusses detailed specifications for the aircraft with the company.

The National Police Agency [NPA] has decided to purchase three large helicopters and six medium-sized helicopters at about ¥4.6 billion from the supplementary budget. With regard to the three large helicopters, the NPA has entered into a contract with the Sony Trading Company to purchase the Superpuma AS332L-1 at a total cost of ¥3.987 billion. The Tokyo Metropolitan Police Department,

the Osaka Prefectural Police Headquarters and the Chiba Prefectural Police Headquarters are each scheduled to receive one of the three large helicopters on 31 March 1993.

The Maritime Safety Agency [MSA] has decided to purchase two Falcon 900s, a Beech 200T and a Bell 212. It has placed an order for the two Falcon 900's with Sony Trading at a cost of ¥7.77 billion. Delivery is scheduled for September 1989.

The Ministry of Construction has selected the Bell 214ST as its large helicopter and Mitsui & Company, Ltd. has entered into a contract with the helicopter manufacturer at a total cost of ¥1.35 billion. Delivery is scheduled for March 1988. This helicopter will be used for various purposes, such as rescue activities, etc. The company will entrust the service of the helicopter to a private helicopter company.

The Science and Technology Agency [STA] has purchased the Dornier 228, which will be used by the National Aerospace Laboratory [NAL], for about ¥1.7 billion. Delivery is scheduled for the end of March 1993.

New Materials for Aircraft

43062548 Tokyo AEROSPACE JAPAN in Japanese Dec 87 p 26

[Article: "Investigation Committee for New Aircraft Materials"]

[Text] The Society of Japanese Aerospace Companies, Inc. [SJAC] has established an investigation committee to explore new materials for aircraft. Its first meeting was held on 11 November. New materials that can be expected to find practical uses around the year 2000 will be selected in keeping with the idea that the development of new materials and advanced materials will play an important role in components of the kinds of aircraft that will appear after the year 2000. This development work is significantly related to these components. Data for working out guidelines for the development work and to consolidate the foundation of this work in the 21st Century will be obtained by developing new materials necessary for the aircraft industries and by investigating potential uses for these new materials. After finishing the above work by the summer of 1993, a conclusion will be formed.

Aviation, Space Technologies

43062548 Tokyo AEROSPACE JAPAN in Japanese Dec 87 p 26

[Article: "Anticipation of Aviation and Space Technologies up to the Year 2015"]

[Text] On 22 September the STA announced its fourth technical expectation and investigation based on the theme, "Investigation Concerning the Direction of Technical Development in Japan."

This investigation, which involves 17 departments and 1,071 subjects for a period of about 30 years from the present to the year 2015, is based on a questionnaire mainly for experts, using the Delphic method. Of the 1,071 subjects, 10 are related to aviation and 39 are related to sapce. For example, a 2-hour flight across the Pacific Ocean will be realized in 2007 and space factories for industrial production work will be realized in 2003. These subjects are enumerated below in sequence from the period in which the number of expected developments is the largest.

1. Aviation

Realization period (year)	Subject
1999	Revolutionary, energy-conserving and high-speed turboprop airplanes will enter into service. They can fly at speeds equivalent to those of jet airplanes. Worldwide air traffic control systems employing artificial satallites will be put to practical use. The service safety of aircraft will be enhanced thanks to the appearance of new man-machine systems in which artificial intelligence will be used in control systems, including an airliner landing and takeoff system. A four-dimensional control system will be developed. This system will calculate the time and position of the aircraft and will include a collision avoidance system used to cope with the enhanced safety and service capacity of the aircraft.
2000	A consistent system for aircraft development work will be developed by fully using AI computers provided with abundant data. These aircraft will be modified by feeding back data on planned development work, manufacturing work and users.
2002	Low-noise and energy-conserving vertical take-off and landing [VTOL] aircraft will be put to practical use for interurban traffic.
2003	A revolutionary and energy-conserving transonic transport will be developed and manufactured by using composite materials. An aerodynamic resistance minimizing control (a laminar flow control) will be used in this transonic transport.
2005	A super-large cargo transport (gross weight: 1,000 ton-class) will be developed for transpacific flight. A supersonic transport [SST] of a hypersonic transport [HST] will be put to practical use.

2007	A new passenger airplane will be developed. It will be able to fly across the Pacific within 2 hours at hypersonic speeds. It will be able to carry almost as many passengers as today's jumbo jet passenger airplanes.

2. Space

Realization period (year)	Subject
1996	Ability to measure air pollution from space.
1997	Practical use of worldwide air traffic control systems using artificial satellites.
1998	Realization of unmanned probing of distant planets. Installation of precise microwave sensors in artificial satellites.
1999	Realization of unmanned experiments on near-Earth planets. Realization of solar observation from oribt outside ecliptic surface. Practical use of Breaton, Starling cycle engine. Development of technologies for assembling artificial satellites in space stations. Realization of a space experiment supporting system. Precise measurement of marine wind speed from space. Installation of precise microwave altimeters in artificial satellites. Installation of precise marine color sensors (solid-state elements) in artificial satellites. Rise in accuracy of earthquake prediction due to rise in accuracy of measurement of diastrophism.
2000	Use of multipurpose platforms for communication and broadcasting observation on the Pacific Ocean.
2002	Rsalization of space work using space robots.
2003	Realization of space plants for industrial production. Realization of microwave radiometers that can be used to carry out measurement work extending over wide areas. Development of an electric propulsion system for transporting large structures in space. Development of high-function materials that can be used to lower the cost of round-trips to space.
2004	Development of a single stage shuttle for space transporting systems.
2005	Development of a huge array processor in space. Development of life supporting technologies using a closed ecological system. Stay of more than 20 scientists in space. Development fo technologies for disposing radioactive wastes in space.

2006	Ability to effect probes outside the solar system. Development of manned round-trip transporting system.
2007	Development of technologies for using solar wind.
2008	Realization of space tourist industry. Commercialization of ultrahigh-speed air transport systems using space orbits.
2009	Construction of solar power plants in space.
2010	Construction of lasting manned space observation stations on the lunar surface.
2011	Application of weightless environments to medical treatments.
2012	Execution of a long-term observation plan with the ultimate goal of devising a plan for modifying the atmosphere of Venus. Development of a lasting manned space station. Development of self-propagating robot systems for developing the lunar surface.
2013	Landing of manned space ships on Mars. Initial use of space substances as resources.
Unrealizable	Advent of a space city with a population of more than 1,000 before 2015.

20143/9738

French-Japanese Roundtable on Human Frontier

3698a143 Paris BIOFUTUR in French Dec 87 pp 63-65

[Article by Sylvia Vaisman: "French-Japanese Roundtable: What Is the Future of the Japanese 'Human Frontier' Program?"; first paragraph is BIOFUTUR introduction]

[Text] Although it was discussed at the last Summit Meeting of the Seven (Venice, June 1987), the Japanese Human Frontier project arouses expectations and suspicion. A paradox: Europe cannot allow the two superpowers to build tomorrow's technologies alone. Yet, how can Japan be prevented from exploiting the research findings? During the visit to BioJapan '87 of the French delegation accompanied by BIOFUTUR, a French-Japanese roundtable was organized to attempt to answer these questions.

Thrust to the forefront of the financially powerful nations, today Japan has to rethink its long-term economic strategy, its research and development policy, and its international reputation. Human Frontier Science Program (HFSP), a vast cooperative research project with the West dealing with life sciences, partly encompasses this ambitious aim. Although it was on the agenda of the last Summit Meeting of the Seven (Venice, June 1987), HFSP is still suffering from a lack of recognition not only abroad, but also inside Japan. (Footnote 1) (Economic declaration on HFSP at the end of the Venice Summit: "We welcome the initiative of Human Frontier Science Program presented by Japan, which is aimed at promoting, through international cooperation, basic research on biological functions. We are grateful for the informal opportunities our scientists have had to take part in some of the discussions of the feasibility study undertaken by Japan. We note that this study will be continued and we would be pleased to be kept informed about its progress.") A definite lack of recognition, but also expectations and suspicion. The situation is paradoxical for more than one reason. On the one hand, it is difficult not to take advantage of Japanese overtures and allow the two superpowers (Japan and the United States) to build the technologies of tomorrow alone. On the other hand, it is not unreasonable to fear the Japanese seizure of the findings of European basic research. How can the risk of Japanese hegemony be avoided? The controversy is still in full swing and decisions are continually postponed. Due to the absence of any consensus and the need to reply to

the many questions that persist, the scientific service of the French Embassy in Tokyo participated in the organization of a French-Japanese roundtable (at the French-Japanese Institute in Kyoto) on HFSP during the visit of a French delegation, accompanied by BIOFUTUR, to the BioJapan '87 exhibition.

The following persons attended the meeting on the Japanese side, but only as private persons:
K. Umehara (AIST [Agency of Industrial Science and Technology], MITI [Ministry of International Trade and Industry], HFSP Office),
M. Okamoto (Council for Science and technology),
K. Mikoshiba (Osaka University, HFSP Working Group),
T. Oshima (Tokyo Institute of Technology, HFSP Committee),
I. Miyagi (AST [Science and Technology Agency]),
S. Kaji (AIST),
T. Shimizu (AIST), and
S. Fukui (vice president of BIDEC).

On the French side those present were:
C. Benicourt (Roussel-Uclaf, Kyoto University),
R. Bluzat (CPE [Forecasting and Evaluation Center]), C. Bourgeois (Adria),
J. Comar (BIOFUTUR),
P. Coulet (CNRS [National Center for Scientific Research], Lyon I),
F. Descoueyte (French Consul General in Osaka),
I. Dimo (Total),
F. Lazard (CNTS [National Center for Blood Transfusion]),
M.D. Legoy (UTC [Technical University of Compiegne]),
M. Lenfant (CNRS),
P. Monsan (BioEurope),
D. Pardo (French Embassy),
M. Peyrache (SFJPI),
J.C. Pinon (CEA [Atomic Energy Commission]),
P. Steck (Sanofi),
G. Tardy (Citicorp),
D. Thomas (UTC),
S. Vaisman (BIOFUTUR),
X. Vanneaud (BioEurope),
A. Verny-Lefrancois (CNTS),
B. Vladescu (Pernod-Ricard),
N. Wasserman (director of the French-Japanese Institute), and
M. Bourene (scientific attache to the EEC, Japan).

BIOFUTUR has selected a certain number of contributions to this conference due to their pertinence or their singularly conclusive nature.

We would like to highlight Professor Okamoto's preliminary comment that the Human Frontier program should survive the political change associated with the succession to Mr Nakasone.

In response to Mr Thomas' comment on the flagrant imbalance between the ambitions of the HFSP project as it is defined by the Japanese themselves and the corresponding budget request for fiscal 1988 (see table);

M. Okamoto: "The program seeks to expand our basic knowledge in life sciences, hence the extensive search through the research subjects proposed. We have made up a list of possible topics from which the areas of more precise investigation have to be selected. Among other tasks, this work will be included in the second phase of the future feasibility study. It is essential that the international community participate in the selection of subjects. The definition of such a world cooperative program cannot be developed without preliminary coordination. Regarding financing, I want to assure you that Japan--as the country which initiated HFSP--will not be restrained and assume the biggest portion of the budget. Each ministry and a good number of government agencies have a biology budget. They will draw from this throughout the 1988 pilot program, although we have already called for HFSP to be allocated its own budget. (Footnote 2) (Part of this budget would be used to construct an international biotechnology research center, an initial step toward HFSP.)

The extent of international support will be a determining factor, however, and the Japanese Government will increase its subsidies in relation to the international interest in HFSP and the budgets allocated abroad. Our country is particularly sensitive to world pressure."

Mr Mikoshiba: "Japan is not very used to international scientific collaboration. If we want HFSP to advance, I think we must reconsider in depth our working methods. It is not easy to direct a clear and coherent biotechnology policy with regard to overseas countries when several ministries claim to be responible for it. We will also have to create a true structure to accomodate foreign researchers."

Mr Umehara: "At the present time, it is impossible to determine the budget necessary for the successful accomplishment of the program. We are proceeding on a case-by-case basis: If and when research subjects arise which have unanimous support, we estimate the funds needed and submit an application for them. Our method is to determine the budgets on the basis of the work to be done and not to subordinate the work to the budget available. This is another approach."

G. Tardy had some questions on the presence of major Japanese companies on the HFSP feasibility committee and on the possibility of a foreign company joining this panel:

Mr Umehara: "The people who make up the committee represent themselves as individuals; under no circumstances do they represent their research centers or the companies that employ them. However, the Japanese private sector will most certainly contribute to the establishment and operation of the program, as it has done for a long time in the field of biotechnology, even in basic research. Foreign companies will also be

able to participate in this endeavor. It is possible to consider the constitution of a three-sided team comprising a Japanese company and university laboratory and a French research agency. In this respect, you can certainly understand that it is most important to be present when the next feasibility study is done. Still, one issue remains to be settled: that of ownership of research findings. Fundamentally, we think that the product of research belongs to the researcher himself, particularly when it is a question of basic research. On this specific issue, there is so much disparity of opinion between countries that a solution to this problem cannot be expected before several years have passed."

Mr Umehara was rather formal regarding the question of integrating the human genome sequencing project into HFSP:

"At present, this program is being handled by RIKEN, but the Science and Technology Agency wants to include it in HFSP so that the scientific bodies of the various countries will cooperate in this area. The question will be decided during the feasibility study."

Finally, in response to Iona Dimo on the imperative need, before setting up any collaboration--particularly with industrial partners--to draw up a real set of specifications detailing the method of financing and the distribution of market shares in the event of industrial outlets.

Mr Umehara: "Working together obviously necessitates the prior definition of a contract. Nevertheless, we must emphasize the variety of cases and eventualities possible. The problem appears to be so very complex for HFSP that each case will have to be dealt with individually. In any case, industrial spin-offs from basic research are not immediate."

Mr Okamoto: "Discussing basic research inevitably introduces the notion of internationalism. Japan is fully aware of having built its economic power by using Western technology to a great extent. This idea of indebtedness is growing among the general public, hence our sense of duty to be the first in line to conrtibute to world basic research."

The fruitfulness of these discussions is beyond doubt and for several reasons. Not official in nature, they allowed a dialogue between the French and Japanese participants. Even if the Japanese replies were not always as clear and constructive as one might have wished, particularly regarding the practical operation of the program, this meeting put HFSP's initiators and interested parties in direct contact, highlighted the main (often cultural) difficulties of establishing a Western Hemisphere-Japanese collaboration, and opened an area for dialogue in which everyone can have a say. However, some topics which were not debated are still pending:

- The very basic nature of the research proposed : "Basic research" is a more accurate translation of the term used by the Japanese than "fundamental research;"

- The obstacle of the pragmatic approach adopted by the Japanese ("step by step"--to quote Mr Umehara) in establishing a large-scale and long-term project, a concept which risks coming up against Western attitudes which dictate that a commitment for a cooperative project cannot be made without sufficient knowledge of its progress and consequences (all the more so because economic spin-offs, thus proceeds, are involved);

- The feeling that HFSP could overshadow the EUREKA projects (actual cooperation agreements, judged on a case-by-case basis, are not so far from being established given the fact that companies [involved in EUREKA] are starting to be coveted);

- Finally, what are Europe's stakes in this type of scientific cooperation with Japan? If the Japanese contribute 50 percent or more of the required investment, they would have the majority share of the industrial ownership (here we are back to the question of the potential domination by Japanese industry). If they do not invest such a high percentage, what are the advantages in it for us?

[Box, p 65]

1987 Feasibility Study of the Human Frontier Science Program

The 1987 feasibility study, entrusted to specialists (scientists or otherwise) from the Summit countries, was essentially aimed at selecting the main research directions, defining the procedures for conducting the program, and developing the research findings (1986 was devoted to the development and expertise of the validity of possible research themes).

The feasibility committee has a total staff of 21: 6 Japanese (from whom the president will be chosen) and 15 foreigners (3 Americans, 2 Canadians, 2 Frenchmen, 2 Germans, 2 Italians, 2 Englishmen, and 2 members of the European Council). The third meeting of the international committee (planned for January 1988) will bring together five members of each country and will be held as a symposium.

Schedule:
- first meeting of the feasibility committee: 2 November;
- second meeting: 3-4 December;
- third meeting: January (date not yet determined);
- fourth meeting: March (date not yet determined).
  (All meetings will be held in Tokyo.)

Research themes currently selected:
- sensory perception and memorization,
- motor control and characteristics,
- expression of genetic information,
- morphogenesis,
- molecular recognition and response mechanisms, and
- energy conversion.

Technology improvement projects selected: DNA sequencing, determination of three-dimensional structures of proteins and associated functions, biological analysis, and ultra-micromanipulation.

Table 1. Budget Projection for Fiscal 1988 (in million yens) (including the 500-million-yen revaluation of the MITI budget projection)

HFSP Budget	1988	1987
*HFSP preparation (coordination: STA) - international meetings and detailed studies - Japanese meetings for feasibility studies in the various areas	3	1.5
*Promotion of research collaboration in life sciences (AIST, MITI) - international research teams, consultation of private-sector university specialists, subject definition	1.7	0
- R&D in biological functions (initiation of young foreign researchers for research projects carried out in the AIST labs)	3.3	0
*Promotion of R&D projects to be integrated into HFSP - human genome (RIKEN)	2.5	0.6
- neurology research program (Frontier Research Program, RIKEN)	2.5	0
- development of analysis and measurement techniques using stable isotopes (coordination: STA, national institutes)	--	0

Other Budgets for Promotion of Biology Research	1988	1987
*ERATO (biophoton, superbugs, biologic information transfer; Research Development Corporation of Japan)	16	18
*Frontier Research Program (biohomeostasis, Frontier Materials, RIKEN)	3	3
*International basic research (coordination): invitations to foreign researchers	6	0
*Accommodation for foreign researchers (Japanese Society for the Promotion of Science): 100 positions in 1988	3.7	0
*Promotion of international cooperative research (Nonbusho; Ministry of Education, Science, and Culture)	23	18

Budget requested by STA; by MITI for the AIST and standardization; by Nonbusho; and by the Ministries of Health, of Agriculture (MAFF), and of Post and Telecommunications.

25041

Takeda Chemical Research, Plans, Organization Reported

Development of New Drugs

43066521a Tokyo ZAIKAI TEMBO in Japanese Dec 87 pp 144-150

[Article by journalist Shiro Kamizono: "Mammoth Takeda Chemical Industries, Ltd., Seems To Be Hasty in Developing New Drugs!?"]

[Excerpts] The nature of Takeda Chemical Industries, Ltd., which was once called a quiet and conservative company of long standing, has suddenly changed. Now, it is concentrating very effectively on development activities so as to be one of the pioneers in biotechnology.

"New Wave" Which Can Change the Company's Tradition

Recently, the Ministry of Health and Welfare approved the application filed by Takeda Chemical Industries, Ltd., (hereinafter called Takeda Chemical) and Nippon Roche to register an interferon produced for the first time in Japan by recombinant DNA technology. This interferon is expected to be launched on the market early next year.

This interferon, which is called "Takeda Canferon A" is an alpha-interferon. In the living body, this interferon is produced by leukocytes and lymphoblast. Another interferon of this type has already been launched on the market by Sumitomo Pharmaceutical Co., Ltd. These two alpha-interferons greatly differ from each other in that the one commercialized by Sumitomo Pharmaceutical Co., Ltd., is a natural one produced by massive culture of lymphoblast, while the one produced by Takeda Chemical is a product of the latest biotechnology, i.e., a result of recombination of genes of Escherichia coli.

As medicaments produced by recombinant DNA technology, insulin (for the treatment of diabetes) and human growth hormone (for the treatment of dwarfism) have already been approved in Japan. The interferon produced by the Takeda Chemical group is the first medicament produced domestically with recombinant DNA technology.

A concrete form which the "new wave" in this company is taking is the plan which is to cover 5 years from this spring. In the last year of this plan, i.e., in 1991, the company plans to achieve annual sales of ¥700 billion

and an operational profit of ¥77 billion. Considering this year's budgeted sales of ¥485 billion and an operational profit of ¥52 billion, the 5-year plan is a highly ambitious one. Top executives of a competing company are quoted as saying that it is quite doubtful whether it can be realized.

What is more, Sumimasa Umemoto, president of Takeda Chemical who had a career as a government official, has a very grand conception: "We intend to increase the annual sales of our company to ¥1 trillion in 10 years. The recently published 5-year plan is a step preparatory for this target. We will study what will be necessary for us to become a ¥1 trillion business, and will solidify the foundation for this goal."

Competitors Feel Uneasy About Takeda's New 5-Year Plan

The 5-year plan is quite different from past plans. "In recent years, there have been new entries into the pharmaceutical industry from other industrial fields (such as the chemical and food industries) one after another. In addition, the aggressive competition from foreign pharmaceutical companies is becoming fiercer. Therefore, if no positive countermeasure is taken, it will be difficult for the companies to survive." Reacting to this sense of growing crisis, the giant company Takeda Chemical was forced to take a counterattack. Shinbe Kinishi, chairman of this company who is related to the Takeda family (the founder of Takeda Chemical), intends to make Takeda Chemical one of the leading pharmaceutical companies in the world, comparable to Bayer, Roche, and Merck.

According to the saying "new wine should be poured into a new wineskin," the company has recently begun to take great interest in the development of new "big" drugs produced through biotechnology (frontier technology). The Central Research Laboratory of this company, located in its Osaka Plant, serves as a center of these efforts.

In 1981, a Bioengineering Laboratory was organized in this laboratory for large-scale studies of biotechnology (at present, the Central Research Laboratory has 8 sublaboratories including the Bioengineering Laboratory and the Drug Formulation Laboratory). In addition to the development of the already-mentioned interferon, this laboratory has been developing new biotechnologically produced "big" drugs one after another.

Leading to Recombinant DNA Technology in Cooperation With Non-Drug Companies and Foreign Drug Companies

For example, hepatitis B vaccine is said to have a potentially larger market than anticancer agents. Takeda Chemical has developed a technology for large-scale production of hepatitis B vaccine with E. coli, utilizing gene recombination. Now, the company is evaluating the safety of such a vaccine. In addition, the company succeeded at the end of last year in developing a new vaccine which has a better immunizing effect than conventional vaccines and which also has the effect of inhibiting viral infection of hepatic cells.

This new vaccine is called a third-generation vaccine. It is said to be effective even for patients who do not respond to conventional vaccines (these reportedly constitute about 20 percent of total cases). The currently used hepatitis B vaccine is the first-generation vaccine which is produced by deriving virus protein from the blood of patients with hepatitis B. A disadvantage of this vaccine is its high cost because it is made from human blood. Therefore, there has been competition between companies to develop second-generation vaccines which are produced by inducing E. coli to produce virus protein using genetic engineering. What Takeda Chemical recently developed is a vaccine which possesses not only the features of a second-generation vaccine but also a unit which regulates viral infection. That is, unlike the first- and second-generation vaccines whose only action is to neutralize viruses, this vaccine additionally has the property of inhibiting the pathogenic action of viruses itself. Hence, the latter is potentially stronger.

Another promising new substance, now being developed by Takeda Chemical, is human interleukin 2 (IL-2) which is a physiologically active substance with an anticancer action. IL-2 is a protein which is produced by a kind of lymphocyte when stimulated by cancer or invasion of bacteria. IL-2 regulates the immune reaction of leukocytes; it also promotes the growth of killer T lymphocytes which attack viruses and cancer cells. Therefore, drug companies are competing with each other over development of this substance as a drug for immunotherapy or treatment of malignant tumors.

Like Shionogi & Co., Ltd., (which cooperates with Biogen, Switzerland) and Yoshitomi Pharmaceutical Industries, Ltd., (which cooperates with Genentics, United States), Takeda Chemical is quickly reaching the stage of mass production of IL-2, utilizing gene recombination. In the autumn of last year, Takeda Chemical established a technique for high-grade (99.98 percent) purification of IL-2, making an additional step towards commercialization of IL-2 as an anticancer agent. It started clinical trials of IL-2 earlier than other companies. Now, Takeda Chemical is leading the other companies in the competition over commercialization of IL-2.

Regarding the technique of mass production of IL-2 by gene recombination, Ajinomoto Co., Inc., and the Cancer Institute are moving ahead of the others. Their patent right for this production technique is being established, and they have granted license for its use to the Roche group. Therefore, Takeda Chemical applied for a license for the technique, and they have agreed to grant one to Takeda Chemical at the beginning of this year. In this way, there is powerful cooperation between the Ajinomoto-Cancer Institute (which is ahead of the others in basic technology), Takeda Chemical (which enjoys a competitive edge over the others in high-grade purification technology), and Roche (which has done excellent immunological studies in the past and which has a worldwide network). It is almost certain that Takeda Chemical will commercialize IL-2 before the other companies. Clinical trials of IL-2 are now going smoothly. It will be launched on the market in about 3 or 4 years at the earliest.

In addition, Takeda Chemical has developed a technique for mass production of monoclonal antibodies which are used for diagnosis and treatment of cancer. Now, the company is studying the application of missile therapy which involves destroying only cancer cells with a combination of monoclonal antibodies and IL-2.

"Avan" Sweeps the Market of Drugs for Treatment of Alzheimer's Disease

Within the framework of the Next-Generation Industrial Key Technology Research and Development Program of the Ministry of International Trade and Industry, Takeda Chemical has been studying mass cell culture technology. In the course of this study, Takeda Chemical developed a serum-replacing medium which is a combination of cell proliferation promoting factors (derived from the serum of mature cattle) and a basic medium. The cost of this medium is only about half that of a medium made of fetal bovine serum. Furthermore, this serum can be produced in large quantities. The development of this serum-replacing medium has accelerated the biotechnology research of Takeda Chemical. Since the demand for this medium from other companies is large, it assigned its production to Daigo Eiyo Kagaku, Ltd., (one of its subsidiary companies), and its distribution to Wako Junyaku Kogyo, Ltd., (another subsidiary). This arrangement also indicates the wide base of Takeda Chemical's biotechnology.

In September of last year, Takeda Chemical launched a newly developed diagnostic agent which is used for diagnosis of pregnancy, choriocarcinoma (a disease affiliated with pregnancy) and tumor of the testicular skin. The sensitivity of this agent in detecting HCG (human chorionic gonadotropic hormone) is said to be higher than that of any other agent marketed in the world. This is the first diagnostic agent which Takeda Chemical has developed independently. This agent is expected to be applicable for early recognition of pregnancy, evaluation of the risk of abortion or premature delivery and diagnosis of ectopic pregnancy and hydatidiform mole. If business in this substance is successful, Takeda Chemical plans to enter into full competition in the field of laboratory and diagnostic agents, actively importing foreign-made agents. The production of this agent was assigned to Tokyo Hyojun Kessei, Ltd., (one of Takeda's subsidiaries).

At the end of last year, Takeda Chemical launched "Avan" [generic name: idebenone] which is a new type of drug for improving brain metabolism and is used for Alzheimer's disease. Competing companies regard this drug as having a very large market potential. The development of this drug is due to the steady efforts of the researchers, such as breeding rats in which cerebral apoplexy occurs at a probability close to 100 percent and which can be used as models for pathological study (these rats were bred by Takeda Chemical for the first time in the world). Considering the sales performance of the already launched drugs "Calan" [generic name: vinpocetine] and "Hopate" [generic name: calcium hopantenate] sold by Tanbe Seiyaku Co., Ltd., the annual sale of Avan is expected to exceed ¥20 billion at its peak. In addition, Takeda Chemical is developing "Sarufa" (an anti-allergy agent), "Maon" (an anti-ulcer agent), and "CV-3317" (a hypotensive agent).

As stated above, the drugs newly developed by Takeda Chemical are going to be launched on the market one after another. The percentage of the self-developed drugs among the total drugs sold by Takeda Chemical was 56 percent in 1984 and 57.4 percent in 1985, which is fairly low compared to the figures (70-80 percent) recorded by Yamanouchi Pharmaceutical Co., Ltd., Eisa Co., Ltd., and Ono Pharmaceutical Co., Ltd.

These low percentages of the self-developed drugs are explained by the history of this company: it grew larger by selling drugs which were imported from other countries or produced by the licensed technology of foreign origin. However, the environment surrounding Takeda Chemical is rapidly changing due to the government policy to reduce medical expenditure and to reform the medicare system and also to the fierce domestic and international competition over new technology and new drugs.

For these reasons, Takeda Chemical is switching its basic nature from a sales-oriented to a development-oriented company. The R&D expenses of this company for 1 year from April 1985 to March 1986 were as large as ¥31.7 billion, larger than the annual R&D expenses of any other pharmaceutical company in Japan.

However, the R&D expenses of foreign multinational large drug companies are three or four times that of Takeda Chemical. However, it is a supreme order for Takeda Chemical to become a large international company. An ultra C (special) measure taken by Takeda Chemical in order to reinforce its basic research is the establishment of the Tsukuba Laboratory whose construction began last October and which is to open next January.

To develop creative new drugs which can be accepted internationally, know-how covering extensive fields (not only medicine, pharmacology, chemistry, and biology, but also electronic engineering and physics) is necessary. That is, cooperation between various academic fields is indispensable. In this sense, Tsukuba is an appropriate place for interacademic cooperation because there are many governmental research institutes and civil-sector laboratories in this district called "Tsukuba Science City." Takeda Chemical appears to intend to make up for the weak point of the Central Research Laboratory (that is, basic research) by utilizing the studies done outside. This hidden aim of this company is noticeable in the explanation of President Umemoto: "The Central Laboratory will engage in applied research whose fruits can be obtained in 3 or 5 years, while the Tsukuba Laboratory will look for next-century technology with a time frame of 10 or 20 years."

Based on this policy, the Tsukuba Laboratory will engage in the study of proteins associated with aging, cell growth, and brain functions. In the future, the laboratory will engage in creating new drugs which are related to the self-reproduction and repair systems of the living body.

Takeda Chemical's "strategy for improving efficiency" making use of the knowledge of outside researchers is apparent also in its participation in the "Institute of Protein Engineering," which was organized jointly by the

government and the private sector. Of the five companies involved in establishing this institute, Takeda Chemical is the only one specializing in the pharmaceutical business. By its participation, Takeda Chemical has built, earlier than other companies, a feedback system for the test information concerning protein engineering, which is said to be a central technology for the 21st century. This policy was also followed when Takeda Chemical decided to join the Human Science Promotion Foundation which was established last spring under the guidance of the Ministry of Health and Welfare. It intends to take the initiative in the operation of this foundation by promoting Einosuke Omura (a former executive director of Takeda Chemical) to the post of representative director of this foundation.

The new strategy of Takeda Chemical to make use of anything that might be practical is seen also in the company's overseas activities. A good example is their cooperative research with Roche for the development of interferon. There is a consensus among executives and researchers that a basic policy for biotechnological research is for Takeda Chemical to develop original technology, and not simply import technology from foreign companies.

In the autumn of last year, Takeda Chemical concluded a contract with Harvard University (United States) concerning cooperative research on vascular generator factors and vascular inhibitor factors. In exchange for financial aid amounting to ¥500 million over 3 years, Takeda Chemical obtained the right to develop new anticancer agents on the basis of the results of cooperative research.

Cooperative research founded on this contract has already produced some promising results. In the spring of this year, a vascular generator factor was successfully produced for the first time in the world by gene recombination in E. coli, and purified to a high grade. This factor allows revascular generation in patients whose blood vessels have been damaged by myocardial infarction or burns and also in elderly individuals. In addition, a counterfactor can be isolated which suppresses the growth of this factor, which will enable the development of anticancer agents effective for various cancers. It is known that the differentiation and growth of cancer cells is only possible owing to formation of new capillary vessels within cancer cells which transport oxygen and nutrition into cancer cells. Therefore, suppression of the formation of new capillary vessels results in suppression of the growth of cancer cells and their annihilation. Takeda Chemical has sent a sample of the vascular generator factor to Harvard University, and they are urgently evaluating it from physiological and pharmacological aspects.

Recently, Takeda Chemical organized a wholly owned subsidiary " Takeda Chemical Products U.S.A." in North Carolina, which is now manufacturing vitamin B_1 on a full scale. In Europe, Takeda Chemical established "Takeda Germany" to serve as a foothold for the bulk distribution of products. In addition, "Takeda France" (a joint venture with the French company Roussel Uclaf) and "Takeda Pharma" (a joint venture with the German company Grunenthal) were established for the distribution of new drugs.

Recent rapid advances in transportation and telecommunications have brought about a situation where the development of medicaments has advanced simultaneously both in Japan and foreign companies. For this reason, negotiation with the foreign partner for research, development, and distribution of drugs usually begins at a fairly early stage. When an application for government approval of a new drug is filed in Japan, a similar application is simultaneously filed in other countries. In some cases, government authorization for a new drug is obtained in another country earlier than in Japan. Following this trend, the exchange of contracts, data, and letters, and negotiation between Japanese and foreign drug manufacturers is sharply increasing. Last year and this year, Takeda Chemical recruited foreign engineers.

High-Tech Engineers, R&D

43066521a Tokyo ZAIKAI TEMBO in Japanese Dec 87 pp 152-160

[Article by Group Topula]

[Excerpts] Basic research is an essential theme for Takeda Chemical which intends to develop internationally acceptable new drugs. Because it is difficult for an enterprise to carry out basic research limitlessly, Takeda Chemical is promoting cooperative research among the enterprise, the government, and academia.

Part I. Research System

There are 1,600 R&D staff members at Takeda Chemical, 260 of whom have a PhD. Their annual R&D expenditure is ¥31.7 billion, which is much higher than that of any other pharmaceutical company in Japan. To further enrich the R&D system, Takeda Chemical began to reform the organization of the Central Research Laboratory this April. Next January, the Tsukuba Laboratory, which is now under construction, will open. At the Tsukuba Laboratory, exploration of new business opportunities and development of new drugs which do not belong to any of the company's conventional product lines will be targeted.

