JANUS

JANUS Trajectory of 50 years
50th
Since1971-2021

Trajectory of 50 years

With the change of
energy and environment

1971 » 2021

JAPAN NUS CO., LTD.

Management Philosophy

Japan NUS Co., Ltd. utilizes its advanced consulting capability developed in the fields of energy, environment, and social science to contribute to the creation of a sustainable society and a prosperous, secure future society.

1 A close partner to our clients at all times

We support our clients to find solutions to their challenges and problems. All our executives and consultants tackle issues together with our clients with a desire to make improvements.

2 Information service from a global perspective

We effectively utilize our global and valuable technical information, knowledge, and wisdom to contribute to creating “new wisdom” and “the future” for our clients.

3 Business beyond the limits of consulting

We utilize our know-hows, experiences, and networks acquired in consulting to take on a range of businesses in Japan and overseas that help to create a sustainable society.

4 Fair and equitable business activities

We always conduct compliance-aware business activities and sustain a high level of social credibility.

JANUS Trajectory of 50 years
1971–2021

With the change of energy and environment

JANUS History of 50 years

From the left, Yukio KISHIMOTO, Chairman and Member of the Board,
and Kazuhiko CHIKAMOTO, Representative Director and President

On the occasion of the publication

JAPAN NUS Co., Ltd. (hereafter called JANUS) celebrates the 50th anniversary of its establishment in June 2021. We would like to express our sincerest appreciation to our clients whose patronage we have enjoyed for many years, our business partners who have cooperated in our business execution, our shareholders who have extensively supported us, our technical advisors who have guided us for the improvement of technical capabilities in various ways, our executives and employees who have made efforts day and night on the front line for the development of the company business, and their families who have supported them.

Fifty years ago, when Japan was at the dawn of the peaceful use of nuclear energy, our pioneers founded the first technical consulting company related to energy and the environment in Japan. They wanted to improve energy situation, improve the environment in Japan, and further contribute to society. Their wishes were supported by many clients and passed down without pause to those who followed. Because of that, JANUS has accomplished slow but steady growth continuously to date.

Including the Great East Japan Earthquake and the severe accident at the Fukushima Daiichi Nuclear Power Station in 2011, our country has experienced major disasters many times during the last 50 years. Our company, JANUS, also faced severe management in difficult circumstances each time. However, we overcame the unprecedented crises many times, driven by the strong desire of our executives and employees to be helpful to our clients and society.

For the next period of our history, we will further strengthen the desire that has continued since the establishment of our company, connecting it to further development. We would appreciate your continued support and guidance.

岸本幸雄

Yukio KISHIMOTO, Chairman and Member of the Board

At the juncture of our 50th year, times are set to change dramatically. In addition to natural disasters that have become more extreme, we are in the midst of the COVID-19 crisis, and the existing sense of values and the social systems that have been built so far are also going to change dramatically. We need to contribute to society while coping with the change, and we need to manage our company in anticipation of the future after the change while facing the significance of our existence once more. People are now discussing the decentralization from Tokyo to other regions. The world is demanding the change to a decarbonized/low-carbon society to cope with the climate change. In a society where discrimination and division have begun to occur, we need free and democratic thought and decision-making with which people can cooperate and sympathize, but for a change to occur, social acceptability is very important in addition to legitimacy from the standpoint of scientific technology.

The energy problems are moving in the direction of diversification where local production for local consumption is ideal. On the other hand, environmental problems such as climate change, marine plastics, etc. are moving in the direction of globalization where the problems need to be solved across borders. I expect that in the coming 50 years, the energy, environment, and society will complicatedly intertwine with each other, various stakeholders will become involved, and the issues that need to be solved will also become complicated. To contribute to society, our company will make use of our intellectual curiosity and technical capabilities that have been cultivated for the past 50 years.

Our company is working on the eternal issues of energy and environment for humanity to live as humans. I am sure that even if our way of being changes, we are universal existence through working on the nature of the issues. We would appreciate your continued support.