In addition, Takeda Chemical has recruited excellent young researchers from overseas, and positively participated in cooperative research with industry, government, and academia.

The reason why Takeda Chemical intends to enrich its R&D capacity is that the capacity to develop new drugs is crucial in this industry, and that development and internationally acceptable new drugs greatly affects whether or not a pharmaceutical company can survive.

According to Shinbe Konishi, the probability of success in developing a new drug by a company is as low as 1/5000 to 1/10000; and the time and cost required are 15-16 years and ¥7-8 billion, respectively. This huge cost is impossible to recover by marketing the new drug in the domestic market alone. Hence, entry into foreign markets is indispensable for survival of the company.

In the laboratory of this company, the YG society (formal name: the society for frank discussion and talks between the laboratory director and research staff members) was organized from the belief that enhancing R&D activity is indispensable for the bright future of Takeda Chemical.

Under the current R&D system, development of medicaments is done by the Central Research Laboratory located at Juso, Osaka. In the other business fields, R&D is done by the research laboratories which belong to each business division, such as the Foods Laboratory, Chemicals Laboratory, Agrochemicals Laboratory, Animal Drugs Laboratory, Production Technology Laboratory and the Technological Development Office of the Fine Chemicals Division.

The Central Research Laboratory consists of six buildings, i.e., a main buildings (eight stories above and two underground; constructed in 1971), and five annex buildings. Specifically, the first annex building is used by the food, chemical, and agrochemical laboratories which belong to each business division. The second annex building is used chiefly for R&D in fermentation, and the third and fourth annex buildings are used for studies of the industrial production of medicaments. The fifth annex building is used for biotechnology research.

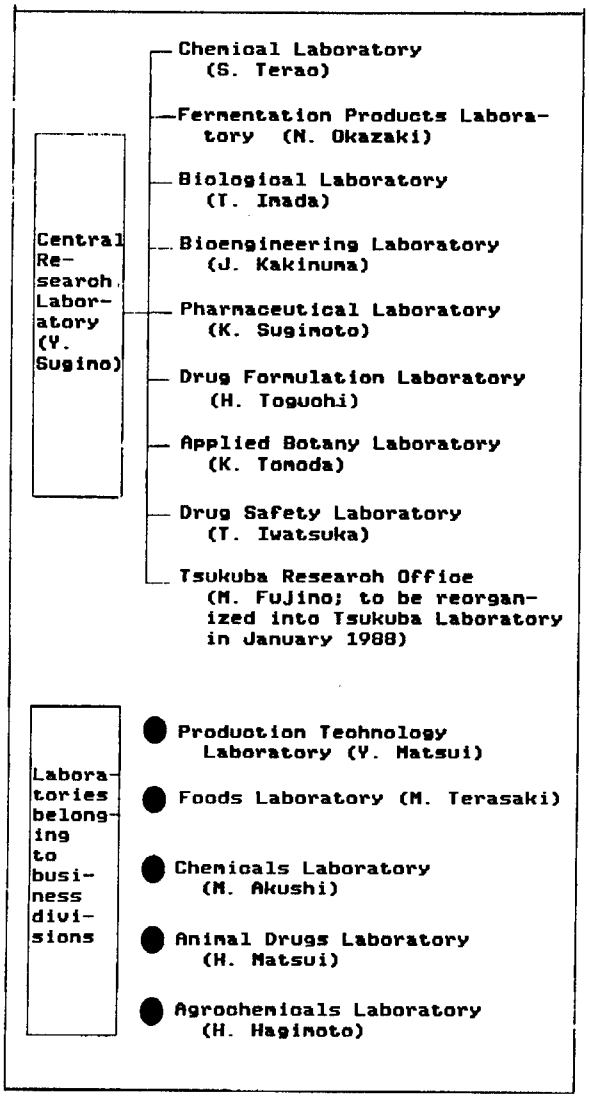
The Central Research Laboratory consists of the following branch laboratories: chemistry, fermentation products, bioengineering, pharmaceutical sciences, drug formulations, applied botany, and drug safety. Under this organization, the Central Research Laboratory carries out the full course of research and development from basic study to the development of commercial products.

In the spring of this year, a substantial personnel reshuffle and reorganization was carried out at the Central Research Laboratory. Regarding this reshuffle, it should be noted that the laboratory heads were replaced at six of the eight laboratories constituting the Central Research Laboratory.

Figure 1 shows an organizational chart of the Central Research Laboratory. Staff members were selected from among both clerical and technical employees.

The main points of the recent reorganization of the Central Research Laboratory are 1) renaming the Crude Drug Laboratory the Applied Botany Laboratory; and 2) creating new posts, i.e., the chief engineer executive researcher, who reports directly to the head of the Central Research Laboratory. Of these two main reforms, the first reflects the recent change in botanical research, which has diversified through utilization of biotechnology although in the past it was limited to the study of crude drugs.

Table 1. R&D System ( ) = name of laboratory head



Efficient Development Through Vertical and Horizontal Cooperation

The task of the Central Research Laboratory is to perform a full course of work from screening new drugs to the commercialization of new drugs. In these stages, jobs are not always allocated vertically to individual organizations. Instead, a project team, consisting of the members of different branch laboratories, is often organized when a promising compound had been discovered. That is, project teams are organized horizontally, involving different units of the vertically organized laboratories. A project team is in charge of basic studies, ranging from discovery of promising compounds to clinical trials. A team is organized by one of the seven or eight project leaders, each of whom is always assigned five or six project teams.

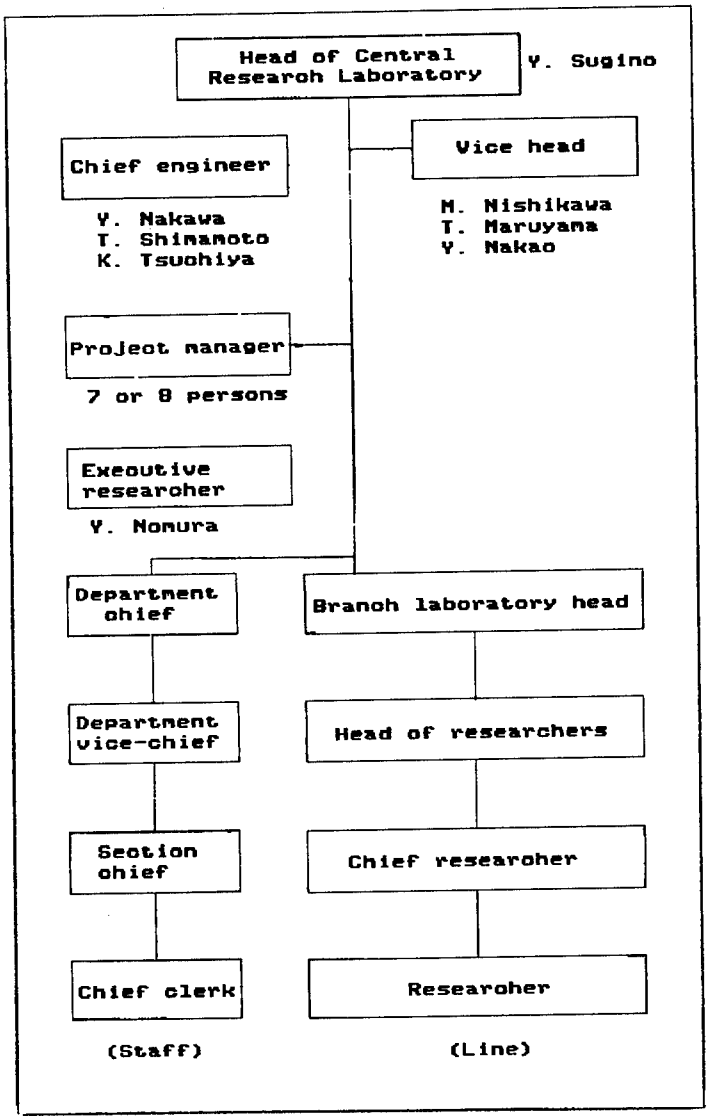


Figure 1. Organization Chart for the Central Research Laboratory

In the research laboratories of other companies, a chief researcher or researchers of similar class are usually appointed to be project leaders. At Takeda Chemical, however, experienced researchers are appointed to the position of project leaders. Project managers are required not only to advance R&D but to manage R&D from an overall point of view.

Now, let us look at the role of the posts newly introduced by the reorganization in spring of this year, i.e., the posts of chief engineer and executive researcher. The executive researcher is engaged in the research of the area specially designated by the head of the Central Research Laboratory. Y. Nomura, the head researcher of the Chemical Laboratory was appointed to the post. Considering that the head researcher of each branch laboratory was frequently promoted to the head of the laboratory concerned in the past, this new post of executive researcher is regarded to be very important.

The chief engineer is expected to carry out special tasks designated by the head of the Central Research Laboratory. K. Tsuchiya (a former project manager of the Central Research Laboratory), Y. Nagawa (a former head of the Biological Laboratory), and T. Shimamoto (a former head of the Drug Formulation Laboratory) were appointed to this position.

Considering that two of these three appointed to chief engineer are former heads of branch laboratories, chief engineers are expected to play a strategic role, making use of their rich experience and personal connections. That is, the task of chief engineer is to seek the possibilities for cooperation at every stage from basic research to product development by collecting and analyzing R&D information at domestic and foreign research institutes from a broader point of view. Relocation of veteran researchers will be actively carried out in the future.

In the past, tests, analyses, and safety tests were carried to individually at each laboratory. A part was entrusted to foreign testing institutes. In the future, Takeda Chemical plans to carry out tests at a single institute, so that cost reduction and improved efficiency by the use of enhanced facilities can be achieved. At present, a new building for the Center for Tests and Analyses is being constructed in the Osaka Plant. In the future, this center will perform tests and analyses for other companies and will be separated from Takeda Chemical as a subsidiary company.

These measures (appointment of younger people to laboratory head and relocation of veteran researchers) are said to be aimed at earnestly promoting new business and peripheral business on a full scale. In the long term, these measures are also aimed at preparing an organization for the development of drugs related to the treatment of senility so as to cope with the increasing aged population.

Creation of Free Atmosphere for Encouragement of New Ideas

As a means to raise the morale of researchers, the researcher encouragement system was established. Since the timespan between the start of research and commercialization of a new drug is very long, this system honors excellent research already at the initial stage, so that the morale of researchers can be raised.

In March 1985, the already-mentioned YG Society was established through a proposal of Morita (head of the Central Research Laboratory in those days; at present, managing director).

The YG Society has its secretariat in the Investigation Department of the Central Research Laboratory. Each branch laboratory has a person (chief researcher or researcher of similar class) who takes care of matters regarding this society. At a meeting of these people from each branch laboratory, the topics to be discussed at the meetings are decided. Recent topics include "study of D.D.S. [drug delivery system]," "study of immune defense in the living body," "study of the brain," and "laboratory automation."

Of these, D.D.S. means a technique by which a drug, which at present requires a daily dose, requires a dose only once a month. This technique involves subcutaneous injection of a special microcapsule, containing a drug, and delivers the drug gradually from this subcutaneous pool.

Once a frontier research theme like this is decided, the chief researcher appoints some researchers majoring in that field or related fields or those interested in that field to report at a planned meeting.

The head of the Central Research Laboratory listens to the opinions of young researchers and gives appropriate advice. The meeting of the YG Society is held at 2 week intervals.

The meeting of the YG Society has received favorable comments because it provides a good opportunity for the laboratory head and researchers (who usually have little opportunity to meet) to make contact with each other. In addition, it is said to be quite useful in widening the interests of young, middle level, and veteran researchers through mutual stimulation. Of course, the main purpose of the YG Society is to find innovative, excellent research topics through creating a free atmosphere in the laboratory.

This year, Takeda Chemical has begun to recruit capable foreign researchers. This measure is to cope with rapidly advancing internationalization. For now on, joint research with European and U.S. enterprises is expected to increase. Following this increase, conclusion of contracts, exchange of data and correspondence with foreign research institutes will increase. Foreign researchers employed by Takeda Chemical will be helpful in such situations. Of course, the major reason for recruiting foreign researchers is "an expectation that their ideas are different from those of the Japanese" (Morita, managing director). Thus, it is expected that the employment of foreign researchers will activate the laboratory.

From now on, Takeda Chemical will probably scout foreign researchers more actively than ever; and they will be assigned to the newly established Tsukuba Laboratory in particular. Takeda Chemical decided to newly establish the Tsukuba Laboratory not only because the Central Research Laboratory has no free space but also because "the way of thinking or the concepts of researchers seems to have reached the limit."

At the Tsukuba Laboratory, investigators will be allowed to cultivate their ideas in a free atmosphere. The laboratory will start with researchers invited from both Japan and other countries. It will be engaged mainly in the study of proteins. It will study substances which are responsible for the differentiation, growth, and aging of cells in order to develop revolutionary drugs for the treatment of senility.

"The Central Research Laboratory sets its sight on developing new drugs in 5 years, while the Tsukuba Laboratory sets its sight on developing revolutionary new drugs in 10 or 20 years," says Morita.

Thus, greater importance is attached to basic studies at the Tsukuba Laboratory. Masahiko Fujino, a former head of the Chemical Laboratory who graduated from Hokkaido University, Department of Biochemistry in 1958, and who is internationally known as a researcher on proteins and physiologically active substances, will be the first head of this laboratory. A major aim of establishing the Tsukuba Laboratory is to promote cooperation with governmental and university high technology research institutes which are concentrated in the Tsukuba district. Taking this opportunity, Takeda Chemical intends to further its connections with Kanto area universities, in addition to the current close connections with Kansai area universities (Kyoto University, Osaka University, etc.). In addition, Takeda Chemical expects that it will employ capable researchers from Kanto area universities earlier following the establishment of the Tsukuba Laboratory.

Part II: Personal Connections

K. Morita (a managing director of Takeda Chemical) is the general coordinator of the R&D division. He is chiefly in charge of external relations. At the same time, he is chairman of the R&D Committee of the Kansai Committee for Economic Development. He is now making efforts to promote cooperation and joint research with nonpharmaceutical companies.

The administration of the laboratories is managed by Yukio Sugino (head of the Central Research Laboratory, who is an authority on molecular biology. Masahiko Fujino, who will be appointed head of the Tsukuba Laboratory (which will be opened next January as a branch laboratory of the Central Research Laboratory) is internationally known as an authority on proteins. He is expected to work as a leader of the "new dream drugs" development projects.

Start of Full-Scale Biotech Research at Bioengineering Laboratory

The Bioengineering Laboratory had 40 researchers in the beginning. These researchers formerly belonged to the microbiology genetics study group, the protein chemistry study group and the immunobiology and cell biology study group of the Biological Laboratory; the fermentation study group and the microbiology gene study group of the Fermentation Products Laboratory; and the DNA chemical synthesis group of the Chemical Laboratory. These researchers were assigned to five research groups at the Bioengineering Laboratory, i.e., the "alpha-interferon," "gamma-interferon," "interluekin 1," "hepatitis B virus vaccine," and "monoclonal antibodies" research groups. By now, the number of researchers at this laboratory has increased to 70.

Up to now, a manufacturing license has been issued for alpha-interferon. Gamma-interferon and interluekin 2 are now at phase III of study (collection of data necessary for registration of a new drug).

Takeda Chemical believes that it leads competitors worldwide in the development of a physiologically active material called interleukin 2. It

development of a physiologically active material called interleukin 2. It will not take much time until it launches interleukin 2 as an anticancer agent. Clinical trails of this agent have been performed with the cooperation of Professor Tetsuo Taguchi of the Osaka University Microbial Diseases Research Institute.

One of the noteworthy achievements of this laboratory is that a vascular generator 6FGF was produced for the first time in the world by recombinant DNA technology using E. coli. This factor is responsible for the growth of vascular endothelial cells. The use of this factor will enable revascular generation in aged patients.

In November of last year, Takeda Chemical concluded an agreement with Harvard University (United States) for joint research of vascular generation factors. Based on this agreement, Takeda Chemical provides Harvard University with highly purified 6FGF, and Harvard University studies it physiologically and pharmacologically.

Sugino places his hope in this joint research, saying, "Harvard University has a rich accumulation of data on vascular generation. Therefore, we can expect an ideal mutual benefit between our company and Harvard University."

The 6FGF is useful in the treatment of senility because it includes vascular growth. If a factor which suppresses the growth of 6FGF is discovered, it will be used as a potent anticancer agent. In this sense, 6FGF is a very promising substance.

Professor Folkman regards Takeda Chemical's research level on molecular biology to be high and he intends to increase joint research with Takeda Chemical.

Emphasis Put on Basic Study, Disregarding Profits

Compared to other pharmaceutical companies, we may say that Takeda Chemical has been putting greater emphasis on basic study, sacrificing profits to a considerable degree. A good example of such an attitude is the development of "Avan" (a drug for the treatment of Alzheimer's disease marketed last year).

To develop a drug for the treatment of Alzheimer's disease, a large number of experimental animals showing symptoms is required. Until the development of Avan, Takeda Chemical raised rats for as long as 20 years. Immediately before his retirement, Professor Kozo Okamoto (now professor emeritus) of Kyoto University brought rats with spontaneous cerebral apoplexy to Takeda Chemical, and asked the company to continue studying these rats.

Takeda Chemical collected and studied rats showing spontaneous cerebral apoplexy for 7 years, to produce rats which develop cerebral apoplexy at a rate of 100 percent. Ten years ago, the company began to develop Avan. In this way, Takeda Chemical continued a study for many years, disregarding profits.

The future of a pharmaceutical company depends on whether or not it succeeds in developing new drugs. In the past, foreign technology could be easily imported. At present, however, foreign companies are not willing to license their technology to Japanese companies who have no original technology to supply in exchange.

Takeda Chemical spends ¥30 billion or more every year for R&D, but the R&D expenditure of major multinational pharmaceutical companies is three or four times larger. Therefore, it seems impossible for one company to perform sufficient basic research. Under such circumstances, joint research with academia and the government (for which profitability can be disregarded) has begun to be promoted.

The Human Science Promotion Foundation, headed by Mr Omura (former head of Takeda Chemical Central Research Laboratory), aims at promoting joint research projects between the government and the civil sector. The following activities related to biological and other studies are its main duties: 1) to send private sector researchers to national research institutes; 2) to promote transfer of new technology to the private sector; 3) to promote international joint research; and 4) to survey, estimate, and evaluate the fundamental technologies.

The Institute of Protein Engineering was established jointly by the government (through the Basic Technology Research Promotion Center) and the private sector (Toray Industries, Ltd., Kyowa Hakko Kogyo Co., Ltd., Mitsubishi Chemical Industries, Ltd., and Toa Nenryo Kogyo K.K.). This institute is now constructing its laboratory in Seri, Osaka, which will be completed by next summer.

Four persons were appointed as advisors who are expected to guide the institute from a broader point of view: Kazutomo Imabori (head of the Mitsubishi Chemical Institutes Life Science Laboratory), K. Ono (research department director, Beckman Research Institute of the City of Hope), Osamu Hayaishi (president of Osaka Medical University), and Yuichi Yamamura (former president of Osaka University). In addition, the institute has concluded research trust agreements with influential universities such as Tokyo University, Kyoto University, and Osaka University.

In Senri, Osaka, the establishment of a third-sector organization tentatively named "Senri Life Sciences Center" is planned for next February by the Osaka prefectural government and nine major companies in the Kansai district. Of course, Takeda Chemical is one of these nine companies.

Next September, construction of an Intelligence Building, which will serve as a core for this center, will be started. This building will have facilities for international conferences and social halls which will be used for academic meetings and seminars, information services, and exchange between researchers. In this way, it will serve as a core for the network of research institutes and facilities.

The area surrounding this center contains many biotech research facilities. The Suita campus of Osaka University (in Suita City) has the Microbial Diseases Institute, the Cell Engineering Center, the Protein Research Institute and the Biotechnology-Related Study Facility. In 1993, the Osaka University Medical School and its hospital will move to this campus. Also, in Ekoda City, the Osaka Bioscience Institute (headed by Hayaishi) is now under construction. To the north of this institute, the Protein Engineering Institute will be opened next summer. The Senri Life Sciences Center will serve as a core for these research facilities.

The plan to establish this center was realized due to the efforts of Umemoto (president of Takeda Chemical) as the representative director of the Kansai Committee for Economic Development. President Umemoto intends to "make Osaka a mecca for worldwide biotechnology research in order to restore the economic power of the Kansai area."

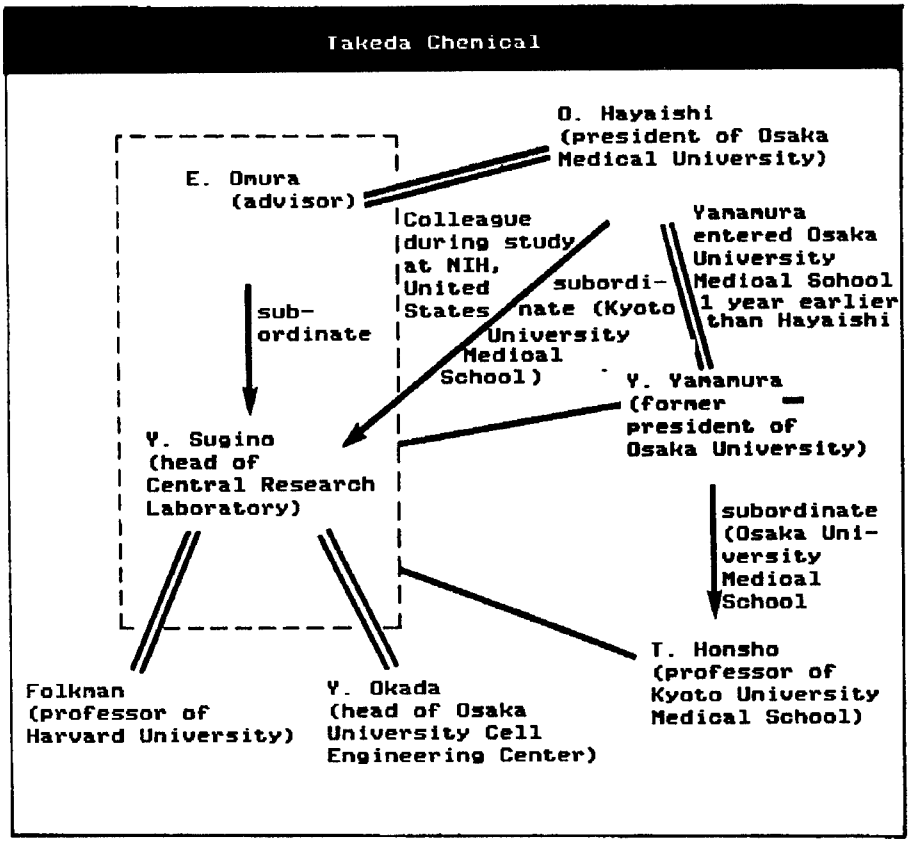


Figure 2. Personal Connections

Development of New Technology

43066521a Tokyo ZAIKAI TEMBO in Japanese Dec 87 pp 162-165

[Article by Suehiro Mizusako, science journalist]

[Excerpts] A key point which explains the excellent R&D capacity of Takeda Chemical (which was founded 206 years ago) seems to be the docking of chemical and biotech studies with biological studies and their balanced management.

The accumulation of studies in these three fields for more than a half century seems to have resulted in the development of a next-generation drug named "Avan."

Takeda Leads Competitors in Fields of Biotechnology

Like chemistry, biotechnology is the first-step technology in the development of pharmaceutical products. Takeda Chemical began to try application of biotechnology earlier than other companies.

A product related to biotechnology is "Nicholin Injection" which the company launched on the market in 1967 as a drug for the treatment of consciousness disturbances.

Before marketing this drug, Takeda Chemical thoroughly carried out toxicological, fetotoxicological, and general pharmacological studies in order to confirm its safety. The thoroughness of these studies indicates that Takeda Chemical has sufficient biological researchers.

A relatively new biotech product is "Dasen" [a brand name of serratio peptidase] which is used as an ingredient of Benza Ace launched on the market in 1979. The development of this product is based on the success of massive production of acidic protease by culture of Pycnoporus coccineus Aoshima in tanks which was done by Takeda Chemical for the first time in the world. This success was stimulated by the study on the enzymes produced by wood-rotting fungi (this study was started in 1960), which disclosed that some microorganisms are involved in the dissolution of silkworms.

Biological Technology Related to Chemical and Biotech Research

The first concrete form of these efforts was the construction of the No 1 building of the general research laboratories which was completed in August 1958 at a total cost of ¥850 million within 1.5 years. This building, made of ferroconcrete, has two stories above and one story under ground as well as a two-story penthouse; it has sufficient facilities for RI research, breeding of experimental animals and experiments. This building covers 2,144 square meters and its total floor space is 12,095 square meters (thereafter, the No 2 and No 3 buildings were constructed. In this building, various research groups (pharmacology, infections, pathology, biochemistry, and pathogenic microorganisms) were gathered.

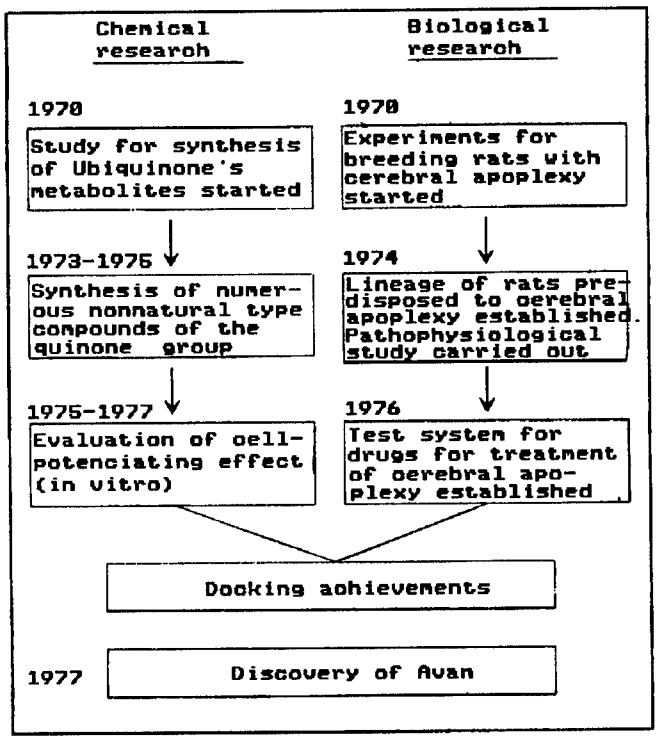


Figure 3. History of Research on Avan

The strength Takeda Chemical has been sufficiently expressed by its patient efforts to develop "Alinamin" and various studies carried out to develop Nicholin. When vitamin B_1 was mixed with garlic in the course developing Alinamin, vitamin B_1 disappeared. Despite such a failure. Takeda Chemical did not give up its development.

Study on Alzheimer's Disease and Development of Avan

The life expectancy the Japanese has been extended to 80 years and the percentage of the aged among the total population is increasing. Under such circumstances, a long-awaited new drug "Avan" was developed through the above mentioned three studies. Like the development of the other drugs, Avan was a result of docking as shown in Figure 4.

This drug for improving brain metabolism and mental problems was developed by a combination of the study on benzoquinone at the Chemical Laboratory and the study of rats predisposed to cerebral apoplexy at the Biological Laboratory.

Avan cannot restore reduced intellectual functions (a chief symptom of Alzheimer's disease), but it activates brain cells. That is, this drug is expected to improve the reduced will or spontaneous activity of the patient, to cure emotional instability (anxiety, suppression, etc.) and to improve speech.

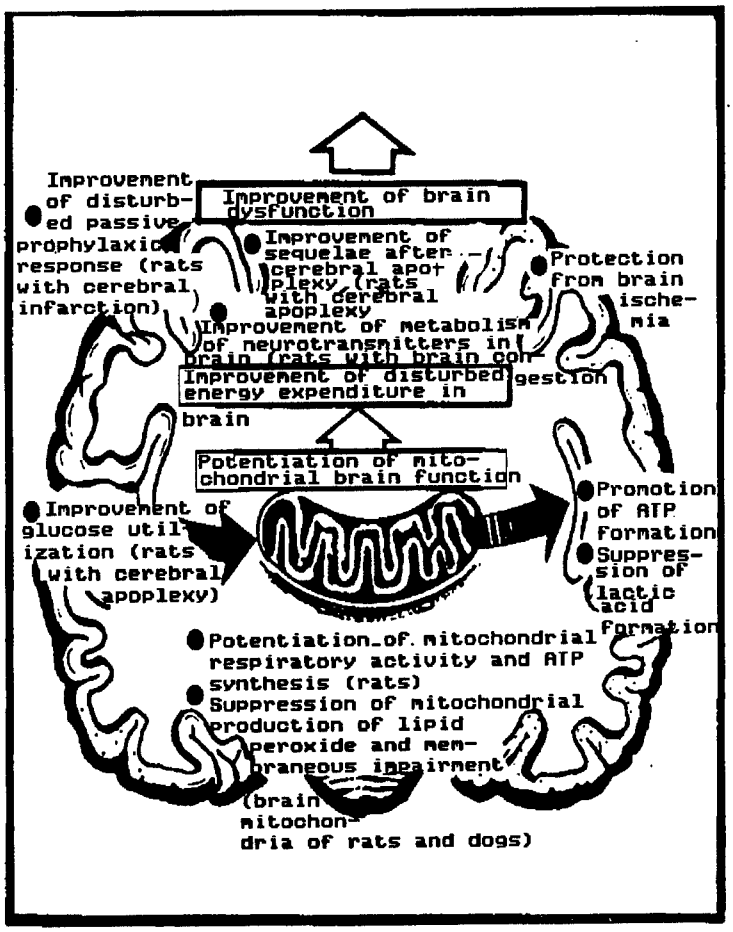


Figure 4. Mechanism for Improvement of Brain Disorder

This drug activates the function of mitochondria in brain cells and promotes energy production which is essential to cellular activity.

The features of this drug indicate that the development is in line with the past R&D of Ubiquinone-7 which was isolated from yeast in 1959. Ubiquinone [a brand name of ubidecarenone] plays a role in mitochondrial electron conduction. It generates energy and activates the cells.

In any event, it is fortunate for Takeda Chemical that through a combination of chemical, biotechnological, and biological studies the company has marketed a "big" product which is expected, in a mid-term plan, to help the company achieve the annual targeted sales of ¥700 billion 5 years hence and ¥1 trillion 10 years hence. This product will compensate for the loss caused by many products which were abandoned without bringing profit.

20123/9365

OUTLOOK FOR MARINE MICROORGANISM RESEARCH DISCUSSED

Research Trends

43066530 Tokyo KAIYO KAGAKU in Japanese Jan 88 pp 4-6

[Article by Professor Uchio Shimizu, Department of Marine Microorganisms, Marine Research Institute, Tokyo University]

[Excerpts] Sea microorganisms live in complicated environment, including on the surface and in the bodies of other organisms. In this article I will discuss the types of marine microorganisms and their ecological diversity together with the rich possibilities of research on marine microorganisms.

1. The Sea and Microorganisms

The sea is the kingdom of microorganisms. The sea, which covers two-thirds of the earth's surface at an average depth of 3,800m, is filled with microorganisms including bacteria. A normal count is about 10^4 bacteria per milliliter of seawater, even in the oligotropic water areas of the open and deep seas that contain less than 1 mgC of organic substances per liter. Microorganisms that are several times more plentiful than these live in the eutrophic coastal seawater and in the sea bottom deposits.

It may be said that the quantity of microorganisms in seawater is about 10^5 to 10^7 times greater than in a comparable volume of air. This fact indicates that it is far easier for microorganisms to live in seawater than in air, where there is practically no water or nutrition and where they are often exposed to ultraviolet radiation.

2. Mutual Relation Between Microorganisms and Sea Organisms

Parasitism: Symbiosis and biologically active substances

It is well known that animals and plants of the sea produce many bio-active substances. The most active field of research in recent years among the marine sciences has been a search for antibacterial substances, antitumor agents or biologically active substances such as toxins and other pharmacologically active substances from many sea animals and plants, such as

sponges, corals, molluscan corals, starfish, sea anemones, sea slugs, sea hares, Flagellata, Chlorophyta, Rhodophyceae, etc.

At present, there are about 3,000 chemical substances that are separated and extracted from sea animals and plants. But it is said that of these, only a few hundred have structures and activities that are well known. In recent years, many research workers have come to suspect that many of these biologically active substances are directly made by microorganisms that are either parasitic on or live together with the animals and plants, or are produced in response to the stimulus of microorganisms, even though the substance is made within the host body. Several facts confirming this conjecture have also been discovered.

It is very likely that many chemical substances act as agents for maintaining the relation between microorganisms and sea animals and plants, whether the relationship be intimate and strained. It may be that the host produces some sort of substance to prevent the invasion of harmful microorganisms or to hold down the aberrant breeding of microorganisms that are living in its body. Moreover, it may be that the microorganisms produce some sort of chemical substances to resist the immune mechanisms of the host or to win the competition with other microorganisms. Furthermore, many microorganisms are inevitably destined to go back and forth from the bodies of animals and plants to seawater and there must be a mechanism for adapting to a totally different environment that has a physical basis.

Setting aside the assignment of an ecological reason, it is a fact that sea microorganisms produce many biologically active substances. Research in this field, in connection with the so-called biotechnology, has shown a rapid development both in Japan and in various foreign countries.

3. Research on Marine Microorganisms

a. Research themes

New microorganisms that we had never even imagined have been reported one after another in recent years and we have the impression that it would not be easy to catch up with the fast tempo.

Research themes on marine microorganisms, reflecting this development, have become extremely diversified, from their foundations to applications. I believe that part of this diversity can be seen in this special edition. Still, it is a matter of regret that many interesting topics had to be omitted due to space limitations.

Recently, the importance of marine organisms, and especially microorganisms, has come to attract both domestic and international attention, particularly regarding potential uses. Several research systems related to this have already been established in the United States. In Japan, several large-sized projects in which various governmental offices are involved have been planned or are now under way.

The problem here is that our knowledge is still limited on such matters as the physiology, ecology and classification of marine microorganisms that are to be the utilization objects. It may be that research on applications will be fruitful in its own right even with today's limited range of knowledge. However, the perfection of a wide range of basic research is more important for pursuing the limitless possibilities possessed by marine microorganisms.

b. Development of research on marine microorganisms

The world of microbial research, whether basic or applied, is now welcoming a great historical turning point. It is well known that the driving force behind this transition is our ability to directly read the information coded in the microbial genes and, at the same time, to freely manipulate a portion of these genes.

The effects of this transition are also being felt in the fields of marine and aquatic microbiology. Research applying the methods of molecular physiology and molecular genetics has also started to appear in basic physiology and taxonomy, and many of these techniques are being clearly used to extract solutions to problems insolvable by conventional means. Although it goes without saying that progress will be made in microbial genetics in the field of applied research, the trend of interpreting, explaining, and studying phenomena at the molecular level will become increasingly dominant in the future.

Food Chain, Aquatic Breeding

43066530 Tokyo KAIYO KAGAKU in Japanese Jan 88 pp 24-27

[Article by Assistant Professor Masachika Maeda, Department of Marine Microorganisms, Marine Research Institute, Tokyo University]

[Excerpts] 1. Introduction

Several important points must be considered in the establishment of aquatic culture and breeding facilities. First of all, the quality of the seawater becomes a problem, as are weather conditions, the supply of electric power and water service. The availability of transportation is also a factor in selecting a site. Seawater that is polluted or has poisonous plankton breeding in it is not desirable as breeding water for fish products. Moreover, the culture of infant fry can be started only after a setup for smoothly supplying the parent fish to produce the spawns and infant fry has been created. Time is a factor in such processes as the culturing and maturing of the parent fish, spawning, and hatching.

2. Forming of Microbial Feeds in the "Water Preparation" Process

The most important point in breeding the infant fry of commercial fish is the so-called "water preparation." Water preparation means artificially preparing

an ideal environment for the larvae by introducing organisms or abiotic substances. For example, in breeding Portunus tridentatus larvae, the standard combination of Rotatoria->Altemia->fish meat products had been tentatively established as the conventional feed system. However, the survival rate from the incubation zoea up to the first age infant crab was generally below 1 percent and it was not unusual for the entire hatch to be lost. Takahashi and Matsui (1972) applied short-necked clam soup, soy-sauce soup and phytoplankton media, etc., from the zoea period of crabs, and they were able to maintain a high survival rate of 50.6 percent (maximum). This became the turning point in accelerating the rapid progress of Portunus tridentatus seeds production technology. Moreover, the water preparation, which was done at the Tamano Operation Plant of the Japan Fish Propagation Association, was performed by adding microbial floc that had been produced by adding glucose, urea, etc., to natural seawater in place of these organic substances, and a high survival rate was recorded by Imamura and Shoda (1972). In investigating the respective increase and decrease in the quantity of bacteria, diatoms, and protozoans in the Portunus tridentatus larvae breeding tank water, which used microbial floc in the water preparation, Maeda (1986) found that the quantity of bacteria suddenly decreased immediately after incubation. Next the protozoan flagellata and then the diatoms decreased up until the zoea II period. It was thought that the Portunus tridentatus had gradually consumed these microorganisms during a period of several days after its incubation. The flagellata and diatoms that become the breeding feeds in this case had spontaneously generated while the diatoms added during the water preparation were not consumed. Water preparation, as shown here, means the forming process of the biotic community of microorganisms that become the feed for the fry or that maintain the environment in good condition.

A similar food chain is also seen in the natural sea. It has been observed in the conventional marine food chain that the primary products were promptly consumed by the phytophagous animals. When this concept is put another way, it means that the phytoplankton (primary producer) which is the stabilizer of the optical energy, is simultaneously looked on as the feed. While it is certain that there are many animals that consume phytoplanktons only, many of the zooplanktons are of euryphagy and they also consume bacteria and protozoans (Maeda, 1982). Moreover, according to the trial computation made by Williams (1981), it is said that 40 percent of the primary production quantity is used in the production of phytoplanktons in addition to the natural decreasing process of phytoplanktons. In fact, the quantity of bacteria in seawater accounts for several tens of percents of the suspended organic substances, and it has also been reported by Maeda (1982) to correspond to the existing quantity of phytoplanktons. Moreover, there are also many flagellata and cilia that consume these bacteria, etc. For example, in the Aburatsubo by of Misaki City, their presence has been computed at 10^5 cells/ml and 10^3 cells/ml, respectively. Cases where the primary producer directly becomes the feed are few in the ecosystem other than in the sea. In the forest, for example, the major portion of the energy flow goes through the organic substance transformation process from fallen leaves on the soil (fallen leaves->microorganisms/protozoans->insects and ferns->medium-sized animals). The same applies in case of the sea and, as shown in Figure 1a

[omitted], the organic substances of the primary producer perform transformation via several processes. They become the "Microbial Food Assemblages" consisting of bacteria, protozoans, fine algas, etc. It is considered that these assemblages become the starting point of the food chain. Similarly, the microbial assemblages formed by the addition of organic and inorganic fertilizers in the seeds production tank become the feed for the infant fry of fishery products (Figure 1b) [omitted].

3. Microorganisms That Become Feeds

Many cases of zooplanktons in the natural sea consuming bacteria have been reported. Table 2 [omitted] shows the hydrospheric Cosepodas that consumes bacteria. In addition to these, it is thought that shellfish larvae and small-sized benthos also consume bacteria. It is in the aforementioned "water preparation" process that the microbial assemblages spontaneously generated by adding organic substances, etc., are used as the feed. However, attempts to use specific microbial strains have also been made.

The usefulness of these microorganisms as feeds for the infant fry of commercial fish was suggested by Ryder (1981) and ZoBell has conducted an experiment to measure bacteria consumption by the Emerita analoga crab, which has a body length of about 8 to 10 mm. The Rotatoria are an important feed for seeds production and it has been made clear by Hirata and Mori (1967) that bread yeast was effective as a feed for this small animal. Higashihara and his fellow workers (1983) have cultured several types of marine yeasts with the alcoholic fermentation mother solution as the substrate. Upon applying it to the Rotatoria they found that the proliferation of the Rotatoria increased even more than when bread yeast was used. Since the marine yeasts proliferate steadily in seawater, and as it is said that the afflux of the endosubstances is also small, they may prove effective as a feed for the Rotatoria in the future.

The phytosynthetic bacteria perform non-oxygen generating photosynthesis and they grow by utilizing organic acids and sulfur compounds. Among these bacteria groups, the Rhodopseudomonas and Rhodacter of the purple non-sulfur bacteria are used as feed for fish. Explanations of these feed bacteria have been made in detail by Ogino (1978). The feed effect for several types of fresh water fish was low when it was applied with the bacteria alone but increased geometrically when it was applied by mixing it with other feeds. Sakamoto and Hirayama have also reported (1983) that a geometrical feed effect appeared when the photosynthetic bacteria were added to the chlorella and bread yeast as the feed for Rotatoria. Although the cause of such an effect on the bacterial feed has not been clarified, it is possible that these sulfur system substances are one of the effective feed components. Kaushik and Luquet (1980) indicated that the feed effect of methane bacteria was low when used alone as a rainbow trout feed but that the growth of the fish was accelerated by adding the sulfur system amino acid to the mixture.

Although there are generally few cases involving the use of bacteria that have been separated from seawater, Taga and Yasuda (1979) used several tens of strains of Vibriom Pseudomonas, Acinetobactor and pigment bacteria separated from the coastal seawater as a feed for shrimp larvae. They reported that many bacteria strains that accelerate the proliferation, ecdysis, and transformation of shrimp can be found in the Pseudomonas genus. Maeda and Ryo (1987) studied the bacterial phase of the plant shrimp larvae in a culture tank. Then, they pure cultured the bacteria separated when the shrimp larvae underwent ecdysis at the zoea III stage and reintroduced the bacteria to the shrimp larvae. After checking the survival rate and the ecdysis rate, they ascertained that one strain among the tested strains was effective for shrimp proliferation. As seen here, these exists a "mutual proliferation acceleration effect" between the feed consuming microorganisms and the feed nonconsuming microorganisms. Consequently, it can be said that a more suitable proliferation environment will be formed for the feed consuming microorganisms.

4. Feeds for Protozoa

A majority of the heterotrophic protozoa possess mouthparts and they consume granular substances such as microorganisms and fine algae. When a protozoan is viewed as a capsule that ingests granular substances that have different nutritional values, it can then be looked on as a feed element consisting of various components. The size of the protozoan is generally between 5μm to 200μm and obtaining a variety whose size is suitable for the infant fry of commercial fish is relatively easy. The protozoan as seen here can be considered as an "organic capsule feed" as opposed to an artificial capsule feed. However, actual cases where protozoan have been used as a feed are still few for such reasons as the fact that information on their ecology has not been sufficiently available, etc.

Imai and Hatanaka (1949) reported that after applying colorless flagellata--which had been cultured by adding seawater to dried roast grass stock--to oyster larvae, the larvae grew well but that the feed effect of the bacteria and diatoms was low. Kashiwara (1960) obtained experimental results showing that the incubated infant black porgy (average total length 2.06mm) grew by consuming colorless flagella and then ciliatea during a period of about 10 days after its incubation (total length of infant fish about 4mm). Thus, they were able to discover that the growth of fishes in the feed-provided area was fast in comparison to the infant fish in the nonfeed-provided area. The conventional wisdom has been that the infant fry existed by absorbing the yolk during the first few days after incubation. This result, however, suggests that feed consuming starts while they still possess the yolk. It had also been thought that in case of plant shrimp feed consumption did not being for 2 days during the nauplius period immediately after incubation. However, it has been shown that the nauplius period survival rate in a microbial feed-provided area is higher than that in the nonfeed-provided area (Maeda and Ryo, 1987). The high death rate of infant fry immediately after their incubation has been the primary factor preventing a reduction of the cost of seed

production. It can be said, however, that future studies on microbial feeds represent one of the promising means for solving these problems.

New Photosynthetic Bacteria

43066530 Tokyo KAIYO KAGAKU in Japanese Jan 88 pp 28-31

[Article by Assistant Professor Tsuneo Shiba, Otsuchi Marine Research Center, Marine Research Institute, Tokyo University]

[Excerpts] Many new types and new genuses of photosynthetic bacteria are continuously being discovered. The aerobic photosynthetic bacterium introduced below is one of these photosynthetic bacteria. It can be said that the discovery of this aerobic photosynthetic bacterium is only one small aspect of the world of photosynthetic bacteria, which is undergoing a great change.

2. Distribution and Separation

This aerobic photosynthetic bacterium is most abundantly separated in such places as the surface areas of sand, rocks, and seaweeds such as the green laver and Asakusa laver that are exposed to sunlight at ebb tide. Since these places are exposed to strong sunlight and the oxygen concentration is apt to become high due to the action of the seaweed, such areas are the most difficult places for aerobic photosynthetic bacteria to live.

4. Physiological and Ecological Properties

Since the anaerobic photosynthetic bacteria proliferate in places where there is no oxygen, the photosynthetic power and the photosynthetic pigment productive power are repressed by even a very small amount of oxygen. However, it has been shown that aerobic photosynthetic bacteria, in contrast to the anaerobic photosynthetic bacteria, have their photosynthetic power and photosynthetic pigment productive power accelerated by oxygen (Shiba, 1984; Harashima et. al., 1980; Shiba, 1987). As indicated in Figure 2 [omitted], the synthesis of bacteriochlorophyll is accelerated by oxygen. However, these properties indicate that aerobic photosynthetic bacteria are a bacterial species that has adapted to the aerobic environment over a long period.

Aerobic photosynthetic bacteria are capable of sufficiently proliferating even in darkness by means of heterotrophism. However, they cannot proliferate by autotrophism utilizing optical energy. Moreover, the photophosphorylation system of the anaerobic photosynthetic bacteria utilizes the same electron transport system as the respiration system. This fact has also been confirmed in the aerobic photosynthetic bacteria and different energy productive systems have to compete for a single electron transport system in the aerobic environment. Therefore, the reason why the aerobic photosynthetic bacteria had a photosynthesis system was not readily apparent.

After conducting several experiments for the purpose of investigating the role played by the photosynthetic power, it was found that although a proliferation acceleration effect could not be observed even when the aerobic photosynthetic bacteria were exposed during the exponential proliferation period, the proliferation acceleration effect could be seen when they were exposed to light in the neighborhood of the termination period (Figure 3) [omitted]. The proliferation curve and the bacteriochlorophyll productive curve of the pick colored aerobic photosynthetic bacteria, Erythrobacter sp. OCh 114, are shown in Figure 4 [omitted]. It is known that the production of bacteriochlorophyll is not seen at the beginning of the exponential proliferation period but is suddenly produced as they approach the termination period. It has been reported by Shioi (1986) and by Harashima and others (1987) that possibly the proliferation acceleration effect could not be seen as the photosynthetic organ was undeveloped in the exponential proliferation period. On the other hand, the aerobic photosynthetic bacteria were suspended in inorganic seawater and cultured for several days in light and in darkness. When the bacteria totally consume the stored substances in their cells by respiration in an environment without organic substances, the production of ATP becomes impossible and they will inevitably die. The survival curves in cultures under bright and dark conditions are shown in Figure 5 [omitted]. As seen in the diagram, a higher survival rate is seen in the bright condition culture than in the dark condition culture. The APT content is higher in light than in darkness, suggesting that the optical energy has been utilized for the survival of the aerobic photosynthetic bacteria.

The marine environment is generally an environment where the concentration of organic substances is small. Organisms must use ingenious means to survive in such an environment, and the photosynthetic power of the aerobic photosynthetic bacteria may be one such contrivance. It may be that the consumption of organic substances for respiration can be economized and that limited organic substances can be efficiently assimilated in an environment with limited nutriments when ATP is produced by optical energy.

Address of thanks: I wish to hereby express my sincere gratitude for the assistance and a support on the seeds culture research from the Agriculture, Forestry and Fishery Technology Meeting of the Ministry of Agriculture, Forestry and Fishery.

Bacteriolytic Enzyme Bacteria

43066530 Tokyo KAIYO KAGAKU in Japanese Jan 88 pp 57-62

[Article by Assistant Professor Isao Sugahara, Marine Microbiology Research Laboratory, Department of Biological Resources, Mie University]

[Excerpts] Bacteriolytic enzymes are enzymes that produce lysis of microbial cells. It appears that microorganisms with the ability to produce bacteriolytic enzymes are universally distributed in the marine environment. Although it is still not clear what the bacteriolytic enzymes produces by

these microorganisms ultimately mean for the marine environment, they are enzymes of interest, including possibilities for practical utilization.

1. Introduction

The term bacteriolytic enzymes is a general term for various enzymes having the capacity to produce lysis of microbial cells. It is known that bacteriolytic enzymes are produced by many animals, plants, and microorganisms and various types of bacteriolytic enzymes have been reported that reflect their substrate specificity and diversity. Detailed scientific study has been conducted on these enzymes, especially on the albumen lysozyme of chickens. Many studies have also been made on the usefulness of lysozyme to foods and drugs. However, there has been practically no information on the bacteriolytic enzymes productive bacteria in the marine environment. Up to now I have investigated the distribution of microorganisms producing bacteriolytic enzymes and conducted separation in areas ranging from the inlet bay and coastal sea areas up to the open sea and from the ocean surface layer down to the sea bottom deposits. A number of studies have been made on the production of bacteriolytic enzymes, their properties, their relationship to the autolytic enzymes, etc. A frequent subject of such studies has been the Bacillus V 37 strain, which has a high bacteriolytic enzyme productive capacity as compared to other separated strains, which total about 500 strains. Here I will outline the results of these studies.

2. Distribution of Bacteriolytic Enzymes

A polypeptone yeast extract seawater agar medium--to which tested strain cells such as the Micrococcus luteus and Vibrio parahaemolyticus, that become the substrates of the bacteriolytic enzymes have been added--is used for counting and separating the bacteriolytic enzyme productive strains in seawater and in sea-bottom deposits. This agar plat medium takes on a turbid and opaque appearance after the tested strain cells have been added. When a sample of the seawater or sea bottom deposits that has been suitably diluted is inoculated and obscure coated with a 0.1 ml film on this agar plat medium and is cultured for a fixed period at a fixed temperature, those strains with a positive bacteriolytic enzyme productive capacity will form a transparent cingulum due to its bacteriolytic action on the periphery of the colony, making it easy to identify. A colony that has generated a transparent cingulum on the agar plate is suspended in order to separate the bacteriolytic enzymes productive bacteria. After the pure culture operation, the colony is inoculated in the agar slope medium. This method can be used to separate a number of bacteriolytic enzyme productive strains by changing the type of tested strains used as the substrate for the bacteriolytic enzymes. In other words, there is a possibility that separated bacteriolytic enzyme production strains will differ according to the type of microbial cell used as the substrate.

The bacteriolytic enzyme productive strains in seawater (using V. parahaemolyticus and Staphylococcus aureus as the substrate cell) were found

to constitute about 24 percent of the heterotrophs in Tokyo bay and about 50 percent of the heterotrophs in Sagami and Suruga bays. Slightly more were observed in their independently floating condition in seawater than adhering to suspended substances. Moreover, among the heterotrophs separated from the zooplanktons--such as the sagitta, paddles, decapods, etc.--those having a bacteriolytic enzyme productive capacity constituted a high percentage, about 63 to 75 percent (Nair et. al., 1985).

Many bacteria productive strains (using M. luteus as the substrate call) were recognized in sea bottom deposits and also in inlet bays such as the Ise, Matoya and Owase bays at a depth of 10 to 30 m and also in deep sea areas down to a depth of 3,700 m. The quantity of strains was about 10-10HP per gram of wet mud and on the average they constituted about 14 percent of the heterotrophs (Table 1) [omitted]. However, there were also instances when the bacteriolytic enzyme productive strains reached 50 percent of the heterotrophs in the deposit samples (article now under contribution by Sugahara, et.al.).

Furthermore, bacteriolytic enzyme productive strains were found to exist in the core samples of all sea bottom deposits form the surface layer down to a depth of 20 cm. In general, there are many bacteriolytic enzyme productive strains in the surface layers of the sea bottom deposits, but there is no consistent relationship between core depth and the quantity of strains.

3. Classification of Bacteriolytic Enzyme Productive Strains

According to reports available up to now, many diverse microorganisms have the capacity to produce bacteriolytic enzymes, as shows in Table 2 [omitted]. All of these microorganisms were separated from environments other than the marine environment.

Most of the bacteriolytic enzymes productive strains found in seawater belonged either to Pseudomonas, Vibrio, or Flavobacterium. The bacteriolytic enzymes productive strains that belonged to the Vibrio or Pseudomonas dominated in the zooplanktons, such as the sagitta, paddles, and decapods (Nair et.al., 1985).

On the other hand, Bacillus was detected in all samples of the sea bottom deposits found in the inlet bays and in the deep sea areas up to depths of 3,700m, and a majority of the bacteriolytic enzymes productive strains proved to be Bacillus. A number thought to belong to Brevibacterium (unidentified yet) were also discovered. However, only a small quantity of the gram-negative strains such as Vibrio, Pseudomonas, and Flavobacterium that dominated in seawater could be recognized in the sea bottom deposits (article now under contribution by Sugahara et.al.).

4. Bacteriolytic Spectrum

Bacteriolytic enzymes, as noted above, are enzymes that produce lysis of microbial cells. Enzymes, in turn, are classified according to the site that can be acted on. Types of enzymes include glycosidase, endopeptidase,

amidase, etc. Moreover, since different microorganisms have different surface layer and cell wall structures, any given bacteriolytic enzyme will not be able to produce lysis on all types of microbial cells. In general, bacteriolytic enzymes that act on bacteria cells cannot produce lysis on yeast or mold cells. On the other hand, this does not mean that a bacteriolytic enzyme productive strain is able to produced only one type of bacteriolytic enzyme. In fact, many types of bacteriolytic enzyme productive strains produce several types of bacteriolytic enzymes at the same time. Therefore, the bacteriolytic enzyme productive strains are generally able to act and produce bacteriolysis on several types of microbial cells.

The bacteriolytic spectrum is used to indicate those microbial cells on which a certain bacteriolytic enzyme is able to produce lysis as well s those against which it does not have a bacteriolytic capacity. The bacteriolytic spectrum sometimes differs according to whether the microbial cell receiving the action is a lie cell or a dead cell. For example, as partially indicated in Table 3 [omitted], the bacteriolytic enzymes produced by the Bacillus V 37 strain which has been separated from the coastal sea area, produce lysis on the live cells, heated dead cells and cell walls of V. parahaemolyticus, Bacillus sp. and M. luteus. However, they are able to produce only a single effect--on the live cells, or the heated dead cells or the cell walls--on the Staphylococcus aureus, Salmonella enteritidis and Pseudomonas aeruginosa (Sugahara et. al., 1976, 1982).

Moreover, only 5 percent of the bacteriolytic enzyme productive strains capable of acting on the V. parahaemolyticus indicated a bacteriolytic action against the S. aureus (Nair et. al., 1985). Since bacteriolytic enzymes act on the surface layer structure of microbial cells, it may also be possible to partially estimate the surface layer structure of the tested strain cells by looking at the bacteriolytic spectrum of the bacteriolytic enzymes for which the functional order of the action is known.

5. Production of Bacteriolytic Enzyme

When the bacteriolytic enzyme productive strains of Bacillus V 37, which is separated from coastal sea areas, is shake cultured in a seawater medium (pH7.0) containing 1 percent polypeptone and 0.5 percent yeast extract at a temperature of 30°C, bacteriolytic enzymes are produced in the culture supernatant liquid (Sugahara et. al., 1978). Although the Bacillus V 37 strains could also be grown by replacing the seawater of the medium component with distilled water, virtually no bacteriolytic enzymes were produced. The effective inorganic salts in the production of bacteriolytic enzymes are NaCl, KCl, LeCl, Na_2SO_4, K_2SO_4, NaSCN, etc. Acceleration actions were not see in $CaCl_2$, $MgSO_4$, NaH_2, PO_4, NH_4Cl, etc. (Sugahara et. al., 1980, 1981).

To clarify the effect NaCl exerts on the production of bacteriolytic enzymes, the Bacillus V 37 strain was cultured in a medium without the addition of inorganic salts. NaCl was aseptically added so that the end concentration after a fixed culture period reached 0.5M and the culture was continued. The growth of the Bacillus V 37 strain was virtually unaffected by the addition of

NaCl. A Bacillus V 37 strain grown for 3 to 6 hours in a medium without NaCl immediately produced bacteriolytic enzymes outside of the strain body. No acceleration of bacteriolytic enzyme production by the addition of NaCl could be seen in the stationary phase cells (15 to 18 hours).

On the other hand, after the culture of the Bacillus V 37 strain for a fixed period in the medium without NaCl, the cells were gathered so that various bacteria were not mixed. These cells were then transplanted to a medium without added inorganic salts and the bacteriolytic enzyme production by the Bacillus V 37 strain was checked. Although there were cells that had undergone partial lysis, and while the turbidity slightly decreased the growth of the Bacillus V 37 strain by the transplantation from the 0.5 NaCl medium to the 0 M NaCl medium (inorganic salt nonadded medium), the turbidity immediately recovered, smooth growth continued thereafter, they increased to about the same size as the control cells before transplantation, and all cells reached the stationary state. However, the Bacillus V 37 strain virtually did not produce bacteriolytic enzymes in the supernatant culture liquid. These facts indicate that while NaCl is necessary for the production of bacteriolytic enzymes in the Bacillus V 37 strains, this need is limited to a fixed period (Sugahara et. al., 1984).

Moreover, the inorganic salts that were effective in the production of bacteriolytic enzymes were not all effective in producing the release of bacteriolytic enzymes from the Bacillus V 37 strain cells (Sugahara et. al., 1981, 1983). There are still many unclarified aspects about the releasing mechanism of the bacteriolytic enzymes to the cell exterior.

6. Sites (Cell Structure) Where Bacteriolytic Enzymes Are Produced

It has been reported by Fishman et. al. (1980) that phenethyl alcohol and n-alcohol selectively inhibit the production of alkaline phosphatase and penicillinase in a concentration in which the growth of the extracellar enzyme productive strain is otherwise not inhibited. This indicates that the production of various enzymes in the cell membrane is remarkably inhibited as the properties and composition of the cell membranes are slightly changed by these alcohols.

To clarify the site (cell structure) where the bacteriolytic enzymes are produced in the Bacillus V 37 strain, n-alcohol, benzyl alcohol, etc., were aseptically added to the culture medium to produce different concentrations. The Bacillus V 37 strain was shake cultured for 24 hours at a temperature of 30°C and the growth and production quantity outside the strain body of the bacteriolytic enzyme were investigated. As a result, it was found that the octanol, decanol, dodecanol, tetradecanol, phenethyl alcohol and benzyl alcohol remarkably controlled the production of bacteriolytic enzymes in a concentration that did not otherwise appear to inhibit the growth of the Bacillus V 37 strain (Table 4) [omitted]. This fact indicates that the production site of the bacteriolytic enzymes has a relation with the cell membrane of the Bacillus V 37 strain (Sugahara et.al., 1984).

7. Properties of Bacteriolytic Enzyme Productive Strain Supernatant Culture Liquid (Coarse Enzyme Liquid)

The supernatant culture liquid of the Bacillus V 37 strain has a bacteriolytic activity (M. luteus cell used as the substrate) and a proteolytic activity. The bacteriolytic activity has an optimum pH range of pH7.0 to pH4.5. The activated condition was completely deactivated by heating the culture for 10 minutes at a temperature of 70°C at pH7.0. Moreover, the bacteriolytic activity decreases as the concentration of inorganic salts--such as NaCl, KCl, LiCl, etc.--increases. Bacteriolytic activity at a level about 55 percent of maximum activity remained in the neighborhood of 0.5M (salinity concentration approximately the same as seawater). However, bacteriolytic activity was remarkably inhibited by the divalent cations such as the Ms^{2+}, Ca^{2+}, et. (Sugahara et.al., 1979).

8. Autolytic Enzymes (Autolysins) and Bacteriolytic Enzymes

The autolytic enzyme (autolysin) plays an important role in the growth of microorganisms. Its functions include cutting the chemical bond of the peptidoglycan part, which is the skeleton of the cell wall, promoting cell wall growth, conducting cell division and metabolic turnover of the peptidoglycan, etc. It is said that normal growth is impossible in autolytic enzyme deficient cells. However, since the cell is subject to lysis and since the autolytic enzyme itself acts as a lethal factor when the action of the autolytic enzyme is strongly manifested, it is thought that a peculiar control mechanism exists in the manifestation of the action in the cell. On the other hand, the acting site of the autolytic enzyme is practically the same as that of the bacteria. And since excretion of the autolytic enzyme to the cell exterior is also thought to be a means for preventing the accumulation of the autolytic enzyme, which represents a lethal factor for the cell wall, it must be that there are many such mechanisms designed to handle the autolytic enzyme in the extracellular bacteriolytic enzymes discovered in many microorganisms (Ogata, 1976).

The autolysis of the Bacillus V 37 strain is remarkable in the cells during the logarithmic productive phase and is low during the stationary phase. It is believed to differ according to the age of the cell (Sugahara et.al., 1982).

The autolysis of the Bacillus V 37 strain produced by adding inorganic salts (NaCl, KCl, etc.) that were effective for the production of bacteriolytic enzymes was extremely strong. Meanwhile, the autolysis of cells grown in a medium without the addition of inorganic salts or in a MgCl-added medium was quite weak and only about one-third to one-half that of the NaCl cultured cells (Sugahara et.al., 1983). Moreover, the optimum pH for the autolytic activity of the Bacillus V 37 strain was in the neighborhood of pH7 to pH9 and the optimum temperature was in the neighborhood of 40°C (Sugahara et.al., 1986).

As noted above, the bacteriolytic enzyme produced in the cell exterior by the Bacillus V 37 strain and the autolytic enzyme of the Bacillus V 37 strain show a marked resemblance in the action site of the enzyme, enzyme production, enzyme activity, etc. It might be, therefore, that the extracellular bacteriolytic enzyme of the Bacillus V 37 strain results from the autolytic enzyme. In other words, it might be that more autolytic enzymes than necessary were produced due to various possible causes (NaCl, KCl, etc.). These enzymes were excreted to the cell exterior to prevent the accumulation of the autolytic enzymes from becoming lethal and these excreted autolytic enzymes in turn became the bacteriolytic enzymes.

The origin of the bacteriolytic enzymes produced by the Bacillus V 37 strain will be elucidated in the future by purifying and isolating both enzymes and by clarifying the various properties of both enzymes.

9. Bacteriolytic Enzyme Activity and Water Pressure

Microorganisms in the marine environment are constantly carried down into deep sea areas from the surface layers by the precipitation of suspended substances to which they adhere. It is thought that a certain percentage of these extrinsic microorganisms are able to survive by withstanding the water pressure and temperature conditions of the deep sea. There is no information at present on whether or not the microorganisms that reach the deep sea from the sea surface layers produce bacteriolytic enzymes in the deep sea environment. If they do produce bacteriolytic enzymes, however, it can be said that there is a possibility that the bacteriolytic enzymes play a role in the decomposition of microbial cells in the deep sea environment together with other polymer organic substance lytic enzymes (amylase, chitinase, cellulase, protease, etc.).

ZoBell et.al (1972) reported that the activity of lysozyme, which is a bacteriolytic enzyme contained in the egg white of chickens, increased together with increases in water pressure at 4°C, becoming 1.68 times the activity level at 1 atmospheric pressure when reaching 1,000 atmospheric pressures. On the other hand, the bacteriolytic enzyme produced by the Bacillus V 37 strain separated from the coastal sea area did not become deactivated when subjected to pressures up to 1,000 atmospheres at all temperatures from 10 to 40°C (Sugahara et.al., 1985). Moreover, bacteriolytic activity showed a decreasing trend with increases in pressure but it still had a residual activity of about 36 to 40 percent of that of 1 atmosphere at pressures of 1,000 atmospheres (article on this now under contribution by Sugahara et.al.). These facts indicate that bacteriolytic enzymes do not lose their activity even under deep sea high-pressure conditions of 1,000 atmospheric pressures and that the bacteriolytic enzymes are capable of taking a part in the lysis of dead or living microorganisms in the deep sea.

10. Utilization of Bacteriolytic Enzymes

Various attempts have already been made to utilize lysozyme as an antiseptic for various foods, raw materials, etc., and it has also been added to drugs.

Moreover, lysozyme has also played an important role in the preparation of the protoplast, which is one of the basic technologies in the bioscience field. However, it appears that there have been no attempts to use bacteriolytic enzymes other than lysozyme.

Sugahara et.al (1975,1982) compared bacteriolytic properties against sea food putrefying bacteria from the standpoint of determining the usefulness of the bacteriolytic enzymes as a food preservative. They found that the bacteriolytic enzymes produced by the Bacillus V 37 strain separated from the coastal sea area acted on the cells and cell walls of the Kamaboko putrefying bacteria and they obtained basic information about possible applications. The bacteriolytic enzyme of the Bacillus V 37 strain was also added to the mackerel meat homogenate, which wa then stored at a fixed temperature and the effectiveness of the bacteriolytic enzyme in maintaining freshness and preventing decay was assessed. They expect to make an announcement on the results of this investigation in the near future.

11. Conclusion

It is well known that cell lysis on a live host cell infected with bacteriophage and Bdellovibrio is caused by the action of the bacteriolytic enzyme produced by the bacteriophage and the Bdellovibrio.

There are extremely few cases where the meaning and importance of bacteriolytic enzymes have been made clear in the life history of bacteriolytic enzyme productive microorganisms. The physiological and ecological importance of bacteriolytic enzymes produced by bacteriolytic enzyme productive microorganisms other than the bacteriophage and Bdellovibrio are totally unknown at present.

However, it may be that the bacteriolytic enzymes capable of producing lysis on the cell walls of other types of microorganisms are acting as antibacterial substances to acquire a food source and to hold down the proliferation of other types of microorganisms to enhance self-proliferation in the life cycle of microorganisms (Ogata, 1976). Moreover, it can also be considered that the bacteriolytic enzymes together with the autolytic enzymes are playing some sort of role in the initial lysis of microbial cells that are either dead or alive in the natural world (Nair et.al., 1985).

On the other hand, Yannasch et.al. (1971) reported that the rate of decomposition of organic substances in deep sea areas was only about 1/10th to 1/100th of the activity at normal pressure at temperatures about 3°C. However, the activity of lysozyme, which is a bacteriolytic enzyme, increased to 1.68 times its activity at 1 atmosphere of pressure even under the deep sea conditions (ZoBell et.al., 1972). Moreover, although the activity of the bacteriolytic enzyme produced by the Bacillus V 37 strain separated from the coastal sea area greatly decreased as temperature dropped, it was not affected as much by pressure, even under 1000 atmospheres of pressure (article on this now under contribution by Sugahara et.al.).