近本一彦

Kazuhiko CHIKAMOTO, Representative Director and President

Contents

JANUS Trajectory of 50 years 1971–2021
—With the change of energy and environment—

Main part

Appendices

I

Prehistory of establishment
1951–1970

1. Peaceful use of nuclear energy that began in the 1950s

In 1951, right after the end of World War II, the first nuclear power generation in history was started in the United States of America (hereafter called the "the U.S."). Nuclear power generation using nuclear fuels such as uranium and plutonium was added as a power generation system to the conventional types such as thermal power generation using fossil fuels and hydraulic power generation.

In 1953, the peaceful use of nuclear energy became the global consensus through the U.S. President Dwight D. Eisenhower's speech "Atoms for Peace" in the United Nations General Assembly.

Also in our country, the "Atomic Energy Basic Act" was established in December 1955, stipulating: Article 1 "The purpose of this Act is to secure energy resources in the future, achieve progress in an academic field and promote industry by encouraging the research, development and utilization of nuclear energy, thereby contributing to the improvement of the welfare of human society and of the national living standards" and Article 2 "The research, development and utilization of nuclear energy shall be limited to peaceful purposes, shall aim at ensuring safety, and shall be performed independently under democratic administration, and the results obtained shall be made public so as to actively contribute to international cooperation." These articles contain the so-called three principles in the use of nuclear energy: "democracy," "independence," and "openness."

This Act clarified the position of nuclear energy in the domestic energy policies, and the Agreement for Co-operation Concerning Civil Use of Atomic Energy between the Government of the U.S. and the Government of Japan also came into effect, following the establishment of the Atomic Energy Basic Act, making it possible to import enriched uranium fuels together with research reactors themselves and related technical information.

In 1956, the Atomic Energy Commission was organized by the government, and the Japan Atomic Industrial Forum and the Japan Atomic Energy Research Institute (former name; hereafter called "JAERI") were also established, which was the start of the efforts of the industry and research institutions on the peaceful use of nuclear energy. In 1957, the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors was promulgated in Japan, and the International Atomic Energy Agency (IAEA) was set up in the world, thus becoming the frameworks to control unregulated development and use.

In order to follow the current trend and take advantage of a business opportunity, Asano Corporation, which was a general trading company based in Nihonbashi in Tokyo, also newly set up the "Nuclear Industry Department" as a business division specialized in nuclear energy. Yasuo Sakakihara, who later became the central figure in the establishment of our company, took office as the sales manager of the Nuclear Industry Department. At that time, Sakakihara had finished his two and a half year stint at the U.S. New York branch and had just returned home. He immediately contacted Internuclear Company (hereafter called "IN Co.") through the New York branch, and secured a contract to become the sole agency in Japan. IN Co. was a subsidiary of a major biochemical manufacturer Monsanto Chemical Company and provided nuclear energy-related consulting services.

2. Success in nuclear power generation for the first time in Japan

The first consulting contract concluded between Asano Corp. and IN Co. was on the technology assessment regarding the Japan Power Demonstration Reactor (JPDR), which was planned by JAERI. It contained the comparison and examination based on the results in the U.S. and technical and economic assessment regarding the boiling water reactor (BWR) and the pressurized water reactor (PWR) which were light water reactors, attracting attention from the domestic electric power industry and electric equipment manufacturers at that time.

Several months after signing the contract, the JPDR was ordered according to the report submitted by IN Co., and in 1958, the construction work for the first BWR in Japan was started at the JAERI site in Tokai-mura, Ibaraki. The first nuclear power generation in Japan succeeded on October 26, 1963.