Although these results differ slightly from the results obtained by Yannasch et.al. (1971), it can be estimated from these facts that the bacteriolytic enzymes play a role in the initial lysis (cell lysis) of microbial cells and may be playing some sort of role in the biogeochemical cycles, not only in the surface layer of the sea but also in the deep sea.

Investigations are presently in progress on low-temperature bacteriolytic enzyme productive strains in deep sea areas together with their distribution. A few low-temperature bacteriolytic enzyme productive strains have already been separated from the sea bottom from a depth of 2,875m. We wish to clarify the production of these bacteriolytic enzymes under low temperature and high pressure conditions together with their bacteriolytic activities by using these separated strains.

It seems that the bacteriolytic enzyme productive strains are universally distributed in the marine environment. A majority of the bacteriolytic enzyme productive strains separated from the marine environment up to now were those that belonged to the Pseudomonas, Vibrio, Flavobacterium, Bacillus, etc. Only a small amount of information has been obtained on the bacteriolytic enzyme production and on the bacteriolytic enzyme properties on a portion of these strains. The majority has been left behind, which means that the behavior of the bacteriolytic enzyme productive strains on the characteristics of the bacteriolytic enzymes in the marine environment remain unknown. It may be that peculiar bacteriolytic enzyme productive strains and bacteriolytic enzymes will be discovered in the marine environment with the progress of future research.

On the other hand, several reports on the marine bacteria that produce antibacterial substances have appeared recently and I hope to relate these reports at another opportunity.

20158/06662

Sumitomo Chemical's R&D Plan Discussed

43067550 Tokyo TOSHI KEIZAI in Japanese Jan 88 pp 140-142

[Text] Ratio of R & D Expenses Slightly More Than 5 Percent Against Sales

The Sumitomo Chemical Co., Ltd. has, since its founding, been an enterprise extremely strong in technology orientation, having hitherto been unsparing in the management resources invested in its R & D.

The results of these investments have pushed up the ratio of the gross sales of its fine chemical products to 33 percent, and these results have been reflected in its steady and satisfactory business results.

The company has set as one of its goals achieving the ratio of 50 percent on fine chemical products at an early stage and, while promoting the fining and speciality realization of products in existing fields, it has expanded its business sphere to include such newly-advancing technology fields as electronics, new materials and biotechnology, along with progress in technological renovation.

The R & D actually covered by the company is certainly wide. It has nine research institutes at five sites across Japan (Ehime Research Institute, Chiba Research Institute, Resin Development Research Institute, Osaka Research Institute, Takatsuki Research Institute, Agricultural Chemicals Research Institute, Life Engineering Research Institute, Safety Research Institute and Process Research Institute) and is conducting wide research and development in all areas of the "New Chemistry," including the biological system, such as agricultural chemicals, medicines and plants, and the material system, such as organics, inorganics and metals. When referring from the business fields, the R & D can be classified into four categories: precision chemical products (including reaction intermediates) field, agricultural chemical products field, petrochemical field and new field, which forms the background of the company's favorite and special technologies, such as organic chemistry, inorganic chemistry, analytical chemistry, polymer chemistry, chemical engineering (purification, separation), computer chemistry, electronics, biotechnology, catalysts and safety.

The current R & D themes in the various fields are as follows:

Precision Chemical Products

Dyes, intermediates (including medical and agricultural chemical intermediates), polymer additives, functional polymers (ion exchange resins, VAE, thermosetting resins, epoxy, UV hardened resins), pigments.

Agricultural Chemical Products

Insecticides → Soil insecticides, nematicides, new insecticides. Germicides → Agal fungicides (insecticides for downey mildew and epidemics), new insecticides. Herbicides → Herbicides for major farm products (soybeans, corn, cotton, rice and cereals), nonselective herbicides. Plant growth regulating agents → rice plants, cereals, fruits, flowers, etc.

Petrochemical

Polyethylene → LLDPE, VLDPE. Polypropylene → Vapor phase polymerization, new catalysts. Polymer alloys → PPE/nylon, polyproalloy, compatible agents. Meta-acryl resins → thermal resisting grade, optical grade. Vinyl chloride → powder forming. SPM (Sumitomo Press Molding) → improved compression molding method. Industrial chemicals → acrylic acid, MMA monomer, etc.

New Field I

Fine ceramics → Aluminum nitride, high purity alumina, silicon carbide, partial stabilized zirconia. Advanced composite materials → Carbon fiber prepregs, alumina fibers, FRM (fiber reinforced metals). Highly functional polymers → PES, PEEK, PAI and LCP of super engineering plastics.

New Field II

Electronic materials → Photoresists, optical discs, MOCVD, EL lamps, galium organic metals, aluminum targets, evaluation technology (Composition and device development). Others → special metal surface treatments.

New Field III

Biotechnology → Bioconversion in the chemical process, cytochrome, P-450 ()′-DNA technology), BT (Bacillus thuringiensis), monoclonal antibodies, plant fiber culture technology, hybrid rice and wheat.

Current R & D themes always numbers about 700. Approximately 10 percent of these themes are reorganized each year and new themes are added. Although it is a matter of course, the management resources invested in R & D amount to a stupendous scale.

In observing the recent investments made in the main research facilities, we find that ¥650 million has been invested in the new building for the

Chiba Research Institute (completed in January 1986), ¥600 million has been invested in the new building for the Ehime Research Institute (completed February 1987) and ¥1.6 billion has been invested in the intermediate test laboratory building for the Process Research Institute (completed March 1987). Moreover, the new building for the Safety Research Institute is now under construction at a cost of ¥8 billion and is scheduled for completion next April.

The number of research workers and the R & D expenses increase continuously every year conjointly with the consolidation of the research facilities. The current number of research workers is approximately 2,000 persons, and the research expenses for 1987 has been set at ¥26 billion.

Research workers account for more than 25 percent of the 7,800 total employees and the percentage of the total sales estimate of ¥510 billion during the December 1987 term of 1987 occupied by R & D expenses is a little more than 5 percent, so it is indeed a technology-based company that ranks among the top level of chemical companies in the world.

Construction of Its Tsukuba Research Institute (Provisional Name) as the Support and Driving Force of the "New Chemical" Era

The Sumitomo Chemical Co., Ltd., will also promote the investment of management resources for its R & D in the future, and it particularly plans to emphasize the above-mentioned new and favorite fields. At the same time, in order to promote the improvement in quality of researchers, it has stated that, "We would like to deepen our interchanges with different fields and also adopt a positive attitude toward the dispatching of researchers overseas."

The increase made in R & D expenses and researchers is not only limited to the Sumitomo Chemical Co., Ltd., but is the trend of the entire chemical industrial circle in Japan.

This trend will become a thick flow and increasingly stronger. As for the Sumitomo Chemical Co., Ltd., it is deemed that the number of researchers will reach about 3,000 persons in the 21st century.

The reason for the entire Japanese chemical industrial circle entering into R & D competition is that a new, yet rich, and growing power has been generated in the chemical industry. The sites utilizing chemical technologies have expanded with the progress of technological renovation, and the chances of expanding into new fields have increased.

Specifically, the relationship with the high technology fields, such as electronics, information, life science and new materials, continues to broaden.

The high technology field consists of "blended undertakings" in which the cooperation of raw material technology and utilization technology are indispensable, and the key to the development of the high technology field

lies in new materials. These new materials have been created by means of chemical technologies and processes. This is why it is called the "New chemistry era" or the "Edge of undertakings, blended undertakings era." When fertilizers and dyes are termed the first generation and petrochemistry the second generation, the "New chemistry era" will become the third generation. The curtain for the third generation is now rising.

This means that the R & D competition among chemical enterprises, backed by the arrival of the "New chemistry era," has spread and the competition in development is also becoming more keen with the advancements made in different fields and enterprises of the United States and Europe. How an enterprise can survive among such a severe competition has now become another important management theme.

The Sumitomo Chemical Co., Ltd. has commented that, "We will make priority investments of management resources in fields capable of utilizing the strong technologies of the company or technologies generated thereof, survive the severe development competition by these investment and wish to grasp the initiative in the field of "blended undertakings."

In the development of products in the high technology field anticipated in the "Blended undertakings era," with the R & D of the technologies, themselves, becoming the nucleus, the integration of these technologies and the guiding of the composite effect become the main theme.

The company has commenced the construction of the following Tsukuba Research Institute (provisional name) for tackling this main theme.

Place of construction ..... Within the northern industrial park of Tsukuba Science City.

Area ..... About 140,000 m^2.

Construction area ..... About 30,000 m^2 (Main research building, trial manufacture plant, incidental research facilities, joint building).

Research institute opening schedule..... April 1989. Construction cost for the First Term Project is about ¥18 billion.

Number of researchers at opening ..... Slightly more than 200 persons. About 1,000 researchers are scheduled ultimately.

The company intends to concentrate here the various research themes (electronics, new materials, etc.) of the high technology field dispersed in various research institutes throughout Japan and actively conduct the development of composite advanced technologies, positioning the Tsukuba Research Institute as its "Research Institute for integrating the high-level advanced technologies."

For the time being, the company's policy is to concentrate its efforts on the R & D of new materials and promote the further compositing of various technologies.

The concrete themes for each research field are as follows:

Inorganic materials ..... Engineering ceramics, functional ceramics, metal materials, etc.

Composite materials ..... FRP, etc.

High functional resin materials ..... Super EMPRA, new polymer alloy, etc.

Optical and electronic materials ..... Recording materials, indicating materials, etc.

Analytical physical properties ..... Ultrafine analysis, molecular structure analysis, solid surface analysis, etc.

Expectations are also harbored in the Tsukuba Research Institute to function as a commonly-owned "Basic Technology Center of the company" by actively utilizing the compositing technologies accumulated here in research involving other existing fields together with acting as a "Research Institute integrating the high-level advanced technologies."

As everybody knows, many national and public research agencies and research institutes of civilian enterprises have moved into the Tsukuba district, which is now becoming a large international research base.

The company intends to actively promote mutual interchanges with such external research agencies and wishes to develop a wide compositing technology, including the various external technologies.

The company states that its research setup following the completion of its Tsukuba Research Institute, including its existing research institutes, will become a "setup in which its research institutes neighboring the Tsukuba Plant will conduct research activities focused on supporting research and its independent research institutes will focus their activities on research to creating new products." In other words, this means that activities will be focused on research for agricultural chemicals and biotechnology at the Takarazuka Research Institute, activities will focus on the merchandising and inorganic synthesis research of the resin division at the Takatsuki Research Institute, and activities will focus on research involving new materials at the Tsukuba Research Institute.

20158/9604

R&D PROGRESS STATUS OF ROBOT FOR HAZARDOUS ENVIRONMENTS

43064021 Tokyo KAIYO KAIHATSU NEWS in Japanese Nov 87 pp 69-73

[Article by Yasushi Okada, Director of Research and Development, Science and Technology Agency: "Major Project of the Science and Technology Agency, MITI"]

[Text] Introduction

The practical use of robots for industrial applications in Japan began during the latter half of the 1960s. In 1967 the "playback" robot was imported from the United States. Together with a shortage of labor during the intensive economic growth of that period, this provided the momentum needed for the development of the robot in Japan. Robot production has steadily grown since that time, and in 1985 approximately 48,000 units were produced, reaching a value of Y300 billion.

At present, up to 95 percent of all industrial robots in Japan are being used in manufacturing fields. However, they are expected to expand to non-manufacturing fields such as mining, building construction, nuclear power, marine development, and medical and welfare service industries. Automation and robotization are greatly needed in these fields to accomplish complex tasks in extremely harsh and hazardous environments which are dangerous to people.

MITI is currently involved n the development of an advanced robot system that can perform tasks in place of human beings under such conditions as a radioactive environment at nuclear power generating plants, underwater operations at marine petroleum development facilities, and fire fighting operations in case of fire at petroleum production facilities. Following is a summary of the Robot for Hazardous Environments Project, and an outline of the research and development activities of the marine petroleum development support robot.

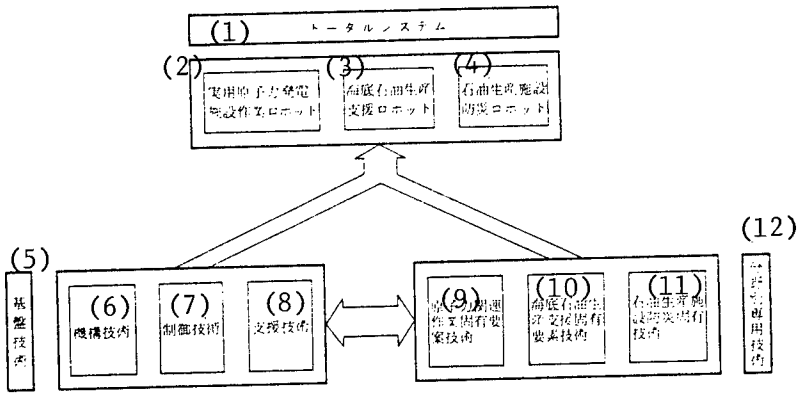
Summary of the Robot for Hazardous Environments Project

1. Objective of Research and Development

The objective of this project is to establish the necessary technologies to achieve a practical robot that is sufficiently mobile and of general

application to perform quickly and accurately complex and intensive tasks in accordance with instructions which are given either beforehand or from a remote location, in various fields of application, such as at nuclear power plants and marine development facilities. The robot is to perform inspections, maintenance work, and disaster relief activities under hazardous conditions such as radiation, high water pressure, and high temperatures environments.

Figure 1. Conceptual Diagram of Research and Development



Key:

1. Total system
2. Robot for practical use in nuclear power generating plant
3. Seabed petroleum production support robot
4. Petroleum production facility disaster relief robot
5. Basic technologies
6. Mechanical technology
7. Control technology
8. Support technology
9. Technology peculiar to nuclear power-related work
10. Technology peculiar to seabed petroleum production support
11. Technology peculiar to petroleum production facility disaster prevention
12. Specialized technologies according to field of application

The development of robot technology requires the development of state-of-the-art technologies spanning many fields such as electronics, communications, instrumentation, control technology, machinery and materials, and also the integration of all of these fields. It will have significant and far-reaching effects with regard to the improvement of industrial technology in general. The development of a robot for hazardous environments will require significant investments in time and money in each of these fields (nuclear power, marine technology, disaster relief, etc.), and a large degree of risk is involved. For this reason, it was decided to promote the Research and Development Project of the Robot for Hazardous Environment as a national project.

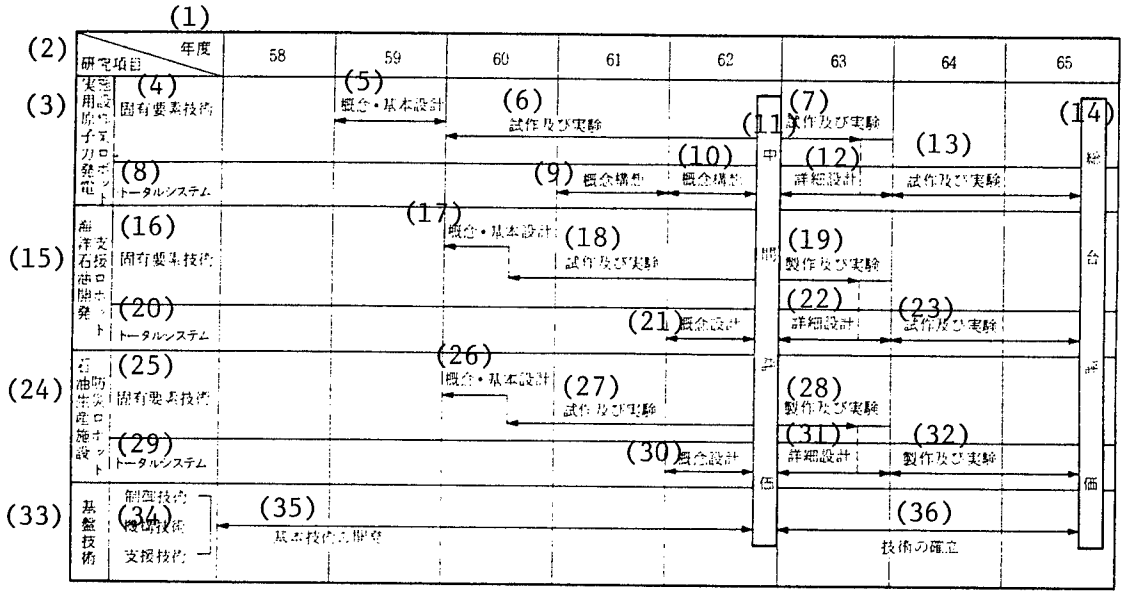
Table 1. Objectives of the Robot for hazardous Environments

Item	Objective
Nuclear Power Robot	To develop a robot that can perform advanced tasks such as the inspection and repair of nuclear power equipment and facilities while receiving support from a remote operator; and that can move nuclear power-related equipment within a working environment in nuclear power plants and other such facilities.
Marine Robot	To develop a robot that can perform advanced tasks such as the maintenance, inspection and repair of platforms under the direction of a remote operator; and that can move in three dimensions underwater and maintain a constant work position while performing the above tasks on ocean development facilities.
Disaster Prevention/ Relief Robot	To develop a robot that can perform advanced tasks in a petroleum production plant at the time of disaster such as moving to the disaster site, ascertaining the disaster status, taking actions to prevent the spread of the disaster, and providing relief operations with support from a remote operator.
Basic Technologies	
Mechanism Technologies	To develop mechanisms which accurately perceive the environment by means of data from sensors; to develop the mechanisms which work smoothly and with dexterity by means of manipulators having multiple joints and fingers; and to develop the mechanisms to provide efficient movement of the robot over unimproved surfaces such as steps and slopes, by such means of legs and wheels.
Control Technology	To develop a system for quick and accurate control based on an operator's instructions based on real-time circumstances; also to develop autonomous robots.
Support Technologies	To develop a method for the efficient utilization of robots by designing multiple robot systems; and to develop robot languages and comprehensive evaluation methods.

2. Research and Development Schedule

The research and development will span a period of 8 years form 1983 to 1990. The individual needs for each of the three fields of nuclear power, marine technology and disaster relief will be addressed to develop a robot having specialized functions. The basic technology which is common to all three fields will also be developed.

Table 2. Schedule for Research and Development



Key:

1. Fiscal year
2. Research item
3. Practical nuclear
4. Specialized technologies
5. Concept and basic design
6. Prototype development and testing
7. Prototype development and testing
8. Total system
9. Concept design
10. Concept design
11. Intermediate evaluation
12. Detailed design
13. Prototype development and testing
14. Comprehensive evaluation
15. Support robot for marine petroleum development
16. Specialized technologies
17. Concept and basic design
18. Prototype development and testing
19. Manufacture and testing
20. Total system
21. Concept design
22. Detailed design
23. Prototype development and testing
24. Disaster prevention robot for petroleum production facilities
25. Specialized technologies

26. Concept and basic design
27. Prototype development and testing
28. Manufacture and testing
29. Total system
30. Concept design
31. Detailed design
32. Manufacture and testing
33. Basic technologies
34. Control technology
    Mechanism technology
    Support technology
35. Development of basic technologies
36. Establishment of technologies

3. Budget

A budget of approximately Y2.4 billion has been appropriated for FY87 for this project. The total budget covering the period from the beginning of research has reached Y7.5 billion.

Table 3. Trends in Budget for Research and Development
(Unit: Y100 million)

Fiscal year / item	1983	1984	1985	1986	1987
R&D budget	0.4	7.8	19.1	24.1	24.2
Marine robot			5.1	7.3	6.5
Other	0.4	7.8	13.8	16.7	17.8

4. Organizations of Research and Development

The "Hazardous Environment Robot Technology Research" group has been established by the Mechanical Technology Research Center and the Electronics Technology Research Center of the Science and Technology Agency for coordination of the basic research elements of this project. This group was established in 1984 and is composed of 18 corporations and 2 organizations.

5. Summary of the Research and Development of Marine Petroleum Development Support Robot

(1) Need for Research and Development

Marine petroleum development activities which have been the focus of general development in the past, have been sluggish in recent years amid the effects of the drop in crude oil prices; therefore, an increase in the demand for underwater robot applications can hardly be expected. However, it is felt that mid-and long-range demand for underwater applications will steadily increase with regard to marine petroleum development. Several projects have actually been started such as the laying of optical fiber cable on the ocean bottom, the establishment of marine petroleum reserve bases, and the cross-Tokyo Bay road project. Other marine activities such as the coastal fishing and culture industries are increasing yearly.

Table 4. Agencies in Charge of Research And Development, Members of the Robot for Hazardous Environments Technology Research Group.

	Agencies in Charge of Research and Development
(1)Basic Technologies	Fuji Electric Co, Ltd., Research Center Yaskawa Electric Mfg. Co., Ltd. International Robot FA/Technology Center
(2)Robot for Nuclear Power Plants	Toshiba Corp. JGC Corp. Power Plant Technology and inspection Agency Hitachi Corp. FANUC, Ltd. Fujitsu, Ltd. Mitsubishi Heavy Industries, Ltd. Mitsubishi Electronic Corp. Fuji Electric Co. Research Center Yaskawa Electric Mfg. Co. Ltd.
(3)Marine Robot	Oki Electronic Industrial Co. Ltd. Kawasaki Heavy Industries Ltd. Komatsu Ltd. Sumitomo Electric Industries Ltd. Mitsui Engineering and Shipbuilding Co., Ltd.
(4)Disaster Prevention/Relief Robot	Ishikawajima-Harima Heavy Industries, Co., Ltd. Kobe Steel Ltd. Nihon Electric Co., Ltd. Matsushita Research Lab International Robot FA/Technology Center

For a country such as Japan which is surrounded by the ocean, it is necessary to use effectively the natural resources of the ocean and to develop appropriate support technologies. Underwater operations in the development of marine petroleum resources involve difficult conditions peculiar to the ocean, such as darkness, water pressure, tidal currents, and low temperatures. Thus, much manpower and time is required to accomplish this type of work. A variety of underwater operations, at each stage from mining and through production, are chiefly performed by divers. Such operations include observation, inspection, testing, cleaning, exchanging parts and equipment, and monitoring which accompanies the installation of facilities and equipment.

With the objective of improving the safety, efficiency and reliability of these types of underwater operations, automation and robotization have moved forward.

Development of the Unmanned Diving Craft (ROV--Remotely Operated Vehicle) has continued from the latter half of the 1970s into the 1980s, and the commercialization already of a part of this field is testimony to this fact. Expectations have recently increased with regard to development of robots that have even more functional capabilities, and operate more independently to accomplish more intensive work operations.

(2) Details of Research and Development

The "Robot for Hazardous Environments Project" is being carried out in response to actual needs, among which are the research and development of the "Marine Robot" which can perform periodic maintenance, inspection and repair of marine petroleum development facilities in the place of divers under condition peculiar to the sea such as darkness, high water pressure, and tidal currents.

As for the details of the research and development, the following technologies are being developed; underwater movement and position control for marine robots; underwater vision, manipulation, and control monitoring technologies. A complete robot system which incorporates these technologies will be designed, tested and evaluated. Furthermore, the technologies pertaining to the marine robot are being developed extensively. This research has resulted in benefits to automation and robotization in other fields of marine petroleum development. It is also expected that this will build a major technical foundation for future development problems such as robotization of intensive operations such as the welding and assembly of undersea structures and the assembly of machine facilities.

(3) Research Status Overseas

The U.S. Navy produced the first unmanned diving craft in the 1960s for torpedo retrieval. In the 1970s smaller unmanned craft for observation and diver guidance appeared. In conjunction with the development of worldwide oceanic petroleum resources, the ISE Corp. of Canada AMETEC Corp. of the United States, Comex Corp. of France, other unmanned craft were introduced into the North Sea, the Arctic Ocean adjacent to Canada, and in the Gulf of Mexico for marine petroleum development operations. In the latter half of the 1970s, many unmanned craft were developed, ranging from those which function only with TV or still cameras for observation applications, to those which perform light-duty tasks and are equipped with manipulators and tools.

In recent years, prototypes have been developed of unmanned craft which perform some heavy duty tasks, visual inspection, cleaning, breakage inspection, and multiple functions. Also, colleges and government agencies are doing research and development of basic technology for high-precision marine robots which perform the simple tasks of former robots but are multi-functional and have greater autonomy.

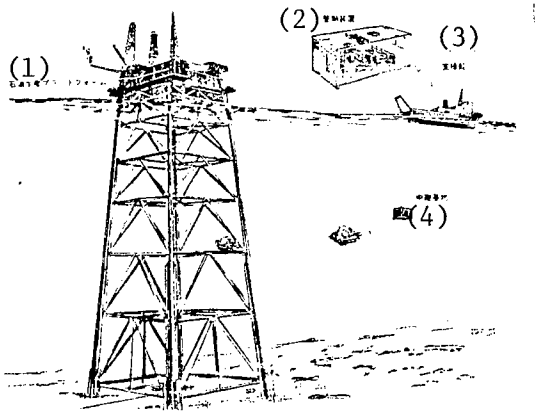
The importance of unmanned diving craft and high precision marine robots is a trend predicted worldwide to become stronger and stronger in the field of underwater operations.

(4) Environmental Conditions and Chief Tasks

Over 90 percent of all marine petroleum production platforms are of the jacket type. These platforms function under the following work conditions: water depth of 50-200 meters, tidal currents of 2 knots, visibility of 5 meters, and surface waves of 2-3 meters.

The chief operations which are performed underwater are external inspections mainly of platform sections, removal of organisms from the supporting structures, cleaning, breakage inspection of welded joints, and valve operation.

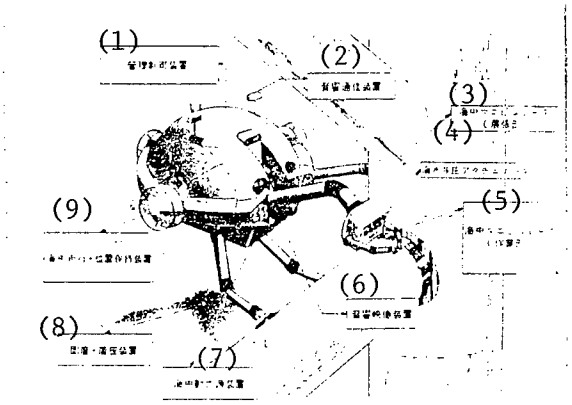
Figure 2. Concept Diagram of Marine Petroleum Development Operations



Key:

1. Platform for petroleum production
2. Monitoring equipment
3. Support vessel
4. Repeater site

Figure 3. Concept diagram of Marine Robot



Key:

1. Management control equipment
2. Sonar communications device
3. Underwater manipulator (extending section)
4. Seawater pressure actuator
5. Underwater manipulator (working section)
6. Sonar image device
7. Underwater power source
8. Attachment/seating device
9. Underwater movement/position control device

(5) Major Functions and Specifications

The major functions and specifications of the marine robot are as follows.

1. Overall System

This consists of a robot capable of remote control operations by an autonomous built-in control system which enables high precision underwater work operations in conditions which fluctuate with time and place, tidal currents, underwater visibility, and water pressure.

Its dimensions are approximately 2.7m wide X 3.2m long X 2.7m high. Its power source is self-contained.

2. Movements

It has an inertia navigation function and a propulsion mechanism (BARI-BACK) propeller system which enables smooth three dimensional movement to the work site. Movement of the robot is controlled by a dynamic control system.

During work operations, the robot's position is maintained by 3 legs with pressure-differential suction type end-effectors which can support the reaction to operations with high accuracy.

Relative speed is 3 knots in all directions in a 2-knot current.

3. Manipulators

The robot has six free-moving pairs of manipulators arms to perform the required tasks while it is in a fixed position at the work site. It also has seawater pressure actuators.

4. Sensory Perception

The robot has a high-quality sonar picture system that can detect targets and hindrances in dark waters.

(6) Current State of Research and Development

1. Overall System

Environmental models and actual picture measurements are being collated. The data processing method which fixes the independent position coordinates is being compiled and actual experiments in the sea are being done regarding the sonar communications technology.

2. Movements

With regard to three-dimensional propulsion mechanism, prototypes have been made of BARI-BACK propeller's variable pitch mechanism, and of other parts

such as the pitch control device. A control system has been developed for experimentation and simulation of three-dimensional position control. A prototype of an actual size endo-effector leg has been made.

3. Manipulators

A single-axis model of a manipulator has been test manufactured, and underwater testing has been done for tidal current compensation and power control. Prototypes of the pump, control valuer and (VENN) motor for the seawater pressure actuator have been made. Experiments have been done on seawater actuators, and joints and physical strength have been tested.

4. Sensory Perception

With regard to the sonar image system, tests are being done on a prototype of the transmit/receive arrays of a cross-fan beam electron focus sonar image sensor.

Near visual perception sensors have also been developed and tested under high water pressure conditions.

6. International Research Corporation

(1) Details

Based on a general agreement that it is necessary to expand scientific technologies to revitalize and foster growth in the world economy, 18 subjects were presented as international projects for research and development at the June 1982 Versailles Summit. The advanced robot technology project was one of those presented. In Japan, the "Robot for Hazardous Environment" project has been promoted as the nucleus of the international cooperative research effort.

(2) Participating Countries

Countries participating in the project are Austria, Canada, EC, France, W. Germany, Italy, Japan, England and the United States (nine countries). Norway and Holland are participating as observers.

(3) International Activities

The aim of this project is to promote international research cooperation regarding the development of a sophisticated robot which can support or replace human efforts in hazardous or harsh environments.

Applicable fields are space, marine, nuclear power facilities, mining, agriculture, construction and civil engineering, factory operations, safety, disaster, relief, family-related medicine, and heath management.

Data and opinion exchange, as well as personnel exchanges, with regard to the sensors, actuators, manipulation, man-machine systems, movement, intelligence and mechanism technologies for each of the fields of application will be carried out.

/12232

Melt Reducing Method of Iron Manufacture Discussed

43067516 Tokyo NIKKO MATERIALS in Japanese Sep 87 pp 12-15

[Article by Atsushi Araki: "Possibility of Melt Reducing Method"]

[Text] "Iron," the material that has supported modern civilization, has been swept by a new current. Other countries as well as Japan are enthusiastically conducting research on the practical use of a melt reducing method of iron manufacture in place of the blast furnace methods that have long been used. Judging from the degree of enthusiasm, there is a strong possibility of demonstration plants being developed and successively put to practical use within 10 years. First of all, melt reducing methods are less expensive than blast furnace methods. Under optimum conditions, the cost of operation can be reduced by at least 30 percent. Facilities and construction are economical, because processes can be omitted. In addition, there need be little concern about deterioration of raw material conditions, because low-quality materials can be used. This may become the trump card for domestic manufacturers worried about a decrease in international competitiveness. Up to now, various processes have been devised and examined by domestic and foreign enterprises, and in the future some of these processes will probably show promise. What is the present status of the melt reducing methods that will affect the future of the steel industry?

The reason why iron (steel) has been the main material selected for use in modern times is that it has such physical properties as high strength, toughness, workability, etc.; it can be produced and used at low cost; and the raw material resources are abundant. For these reasons manufacturers increased the capacity of blast furnaces, and the advent of efficient blast furnaces further promoted this increase. Even now, the annual world output of crude steel is more than 700 million tons--an amount unmatched by any other industrially produced material.

However, the merits of blast furnaces have gradually faded with the elapse of time. The diversity of steel materials has increased, mass production of some of them has not always been necessary at the raw materials processing stage, and it has become difficult to operate at high efficiency the large blast furnaces that have been constructed in industrially advanced nations because of the decrease in total. In other words, it has become difficult for blast furnaces to cope with the large fluctuation in

demand. In addition, the high-quality raw materials (iron ore = lump ore and coal = caking coal) necessary for the blast furnace method have become depleted throughout the world.

Inefficient blast furnaces have become symbolic of industrially advanced nations such as European countries, the United States, and Japan. These advanced countries have unavoidably had to lower the operating rate of blast furnaces and finally to suspend operation of low-efficiency blast furnaces, because the work of producing high-quality materials has gradually been taken over by semi-industrialized countries where the cost of labor is lower. When demand is increasing, processes are highly advantageous, but when it is decreasing, they are highly disadvantageous.

Principle Devised in West Germany in 1950's

Processes were required that could deal flexibly with the fluctuation in demand and with the variety of products. On the basis of such processes, new iron manufacturing methods were needed wherein even low-quality raw materials could be used efficiently.

The principle of the melt reducing method was devised in West Germany as early as the 1950's and 1960's, and very recently, i.e., in the early 1980's, full-scale research and development of this principle began for the purpose of putting the principle to practical use. At first, the principle was complex, and the need for putting it to practical use was not as great as at present.

A direct reducing method devised as a new process to replace the blast furnace method was put to practical use earlier than the melt reducing method, and at present plants employing the direct reducing method are being operated throughout the world. But the spread of the direct reducing method is restricted by the fact that natural gas--which is the low-cost means used to reduce the ore--is limited.

The basic process of the blast furnace method is that the ore is gradually melted through the combustion heat of coke (combustion generated by the blowing of a hot blast), then reduced in a single furnace by the use of coke, and finally decomposed into molten iron and slag in the lower portion of the single furnace. In this case, however, a large amount of coke in which caking coal is carbonized must be prepared in advance. It is also necessary to sinter ore fines to the proper size or to regulate the particle size of the lump ore as necessary. That is, it is necessary to prepare a huge blast furnace, a coke-oven plant, a sintering furnace, and particle size regulating facilities corresponding to the huge blast furnace. The cost of facilities becomes very high.