Beginning with the establishment of the Atomic Energy Basic Act, the expectation on the peaceful use of nuclear energy heightened, and meanwhile, new subjects of study related to nuclear energy were founded in universities and higher professional schools. Sakakihara obtained the information that Kyoto University was planning the construction of research reactors in the Kansai area in cooperation with Osaka University, and immediately started to make approaches to Kyoto University. While relentlessly visiting the professors and personnel who were involved in the construction project, and gathering the information on the key points, progress, etc. of the project, he held many discussions with IN Co. to thoroughly prepare for the receipt of orders for the project.

The project had three policies: [1] The Research Reactor Installation Committee should play a key role in creating a basic design; [2] Verification of the practicability of the basic design should be entrusted to proven overseas engineering companies; [3] The production of equipment and the construction work should be ordered to domestic manufacturers and construction companies. Asano Corp. and IN Co. participated in the bid for the entrustment of verification of the basic design discussed in [2] and were able to accept the orders.

In September 1961, Sakakihara went to the U.S. with his assistants in charge at Kyoto University and the manufacturer's engineers, verified the basic design at IN Co. for more than one month, and completed the feasible final specification.

The evaluation for this far exceeded Sakakihara's expectations, and Asano Corp. was designated to accept the orders collectively including construction works as the sole agency of IN Co.

The Kyoto University research reactor (KUR) was constructed under the supervision of the engineer dispatched from IN Co., and was completed as planned in 1964, which was the target year. KUR achieved the first criticality in June that year, arrived at the rated output of 1,000 kW in August, increased the power to the rated output of 5,000 kW in 1968, and has continued operating without major problems up until the present day.

3. JGC taking over nuclear energy-related business operations

With the Japan Atomic Power Company (hereafter called "JAPC") established through the investment of nine electric power companies in 1957, the industry started to move toward the construction of commercial nuclear reactors in Japan.

In 1964, JAPC introduced light water reactors from the U.S., and IN Co. accepted the order for the preparation of the international bidding specification for the Tsuruga Power Station to be constructed in Tsuruga Peninsula in Fukui Prefecture. For light water reactors, the manufacturers in the U.S. were divided into two camps of BWR and PWR, developing competition for receiving orders, but since IN Co. professed themselves to be neutral, they were expected to be able to prepare an unbiased bidding specification. After that, JAPC concluded an extensive consulting contract with IN Co. for evaluation and selection of the bids submitted from each camp.

However, in the same year, Monsanto Chemical Company, the parent company of IN Co., desisted the nuclear power development, and IN Co., a nuclear power consulting company, had no choice but to dissolve. The operations of IN Co. were taken over by NUS CORPORATION in the U.S., a start-up nuclear power consulting company, and Asano Corp. continued to be the sole agency.

In the next year, however, it was decided that Asano Corp. would go under the umbrella of a major trading company due to the poor performance of other divisions despite the nuclear energy-related business operations continuously expanding.

Viewing this crisis as an opportunity, Sakakihara transferred to the Nuclear Energy Department, which was a new division of Japan Gasoline Co., Ltd. (currently JGC Holdings; hereafter called "JGC") at that time. As a result, in 1966, JGC became the sole agency of NUS CORPORATION in Japan because of the trust relationship that had been established between NUS CORPORATION and Sakakihara.

JGC started active sales activities and received many orders for consulting services from Power Reactor & Nuclear Fuel Development Corporation, The Federation of Electric Power Companies of Japan (hereafter called the "FEPC"), nine domestic electric power companies, Korea Electric Power Corporation, Taiwan Power Company, etc. Incidentally, the international bid for the light water reactors to be introduced by JAPC in the Tsuruga Power Station was won by the General Electric Company (GE) in the U.S., which proposed BWR, and in 1970, the construction work of the Tsuruga Power Station Unit 1, the first commercial nuclear power plant in Japan, was started. In the same year, JGC concluded a new contract (contract on the provision of services and information, etc.) with NUS CORPORATION and started to move toward the establishment of a Japan-US joint venture company which mainly provided consulting services.