In contrast, in the melt reducing method, a reaction extending over molten iron is generated in a reactor. The reaction in most of the various processes is divided into two stages. In the first stage iron ore is preheated and prereduced, and in the second stage it is finally reduced and melted. Systems such as an electric furnace, a blast furnace type shaft

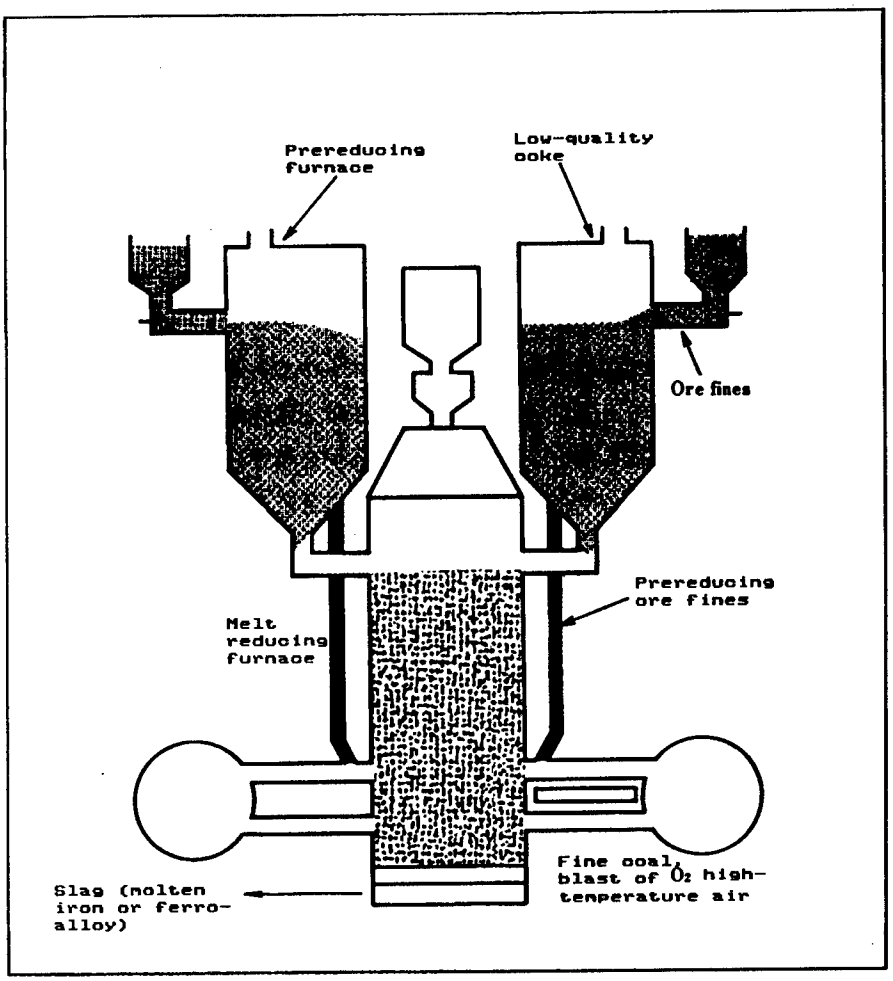


Figure 1. Melt Reducing Furnace Devised by Kawasaki Steel Corp.

furnace, a converter, etc., have been adopted for the reduction melting actions in the second stage.

The most important feature of this method is that ore fines can be used without change as raw materials, and general coal can be used instead of caking coal. Accordingly, the cost can be reduced and resources can be used effectively. From the standpoint of the cost of facilities, sintering furnaces and coke oven plants for preprocessing are unnecessary. In addition, it is expected that relatively small facilities can be used. In crude steel converting capacity, the present blast furnaces are considered unprofitable unless they can produce more than 1 million tons annually, while it is expected that when the melt reducing method is used the cost equivalent to that of blast furnaces can be realized at a scale of only 1 million tons. The facility and operating costs are not only low, but also it is possible to maintain a high reaction speed by increasing the speed of supplying substances and energies to reaction spaces. In addition,

the melt reducing method is very promising because it is considered that converters for post processes can be omitted and because C_1 chemical industry can be combined with this method.

Two or Three Patterns Depending on Structure

The processes that have been developed up to now can be broadly classified into two or three patterns depending on the structure of the melt reducing furnaces (final reduction furnaces): "packed bed type," "iron bathing type," and "intermediate type." In addition, they are classified into three kinds: "coal-based type," "coal-based electric power use type," and "electric power-based type," depending on the heat supply system.

Of the melt reducing methods presently being developed in Japan, packed bed type patterns are being developed by Sumitomo Metal Industries, Ltd., and Kawasaki Steel Corp., and an iron bathing type pattern is being developed by Nippon Kokan K.K. Nippon Steel Corp. has not disclosed the present status of its pattern development, but it appears that it is developing an iron bathing type pattern.

The packet bed type pattern is devised so that a high-temperature zone having a reducing atmosphere is achieved by putting oxygen and fine coal in coke beds packed in advance, and ore is melted and reduced by feeding the ore into this temperature zone. In this case, fine coal plays a role in generating the heat and reducing gas, while coke only plays a role as a path for the melt and gas. There is also a method in which in place of oxygen, reducing gas is turned to plasma and electric power is blown in in the form of heat.

The process being developed by Kawasaki Steel Corp. is a modification of the blast furnace method. It consists of a prereducing furnace and a melt reducing furnace, and is called a "process that requires neither lump ore nor coke." The significant feature is that coal is simultaneously carbonized, melted, and reduced in a melt reducing furnace. This melt reducing furnace is of a vertical type having two-stage tuyeres. The fluidized bed and packed bed of coal (or coke) are formed in the upper and lower portions of the furnace by sending high-temperature air and oxygen from these tuyeres to the furnace. Coal put inside the furnace from the top is heated in the fluidized bed and then moved to the lower portion of the furnace. Molten pig iron can be made by feeding preliminarily reduced ore fines from the upper stage tuyere to the lower portion and quickly melting and reducing the coal.

Tests have already been conducted, as a pilot plant employing a system for charging low-strength coke was constructed at the Chiba works of Kawasaki Steel last year. Construction of a pilot plant that will be operated only using coal will be started next spring for the purpose of increasing the pace of development of melt reducing methods.

The process being developed as an SC method by Sumitomo Metal Industries employs a system in which a blast furnace is vertically divided into two parts by the use of a fusion bond zone. Pellets and ore are reduced in a

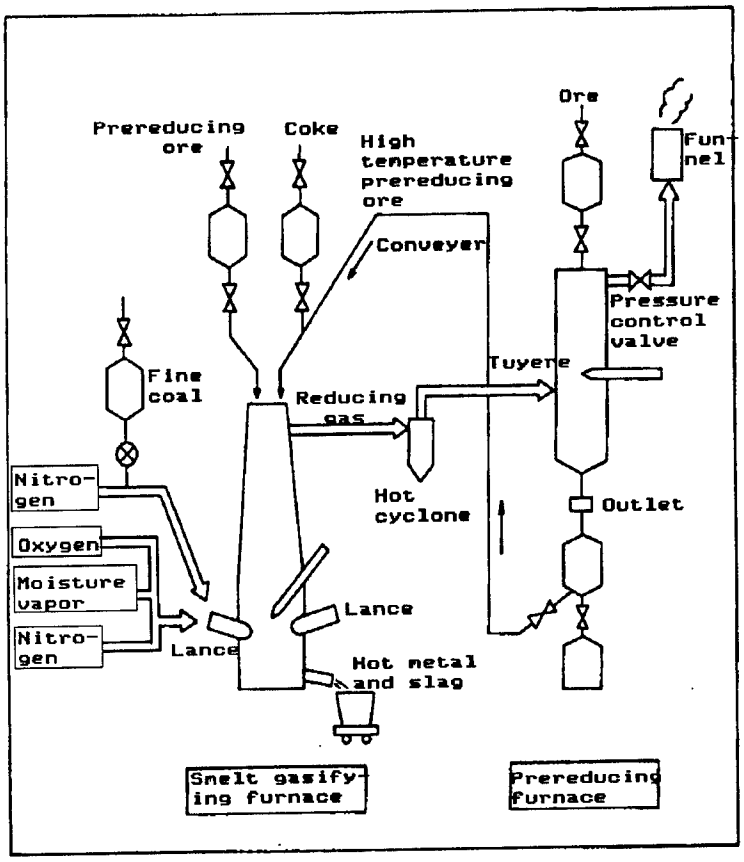


Figure 2. Outline of Shaft Furnace Type Melt Reducing Method Devised by Sumitomo Metal Industries, Ltd.

prereducing furnace that is equivalent to the upper portion of a blast furnace, and they are then put in a smelt gasifying furnace that is equivalent to the lower portion of a blast furnace, while a high temperature is maintained. Oxygen containing nitrogen and moisture vapor is gasified by feeding fine coal into the smelt gasifying furnace. In addition, prereducing ore, whereby high-temperature gas is put on coke packed beds, is melted and reduced. The gas ventilating resistance is small, only one-sixth that of a blast furnace, and the productivity can be increased to three times that of a blast furnace, because the smelting speed of charges in a smelt gasifying furnace is higher than that of charges in a blast furnace, and no cohesive zone can be formed in the smelt gasifying furnace. Tests on this matter are being conducted at a pilot plant installed at the General Research Institute of Sumitomo Metal Industries, Ltd.

Both cases have the advantage that if circumstances requires, both can be put to practical use by using a relatively small blast furnace.

Iron Bathing Type Tested Even With Ferrochrome

On the other hand, the iron bathing type melt reducing iron manufacturing method means that molten iron is changed to a medium of heat and carbon

(reducing agent), and this medium is rapidly melted and reduced by feeding or putting ore in the medium. This method was adopted in the ferrochrome melt reducing method developed as a technology for inducing melt reducing iron manufacturing methods in the Japanese national project. The Research Association for New Smelting Technologies [RANST] was organized and research work was started in FY 1982. Tests are being conducted at a pilot plant that has already been constructed at the Kimitsu works of Nippon Steel Corp.

This method is used in a furnace called an "upper bottom blasting converter type melt reducing furnace." High-temperature zones are formed by feeding oxygen into the furnace from the upper portion and combusting coke on the upper portion of the slag. Meanwhile, strong agitation is generated inside the furnace by gas sent in from the bottom, so the heat is supplied wholly inside the furnace, and reduction is promoted thereby.

It has been considered up to now that ferrochrome can be manufactured only under the condition of high-temperature strong reducibility in an electric furnace, but this new process has brought about a result in which difficult-to-reduce chromite can be reduced with high efficiency while causing combustion (feeding oxygen into an identical furnace).

It appears that this success has greatly affected the decision on the future course of development of melt reducing iron manufacturing technologies of Nippon Kokan K.K. and Nippon Steel Corp., which are the main members of RANST. Since last year, Nippon Kokan K.K. has been operating a pilot plant at its Fukuyama works using a multipurpose melt reducing furnace that can manufacture both iron and ferrochrome. It appears that Nippon Steel Corporation is also enthusiastically conducting research on practical use of an iron bathing type melt reducing iron manufacturing method, but the company has not disclosed any details of this method.

Nippon Steel Corporation has disclosed that it will put a new iron source procuring technology to practical use. This technology will replace even the conventional blast furnace and converter methods being used in the rationalization process promoted at present. The company intends to introduce a new steel manufacturing method in which scraps generated at both the Muroran and Hirohata works are directly smelted as raw materials in converters. The reason why these scraps are being generated there is that both works will stop operating their furnaces. It can be said that this introduction means that the company is making a strong effect to advance quickly to practical use of the melt reducing method. That is, the company has indicated its intention so as to forestall objections to continued use of blast furnace methods in iron manufacturing in the 21st century.

There is another reason why blast furnace manufacturers are making haste in putting new iron manufacturing methods to practical use. Of the present facilities, while the lifetime of blast furnaces can be extended by modifying them, when a specified term expires, coke and sintering furnaces must be constructed all over again. Their lifetime is regarded to be some

30 to 35 years. All of the facilities being operated at present were constructed during the period 1962 to 1965, so coke furnaces, etc., will reach the end of their operating life by about the year 2000.

If blast furnaces were still competitive at that time, it would be necessary only to modify the coke and sintering furnaces, but that possibility is very slight. Accordingly, the respective blast furnace manufacturers must inevitably establish new iron manufacturing methods by that time.

Of course, there are many technical aspects to the melt reducing method. The specialization and miniaturization of functions will cause an increase in heat loss. It is necessary to supply a large driving force to a small space in order to obtain high heat transfer and high reaction speed. Inevitably, high temperature and high calorific gas is discharged, and recovery of the heat of the gas and the use of the gas have a bearing on the processes. In addition, inexpensive oxygen manufacturing methods are indispensable, because a large amount of oxygen is necessary.

Every Effort To Put Melting Reducing Methods to Practical Use

The respective companies recognize that agreement must be reached on these subjects and that it is essential to put melt reducing methods to practical use. The attitude of the leading companies has been indicated by the fact that a project has almost been decided upon. That is, five leading companies will join together, each bringing the research results they have obtained up to now, to organize a joint development committee under the Japan Iron and Steel Federation [JISF] wherein, research work will be conducted in collaboration. It is uncertain what system should be selected as a theme, but in any case, they have agreed that they will start research work in FY 1987. Under a JISF concept, the five companies will obtain a subsidy for "coal use technical promotion subsidiary work" from the government, because of the use of general coal, whereby they will establish practical technologies in about 9 years at a cost of about ¥14 billion. It has been decided that two furnace companies, i.e., Nissin Steel Co., Ltd., and Nakayama Steel Works, Ltd., as well as the five companies will participate in the research work as a national project.

Even if melt reducing methods are put to practical use, blast furnaces will not become unnecessary at once in Japan. But there is no doubt that such practical use will increase cost competitiveness in the Japanese steel industry. The semi-industrialized countries that have up-to-date furnace facilities have not yet reached the point where they need to renew their facilities in terms of practical use.

But as time passes, the difference between advanced countries and semi-industrialized countries in regard to international cost and technologies will undoubtedly be narrowed. The establishment of technology means the start of new competition; this is historically unchangeable.

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Government Surveys Views on Nuclear Power Generation

43062560 Tokyo GEKKAN YORON CHOSA in Japanese Jan 88 pp 3-20

[Text] **1. Recognition of Nuclear Power**

(1) Knowledge About Nuclear Power

The following are data on the ratio of persons who responded affirmatively when we asked them, "Do you know about the following nuclear power-related matters?" (Figure 1):

The system of nuclear power generation is the same as that of thermal power generation because a turbine is rotated using steam to generate power--40.1 percent
We are normally exposed to radiation from the earth and the universe--65.8 percent
Emergency medical care and evacuation measures can be provided in case of an accident at a nuclear power station, based on the pertinent laws, as in the case of an earthquake--37.6 percent
The uranium that is used as fuel for nuclear power generation can be reused--43.5 percent

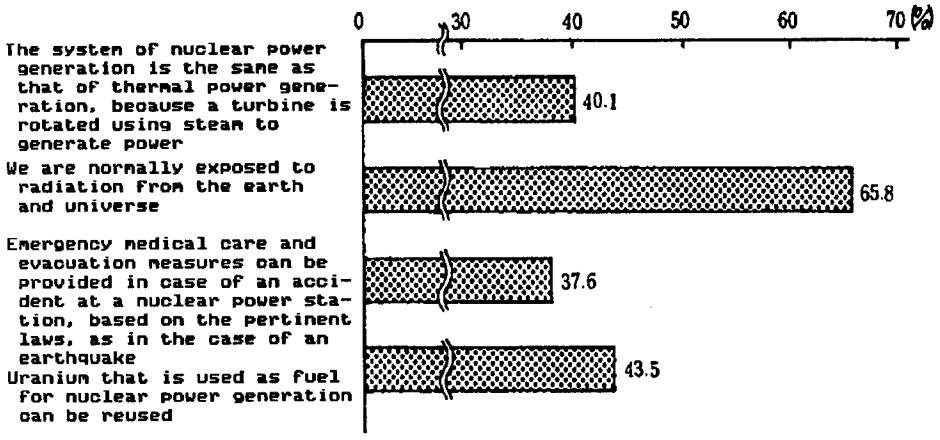

Figure 1. Knowledge About Nuclear Power (Ratio of persons who said they knew about nuclear power-related matters)

Next, when we asked those (1,802) who said that they knew about even one of the above four matters regarding nuclear power, "How did you acquire this knowledge about nuclear power?," we were given the following responses (multiple answers) (Figure 2):

By watching TV and listening to the radio--80.9 percent (four out of five persons)
By reading weekly and other magazines--29.5 percent
By asking others--14.4 percent

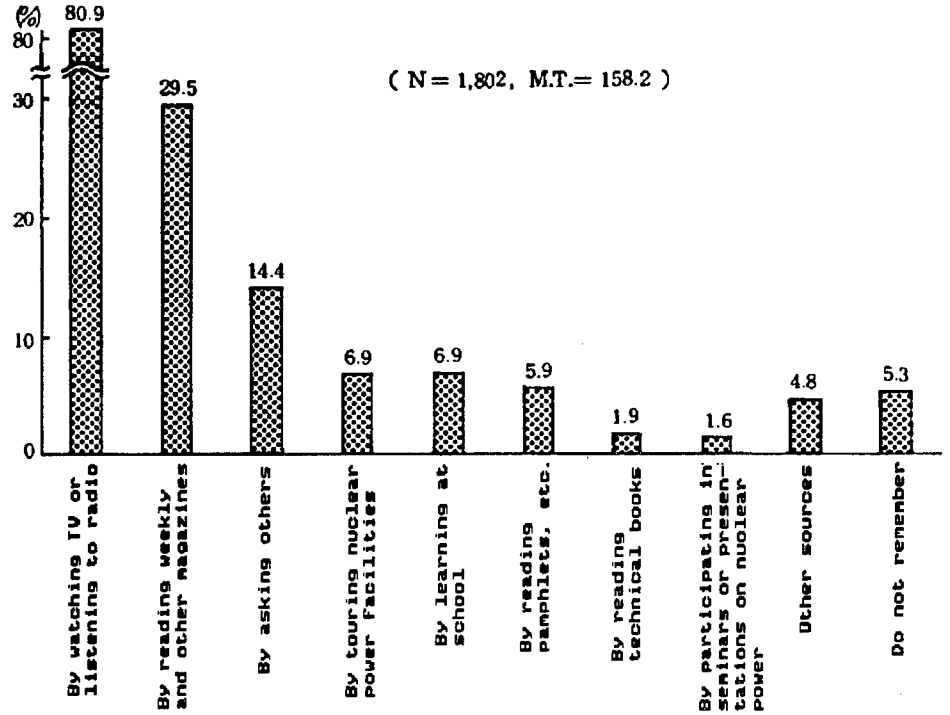

Figure 2. Sources of Knowledge About Nuclear Power (of the people who said that they knew about even one of the nuclear power-related matters, multiple answers)

(2) Awareness of "Nuclear Power Day" and "Science and Technology Week" (Figure 3)

The ratio of persons who said that they knew of the establishment of "Nuclear Power Day" and "Science and Technology Week"--34.6 percent (one out of three persons):

Persons aware of both--21.9 percent
Persons aware of "Nuclear Power Day"--10 percent
Persons aware of "Science and Technology Week"--2.8 percent

The ratio of persons who said that they knew about "Nuclear Power Day"--31.9 percent (persons aware of both "Nuclear Power Day" and "Science and Technology Week" plus those aware of "Nuclear Power Day"
The ratio of persons who said that they knew about "Science and Technology Week"--24.6 percent (persons aware of both "Nuclear Power

Day" and "Science and Technology Week" plus those aware of "Science and Technology Week")

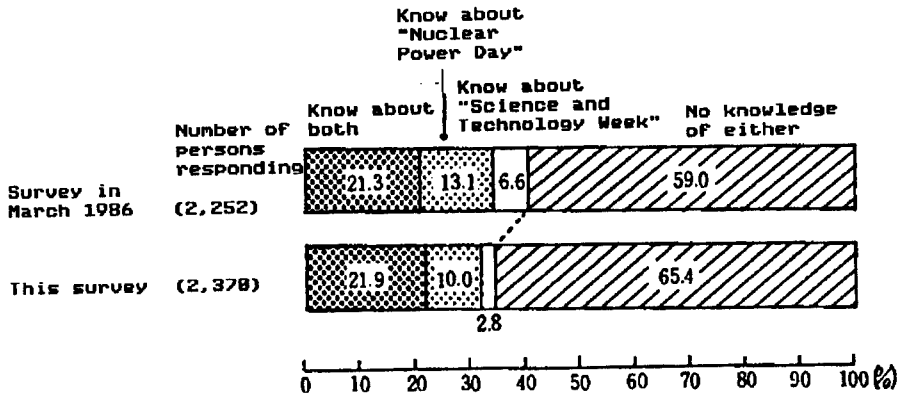

Figure 3. Awareness of "Nuclear Power Day" and "Science and Technology Week"

(3) Details of Knowledge About Nuclear Power (Figure 4)

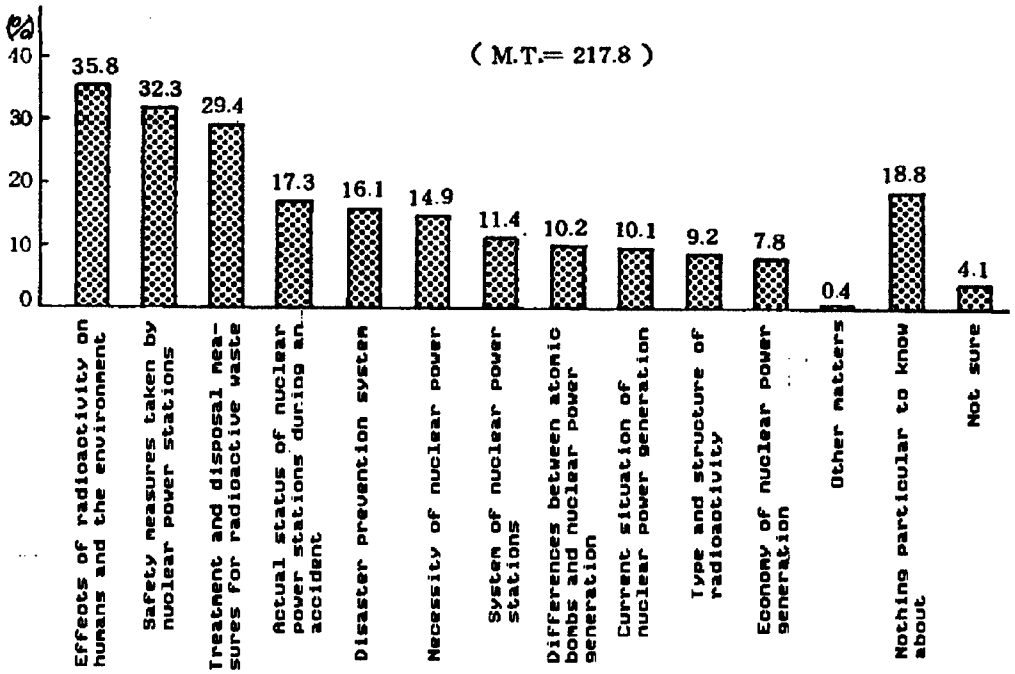

Figure 4. Knowledge About Nuclear Power (Multiple answers)

When we asked what people would like to know about nuclear power, 77.1 percent (approximately three out of four) said that there were matters they would like to know about. The details are as follows (multiple answers):

Effects of radioactivity on humans and the environment--35.8 percent
Safety measures taken by nuclear power stations--32.3 percent
Treatment and disposal measures for radioactive waste--29.4 percent

2. Accident at Chernobyl Nuclear Power Station

(1) Awareness of Accident

Concerning the accident that took place at Chernobyl nuclear power station in April 1986, 92.9 percent said they were aware of it and 7.1 percent said that they did not know (Figure 5).

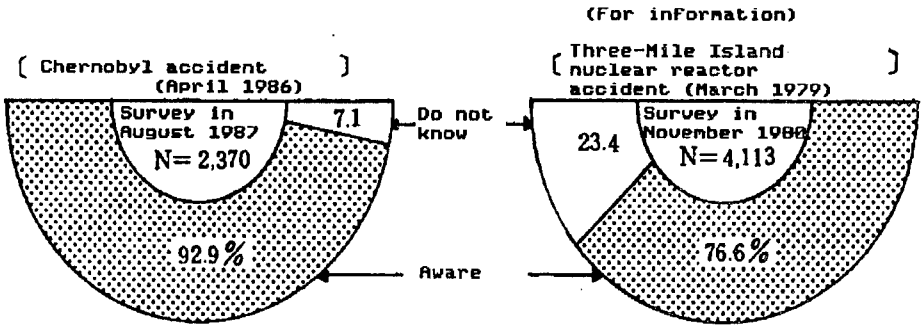

Figure 5. Awareness of Nuclear Power Station Accidents

Next, when we asked those (2,201) who said they knew about the accident at Chernobyl, "To what extent did the accident become topical at your place of work and in your neighborhood?," 64.1 percent--about two out of three--said it become topical (16.8 percent said it was a large topic and 47.3 said it was somewhat of a topic); 35.9 percent said it was not a topic (28 percent plus said it was hardly a topic, while 7.9 percent said it was never a topic) (Figure 6).

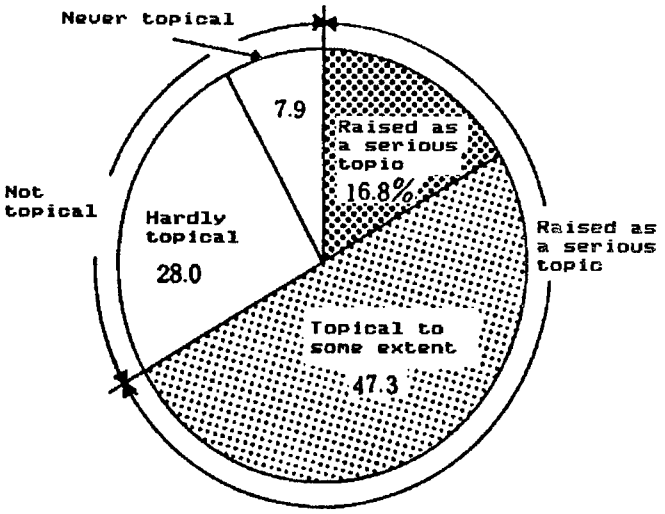

Figure 6. Topical Extent of Accident (among the 2,201 persons who said they knew about the accident)

(2) Explanations, Etc., About Nuclear Power Stations

After the accident at Chernobyl, 56.2 percent of the people said they had heard explanations and commentaries in nuclear power stations, while 43.8 percent said they had not (Figure 7).

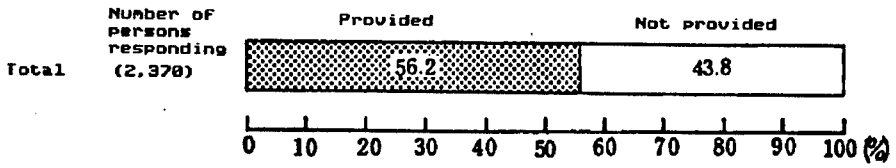

Figure 7. Information Provided on Nuclear Power Stations Such as Explanations

Next, when we asked those (1,331) who said they had heard explanations, etc., about nuclear power stations after the accident, "Where did you obtain the information?," as many as 92.6 percent said it was from general reports by the mass communications media, while 8.3 percent said it was from government publicity (multiple answers) (Figure 8).

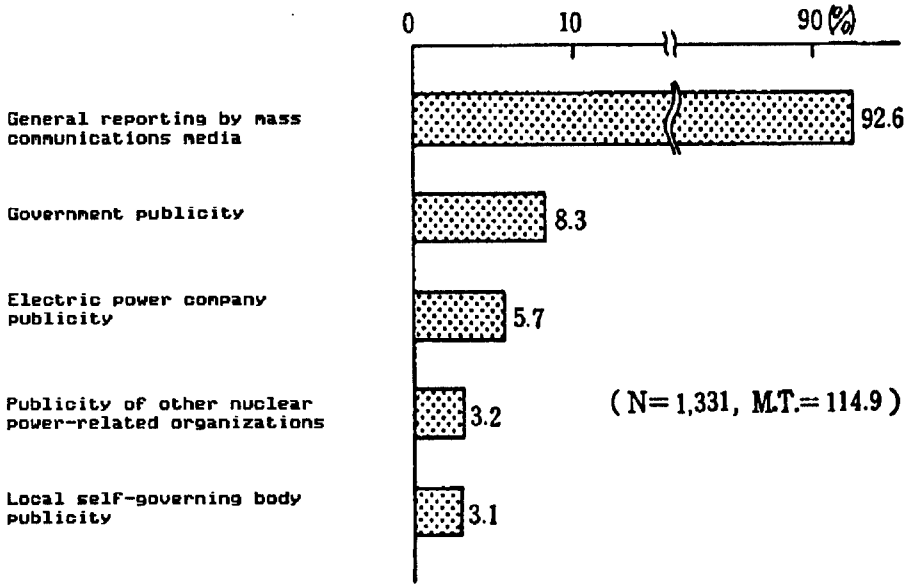

Figure 8. Sources of Information Such as Explanations About Nuclear Power Stations

3. Recognition of Nuclear Power Generation

(1) Present and Future Major Power Generation

When we asked, "What do you think is now the major source of power generation?," 39.5 percent--the highest number--answered "thermal power generation by petroleum," 27.9 percent said "hydropower generation," and 17.3 percent answered "nuclear power generation."

Then, when we asked, "What do you think will be the major source of power generation in the future?," 60.6 percent--the highest number--said "nuclear power generation," 10.7 percent said, "photovoltaic power generation," and 7.4 percent answered "thermal power generation by petroleum" (Figure 9).

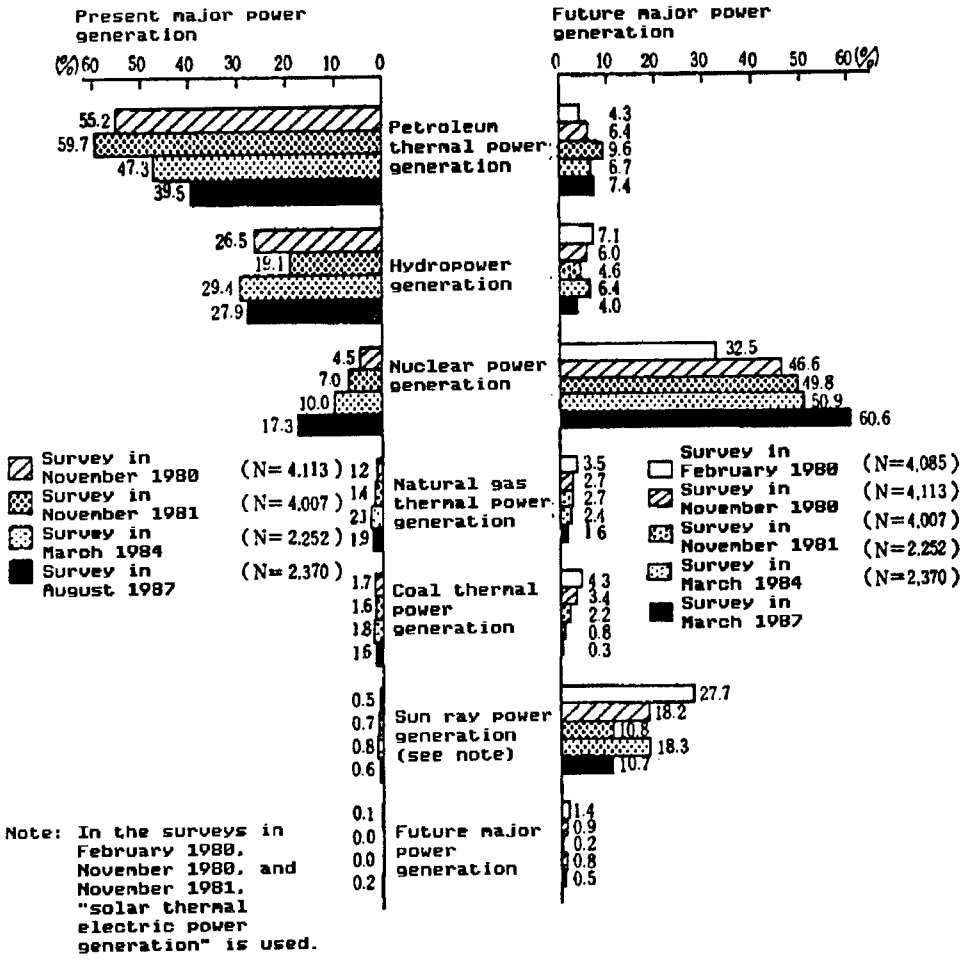

Figure 9. Present and Future Power Generation

Compared with the results of the previous survey, there was an increase in the ratio of those who said, "the present major source of power generation is nuclear power generation" and a decrease in the ratio of those who answered "petroleum thermal power generation."

Also, there was an increase in the ratio of those who said, "the future major source of power generation will be nuclear power generation" and a decrease in that of those who answered "photovoltaic power generation."