NUS CORPORATION

NUS CORPORATION was a company established in 1960 by the specialist group who participated in the U.S. nuclear energy development planning to make use of their abundant experiences to provide consulting and engineering services in the nuclear energy field. The company was called Nuclear Utility Services, Inc. at the establishment and mainly provided services related to nuclear power generation as its name suggests, but after that, the company added engineering services related to environmental problems to its operations and changed its name to NUS CORPORATION in 1962.

NUS Clearwater Laboratory in Florida, the U.S.
(in the mid-1970s, provided by Curtiss-Wright Nuclear)

In front of the NUS head office (1988)

John E. Gray, the First Chairman and Member of the Board

Yasuo Sakakihara

I met Mr. Gray through an introduction by President Widdoes of IN Co. IN Co. was an engineering company in St. Louis, the U.S., which undertook subcontract works from the design to construction work and trial operation when Asano Corp., which I worked for then, constructed the Kyoto University research reactor (KUR).

At that time, trading companies in Japan actively developed their sales activities in every field to expand their trading area, and Asano Corp. was one of them. The company newly set up the Nuclear Energy Department to develop new businesses by accepting orders of nuclear energy-related businesses not only from KUR, but also from JAERI, other government agencies, and electric power companies, with domestic and overseas engineering companies, equipment manufacturers, constructors, etc. as subcontractors. Among such activities, epoch-making achievements were collectively receiving orders from the preparation of the international bidding specification for the JAPC Tsuruga Power Station to the examination of the bidding and the supervision of its trial operation and completing them with IN Co. as a subcontractor, which showed the significance of consultants in the nuclear energy industry.

Due to the great change of the nuclear energy policies in the U.S., IN Co. was dissolved with all its pending projects taken over by NUS CORPORATION, and when President Widdoes visited Japan with President Gray of NUS CORPORATION, I met President Gray for the first time at Haneda Airport and was introduced to him by President Widdoes.

I visited all our clients in Japan with both presidents to announce the succession of business between the two companies, both presidents responded to the clients as rehearsed in a hotel room, and the clients willingly accepted us.

In one case, I guided both presidents to Tokai-mura, where the window of the contract with JAERI was located. Tokai-mura in early summer was set in the midst of quiet rural scenery with a fresh breeze blowing. On the way to JAERI's office, the three of us walked on the pathway between the rice fields to enjoy the rural Japanese scenery.

In the rice fields where rice planting had just finished, rice seedlings rustled in the soft breeze, and the bellies of little crucian carps glittered in the side channel. At that moment, three of us unexpectedly sniffed the air. In the green balmy breeze, we smelled a sulfurous odor. We saw one farmer carrying a night-soil buckets on a pole across his shoulders. The odor was coming from the buckets. The farmer was going to a night-soil reservoir in the corner of the field through the pathway between rice fields along which we had strolled. We shifted to one side of the pathway to let the night-soil buckets go through and heard the faint sound of human waste slopping around in the buckets. I broke into a sweat. I was afraid that they might laugh at the anachronism of using human waste as fertilizer while we were on our way to adopt nuclear power generation, a cutting-edge technology of civilization. However, Mr. Gray said, "Will you buy me one of those honey buckets (night-soil buckets)?" Without even thinking, I asked, "Sorry, what will you use it for?" He answered, "It will be ideal for cooling wine bottles." "Yes, please buy me one, too," said Mr. Widdoes, smiling.

When we finished the talk on the succession of business between both companies in the JAERI office, I immediately visited the purchasing division, explained the details, and requested the purchase of two night-soil buckets. The person in charge immediately asked his colleague from Tokai-mura, who willingly accepted the request while laughing out loud. The two presidents and I stayed overnight at a country hotel near a marsh and received two brand-new night-soil buckets the next morning. On each of the two night-soil buckets, a piece of paper was attached for Mr. Gray and Mr. Widdoes with the following English sentence: "This is donated from the Japan Atomic Energy Research Institute as a souvenir." They were "honey buckets" with refreshing green bamboo hoop on plain wood. Watching the two Americans admiring the body of the buckets with satisfaction, I was glad, too.