(2) Future Ratio of Nuclear Power Generation

In Japan, about 27 percent of the total volume of power generation is generated by nuclear power, and this ratio is scheduled to be increased in the future. When we asked, "What do you think about this?," the answers and the ratio of those who gave them are as follows:

The ratio of nuclear power should be positively increased--6.7 percent
This ratio should be carefully increased--50.1 percent (one out of two persons)
The ratio should not be increased further--23.2 percent
The ratio should be smaller than at present--4.5 percent
The nuclear power stations that are now on-line should be halted--1.8 percent (Figure 10)

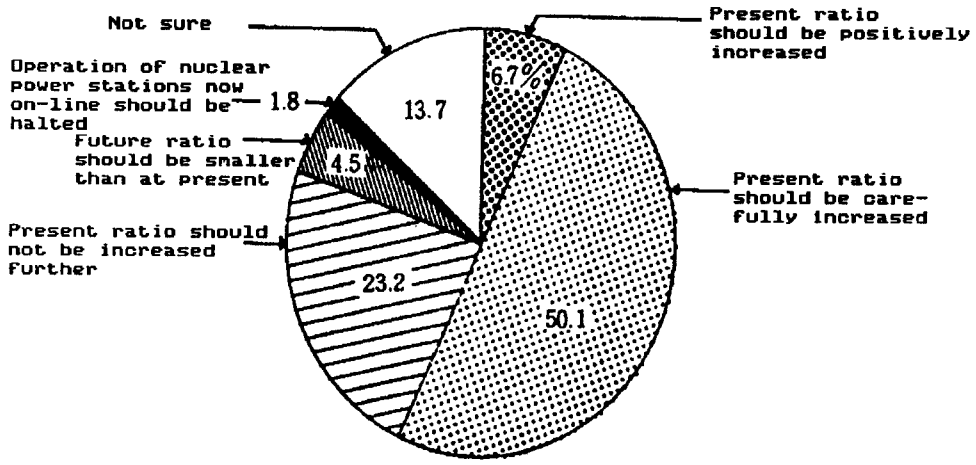

Figure 10. Future Ratio of Nuclear Power Generation

By city, the percentage favoring a careful increase is highest in metropolitan Tokyo, and that favoring no increase is highest in the 10 big cities (Table 1).

By sex, the ratio of males favoring an increase is higher than that of females, while the ratio of females favoring no increase or a decrease in nuclear power generation is higher than that of males.

By age, the ratio of persons in their thirties who favor a careful increase is higher.

Concerning the major source of power generation, three out of five persons who said that nuclear power would be the major power source favor a careful increase, and the majority of those who said that petroleum thermal power and hydropower would be the major power sources favor no further increase in nuclear power generation.

As to the provision of information such as an explanation about nuclear power stations after the accident, more persons who received such information favored a careful increase than those who did not (Table 1).

Table 1. Future Ratio of Nuclear Power Generation

	Number of persons responding	Positive increase	Careful increase	No further increase	Ratio should be smaller than at present	Power stations now on-line should be halted	Not sure
		%	%	%	%	%	%
Total number	2,370	6.7	50.1	23.2	4.5	1.8	13.7
(City scale)							
Metropolitan Tokyo	149	8.1	60.4	18.1	4.7	2.7	6.0
10 big cities	304	7.2	44.4	27.0	4.3	2.0	15.1
Cities whose population is 100,000 or more	864	6.5	51.9	22.8	4.5	2.2	12.2
Cities whose population is less than 100,000	456	5.5	48.7	25.0	4.6	1.3	14.9
Towns and villages	597	7.4	48.9	21.8	4.4	1.3	16.2
(Sex)							
Male	1,116	9.3	58.1	18.9	3.3	1.5	8.9
Female	1,254	4.4	43.0	27.0	5.5	2.1	18.0
(Age)							
20-29 years old	288	4.2	52.4	26.4	5.6	1.7	9.7
30-39 years old	537	4.8	54.0	23.6	5.0	3.0	9.5
40-49 years old	533	8.3	50.8	20.8	4.9	2.4	12.8
50-59 years old	507	8.3	47.5	27.4	3.6	0.8	12.4
60 years or more	505	6.9	46.3	19.2	3.8	1.0	22.8
(By site of nuclear power station)							
Site preference	574	5.7	47.9	25.6	6.1	0.7	13.9
No site preference	1,796	7.0	50.8	22.4	4.0	2.2	13.6
(Future major power generation source)							
Petroleum thermal power generation	176	6.8	36.4	36.4	6.3	1.7	12.5
Coal thermal power generation	6	—	50.0	50.0	—	—	—
Natural gas thermal power generation	39	2.6	51.3	25.6	—	12.8	7.7
Hydropower generation	95	8.4	28.4	37.9	7.4	—	17.9
Nuclear power generation	1,436	7.0	60.7	19.3	3.7	1.2	8.1
Sun ray power generation	254	6.7	46.1	28.0	5.9	5.9	7.5
Geothermal power generation	12	33.3	16.7	25.0	8.3	—	16.7
Other	2	—	50.0	50.0	—	—	—
Not sure	350	4.9	23.1	24.3	5.4	0.9	41.4
(Information on nuclear power stations by explanation)							
Provided	1,331	6.9	54.7	23.0	5.0	2.5	8.0
Not provided	1,039	6.4	44.2	23.5	3.8	1.0	21.1

4. Safety of Nuclear Power Generation

(1) Concern and Anxiety About Nuclear Power Generation

Among the 85.9 percent of persons who said they had some concern and anxiety about nuclear power generation, the following were the reasons and percentages:

The leaking of radioactivity due to accidents and problems--39.9 percent
Radioactivity on the human body and offspring--39.4 percent
Storage, treatment, and disposal of radioactive waste--29.7 percent

The ratio of those who said they did not have any concern or anxiety is 8.1 percent (Figure 11).

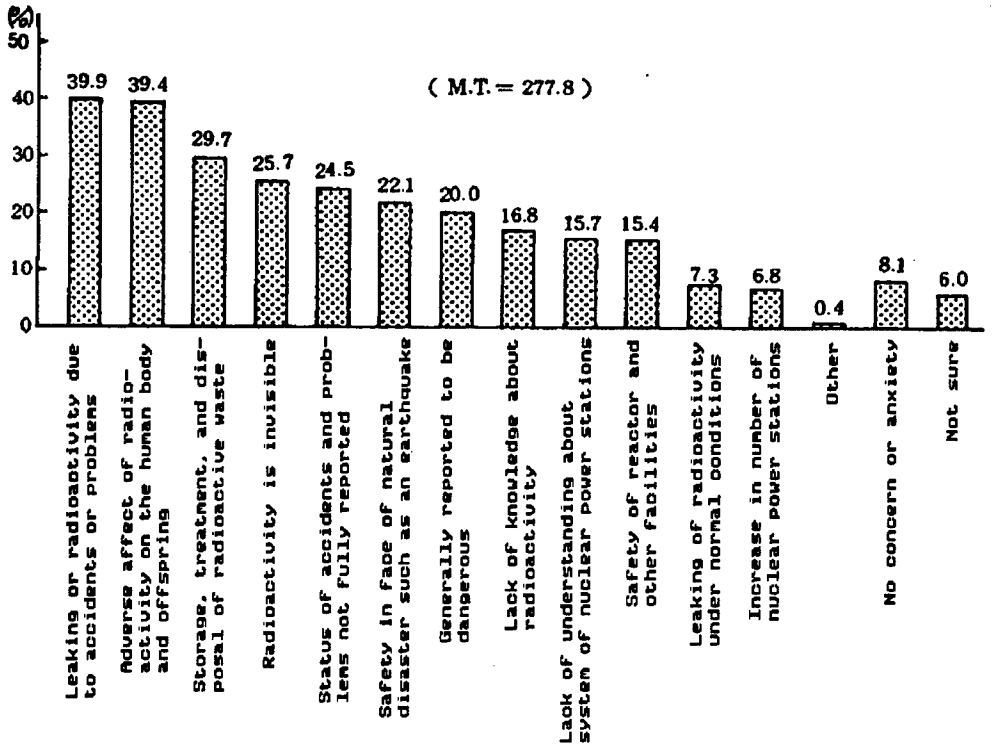

Figure 11. Concern and Anxiety About Nuclear Power Generation

(2) Safety of Japanese Nuclear Power Stations

The ratio of those who said that the safety of the Japanese nuclear power stations was reliable is 51.7 percent (4.4 plus percent said "fully reliable," 47.3 percent said "reliable to some extent") (one out of two), exceeding the 32.7 percent who said that such safety was unreliable (29 plus percent said "hardly reliable," 3.7 percent said "never reliable") (Figure 12).

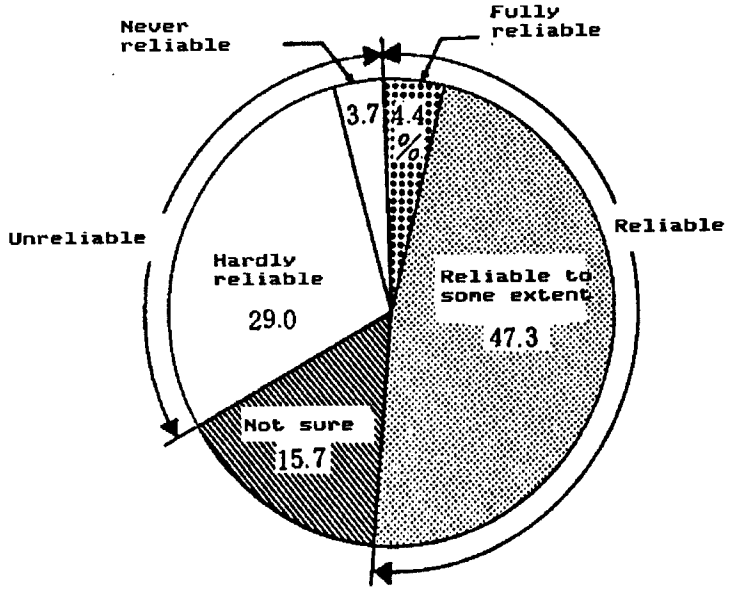

Figure 12. Safety of Japanese Nuclear Power Stations

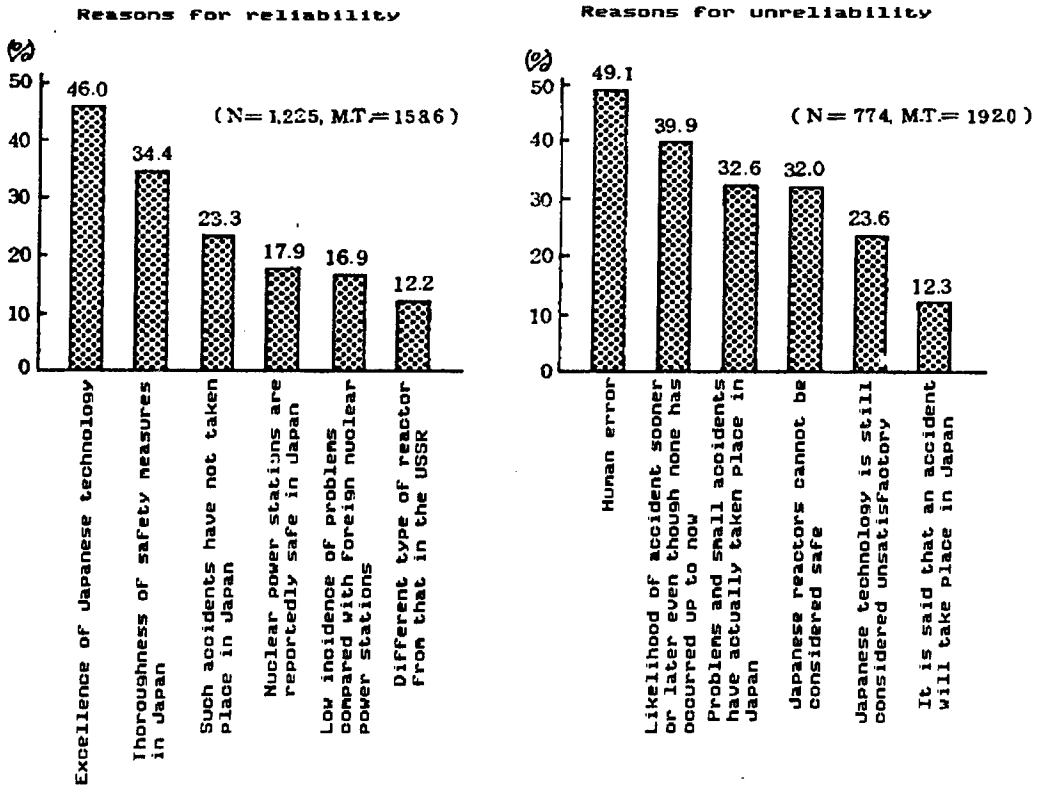

Figure 13. Reasons for Reliability or Unreliability of Japanese Nuclear Power Stations (Multiple answers were given by those who said that the safety of the Japanese nuclear power stations was reliable or unreliable)

Of those who said they consider the safety of Japanese nuclear power stations reliable, the highest numbers were found among those who live in metropolitan Tokyo by city scale, were male rather than female by sex, were in their twenties to forties by age, and had a higher level of education (Table 2).

Table 2. Safety of Japanese Nuclear Power Stations

	Number of persons responding	Reliable	Fully reliable	Reliable to some extent	Unreliable	Hardly reliable	Never reliable	Not sure
		%	%	%	%	%	%	%
Total number	2,370	51.7	4.4	47.3	32.7	29.0	3.7	15.7
(City scale)								
Metropolitan Tokyo	149	61.7	4.0	57.7	26.2	24.8	1.3	12.1
10 big cities	304	49.0	5.6	43.4	34.2	28.9	5.3	16.8
Cities whose population is 100,000 or more	864	51.7	3.8	47.9	33.6	30.2	3.4	14.7
Cities whose population is less than 100,000	456	50.4	4.2	46.3	35.7	32.7	3.1	13.8
Town and village	597	51.4	4.9	46.6	29.8	25.5	4.4	18.8
(Sex)								
Male	1,116	59.6	6.5	53.1	29.7	26.6	3.0	10.8
Female	1,254	44.7	2.6	42.1	35.3	31.1	4.2	20.0
(Age)								
20-29 years old	288	55.6	3.8	51.7	35.1	31.3	3.8	9.4
30-39 years old	537	48.4	3.7	44.7	38.9	35.4	3.5	12.7
40-49 years old	533	55.2	2.6	52.5	33.4	29.3	4.1	11.4
50-59 years old	507	51.5	5.7	45.8	31.6	27.8	3.7	17.0
60 years old or more	505	49.5	5.9	43.6	25.0	21.8	3.2	25.5
(Academic background)								
Graduated from: Primary school, old higher primary school, new Junior high school	780	44.7	4.2	40.5	29.2	25.9	3.3	26.0
Senior high school	1,116	54.5	4.5	50.0	34.5	31.2	3.3	11.0
Old senior high school, higher technical college, university	453	57.4	4.4	53.0	33.8	28.5	5.3	8.8
Unclear	21	38.1	4.8	33.3	38.1	38.1	—	23.8

In regard to those (1,225) who said that Japanese nuclear power stations were reliable, the reasons given and percentages were as follows:

The excellence of Japanese technology--46 percent (highest)
The thoroughness of safety measures--34.4 percent
Such accidents have not taken place in Japan--23.3 percent

Also, of those (774) who said that the Japanese nuclear power stations were unreliable, the reasons and percentages were as follows (multiple answers) (Figure 13):

Human errors--49.1 percent (highest)
Likelihood of an accident sooner or later, even though none has occurred up to now--39.9 percent
Probl . ; and small accidents have actually occurred in Japan--32.6 percent
Japanese reactors cannot be considered safe--32 percent

Questions and Answers

Q1 (Answer slip 1) Do you know about "Nuclear Power Day" and "Science and Technology Week?"

(21.9)	(10.0)	(2.8)	(65.4)
(a)	(b)	(c)	(d)
Know about both	Know about "Nuclear Power Day"	Know about "Science and Technology Week"	Do not know about either

Q2 Do you know about the following matters related to nuclear power? Please answer "know" or "do not know."

		Know	Do not know
(1)	The system of nuclear power generation is the same as that of thermal power generation as power is generated by turning a turbine using steam	(40.1)	(59.9)
(2)	We are normally exposed to radiation from the earth and the universe	(65.8)	(34.2)
(3)	In case of an accident at a nuclear power station, emergency medical care and evacuation measures can be provided under the law, as in the case of an earthquake	(37.6)	(62.4)
(4)	The uranium that is used as fuel for nuclear power generation can be reused	(43.5)	(56.5)

(Those who responded "do not know" to items (1) through (4) are asked to proceed to Q3)

SQ (Answer slip 2) Where did you learn about the matters mentioned in Q2? You may select more than one answer from the following column.

(N=1,802) (M.A.)

(6.9) (1) By touring nuclear power facilities
(1.6) (2) By participating in a seminar or presentation
(6.9) (3) By learning at school
(14.4) (4) By asking others
(80.9) (5) By watching TV or listening to the radio
(29.5) (6) By reading weekly magazines and other magazines
(5.9) (7) By reading pamphlets, etc.
(1.9) (8) By reading technical books
(4.8) Other ( )
(5.3) Do not remember
(M.T.= 158.2)

Q3 (Answer slip 3) From among the following, which do you think is now the major source of power generation in Japan? Please select only one.

(39.5) (1) Petroleum thermal power generation
(1.6) (2) Coal thermal power generation
(1.9) (3) Natural gas thermal power generation
(27.9) (4) Hydropower generation
(17.3) (5) Nuclear power generation
(0.6) (6) Photovoltaic power generation
(0.2) (7) Geothermal power generation
(0.0) (8) Other ( )
(11.1) Not sure

Q4 (Answer slip 3) Then, of the following sources of power generation, which do you think will be the major power generation source in the future? Please select only one.

(7.4) (1) Petroleum thermal power generation
(0.3) (2) Coal thermal power generation
(1.6) (3) Natural gas thermal power generation
(4.0) (4) Hydropower generation
(60.6) (5) Nuclear power generation
(10.7) (6) Photovoltaic power generation
(0.5) (7) Geothermal power generation
(0.1) (8) Other ( )
(14.8) Not sure

Q5 (Answer slip 4) In Japan, about 27 percent of the current total power generation volume is generated using nuclear power, and nuclear energy accounts for about 10 percent of all the energy used in Japan. According

to plan, the rate of nuclear power generation in Japan is to be increased. What do you think about this? Please select one of the following.

(6.7) (1) The rate should be positively increased
(50.1) (2) The rate should be carefully increased
(23.2) (3) The rate should no longer be increased
(4.5) (4) The future rate should be smaller than at present
(1.8) (5) The operation of nuclear power stations now on-line should be halted
(13.7) Not sure

Q6 (Answer slip 5) Do you have any concern about nuclear power generation? If so, what is the reason? You may select more than one answer from the following. (M.A.)

(15.7) (1) The system of nuclear power stations is not understood well
(16.8) (2) Do not know much about radioactivity
(25.7) (3) Radioactivity is invisible
(24.5) (4) The status of accidents and problems is not fully reported
(20.0) (5) Nuclear power stations are generally said to be dangerous
(6.8) (6) The number of nuclear power stations is increasing
(7.3) (7) Radioactivity leaks under normal conditions
(39.9) (8) Radioactivity leaks due to accidents and problems
(39.4) (9) Radioactivity has an adverse affect on the human body and on offspring
(15.4) (10) Concern about the safety of nuclear power reactors and other facilities
(22.1) (11) Concern about safety in the face of a natural disaster such as an earthquake
(29.7) (12) Concern about storage, treatment, and disposal of radioactive waste
(0.4) Other ( )
(8.1) No concern
(6.0) Not sure (M.T.=277.8)

Q7 Do you know about the accident that occurred at the Chernobyl Nuclear Power Station in the USSR in April 1986?

(92.9)	(7.1)
Know	Do not know
↓	(to Question 8)

SQ (Answer slip 6) To what extent did this accident become a topic of conversation at your place of work or in your neighborhood? (Please select one of the following. (N=2,201)

(16.8)	(47.3)	(28.0)	(7.9)
(1)	(2)	(3)	(4)
Serious	To some extent	Hardly	Never

Q8 Did you hear explanations or commentaries about nuclear power stations after the accident at Chernobyl?

(56.2)	(43.8)
Yes	No
↓	(to Question 9)

SQ (Answer slip 7) Where did you hear? You may select more than one answer from the following. (M.A.) (N=1,331)

(8.3) (1) Government publicity
(3.1) (2) Local self-governing body publicity
(5.7) (3) Electric power company publicity
(3.2) (4) Other nuclear power-related organization publicity
(92.6) (5) General reports by mass communications media
(1.0) Other ( )
(1.1) Do not remember (M.T.=114.9)

Q9 (Answer slip 8) After the accident that occurred at Chernobyl in the USSR, how do you feel about the safety of Japanese nuclear power stations? Please select one of the following.

(4.4)	(47.3)	(29.0)	(3.7)	(15.7)
(1) Fully reliable	(2) Reliable to some extent	(3) Hardly reliable	(4) Never reliable	(5) Not sure
↓		(to SQb)		(to Q10)

SQa (Answer slip 9) Why did you give your answer? You may select more than one answer from the following. (M.A.) (N=1,225)

(12.2) (1) The Japanese reactors are a different type from those in the USSR
(46.0) (2) Japanese technology is excellent
(34.4) (3) Thorough safety measures are taken in Japan
(17.9) (4) It is said that the Japanese reactors are safe
(23.3) (5) Such accidents have not occurred in Japan
(16.9) (6) The incidence of problems with Japanese reactors is lower than that of foreign reactors
(0.8) Others ( )
(2.0) Not sure (M.T.=153.6)

SQb (Answer slip 10) Why did you give your answer? You may select more than one answer from the following. (M.A.) (N=774)

(32.0) (1) It cannot be said that the Japanese reactors are safe
(23.6) (2) It is considered that Japanese technology is still unsatisfactory
(49.1) (3) Human error

(12.3) (4) Such an accident is said to have taken place in Japan
(39.9) (5) It is considered that such accident is likely to occur sooner or later, even though none has occurred up to now
(32.6) (6) Problems and slight accidents have actually occurred in Japan
(1.3) Other ( )
(1.2) Not sure (M.T.=192.0)

Q10 (Answer slip 11) Is there anything you want to know about nuclear power? What about the following matters? (M.A.)

(14.9) (1) Necessity of nuclear power
(7.8) (2) Economy of nuclear power generation
(35.8) (3) Impact of radioactivity on the human being and the environment
(9.2) (4) The type and structure of radioactivity
(11.4) (5) The systems of nuclear power stations
(10.2 (6) The difference between atomic bombs and nuclear power generation
(32.3) (7) Safety measures at nuclear power stations
(10.1) (8) Current situation of nuclear power generation
(17.3) (9) Actual situation during an accident at a nuclear power station
(29.4) (10) Treatment and disposal measures for radioactive waste
(16.1) (11) Disaster prevention system
(0.4) Other ( )
(18.8) There is nothing in particular that I wish to know
(4.1) Not sure (M.T.=217.8)

<Fact Sheet>

F1 (Sex) (47.1) Male (52.9) Female

F2 (Age) Give your present age.

	(12.2)	(22.7)	(22.5)	(21.4)	(14.2)	(7.1)
(year)	20-29	30-39	40-49	50-59	60-69	More than 70

F3 (Academic background) Highest level school from which you graduated, out of the following:

(32.9) (1) Primary school, old higher elementary school, new junior high school
(47.1) (2) Old junior high school, new senior high school
(19.1) (3) Old senior high school, higher technical college, university
(0.9) Unknown

F4 (Occupation) Your occupation.

Independent business
(5.9) Agriculture, forestry, and fisheries
(9.8) Commerce and industry, service business
(1.5) Liberal profession

Service workers and their families
(3.2) Agriculture, forestry, and fisheries
(4.5) Commerce and industry, service business, liberal profession
Employees
(2.2) Management personnel
(2.7) Discipline engineer
(13.5) Office workers
(19.4) Laborers
Persons without occupation
(25.7) Housewives
(1.3) Students
(10.3) Other persons without occupation

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NUCLEAR POWER NEWS UPDATED

Bigger Role Forecast for Nuclear Power

43062030 Tokyo GENSHIRYOKU KOGYO SHIMBUN in Japanese 10 Dec 87 p 1

[Text] Nippon Enerugi Keizai Kenkyusho has issued a report called "The Desirable Electrical Supply Configuration" of Japan in the future.

According to the report, the best electrical supply mix in terms of cost, supply stability, etc. in the year 2010 would have nuclear power with a power supply facilities of 69 million kW and coal with 61 million kW, the two accounting for nearly half of the electrical power supply facilities and three fourths of the total generated electrical power.

Ene Ken's study of the power supply mix considered factors such as cost, supply stability, and load follow capability.

According to a simulation that stressed cost considerations, nuclear power generation will have an equipment amount of 69.15 million kW and a power generation of 484.4 billion kWH, each accounting for 25.4 percent and 45.2 percent of all equipment and power generation quantities.

An important factor besides cost in determining the amount of power generation equipment is its peak load follow capability. The report pointed out that the efficiency of other power supplies to respond to peak demands determines the amount of power generation equipment. This is the reason that the use of coal-fired power production, with its load follow capability, will increase despite its greater cost as compared to nuclear power generation.

If it is assumed that nuclear power plants do not have a load follow capability, the amount of nuclear power plant equipment will drop down to 66.21 million kW, 2.94 million kW less than under the "cost-stressed model." The report says that there will be no effects if a load follow capability of 75 to 100 percent is realized for nuclear power plants.

A stable-supply model cited in the report allocates an equal share, 61.13 million kW or 22.6 percent each, of equipment to nuclear power, coal, and LNG.

In terms of the amount of generated power, this means 40.7 percent for nuclear power generation, 32.1 percent for coal-fired and 13.1 percent for LNG-fired. According to calculations by Ene Ken, the cost under this mix will be 20 percent higher than that under the "cost-stressed model."

Even though the report writes that an equal allocation of equipment among the three power sources is favorable in terms of supply stability, the report gives the greatest importance to economy in evaluating the desirable power supply configuration of 2010 and writes, "It is necessary, as much as possible, to develop nuclear power generation which is the most inexpensive. To maintain a balance, a power supply mix of 69 million kW of nuclear power generation (25 percent), approximately 61 million kW of coal (23 percent) and approximately 54 million kW of LNG (20 percent), and power generation amount mix of 484 billion kWH of nuclear power (46 percent), 300 billion kWH of coal (28 percent) and 96 billion kWH of LNG (9 percent) are the most desirable."

New Radiation Protection Standards

43062030 Tokyo GENSHIRYOKU KOGYO SHIMBUN in Japanese 10 Dec 87 p 2

[Text] The hoshasen shingi kai (chairman Toshiyuki Kumatori, director of the Hoshasen Eikyo Kyokai), studying the incorporation into domestic laws of the basic recommendations (Publication 26) put forth in 1977 by the International Committee for Radiation Protection (ICRP), issued a report on the subject on December 9 to six ministries and agencies including the Science and Technology Agency. The report is an almost complete endorsement of ICRP's recommendations. The ministries and agencies receiving the report expressed their wish to promulgate the revised ministerial orders, etc. during this fiscal year and implement them around the spring of 1989.

In the reported technical standards, the existing permissible worker dose (under official notices based on the Nuclear Reactor Regulation Law) of 3 rems in 3 months for the entire body and a permissible accumulation does of $D = 5 \times (N - 18)$ where N is the age are abolished. Instead, an effective dose-equivalent limit of 5 rems per year is established.

ANERI Considers Use of New Materials

43062030 Tokyo GENSHIRYOKU KOGYO SHIMBUN in Japanese 10 Dec 87 p 3

[Text] The genshiryoku yo jisedai kiki kaihatsu kenkyusho (ANERI) held its first conference to announce its research findings on November 26 at the Tokyo Norin Nenkin Kaikan in Toranomon, Tokyo.

Hirohira Tomita, assistant director of ANERI, who described the annual experiment and research plans, disclosed the development schedule at ANERI by saying that the possibility of using new materials will be studied in fiscal 1989, that tests to evaluate the applicability will be conducted in fiscal 1990 and that improvement and development of new materials for nuclear power use will be targeted for fiscal 1991.

Tomita, who discussed the applicability evaluation tests of new materials obtained by materials research, reported, among others, on radioactive environment tests and high-temperature high-pressure water environment tests.

Tomita described cobalt 60 irradiation facilities owned by the Kogyo Kaihatsu Kenkyusho and used for testing radiation resistance by irradiation with gamma rays, facilities that simulate a reactor water environment and test elution under a high-temperature high-pressure water environment, and high-temperature high-pressure water circulation equipment used for durability testing.

As a sea-water related test, Tomita said that test facilities are now being constructed to test pipes and pump materials for their durability, sea-water corrosion and adhesion of marine organisms.

Tomita also reported on the overseas study activities being conducted by ANERI as a voluntary research topic.

Tomita reported on the results of overseas information research activities that studied the trends and the actual use of new materials in light water reactors in Europe and the United States and whose report was compiled in March 1987. He also discussed the results of investigative missions sent to the United States in January 1987 and to Europe in September. Tomita said that Japan is a step ahead of Europe and the United States in the study of the use of new materials in light water reactors.

Mitsubishi To Import Robots for Dismantling Operations

43062030 Tokyo GENSHIRYOKU KOGYO SHIMBUN in Japanese 10 Dec 87 p 4

[Text] Mitsubishi Corp has begun the import and sales of a remote-controlled dismantling robot called the "BROKK250" (see photo) from the Swedish company of Horumuheddo [transliteration] (head office in Serefutea [transliteration], president L.F. Lindbrom [transliteration]). The robot is reportedly effective in the dismantling of nuclear power plants.

The robot, which is remote controlled, is highly suited for performing tasks in high radiation dosage environment near nuclear reactors. Because it is electrically and hydraulically driven and no exhaust gases are produced, the robot can operate for extended periods in a hermetically sealed environment such as in a reactor container. The robot can be reportedly modified so that water is discharged from the tip of the breaker so as to minimize the problem of dust, which is a problem along with exhaust gases.

The robot weighs approximately 3 tons with a width of 120 cm and a height of 180 cm in a mobile configuration. Its compact dimensions can be further reduced by folding the outriggers so that the robot can be transported through a width of 80 cm.

Despite the weight of less than 3 tons, breakers and crushers weighing approximately 400 kg can be fitted. By using the outriggers, the arm can reportedly swing around 360 degrees and be extended to a maximum of 7 meters.

The robot was reportedly used during the dismantling of the Augusta nuclear power plant (PHWR, 12,000 kW) in Sweden to dismantle a reinforced-steel concrete biological shield (7.6 m x 7.6 m x 5.3 m, thickness of 1.8 m) with three workers while monitoring the safety.

The robot costs 20.5 million yen. Mitsubishi Corp plans to sell 20 to 30 robots per year mainly to general contractors.

New Photon Radiation Principle

43062030 Tokyo GENSHIRYOKU KOGYO SHIMBUN in Japanese 10 Dec 87 p 5

[Text] Researchers at Osaka University Nuclear Physics Research Center (headed by E. Ikegami) have discovered two new principles that expand the energy region of existing synchrotron photo radiation (free positronium photo radiation) by a million-fold. The Center has placed an order with Sumitomo Heavy Industries for one of the world's largest ring cyclotron which generates all photon radiation at the same time.

This plan is a part of a 4-year ring cyclotron installation plan starting in fiscal 1987 and taking place at the Center which is a national joint usage institution of the Ministry of Education.

It is known that a positron storage ring is superior to an electron storage ring for the production of high quality synchrotron photon radiation. However, a high energy electron beam is required for the production of a strong positron beam.

The new equipment stores both negative and positive electron beams so as to uniformalize the beam energy while the undulatory section of the storage ring is used to provide synchrotron radiation. Some of the positive and negative electrons are converted to high-speed positronium at the junction of the storage ring while generating a sharp beam of free positronium formation radiation (FPFR).

High-speed positronium is instantaneously destroyed and converted to a sharp beam of free positronium annihilation radiation (FPAR) whose energy level is 100,000 times higher than that of FPFR.

Depending on the operation, it is possible to generate synchrotron photon radiation while freely stopping and starting the generation of free positronium photon radiation. It is also possible to increase the number of undulatory sections and increase or decrease the ratio of synchrotron photon radiation. It is also possible, depending on the magnet construction, to integrate the negative and positive electron rings into a single unit.

Because the acceleration proton energy of the AVF cyclotron is more than twice as large as that of a conventional incident AVF cyclotron, the ring cyclotron, which is the lightest variable energy cyclotron in the world at 2,500 tons, can accelerate protons to a maximum energy level of 400 megavolts.

It is hoped that the completion of the research faculties will mean surpassing Europe and the United States in the research of intermediate energy precision nuclear physics which is a discipline that links nuclear physics and elementary particle physics.

Nuclear Power White Paper Stresses Improvement in Quality

43062030 Tokyo GENSHIRYOKU KOGYO SHIMBUN in Japanese 10 Dec 87 p 6

[Text] This year's Nuclear Power Annual Report (white paper) released December 1 says that nuclear power generation is at a crossroad from quantitative expansion to qualitative improvement. The report is in response to the long-term nuclear power development/usage plan established in June 1987. A summary of the section of the report describing the need to develop nuclear power based on a broad perspective is provided in this issue.

Breaking the Barrier of Energy Constraints; Nuclear Power To Become a Pivotal Energy Source

Nuclear power, which accounts for approximately 16 percent of the world's total electrical power generation and produces energy equivalent to 1 million kiloliters of oil every day, contributes to stabilization of energy supply.

However, the nuclear power plant accident at Chernobyl in April 1986 has shocked the international community and has shaken the trust of people in nuclear power generation. The accident has reconfirmed the need to ensure the safety of nuclear power.

A general meeting (special session) of the International Atomic Energy Association (IAEA) was held in September 1961 participated by 91 nations to discuss the Chernobyl nuclear power plant accident. The participants concluded that nuclear power was an important energy source for mankind and its socioeconomic development, that a highest level of safety was mandatory for using nuclear power and that international cooperation must be strengthened for this. Based on the conclusion, those involved with nuclear power throughout the world has, with IAEA at the center, undertaken the large task of strengthening international cooperation and linkage to ensure safety and to recover trust in nuclear power by accumulating a safety record.