JGC, which became Japan's sole agency of NUS CORPORATION in place of Asano Corp. in 1966, accepted the order of the extensive investigation called "Overseas Investigation on Nuclear Fuels" from FEPC the next year, and the specification for this investigation contained the investigation by dispatching a delegation to North America with Vice President Naojiro Tanaka of Tokyo Electric Power Company (hereafter called the "TEPCO" , currently TEPCO Holdings) as its head. I acted as their guide. After the group visited uranium mine digging sites and smelting plants in Canada and the U.S., we attended the welcome home party at the home of President Gray and saw the wooden ice bucket with some wine bottles pushed into broken pieces of ice on a large table in the center of the room. President Gray added at the end of his speech at the opening, "The beautiful ice bucket on this table was donated to me directly by the Japan Atomic Energy Research Institute of Tokai-mura. I hear this bucket is used for other purposes in the rural village of your country, but what a beautiful work of art it is. This is a really nostalgic and memorable souvenir for me," and winked at me as if to say, "I will let you do the rest." I sweated again, but since no one in the place knew the real facts, I explained the background, which entertained them and broke the ice.

Next, Mr. Naojiro Tanaka, who was the head of the delegation, gave a greeting and proposed that "Since the word NUS resembles the Japanese word 'NASU (do),' we greatly expect NUS CORPORATION to play an important role in the progress of nuclear power generation in Japan," which was very impressive for me. Mr. Kaoru Yosano, who is a current Diet member and worked for JAPC at that time, simultaneously interpreted the conversation between President Gray and the party from the beginning to the end. He was still young but was an excellent interpreter.

Presided Gray liked a Japanese banquet, especially a cozy night banquet. In Kyoto, he was completely charmed by the young okami of the tea house in Kitano Kamishichiken where a certain assistant professor in charge of KUR was a regular customer, and it was impressive that when she visited the hotel room of President Gray with a junior geisha who had attended the banquet, his excitement was almost child-like, and he was completely puzzled as to how he should treat them.

In Tokyo, he really enjoyed the hospitality at the prestigious "Nakagawa" in Akasaka, which was the favorite of President Suzuki of JGC. Since President Gray admired the shape of the pine branch on the gold background of the folding screen put up in the room, he was given a two-fold screen of a similar design by President Suzuki. In later years, when I visited the house in the suburbs of Washington D.C. where retired President Gray lived alone, the folding screen was hung on the wall of his living room, but since it was upside down, I immediately helped him fix it. I heard that he was very active both in work and in friendship when he was young, but I thought that he was quite lonely in his later years.

* The text is as written originally by Former President Sakakihara at our request around 2002 on recounting his memories at the company establishment.

Ⅱ

Creating the basis for growth
1971–1980

1. Establishment of JAPAN NUS Co., Ltd.

At the organizational meeting in 1971 (Chairman Gray in the center of the front row, President Suzuki on the right, and Managing Director Sakakihara at second from the left of the back row)

JAPAN NUS Co., Ltd. was founded according to the contract to form a joint venture company signed between JGC and NUS CORPORATION on June 3, 1971. In addition to JGC and NUS CORPORATION, a major client TEPCO participated as a shareholder, and Kansai Electric Power Company (hereafter called the "KEPCO") and Chubu Electric Power Company (hereafter called the "Chubu EPCO") also newly participated as a shareholder in 1974, which further strengthened the management foundation. For the management, Yoshio Suzuki, who was the Representative Director and President of JGC, assumed the position of Representative Director and President (part-time) of our company, and Sakakihara with the title of Managing Director led our company as the substantial top executive.

The business operations of our company at its establishment were mainly nuclear energy-related consulting and engineering services including the import of information on the U.S. nuclear energy regulations from NUS CORPORATION, its translation and provision, etc.