The healthy development of the world economy is indispensable for world peace and stability. Particularly important is the economic development and improvement of the living standards in the developing countries where more than three-fourths of the world's population live, consuming less than

one-fourth of the world's energy supply and about one-tenth of those living in the industrialized countries on a per capita basis.

It will be increasingly important for advanced nations to pursue energy conservation and development of alternative energy sources and thereby contribute to stabilizing the international energy supply and demand and ensure the supply of low-cost energy to developing nations. Nuclear power, which does not face the resource constraints faced by fossil energy, is an energy source with a potential of greatly contributing to solving the world's energy problem.

The development and use of nuclear power in Japan are steadily improving. Nuclear power generation, which surpassed oil-fired power generation for the first time in fiscal 1985, accounted for approximately 28 percent of the total power production in fiscal 1986. Coupled with its stable availability record, nuclear power plants have established themselves as a main source of electrical power. As of October 1987, 35 nuclear power plants are producing a total output of 27.88 million kW.

Large R&D projects in the field of power reactor development and nuclear fuel cycle, which were promoted by the Power Reactor/Nuclear Fuel Development Corporation in response to national policies, have reached a position, albeit not the same level of development for all projects, where they may be privatized. It is now important to use the accomplishments of the Corporation of the past 20 years and the cooperation between the government and the people as a basis for the establishment of a technical foundation rooted in the private sector and to achieve economic advantages.

The Nuclear Power Committee, which developed the "Long-term Nuclear Power Development/Usage Plan" to serve as the basis for the development and use of nuclear power based on this plan. The long-term plan until now was established in June 1982.

During the elapse of 5 years since then, the energy situation and the circumstances surrounding nuclear power have changed significantly. Energy demand is growing gradually, and the age of quantitative expansion of nuclear power generation which lasted from the mid-1960's to the mid-1970's based on the belief in the continued dominance of light water reactors, is now being replaced by the age of qualitative improvements where stress is placed on the safety, reliability, economy, etc. of nuclear power generation.

It is now important to improve and advance the technology so as to achieve a greater level of safety, reliability, and economy without sacrificing any of them. With nuclear power generation becoming a permanent fixture, policy concerns are shifting to the establishment of a nuclear fuel cycle, including the disposal of radioactive wastes.

Against this background, the Nuclear Power Committee reevaluated the previous long-term plan this June and established a new long-term plan to be effective until the year 2000 while keeping in mind the coming 21st century.

Recognizing the drop in the rate of growth of energy demand and other factors, the new long-term plan has reduced the expected level of nuclear power generation that needs to be developed.

However, there is a large possibility that the energy situation may become tight in the mid- to long-term. Nuclear power development is hence necessary for Japan, a country with limited energy resources and a high dependency on oil. Nuclear power, which is a source energy produced by technology, is positioned as an essential energy source for Japan to overcome her vulnerability to energy supply. With "peaceful usage" and "safety" as the major premises, the new plan clearly calls for the steady development of nuclear power generation.

For Japan which must obtain natural uranium from overseas sources, the effective usage of uranium must be realized. For this end, research and development in fast breeder reactors, etc. must be promoted with the aim of realizing reprocessing and recycling so that plutonium may be recovered from spent fuel and used in fast breeder reactors.

Use of Human Resources in Basic Research; International Provision of Information

The direction of future development was established based on the above-described basic views and keeping in mind the following points.

First, based on the Nuclear Power Basic Laws and the spirit of treaties related to nuclear arms nonproliferation, Japan will contribute to the maintenance and strengthening of the global nuclear nonproliferation system. At the same time, the development and use of nuclear power in Japan will be promoted while strictly limiting its application to peaceful purposes. This spirit must be adhered to when involved in the development and use of nuclear power overseas.

Second, without becoming complacent with the past record of safety, efforts must be expended to achieve a yet greater level of safety. The recent drop in the cost of fossil energy has intensified the competition between fossil energy and nuclear power. This has created a need to improve the technology to further enhance the economy of nuclear power, but this must not be done at the expense of the safety of nuclear power.

Third, nuclear power must be developed as a well-coordinated energy system. For nuclear power generation to remain the principal power source, nuclear power plants and the nuclear fuel cycle must be considered as a system, with safety, reliability and economy being improved from a total perspective.

The technology for the construction and operation of nuclear power plants in Japan can be said to have reached the top class in the world. However, the nuclear fuel cycle, which includes uranium enrichment, recycling, and disposal of radioactive wastes, lags behind the level of development achieved with

power reactors. This is an important field in establishing nuclear power as a domestic energy that does not depend on foreign countries.

Fourth, the foundation that supports the development and use of nuclear power must be strengthened and enhanced. To allow the healthy development of nuclear power, the foundation must be strengthened and enhanced, encompassing both the human and technical aspects.

Numerous researchers and engineers in the field of nuclear power have been nurtured in Japan in industry, research institutions and academia. To solve the problems faced by nuclear power and to enable its further development, these human resources and facilities must be actively used for further efforts in basic research and basic technology development.

Research and development until now had been the "catch-up" type, the goal being to catching up with the advanced nations. From now on, it is necessary to strive for a creative research and development where the goal is the development of new technology.

Fifth, when viewed from an international perspective, nuclear power technology used for peaceful purpose is an international asset to be shared by the entire mankind. Believing that Japan must contribute to its development, Japan will become more actively involved in international cooperation than in the past.

The importance of actively sharing Japan's safety technology and experience with the international community and becoming involved in the joint cooperative efforts with other nations is stressed.

Promoting the smooth development and use of nuclear power requires not only the unending efforts of those directly involved but also the understanding and cooperation of the Japanese people. The Nuclear Power Committee will promote the development and use of nuclear power based on the new long-term plan. As for specific implementations in different fields, technical advances and other conditions will be tracked so as to develop and use nuclear power in a manner that fulfills the trust of the Japanese people.

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NUCLEAR DEVELOPMENT RELATED NEWS UPDATED

Reprocessing Technology Strategy

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 1

[Article: "To Explore Future Strategy on Reprocessing Technology: Science and Technology Agency to Establish Investigation Committees; Discussions Based on New Long-Term Plan"]

[Text] The Science and Technology Agency's Atomic Energy Bureau plans to hold in the near future the first meeting of the Committee on strengthening Reprocessing Technological Base (chairman: Tokai University Professor (K. Kiyose) and of the Committee on Advancement of Reprocessing Technology (chairman: Yoichi Takashima, professor emeritus, Tokyo Institute of Technology). As a follow up to the long-term plan that the Atomic Energy Commission set forth in June 1987, the bureau is making it a practice to probe from a technological viewpoint the present state of reprocessing and its future problems, and to explore the proper nature of Japan's reprocessing technology in the 21st century.

In regard to Japan's future reprocessing, at present a plan to build the first private-sector reprocessing plant, with an annual reprocessing capacity of 800 tons, is being pushed forward with the aim of commencing operations in the mid 1990's.

Furthermore, concerning the second private-sector reprocessing plant, which is to follow it, a policy was set forth in last June's new long-term plan that: "It is important that it be built as something more economical by means of independent technology, and in order to achieve this, based on a long-term perspective we shall promote such things as development of technology in a comprehensive manner, with a target date of about the year 2010 for commemcement of operation."

At the Atomic Energy Bureau, taking this policy too into account, it was decided to establish these two committees in order to make a comprehensive inquiry into the proper nature of Japan's future reprocessing technology.

To be precise, the "Committee on Strengthening Reprocessing Technological

Base" will aim at firmly anchoring the reprocessing technology which Japan has employed up to now, and will make it a practice to conduct discussions which are rather thorough in terms of technology. In particular, it plans to set its sights on long-term, stable operation, and push ahead with the investigation in a systematic manner. Moreover, the question of materials is also expected to become a focal point at this investigation committee.

Meanwhile, at the "committee on advancement of reprocessing tehcnology," study from a more long-term perspective will be conducted on such things as enhancing economy, new technology and improved technology.

Moreover, since 21st century reprocessing technology will also be covered in this investigation, it will probe not only light-water-reactor reprocessing, but also such things as FBR [fast breeder reactor] reprocessing.

The following are the members of the investigation committees.

The Committee on Strengthening the Reprocessing Technological Base: Yosuke Katsumura (Tokyo University), Kiyoshi Kiuchi (Japan Atomic Energy Research Institute), Iwao Kobayashi (Japan Atomic Energy Research Institute), Sadaaki Sasaki (Japan Atomic Fuel Corporation Service), Hiroshi Takeda (Power Reactor and Nuclear Fuel Development Corporation), Tomo Tanaka (Tokyo University), Tetsuro Tanabe (Osaka University), Toshihide Tsuji (Nagoya University), Tsutomu Nomizu (Nagoya University) Shiro Matumoto (Saitama University) Yozo Miyazaki (Federation of Electric Power Companies), H. Yamana (Power Reactor and Nuclear Fuel Development Corporation) and Tatsuhiko Watanabe (National Research Institute for Metals).

The Committee on Advancement of Reprocessing Technology: Naotake Kato (Kogakuin University), T. Kitamoto (Tokyo Institute of Technology), Toshio Kinuhata (Power Reactor and Nuclear Fuel Development Corporation), Yoshiaki Komori (Japan Atomic Fuel Corporation Service), Jun Shibuya (Power Reactor and Nuclear Fuel Development Corporation), Atsuyuki Suzuki (Tokyo University), Masao Takahashi (Nuclear Material Control Center), Keisho Takishita (Federation of Electric Power Companies), Mitsuru Maeda (Japan Atomic Energy Research Institute), Somei Mitsugashira (Tohoku University), Yasuharu Morita (Japan Atomic Energy Research Institute), Hirotake Moriyama (Kyoto University) and Kazuyoshi Yamamoto (Nagoya University).

Application of Superconductive Materials

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 1

[Article: "To Investigate Application to Atomic Energy: Japan Atomic Energy Research Institute, Power Reactor and Nuclear Fuel Development Corporation Too Research Superconductivity"]

[Text] The Science and Technology Agency will invest Y2.044 billion in connection with the FY88 budget's "Multicore Project For Research on Superconductive Materials." Within this, the amount related to atomic energy is Y292 million for the Japan Atomic Energy Research Institute and Y26 million

for the Power Reactor and Nuclear Fuel Development Corporation. The Research Institute will conduct research on radiation exposure and analysis, and a survey on trends in application; the Power Reactor and Nuclear Fuel Development Corporation will conduct a survey on trends in application to such things as the nuclear fuel cycle and fast breeder reactors.

The breakdown for the Research Institute is Y237 million for expenditure on research and development of a radiation exposure device for analyzing such things as changes in superconductivity characteristics in an environment of radiation of such things as gamma rays, which are characteristic of the atomic energy field. In concrete terms, it will develop such things as a device to make samples of high-temperature superconductive film, a device to measure superconductivity characteristics under exposure to gamma rays, a device for ion irradiation under a strong magnetic field at very low temperatures, a high-temperature superconduction quantum interference fluxmeter, a device to measure the structure of high-temperature superconduction bands and a low-temperature stage for an electron microscope for observing high-temperature superconductor samples. Furthermore, it will also develop such peripheral devices as a superconductive-ceramics device, accompanied by actinoid-system radioactive matter, for measuring low-temperature matter.

Moreover, Y45 million will be appropriated for analysis of crystal structure by neutron-ray diffraction making use of the Research Institute's existing research reactors, and so on, and the research potential cultivated by research on atomic energy materials. As research equipment, it will develop a cooling system for use in measuring neutron scattering, and a system, based on neutrons, for analyzing the structure of high-temperature superconductors.

Furthermore, in order to investigate the application of new superconduction technology to such atomic energy fields as nuclear fusion, Y10 million is being appropriated for expenditure for a study on such trends in application as the present state of research and development and the future influence on atomic-energy planning.

For the Power Reactor and Nuclear Fuel Development Corporation, the study of trends in application is central; it will use Y19 million for a study on application to the fuel cycle. In concrete terms, it will do such things as magnetic separation technology applying superconductive magnets; for example, by doing things like magnetic analysis of the uranium and plutonium in the waste water produced in the reprocessing process, it will explore the possibility of using it in the recovery of uranium from sea water. And, in systems for underground storage of radioactive waste, such things are also being considered as making it possible to regulate the acceleration of fall by using superconductive tubes when sending the waste under the ground. And it will research the possibility of superconductive material which contains actinoid-system matter. In addition, expenditure for a study on application to fast breeder reactors is Y7 million; it will conduct such research as feasibility studies of a liquid-metal superconductive electricity-generating system and a superconductive magnetic pump.

The Science and Technology Agency is adopting a system of establishing the "Multicore Superconduction Material Project" and conducting joint research

which is opened to such outside research facilities as those of universities and the private sector. In addition to the Japan Atomic Energy Research Institute and the Power Reactor and Nuclear Fuel Development Corporation, such entities as the National Research Institute for Metals, the National Institute of Research in Inorganic Materials, the Institute of Physical and Chemical Research and the National Space Development Agency are taking charge of various fields.

Budget Reaches Y367 Billion

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 1

[Article: "Government's Atomic Energy Draft Budget Reaches Y367 Billion"]

[Text] The Science and Technology Agency collected and arranged the atomic-energy related FY88 draft budgets for each ministry and agency, excluding the Ministry of Education, and reported to the Japan Atomic Energy Commission on 12 January.

According to that report, the total atomic energy budget for the next fiscal year came to Y181.124 billion for the General Account (a decrease of 1.2 percent compared with the previous fiscal year) and Y186.098 billion for the Special Account for Electric Power Source Development and Promotion Measures (a 5.2 percent increase over the previous fiscal year), a total of Y367.222 billion (a 1.9 percent increase).

When we look at it separately by agency, combining the General Account and the Special Account for Electric Power Source Development and Promotion Measures, the Science and Technology Agency's budget came to Y271.491 billion (a decrease of 0.7 percent) and MITI's came to Y91.265 billion (an increase of 0.5 percent).

The Ministry of Foreign Affairs' budget is Y2.882 billion (an increase of 5.0 percent): the contribution to the IAEA [International Atomic Energy Agency] and a donation are Y2.655 billion, an increase of Y124 million, and the donation to the OECD-NEA [Nuclear Energy Agency, Organization for Economic Cooperation and Development] comes to Y211 million; Japan's share of the burden of the IAEA (calculated by a formula based on GNP) is 10.73 percent, the same as in the previous fiscal year.

The Okinawa Development Agency's budget is Y1.187 billion (a 3.6 percent increase); it will continue to carry on the project to control and eradicate "urimibae" on Kumejima and the islands in the vicinity of the main island of Okinawa.

The Ministry of Agriculture, Forestry and Fisheries' budget is Y362 million (a 13.6 percent increase); it will be applied to necessary expenses in the control and eradication of urimibae on the Amami Archipeligo and so on.

The Ministry of Transport's budget is Y34 million (a 4.0 percent increase); Y23 million is appropriated for study and analysis required in order to devise

safety standards for the transportation of radioactive matter, Y3.6 million for confirmation of safety in transportation of radioactive matter and Y3.5 million for development of a nuclear powered ship.

Cancer Treatment Facility

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 2

[Article: "Heavy Particle Beam Cancer Treatment Device: To Begin Construction of Facility Next in Fiscal Year; Aim at Completion Six Years Hence; To Begin to Build Synchrotron Too"]

[Text] In the next fiscal year the Science and Technology Agency will begin construction of a National Institute of Radiological Sciences' facility for a heavy particle beam cancer treatment device (HIMAC). This facility is one link in the "10-year comprehensive strategy against cancer" which was proposed by the Nakasone cabinet in 1983. It is anticipated that heavy particle beams will be ideal radiation with a strong healing effect and little influence on normal cells. The construction plan covers the 6-year period up to FY93. The Science and Technology Agency estimates Y2.7 billion as the next fiscal year's budget for the project and will build the main accelerator and the like and do the foundation work on the buildings.

The methods of cancer treatment up to now have been surgical therapy by surgery and chemotherapy using such things as cancer-controlling drugs, but there are such problems as loss of bodily function with surgery and drug side effects with chemotherapy.

On the other hand, great hopes are being placed on radiation therapy with such rays as X-rays and gamma rays because it has the advantage of there being little loss of function.

The main point in the treatment of cancer by radiation is the "dose distribution," which indicates approximately how much radiation is given at about what depth from the body's surface when the radiation enters the body, and its "biological effectiveness" (capacity to kill and injure cancer).

Within radiation therapy, although neutron rays have great biological effectiveness, the dose diminishes as it penetrates from the surface of the body to deeper areas, so damage to normal cells cannot be avoided when irradiating cancer cells. Furthermore, since proton rays carry an electric charge, they have the advantage of possessing an energy-giving dose distribution at a certain depth below the surface of the body, but their biological effectiveness is less than that of neutron rays.

In contrast to this, heavy particle beams have large atom nuclei as with such elements as carbon, silicon and argon, so they also have great biological effectiveness. Furthermore, they have a similar dose distribution to that of proton rays, so one can reduce injury to normal cells by matching the peak part of the dose to the area affected by the cancer.

The device planned by the Science and Technology Agency is a setup in which heavy particle beams from an ion source are accelerated to the level of 6 megaelectron volts by the prestage accelerator, their energy is increased to 8 megaelectron volts in the main ring (synchrotron), and they are irradiated in the therapy irradiation room.

Furthermore, it is arranged that the device will have two-gate irradiation, from horizontal and vertical positions, in order to increase the dose at the irradiation target area and reduce the influence on normal cells; therefore, it will be equipped with two main rings.

Overseas, America's Lawrence Berkeley Laboratory has a record of 700 treatments utilizing accelerators which are used for physics experiments, and West Germany's Institute of Heavy Ion Science (GSI), too, is currently constructing an accelerator. Incidentally, the National Institute of Radiological Sciences' device will be the first heavy particle beam accelerator in the world to be used exclusively for medical treatment.

The total amount of the construction budget is Y36 billion. The facility will have two floors below ground and one above ground, and total floor space of approximately 20,000 square meters. The Science and Technology Agency has already secured a building site adjacent to the cyclotron, and is currently designing the device and the building. It will begin foundation work and the manufacture of such equipment as the main accelerator in the coming fiscal year; the target for starting up operation is 1993.

Extending Reactors' Useful Life

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 2

[Article: "Extension of Reactors' Useful Life Possible: MITI Makes Preliminary Assessment"]

[Text] The Ministry of International Trade and Industry, which is putting effort into a plan for extending the useful life of light water reactor plants, which constitute the mainstream of nuclear power generation, has entrusted it to the Association for Inspection of Power Generation Equipment and Technology as a "project to develop technology for extending useful plant life," and is conducting researches and inquiries.

This commissioned project is being advanced by an 8-year plan which began in FY85; the entire plan is divided into three periods: Phase I, investigation of the feasibility of extending useful life (FY85, 86); Phase II, evaluation of technology for extending useful life (FY87-90); and Phase III, overall evaluation (FY90-92), and defines the items for research and development.

The Association organized a "Committee on Extending the Useful Life of Nuclear Power Plants" (chairman: Y. Mishima, professor emeritus, Tokyo University), made up of persons of learning and experience and specialists from such as electric power industry circles, reactor manufacturers and construction industry circles, and is conducting investigations.

In the Phase I investigation of the feasibility of extending useful life, in addition to surveying the state of R&D in various countries, primarily the United States, the committee made clear the factors for deterioration with age in regard to such major equipment as the reactor pressure vessel, the reactor container, the main pump, and the electric cables as a preliminary evaluation on extending useful life. And taking into consideration such matters as operation record, design specifications, and the environment which it is used, the committee conducted a survey on the feasibility of useful life and concluded that "although replacement, repair, and monitoring of age deterioration are necessary, it is possible to extend useful life.

Furthermore, in order to pick out the critical equipment and devices which control the useful life of plants, first it made a primary selection based on the influence which the loss of function of that equipment or device exerts on plant operation and on whether replacement is a premise in terms of design, then it made a secondary selection based on such things as the technical level of such things as the amount of work and amount of exposure to radioactivity when converting or repairing, and picked out the critical devices and equipment, such as the reactor pressure vessel, reactor inner structures, pumps, valves and so on for both BWR [boiling water reactors] and PWR [pressurized water reactors].

It has been decided to study and evaluate these critical devices and equipment in the Phase II evaluation of technology to extend useful life.

Moreover, in regard to concrete structures as well, it is planned to pick out critical structures in the same manner and go on studying them further.

Many topics related to such things as deterioration of materials with age, diagnosis of deterioration, monitoring methods and replacement and repair were picked out as items for future research and development. For example, at present in order to monitor the state of a pressure vessel's deterioration with age, one places a monitoring test-strip of the same material inside the reactor and takes it out and conducts tests on it at the time of regular periodic inspections. But it is also expected that when the extension of useful plant life advances, it will no longer be possible to test sufficiently by means of the volume of test strips, which has been considered sufficient up to now; therefore, development of such things as technology for regenerating test strips is being studied.

Commercial Processing Plant

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 2

[Article: "Application for Business as Early as Next Autumn: Commercial Processing Plant to Marshal World's Highest Technology"]

[Text] The Japan Atomic Fuel Corporation Service plans to apply as early as November of this year for permission to conduct reprocessing business.

The reprocessing plant which the corporation is building in the Iyasakadaira district, Rokkashomura of Aomori Prefecture with the intention of beginning operation around 1995 will be constructed at a total expenditure of Y840 billion, and its site has an area of approximately 390 hectares. It will employ the purex process as its reprocessing technology, its processing capacity will be approximately 800 tons per year, and the capacity of its pool for receiving and storing processed fuel will be approximately 3,000 tons.

The Japan Atomic Fuel Corporation Service acquired the site in August 1986. In February 1987 it concluded a contract for introduction of French technology and has finished placing orders for basic design of the entire process.

Basic design of the main processes has been entrusted to Mitsubishi Heavy Industries, Ltd, and within this design work, France's SGN Corporation will share in the design of the main process. Furthermore, British (pressure-reducing evaporation technology) and West German iodine removal technology will be introduced in one part of the same process, and so on, so the corporation is aiming for a plant which will employ the world's top-class of technology.

At present, progress has been made in preparation of the Rokkashomura site and in basic design as the first stage of designing the facility; after this the corporation will push ahead with preparatory work for the November application while grasping progress in the design from now on.

New Materials Group Inaugurated

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 5

[Article: "New Materials Study Group Inaugurated by Industry, Academia, Government: 18 Manufacturers etc. Participate; Hopes Held for Material for Walls of Nuclear Fusion Reactors"]

As early as next month, 18 manufacturers such as Mitsubishi Heavy Industries, Ltd, Hitachi, Ltd and Nippon Steel Corporation will inaugurate the ("tilt-function materials study group") (Chairman: Masao Yamanouchi, former director of the National Space Development Agency) jointly with nine universities from all over Japan and various national research facilities such as the Science and Technology Agency. The aim is to attempt to promote research and development on this material, which is superior in terms of heat resistance and radiation resistance, and for which broad applications are anticipated in such fields as nuclear fusion and aerospace. Through development of basic technology and dissemination of the fruits of technology, the study group will aim at early development for practical use.

In such leading-edge fields as nuclear fusion and aerospace, development of very heat-resistant material with superior thermal-insulation qualities has become a key technology.

However, it is difficult to develop these very heat-resistant materials from conventional, homogeneous materials; it is necessary to develop them by means

of heterogeneous materials composed of a multiple number of materials.

In such a case, the biggest problem for heterogeneous materials is the existence of interfaces. This is because such material differentials as a difference in thermal-expansion at interfaces have become limiting conditions when materials are manufactured and used.

In contrast to this, tilt-function material is not something in which different materials have been pasted together; it is material whose composition has been gradually changed from its surface to its inside on a micro-order particle level.

Such combinations are conceivable as having on one side a ceramic which is excellent in terms of heat resistance, and on one side a very heat resistant material on which is distributed metal which has mechanical strength, or having on one side a plastic which is excellent in terms of corrosion resistance and on one side a corrosion resistant material on which is distributed metal. Application to such things as the nuclear power field with the first wall of nuclear fusion reactors, equipment for use in reprocessing plants and so on, the aerospace field with such things as the outside shell of the space shuttle and the field of medicine with such things as artificial dental roots can be anticipated; so at the Science and Technology Agency, too, basic research is being started from the current fiscal year.

In particular, in the field of nuclear fusion in it will also be possible to develop a radiation-damage resistant material possessing a "nuclear tilt function" as material for use in the first wall of a reactor by distributing on the reactor-core side materials with low-atomic-number ingredients, which are superior in resistance to neutrons, and on the coolant side, metal material which is superior in terms of thermal conduction and relaxation of thermal stress.

Representative methods for manufacturing this material are the "sintering process," in which such materials as metal and ceramics are spurted out of two nozzles while regulating the proportion of materials and are hardened by baking with a laser or the like, and the "physical and chemical deposition processes."

In addition to these structure-control technologies, the Science and Technology Agency is planning, by a 3-year plan from the current fiscal year to FY89, to evaluate such things as thermal stress, thermal shock and material design which makes materials according to their uses by altering, based on computer simulation, such things as the proportion of changes in composition, and aims, as its development objective, at development of a tilt-function material, 1 to 10 millimeters in thickness, which can withstand a surface temperature of 1,700 degrees and a temperature head of 1,000 degrees.

In the new study group, industry, academia and government will go on promoting development of this material in line with these trends through development of basic technology and interchange of information; in concrete terms, the group is planning such things as holding symposia and workshops and publishing a newsletter.

Earthquake Proofing Demonstrated

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 5

[Article: "Big Earthquakes Also Clear: Nippon Kokan K.K. Demonstrates by New-Model Quake-Proofing Device"]

Nippon Kokan recently succeeded jointly with the Industrial Engineering Department of Nihon University in experiments with an operational-scale, friction-type, horizontal, bidirectional quake-proofing device (NKK-type quake-proofing device).

The device is arranged to be placed under computers and precision machinery or free-access floors; at the time of a big earthquake the friction is cut off and slips, so the input acceleration of instruments on top of the device is reduced, and by establishing a spring which has the proper rigidity it is possible to contain the maximum displacement and residual displacement of the slip within the required values.

Therefore, instruments above this device will be able to maintain their function without being damaged by the earthquake, and at the same time the post-earthquake restoration also becomes easy.

The special feature of the NKK-type quake-proofer is that it is approximately 4 centimeters thick, a thin model compared with the conventional type (approximately 30 to 40 centimeters); it is light, low in cost, easy to assemble and has superior operational qualities. Moreover, it can be adapted to such things as use with machines and to free access floors on which are set up such things as computers which are wired under the floor.

The quake-proofing device used in the current experiment is a friction-type horizontal bidirectional quake-proofing device which sets up legs perpendicularly below a device of which one unit is formed from four panels, each 60 centimeters square, and below that sandwiches metal plates processed with low-friction-factor teflon.

In the experiment one unit was set up on a shaking table, the input acceleration was set at a sine wave with maximum acceleration of 350 gals, and a random wave with a value of 300 waves was input, the maximum acceleration for waves actually observed off the shore of Tokachi and Miyagi.

The result was that the acceleration of the steel plate part was contained to 200 gal or less, so there was a quake-proofing effect. Furthermore, it is said to have been confirmed that the residual displacement was also of a degree which could be ignored.

In the future Nippon Kokan will study reduction in cost and improvement in operational character, and would like to develop it as a commercial product.

Quake-proofing devices are growing in importance due to such computing-devices

as computers, so in nuclear power plants too their employment in such places as the central control room is expected.

High-Level Vitrification

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 7

[Article: "Shed Light on Cause of Drop in Rate of Nuclide Leaching in High-Level Vitrified substances: Central Research Institute of the Electric Power Industry Confirms Inhibiting Effect of Surface Layer"]

[Text] The Central Research Institute of the Electric Power Industry recently announced that the rate of nuclide leaching from vitrified high-level radioactive waste decreases because the surface layer which is formed on the vitrified substance inhibits leaching.

One important item in the assessment of safety when disposing of high-level radioactive waste in geological formations is estimating the long-term leachability of radioactive nuclides.

When the silicon and boron which form vitrified substances come into contact with water, they dissolve at a rate of several micron per year. This rate of leaching decreases with time, and the causes are assumed to be the degree of saturation of the leach liquor and the influence of the layer which is formed on the surface of the hardened substance. There is no divergence of opinion concerning the degree of saturation, but no conclusion had emerged concerning the influence of the surface layer.

In tests of leachability, three borosilicate vitrified substances of different compositions and manufacturing methods were used. First, as preprocessing, a 56-day leaching test was conducted and a surface layer was permitted to form on the glass samples. After that a leaching test was conducted once more in pure water, and the influence that a 120-day surface layer exerts on leachability was checked.

The result was that, compared with the glass sample which had not been preprocessed, the leaching rate declined to 50 to 60 percent for ABS39 (developed in Sweden), and to 70 to 85 percent for PNL76-68 glass (developed by Pacific Northwest Laboratory of America's (Batteru), but a conspicuous decline was not seen for DG-1A glass (virtually the same composition as that of transformed glass). Moreover, it is said that the greater the number of preprocessing days, the more conspicuous the decline in the leaching rate for ABS39.

Furthermore, when we look at the leaching rate for each element, the leachability of the boron and sodium in ABS39 glass was higher than that of other glasses; so these elements are leaching selectively.

Thus, it is said that the rate of leaching of ABS39 glass declines due to the formation of a surface layer, but that almost no surface-layer influence was seen with DG-1A glass and PNL76-68 glass.

Moreover, when observing the surface layers, surface layers were observed on the ABS39 and the PNL76-68, but no conspicuous surface layer was observed on the DG-1A.

And as to the elements of the surface layer, from the fact that there was little silicon in the PNL, but a heavy concentration of iron and zinc, it became clear that it was formed by deposit from the leach liquor side. On the other hand, from the fact that the ABS39 had a similar element structure to the inside of the solid, with an abundance of iron and rare earth elements, it became clear that it was a layer formed after the selective escape of alkaline elements.

It is said that because these experiments it is assumed that a surface layer which is formed by escaping boron and sodium, which leach easily, inhibits leaching, but that a surface layer formed by deposit of such things as iron and zinc exerts virtually no influence on leachability.

Nuclear Power Paint Contract

43062043 Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 14 Jan 88 p 7

[Article: "Contract Concluded on Paint Designed for Nuclear Power Plants: Chugoku Marine Paints, Ltd to Introduce Technology From French Firm"]

Chugoku Marine Paints, Ltd (headquarters: Hiroshima; president: Shoji Kato) has concluded a contract with France's government-run (Cofideppe Corporation) (headquarters: (Puleau) [puro]; president: (Jaque Joeffrey) [jakku jofure]) on introducing new technology on paint used for various equipment (including reprocessing equipment) connected with nuclear power plants.

Confideppe has many achievements in paint used for nuclear power plants in Europe, and as a firm which holds first place in France (a 75-percent share) and is also a top manufacturer in Europe as a whole, it possesses excellent technology. And since it also has painting technology for the spent-fuel reprocessing facilities which are being studied in every country, this time it was decided to introduce that company's technology.

Furthermore, the term of the contract is 10 years, and Chugoku Marine Paints acquired the right to a monopoly on sales in Japan, China, Taiwan, the Republic of Korea, Thailand, Malaysia, Singapore, Indonesia and the Philippines.

For use in nuclear power plants, one requires general paint and radiation-resistant paint. But up to now Chugoku Marine Paint had neither technology for radiation-resistant paint nor on-specification products.

In the future Chugoku Marine Paints plans to grapple actively with nuclear power plants and reprocessing equipment scheduled for construction in Japan and the Southeast Asia region and with repair of existing equipment.

Furthermore, even up to now Chugoku Marine Paints has been developing and selling for electric power equipment such paints as ones for non-toxic, antifouling use, for use on power transmission towers, for use in hardening in water and for super weather-resistant use. In the future it will not only become able to cope comprehensively by adding new technology for use with nuclear power, it will be possible to make use of the current introduction even in building and in the field of general concrete corrosion proofing, so it wishes to take this opportunity to expand its industrial-use paint and go on responding to the needs of users by advanced technology for expansion of domestic demand.

Moreover, production-department activity will begin this spring, and a market of approximately Y500 million to Y1 billion is anticipated.

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TRANS-PACIFIC CABLES PROJECT UPDATE

43066034 Tokyo TSUSHIN KOGYO SHIMBUN in Japanese 7 Dec 87 p 2

[Text] The third Trans-Pacific Cables Project (TPC-3) is expected to play a major role in the Pacific region expansion of international communications. As the first optical ocean floor cables in the Pacific region, it is the forerunner of the new worldwide Integrated Service Digital Network (ISDN) and will become the backbone of numerous upcoming Pacific region optical fiber cable projects. KDD has already begun construction on the Japanese side, and construction will continue from April to August 1988, with operations officially beginning at the end of December 1988. The completion of TPC-3 will mean the economical offering of more sophisticated and diverse international communications services such as high-speed data transmission, high-speed facsimiles, and teleconferencing.

At present, KDD and AT&T are working on the construction of TPC-3. TPC-3 is also jointly called HAW-4/TPC-3 because it links up with the fourth Hawaii cable project HAW-4.

The TPC-3 project was first announced 10 years ago at a Pacific cable project summit meeting. At that time, the plan was for a 1600~1800 circuit capacity by 1985 or 1986.

However, circumstances in the United States greatly delayed the completion of the HAW-4 project from the target date of 1982 decided at the same summit meeting, and as a result from TPC-3, which is to connect to the HAW-4, was also delayed.