At that time, however, NUS CORPORATION in the U.S. had already made great achievements in consulting on the environmental field to the degree that it surpassed the Nuclear Energy Business Division. In the U.S., the National Environmental Policy Act was established in 1969, and the environmental impact statement was necessitated at the submission of the application for approval of construction of a nuclear power station. In response to these, NUS CORPORATION organized the Environmental Business Division faster than anywhere else.

2. Commencement of Consultation for Environmental Issues

In 1972, we commenced providing consulting and engineering services for environmental issues in the same way as NUS CORPORATION.

Sakakihara received valuable advice from Mr. Kiyoshi Tanii, a counselor of the Japan Fisheries Resource Conservation Association, when he was setting up our Environmental Business Division. Mr. Tanii told him that, "You should have the best expert in Japan as a technical advisor, and the right person is Dr. Tadao Nitta of the Fisheries Agency." Sakakihara went straight to Dr. Nitta, who was a leading expert in water quality science at the Fisheries Agency's Tokai Regional Fisheries Research Laboratory (at that time), to ask him taking up the post of technical advisor. Initially, Dr. Nitta firmly declined the offer. However, after repeated visits by Sakakihara, he finally accepted the post, but he said, "I feel anxious on my own." Therefore, he accepted on condition that Dr. Teiji Kariya, Associate Professor of the Faculty of Agriculture at Tohoku University, would also become a technical advisor.

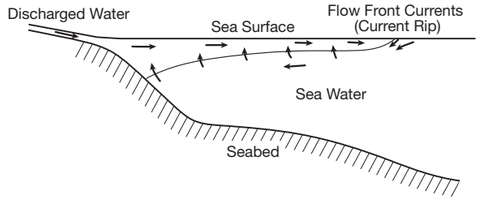
Dr. Tadao NITTA
Technical Advisor

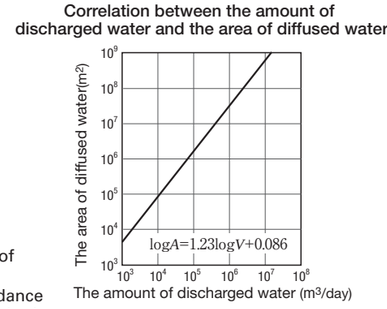
Dr. Teiji KARIYA
Technical Advisor

Sakakihara agreed to this suggestion and willingly accepted a request from Dr. Kariya asking that JANUS take over the environmental survey related to fishery compensation for the construction of breakwater at the entrance of Kamaishi Bay. This is how Dr. Tadao Nitta and Dr. Teiji Kariya were appointed as our technical advisors, and how our Environmental Business Division started accompanied by the leaders with perfect achievements and leadership.

In 1972, the Cabinet of Japan approved "Concerning the Environmental Conservation Measures in Relation to Public Works". This was in response to trends in the U.S. that the environmental assessments for public works were institutionalized based on this approval, and large-scale power plants were within this scope. In the following year, the Agency for Natural Resources and Energy was to review the environmental assessments for power plants.

However, power companies at the time did not have the sufficient knowledge required to carry out environmental assessments. Therefore, we conducted a literature review on the impact assessment of discharged thermal effluent from power station in the U.S., where the environmental assessment system had already been introduced. As a result, in the U.S., there were cases of impacts caused by discharge of thermal effluent into rivers, lakes, lagoons, etc., where hydrological retention tends to happen. On the other hand, in Japan, it seemed unlikely that a significant impact on the marine ecosystem would occur because the thermal effluent is discharged into the sea where there is little hydrological retention. In considering the impacts of such thermal effluent, the guidance given by our technical advisor, Dr. Nitta, who invented the simplified diffusion prediction formula for thermal effluent "Nitta's experimental equation", formed the foundation for making a leap forward in our technological capabilities.





Correlation between the amount of discharged water and the area of diffused water ("Nitta's experimental equation")
(Source: Japan Fisheries Resource Conservation Association, "Guidance for establishing water discharge standards to maintain quality standards for fishery water.", July 1968.)

3. The Establishment of Nuclear Energy Business Division and Environmental Business Division

In 1974, there were two important topics holding the key to the growth of our Nuclear Energy Business Division. First, the enactment for the Three Laws for Power Development (the Act on Tax for Promotion of Power Resources Development, the Special Budget Law for the Development of Electric Power and the Law for the Adjustment of Areas Adjacent to Power Generating Facilities) has created an environment

where construction of nuclear power plants can proceed smoothly. This resulted in new nuclear power plants to be built one after another until the 2000's, and the demand for nuclear energy consulting and engineering services has increased rapidly.

Secondly, a new membership information service called LIS (Licensing Information Service) was started, providing a database of the latest licensing information of nuclear power plants in the U.S., based on the import and translation service of the U.S. nuclear regulatory information that had been continuously implemented since our establishment. Thereafter, it has been consistently providing us stable profit as a core business of our Nuclear Energy Business Division. It also formed the basis of similar membership information services in our business model.

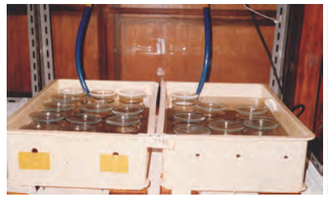
Similarly, in 1974, our Environmental Business Division received an order for an environmental radioactivity monitoring project at TEPCO Fukushima Daiichi Nuclear Power Station (Fukushima Daiichi NPS). This monitoring project led to the advancement of our environmental assessment business. In the same year, an environmental study started at TEPCO HD Kashiwazaki-Kariwa NPS. Unit 1 of the Kashiwazaki-Kariwa NPS commenced commercial operation in 1985, and our monitoring work on the impact of discharged thermal effluent to the surrounding sea areas has been ongoing since then.

Parameters for monitoring the impacts of thermal effluent at the Kashiwazaki-Kariwa NPS were water quality, marine sediment, and marine organisms, but initially there was a shortage of human resources capable of surveying and analyzing. As a result, the survey work, including water sampling, was outsorced to partner companies, and one of our employees in charge of directing the work was onboard each research vessel. For the analysis work, on the other hand, we were only in charge of fish analysis, and outsourced everything else. After hiring employees specialized in ichthyology and chemical analysis, we were able to conduct in-house analysis of fish eggs and larvae, and also do water quality analysis. In particular, our analyses of fish eggs and larvae were highly evaluated for their high accuracy, which later became our strength.

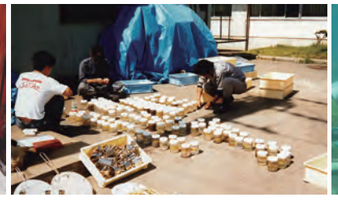
In 1975, we received a contract from TEPCO to prepare environmental assessment reports and related materials for NPSs (Unit 1 of Kashiwazaki-Kariwa NPS, Units 3 and 4 of Fukushima Daiichi NPS).

At the time of these orders, the environmental assessment of the large-scale power plant project was subject to the "Concerning the Environmental Conservation Measures in Relation to Public Works" (1972) approved by the Cabinet, but there are no examples of implementation at the power plant yet. Also, it was before the ministerial decision (Ministry of International Trade and Industry, 1977) and the notification (Agency for Natural Resources and Energy, 1979) were implemented with the aim of strengthening the environmental impact assessment of power plants. Therefore, we carried out the first environmental assessment of a power plant in Japan together with TEPCO, referring to the interim report on the environmental assessment by the Environment Agency (1974) and the case examples in the U.S.

Furthermore, in 1976, we prepared materials related to marine ecology, which is our specialty, in order to correspond to the governmental reviews of environmental assessment reports by the Agency for Natural Resources and Energy. In the same year, we received an order a large-scale project of a feasibility study for siting the Tomari NPS of the Hokkaido Electric Power Company, Incorporated (HEPCO). Our business performance had declined due to the impact of the oil crisis in 1973, and we fell into the red in 1974, but it recovered with this contract for a large-scale project.