Conditions initially assumed also changed drastically with the passage of time, leading participants to call for a re-examination of the completion date, circuit capacity, and route, and it wasn't until 1980 that participating operators reached a basic agreement. The construction and maintenance agreement was signed in January, 1984, making longterm and concrete construction plans for the TPC-3.

Although the construction of ocean floor cables is an international joint project, each country's project remains a competitive operation, and it is difficult to coordinate the work of participating operators up to the point where an agreement is signed. the U.K.'s C&W signed a preliminary agreement with other operators with the intention of proprietary participation, but when

its request for a direct route between the United States, Hong Kong, Japan without going through Hawaii was not adopted, the company abruptly withdrew its participation just before the signing of the construction and maintenance agreement in December of 1983 without clarifying the reason. KDD, a "terminal country," therefore had to take over the portion that was supposed to be completed by C&W and then handed over to IRU.

C&W requested at the TPC-3 conference held in Kyoto from 29 september to 2 October 1987 that it be allowed the right of proprietary participation in the circuits slated for IRU participation (surplus circuits owned by KDD and AT&T and already counted in their data base). However, numerous operators elected to postpone a decision until the next meeting in April 1988.

By the way, ocean floor cables came into use in international communications in the Pacific region with Intelsat satellite and trans-ocean cables. TPC-1 was constructed in 1964 (138 circuit capacity), and TPC-2 in 1975 (845 circuit capacity). Both are running at full capacity, and the TPC-1 in particular will reach the end of its design lifespan at the end of the 1980s.

This situation is what brought about the necessity of constructing the TPC-3. When joined with the HAW-4, the cables will link Japan, the continental United States, and Guam. Covering a total 13,200 km, the cables are the first long-distance optical fiber ocean floor cables to use Japanese technology. This signifies international recognition of Japanese success in research and development.

The cable is comprised of two-paired optical fibers with a transmission capacity of 280Mbits per second at any distance. This translates to 3,780 single-paired telephone circuits, and this capacity can be further increased up to five times through the use of multiplexing equipment according to demand. This should amply meet Pacific region communications demands up to the year 2000. Furthermore, although communications between the United States and Japan now lean heavily on satellite circuits, the TPC-3 should even out the imbalance between satellite and cable circuits and create a mutual back-up system when there are problems.

Furthermore, because the TPC-3 links the three geographic points of Japan, Hawaii, and Guam through a network comprised of underwater switching equipment, the same cables can be used to expand the route. This firms up the possibility of a future Asia region fiber cable network and greatly increases the reliability of service.

Although seven cables already link Japan with the major countries in Pacific region and Japan occupies an important position in the Pacific ocean floor cable network, this position will become even more crucial with the completion of the TPC-3.

The TPC-3 will become the leading edge of the ISDN that is being pursued around the world. It is expected to economically achieve such sophisticated and diverse service as high-speed data transfer and facsimiles, and teleconferencing.

The entire laying of the cable is being carried out by KDD's cable-laying ship the KDD Maru and AT&T's Long Lines. KDD will lay approximately 3,850 km of cable, from the Chikura Coastline of Japan's Chiba Prefecture, cutting across the Trench of Ogasawahara, and passing through the South Torishima undersea switching equipment to Guam, including as well approximately 150 km of cable toward Hawaii. For AT&T's part, it will lay 9,350 km of cable from the continental United States, passing through Hawaii to nearby the undersea switching equipment.

The KDD Maru will lay cable in four operations. The first consists of pulling cable into the Chikura Coastline Landing Station and laying it approximately 20 km out at sea by the beginning of December, 1987. From April to August of 1988, KDD will complete the cable laying, and after connecting it to the undersea switching equipment and the cable laid by AT&T near Hawaii, will conduct final operation tests. TPC-3 is then scheduled to go into official operation in December, 1988.

Additionally, the Australian International Communications Corporation (OTC), Telecommunications New Zealand (TCNZ), KDD, and AT&T are planning to jointly lay two cables in the South Pacific. These will consist of the Pac-Rim East Cable, 8,600 km long, linking New Zealand and Hawaii, and the Pac-Rim West Cable, 7,400 km long, linking Australia and Guam. These cables in turn will hook up with the TPC-3, TASMN-2, and HAW-4 cables to form a Pacific Rim optical fiber ocean floor cable network. The Pac-Rim East is scheduled for completion in 1993 and the Pac-Rim West in 1996. This means that all the important countries on the Pacific Rim will be linked through optical ocean floor cables.

Moreover, the plans have been hammered out for the construction of the TPC-3 by KDD and AT&T, and agreed upon by the principal countries attending the recent conference in Kyoto.

13210/12232

Underwater Image-Transmission System Developed

43066553 Tokyo FUNE NO KAGAKU in Japanese Feb 88 pp 43-49

[Article by Toshiyuki Nakanishi, staff of Deep Sea Development Technology Division, Marine Science and Technology Center: "Development of Underwater Image-Transmission System"]

[Excerpts] **1. Introduction**

The idea to develop an underwater image-transmission system occurred to me during a marine survey on the Shinkai 2000. I felt that efficiency could be enhanced if the ocean floor conditions could be shown in terms of image. If researchers aboard the underwater craft are specialists in the research being conducted, communication with the researchers aboard the mother vessel could provide sufficient information regarding the conditions. However, because the capacity of the submerged craft is three, and the number of researchers per submerged trip is limited to one, it is necessary for the underwater craft crew to provide the specialists aboard the mother vessel with information outside the scope of the survey so that they can determine which action to take.

$$f_{max} = \frac{1}{2} k n^2 f_p \left(\frac{wh}{hv}\right)\left(\frac{kv}{kh}\right) \quad \text{(Hz)} \qquad (3)$$

where n = number of scanning lines,
f_p = number of images per second,
wh/hv = aspect ratio of the screen,
kv = effective scanning ratio of the vertical scan,
kh = effective scanning ratio of the horizontal scan, and
k = Kell factor

In the standard TV method, n = 525 lines, $wh/hv = 4/3$, $f_p = 30$, $kv/kh = 0.95/0.84$; 0.7 is chosen for k in the case of TV; therefore, f_{max} becomes 4.3 MHz. This bandwidth cannot be realized with the propagation characteristics of sonic waves underwater. In formula (3), wh/hv, kv/kh, and k are determined by the TV signal method. Therefore, to minimize f_{max}, n (number of scanning lines) or f_p (number of images per second) must be decreased. Generally, a TV receiver has 250 lines for n. If we assume the same image level, take n to be 250 lines, we obtain formula (4) for a relationship between f_p and f_{max} from formula (3).

$$f_p = 3.88 \times 10^{-5} f_{max} \quad \text{(Hz)} \tag{4}$$

If we illustrate the relationship between the time it takes to transmit one image ($1/f_p$) and the band (f_{max}) required for transmitting image signals with this formula as a base, Figure 3 is obtained.

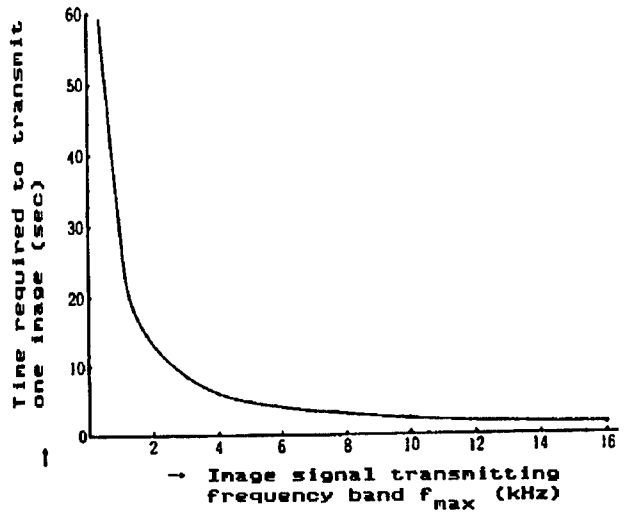

Figure 3. Transmission Frequency Bandwidth and Time Required to Transmit One Image

Since the relationship in formula (4) is determined by the number of bits with which to transmit one image in the digital transmission system when transmitting in the analog method, T_p for transmitting one image is expressed by formula (5).

$$T_p = \frac{n^2 x C}{N} \quad \text{(sec)} \tag{5}$$

where n = number of picture elements, vertical and horizontal,
c = number of bits indicating color tone or brightness or darkness,
N = Baud rate

In other words, the time it takes to transmit 1 picture element, 256 x 256 picture elements, 8 bits, at a Baud rate of 5,000 bit/sec, is 110 seconds. How much we can shorten C indicating color data in order to shorten this time is a task to be tackled in image transmission using the digital method.

5. Sound Converter (Transmitter and Receiver)

One reason why it is impossible to accomplish wide transmission is the frequency characteristics and directional characteristics of the transmitter and receiver. The transmitter is normally used near the resonance point to increase its output, but when the degree of acuteness of the resonance point is large, the bandwidth cannot be obtained. For image transmission, the cable transmitter with a wide bandwidth and high output

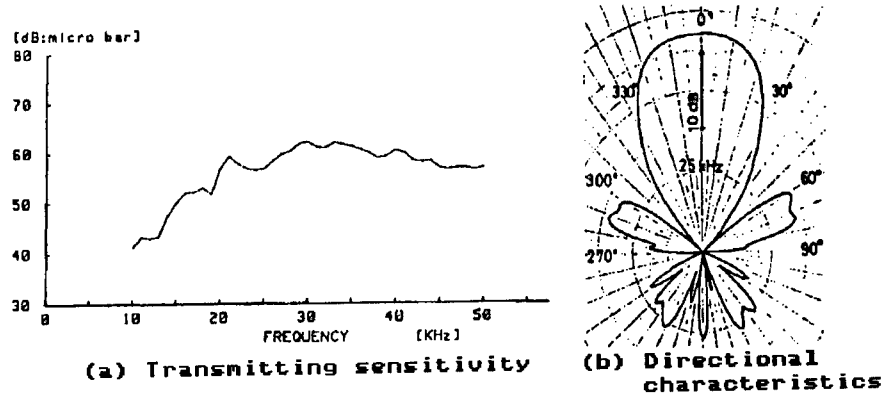

Figure 4. Frequency Characteristics With Respect to Transmitting Sensitivity and Directional Characteristics of the Transmitter

is required. To obtain these characteristics, joint research was conducted with NEC to develop the transmitter with a matching layer in the transmitting part. Its frequency characteristics with respect to transmitting sensitivity and directional characteristics are shown in Figure 4(a) and (b). In the same way, characteristics of small side beams in the wide band is required of the receiver. Such characteristics are shown in Figure 5(a) and (b).

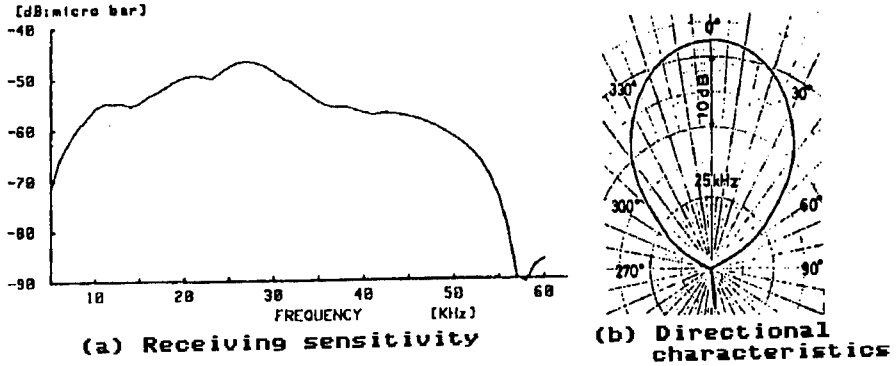

Figure 5. Frequency Characteristics With Respect to Receiving Sensitivity and Directional Characteristics of the Receiver

6. Image Transmission and Receiving

System diagrams of the transmitting and receiving circuits are shown in Figure 6(a) and (b).

The transmitting system is shown in Figure 6(a). Images of the ocean floor caught by the TV camera are transmitted to the mother vessel. TV camera images are of the NTSC (National Television System Committee) method and

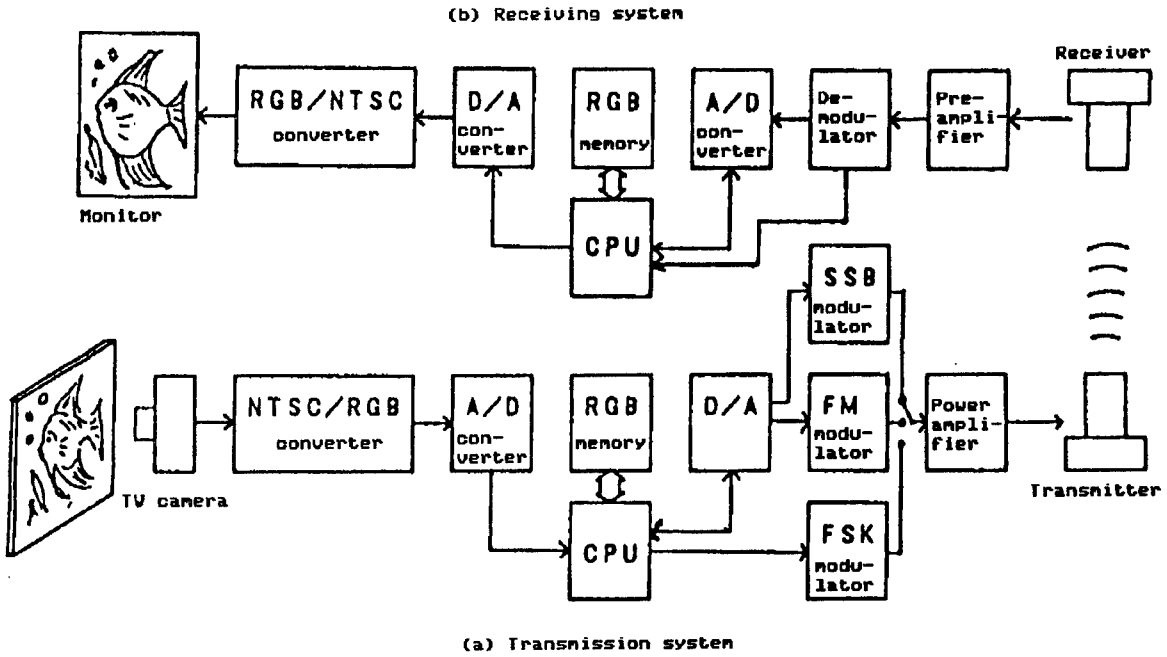

Figure 6. System Diagram of Image-Transmission Equipment

color composite signals. These images can be replaced by the NTSC/RGB converter into color signals of R (Red), G (Green), and B (Blue) and brightness signals. Replaced signals are analog signals in R, G, and B, respectively, so that they are converted to digital signals by the A/D converter and stored in the RGB memory through the CPU. Consequently, brightness information in terms of R, G, and B is recorded in the memory. In the case of analog transmission, signals thus recorded are transmitted through the CPU control, at a speed that permits sonic wave transmission, to the D/A converter. The order in which signals are read from the RGB memory is in order of R, G, and B for each scanning line. In the case of the digital method, signals are transmitted from the CPU directly to the FSK modulating equipment. For transmission, 64 bytes are for 1 packet and the packet number is used for the first byte. Since 1 byte is currently used for color information this means a transmission of 63 picture elements per packet. Note also that the packet number signals and picture element signals are transmitted by giving the same weight to the error rate. In the analog method, signals which have been D/A converted are subjected to voltage/frequency conversion. They are further subjected to amplitude modulation or frequency modulation for amplification, then transmitted as sound signals. In amplitude modulation, only a single-side band is used.

Figure 6(b) shows the receiving system. In the analog method, after demodulation, signals are frequency/voltage converted, further converted to digital signals by the A/D converter, and stored into the RGB memory via CPU control. Then, they are D/A converted in order of R, G, and B and transmitted to the RGB/NTSC converter where the color data is synthesized and seen as color images on the monitor display.

Modulation methods being tested are the four types shown in Figure 7. Of these, experiments on PSK include only transmission tests in the case of eight phases.

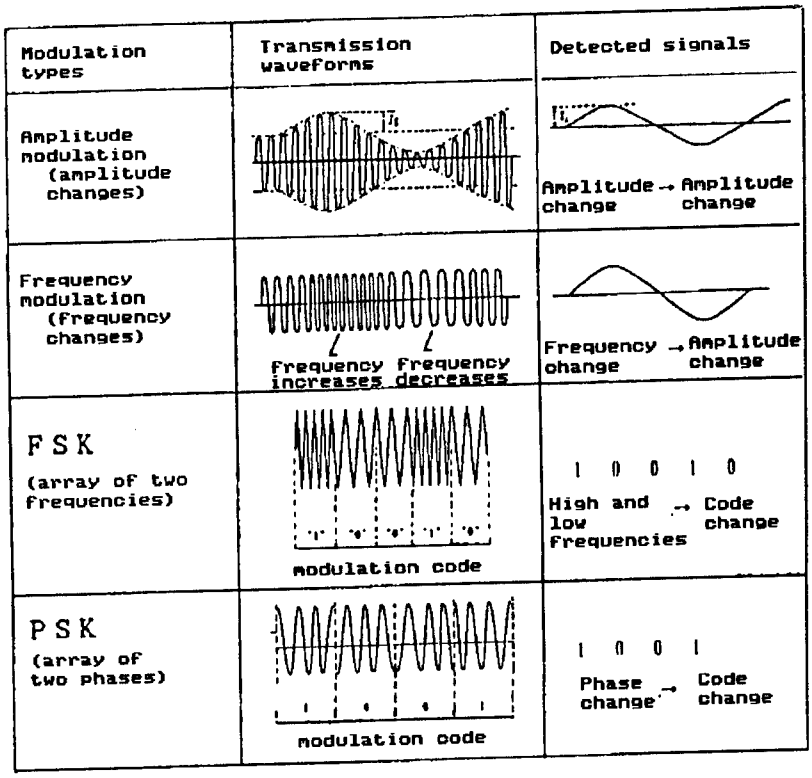

Figure 7. Modulation Types, Transmission Waveforms, and Detection Signals

7. Selection of Frequencies and Required Sound Levels

The experiments are conducted with a frequency band of 10 kHz from 20 kHz to 30 kHz used for image transmission. In selecting this band, the following factors were taken into consideration:

(1) Frequencies of the sound equipment used in the Shinkai 2000 system
(2) Noise from the mother vessel
(3) Attenuation of underwater sonic wave propagation

The frequencies used in the sound equipment of the Shinkai 2000 system in (1) are shown in Figure 8 and do not interfere with this equipment. Also, the band which does not get interference is above 20 kHz. At a band above 20 kHz, a high-level sonar uses a frequency of 23 kHz. But, since this transmits and receives from the ocean floor, mutual interference can be ignored.

The noise level of the mother vessel in (2) is -3 dB (dB re 1 μ bar) at the receiver position in the 20 kHz ~ 30 kHz bandwidth.

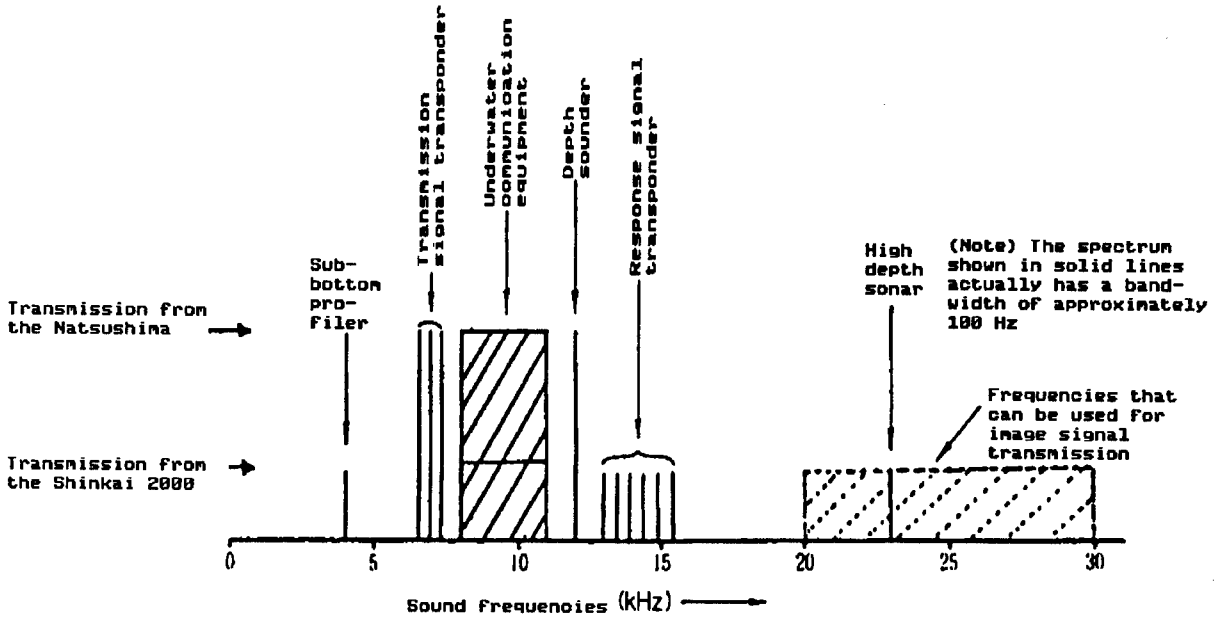

Figure 8. Sound Equipment and Frequencies Used by the Shinkai 2000 System

Attenuation through propagation in (3) is 95 dB from Figure 1 for a distance of 3,000 m for transmission and receiving.

Also, from water tank experiments, for the SN ratio necessary to obtain an image, the directional gain of the receiver requiring 15 dB can be considered to be 15 dB. Consequently, they are substituted for sonar formula (6).

$$SL \geqq NL + TL - DI + DT \qquad (6)$$

where NL = noise level = -3 dB (dB re 1 μ bar),
TL = propagation loss - 95 dB (30 kHz, 3,000 m),
DI = directional gain = 15 dB,
DT = threshold of detection = 15 dB,
SL = sound source level

According to formula (6), the sound source level is 93 dB.

On the other hand, the transmission sensitivity (sound source level obtained by impressing 1 V) is 62 dB at 30 kHz, therefore, the required voltage is 31 dB (= 93 - 62) $\fallingdotseq$ 36 V. The required voltage is about 23 V even for a small transmission sensitivity of 25 kHz within the band in use.

8. Experimental Device

Since the Shinkai 2000 cannot be held for long periods in view of the ocean experiments, experiments have been conducted according to a method shown in Figure 9. This experimental device consists of the above-mentioned section

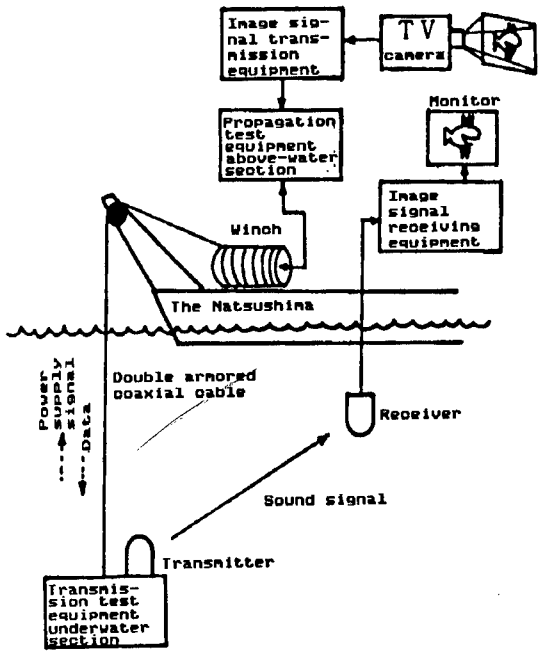

Figure 9. Schematic Presentation of Experimental Equipment

and the underwater section which is hung by a double armored coaxial cable to the required depth.

Data transmission between the above-water section and the underwater section and control is carried out by the frequency division multiplex transmission system. From the above-water section are transmitted the power supply, transmitter output control signals, switch changeover signals, etc., while response signals for direction, pitch, roll angle signals, and control commands are transmitted from the underwater section. Sound output levels of the transmitter can also be monitored.

Direction, pitch, roll angle sensors, power amplifiers, transmitter, transponder for position determination, modulators for frequency division multiplex transmission are mounted on the underwater section.

9. Ocean Experiments and Results

The ocean experiments were conducted in February and October 1986, and May and October 1987. For the first and second experiments, a prototype of monochrome image transmission equipment with 4 bits per picture element, 128 x 128 picture elements, was used. Using the amplitude modulation system, the first experiment transmitted from a depth of 1,800 m. In the second experiment, an experiment using amplitude modulation, frequency modulation, and FSK system was conducted to study the degree of image deterioration with distance as a parameter. In this case, the maximum transmission depth was 2,700 m. In amplitude modulation, image deterioration due to surface wave interference was noted, while the kind of interference found in amplitude modulation was not noted in frequency

modulation although noise increased on the screen. In the third experiment, a transmitter with characteristics shown in Figure 4 was used for color image transmission by way of amplitude modulation, frequency modulation, and FSK. The number of picture elements was 256 x 256 picture elements with 8-bit tone wedge (R:3, G:3, B:2). The transmission depth was a maximum of 3,500 m. The analog method did not produce good images.

FSK images offer somewhat discolored impressions as compared with analog images. This means a difference in the amount of information provided by the analog method which varies R, G, and B color information closely to the 600 Hz frequency displacement and that provided by the digital method which expresses R in 3 bits, G in 3 bits, and B in 2 bits. In FSK, transmission was made in 9,600 bit/sec from a depth of 2,500 m, but stable transmission could not be accomplished. In the fourth experiment, collection of data in 2-, 4-, and 8-phase changes via PSK transmission was conducted, and the results are being analyzed now. At present, transmission in 4-phase, 4,800 bit/sec is thought to be possible. It must be mentioned, however, that phase changes due to rolling and pitching were observed. Improvement of this filtering is a problem to be solved in the future.

In the digital method, the PSK system is more advantageous than the FSK system in that it enables transmission of more volumes of data.

10. Conclusion

According to the results of experiments conducted four times, for the image-transmission equipment to be used in the Shinkai 2000, the analog system can be used. Its transmission speed can be improved by increasing the CPU performance. Although the digital method is more advantageous if we take image processing into consideration, noise interference was hardly observed so that serviceable images can be transmitted without image processing. Note that when applied to the 6,500 m underwater boat with no cable, an unmanned boat is considered when the transmission speed per image must be kept to within a few seconds, improvements in image processing and transmission speed must be studied.

20107/9365

COMMUNICATIONS EQUIPMENT FOR CS-3 REPORTED

43066532 Tokyo TOSHI KEIZAI in Japanese 2 Feb 88 pp 88-89

[Article by Yuta Sagara, scientific journalist: "Domestic Technology-Intensive Practical Communications Satellite CS-3"]

[Text] Commercial Satellite Based 80 Percent on Domestic Technologies

The commercial communications satellite CS-3a, developed through the intensive use of domestically-developed technologies, will be launched from the National Space Development Agency's space center on Tanegashima Island using an H1 rocket in early February. The CS-3a is one of the two CS-3 satellites to be orbited, with the other being the CS-3b. The CS-3b is scheduled to be launched in August. Each is 550 kg heavier than its predecessor, the Sakura-2 (CS-2).

The CS-3 has a transmission capacity equivalent to 6000 telephone circuits, compared with the Sakura-2 whose transmission capacity is equivalent to about 4,000 telephone circuits. Its reserved capacity ratio is 50 percent. Its design life, 7 years or longer, is also much longer than the 3 years of the Sakura-2. A feature of the CS-3 is that it incorporates many devices, e.g., transponders and solar cells, fabricated making full use of the world-leading advanced electronic technologies developed in Japan.

Work for the development of the CS-3 was initiated in fiscal 1983 with the aim of (1) taking over the services that Sakura-2 had been performing, (2) meeting the increasingly large and diversified needs for communications, and (3) developing advanced technologies for communications satellites. First, Nippon Telegraph and Telephone Corp. (NTT) developed a communications antenna and transponders, which led to the development of the satellite by the National Space Development Agency. The CS-3 has a cylindrical shape, measuring about 2.18 meters in diameter and about 2.43 meters in height. When the antenna is included, the height reaches about 3.56 meters. At launching, it will weigh 1,099 kg. Upon reaching a stationary orbit about 36,000 km above the equator, it will initially weigh about 550 kg. The manufacturing has mainly been undertaken by Mitsubishi Electric Corp.

The CS-3 incorporates many domestically-developed advanced technologies. The ratio of its domestic technology-based portions is 80 percent on a value basis, compared to 64 percent for the Sakura-2. It has become the

first satellite to be manufactured under the design authority of the Japanese.

The main features of the CS-3 include a bus structure made of a CFRP (carbon fiber reinforced plastic), which is a composite material. Most satellites manufactured so far, including the Sakura-2, had structures made of metals, such as magnesium alloys and beryllium alloys. The adoption of the light and strong CFRP, for the CS-3 has resulted in a long design life for the satellite; the reduced satellite weight allows the loading of more fuel (hydrazine) for use in altitude control. Mitsubishi Electric offers superior technology for space-use CFRP. The performance of its space-use CFRP has already been verified using the technical test satellite Kiku-5 launched last August.

Gallium Arsenide Cells Adopted for First Time in World

For the CS-3, gallium arsenide cells have been adopted, for the first time in the world, as the power supply for transponders. The solar batteries attached to most of the satellites manufactured so far have been composed of silicon cells. The adoption of gallium arsenide cells, which are more efficient in energy conversion than silicon cells, was selected to enable the generation of much electric power using the limited surface area of satellite, since the surface area of the CS-3 is larger than that of the Sakura-2 by only about 20 percent. The energy conversion efficiency of the gallium arsenide cells is about 17.5 percent. The gallium arsenide cells were also manufactured by Mitsubishi Electric. A total of 36,600 gallium arsenide cells are put on the circumferential surface of the CS-3 to generate about 800 W of power over a period of 7 years.

The CS-3 is also equipped with a charging system which can operate independently to keep all of its transponders powered for 24 hours, even when the satellite experiences a semiannual eclipse (a phenomenon in which the moon comes in between the satellite and the sun to reduce the amount of solar rays that reach the cells). The charging system contains a battery made in the United States and solar cells made by Sharp Corp. of Japan.

Eighteen Transponders Installed

The CS-3 has a communications system consisting of an antenna and transponders. It enables communication channels to be established between fixed stations, transportable stations, or mobile stations located or installed in any part of Japan, including the outlying islands. The CS-3 has 18 transponders. They comprise 15 (including 5 as spares) K-band transponders (for 30-GHz reception and 20-GHz transmission) and 3 C-band transponders (of the same type, for 6-HGz reception and 4-GHz transmission).

The K-band transponders equipping Sakura-2 are of a type which, when the signals received from the earth, converts them into intermediate-frequency signals. Those carried by the CS-3 are of the frequency conversion type and contain microwave integrated-circuit (MIC) amplifiers--it is due to

the development of the MIC amplifiers that the transponders have been made small and light. The K-band traveling-wave tube (TWT) amplifiers used in the CS-3 have an output power of 10 W, compared with 5 W of those used in the Sakura-2. With the improved amplifiers, the CS-3 can serve a larger area than Sakura-2, even including Okinawa in its service area.

Unlike the C-band transponders of the Sakura-2 which contain TWT amplifiers, those of the CS-3 incorporate high-output FET amplifiers made of gallium arsenide. The adoption of gallium arsenide FET amplifiers contributed to the realization of small, light and low-power-consuming C-band transponders for installation in the CS-3, resulting in improving the reliability of the satellite's performance. The transponders were fabricated by NEC under the guidance of NTT.

Users Increasing

The H1 rocket used to launch the CS-3 is a three-stage rocket capable of launching a stationary satellite of up to about 550 kg. Although the first stage of the rocket is manufactured under a U.S. license, the second stage, consisting of an engine (LE5) fueled by liquid oxygen and liquid hydrogen, the third stage comprising a solid-fuel rocket, and an inertial guidance device (NICE) have been developed domestically. The National Space Development Agency successfully orbited the experimental geodetic satellite "Ajisai," the amateur satellite "Fuji," and a device for testing magnetic bearing-type flywheels using experimental two-stage rockets in August of the year before last [1986]. It then successfully put Kiku-5 into stationary orbit using an experimental three-stage rocket last August [1987]. The CS-3a is going to be the first commercial satellite launched by the agency using a three-stage rocket.

If all goes well, the CS-3a will be launched on the night of 1 February. The satellite is scheduled to be separated from the third stage of the rocket 26 minutes after the blastoff. It should secure a stationary position 30 days later. Its operation is to be taken over by the Telecommunications Satellite Corp. of Japan within 90 days after launching.

Satellite communications systems offer such features as not being easily affected by accidents on the ground, enabling long-distance, wide-area communications, and being appropriate for multiaddress calling. The users of Sakura-2 comprise NTT, the National Police Agency, the Ministry of Construction, the Fire Defense Agency, the Radio Research Laboratory of the Ministry of Posts and Telecommunications, JR [Japan Railway companies], and enterprises engaged in telecommunications businesses. The services of the CS-3 will be used by the same users, plus such additional ones as the National Land Agency, the special accounts of the Ministry of Posts and Telecommunications, Osaka Gas, Fujitsu, NEC, Sogo Keibi Hosho, and Nomura Computer System. NTT plans to use three transponders to introduce a common alternate routing system which comprises a telephone circuit network, configured like a mesh, linking telephone offices throughout Japan.

20109/9604

- END -

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