Plankton, fish eggs and larvae samples during the breeding test at higher water temperatures (in 1979)



Checking fish eggs and larvae samples of the environmental surveys at surrounding sea area of the Kashiwazaki Kariwa NPS. (in 1985)

Distribution survey of seaweeds species as one of the environmental surveys at surrounding sea area of the Kashiwazaki Kariwa NPS. (in 1985)

In the midst of unsettled business conditions at the beginning of our establishment, an unfortunate tragedy that should not happen had happened. On January 23, 1976, one of our employees lost his life in an accident during a seawater sampling, which was regularly conducted as part of surveys on marine organisms. To prevent such accidents from happening again, we designated January 23 as "Safety Day" with deep remorse and condolences, and we conduct safety education for our employees every year.

In 1980, the Niigata Field Survey Office (currently the Niigata Office) opened in response to the expansion of investigations on the impact of discharged thermal effluent into the sea area around the Kashiwazaki Kariwa NPS. As a result, the local office could promptly respond to various requests from clients other than investigations at the sea area, and could also provide appropriate advice based on the local situation. This enabled us to build trust with clients, which led to a further increase in orders. Moreover, many of our employees worked to build better relationships with the local community by responding politely and meticulously to local fishermen, and participating in local resident gatherings and volunteer activities. This approach by the Niigata Field Survey Office has been handed down not only to the Niigata but also to our offices in other regions.

4. 1970s: Engaged in various operations to develop creative capabilities

In our business guidebook for the Nuclear Energy Business Division in the 1970s, we find they developed technical services for various fields such as technical assistance for the procurement and management of nuclear fuels and provision of services for incore fuel management by making use of the advanced analysis capabilities and abundant experiences, as well as safety, planning, construction, operation, quality assurance, water chemistry, and removal of radioactive contamination, etc. of nuclear power stations. It shows that our company had already aimed at the provision of extensive engineering services in the nuclear energy field at that time.

In 1977, our company temporarily transferred our engineers to the Central Research Institute of Electric Power Industry, which was a research institution affiliated with electric power companies, to make improvements of the core management code of nuclear power stations. Our company also conducted very advanced investigations, analyses, and evaluations such as collecting pine needles in the site of a nuclear power station to analyze the environmental radioactivity and conduct verification according to the result of the simulation by a mainframe computer.

Three Mile Island Nuclear Power Plant in the U.S.

The Environmental Business Division significantly improved its financial results in the late 1970s. One of the reasons was because it received more orders for the environmental assessment operations for nuclear and thermal power stations in accordance with the "Enhancement of environmental impact study and environmental review on the siting of power stations" (ministerial decision in 1977) described above. In the operations related to the Kashiwazaki-Kariwa NPS in which our company had been engaged since 1974, our company started bioassays (breeding tests at higher water temperatures for plankton, fish eggs and larvae) in 1978 to elucidate the influence of thermal effluents. Such increase of the operations in which our company could utilize its strength would also be the reason for growth of our business.

Inside the control room of the plant after the TMI accident (1979)

The accident which occurred in Three Mile Island Nuclear

Generating Station in Pennsylvania, the U.S. on March 28, 1979 (hereafter called the "TMI accident") was a severe accident with a larger scale damage of the core than postulated in the safety review, having a large impact not only in the U.S., but also on the nuclear power generation business in Japan which referred to the design and technology and safety regulations of the U.S. at that time, as well as the Nuclear Energy Business Division of our company. To follow up the trends of the U.S. regulations that were considerably reviewed after the TMI accident, our company summarized the enormous amount of information that received from NUS CORPORATION in quarterly reports as quickly as possible, and sent national caravans to visit domestic electric power companies every three months to present our reports (continued until 1981). In 1980, since revision of the siting criteria for NPSs started to be considered, our company conducted investigations, analyses, and examinations on its trends and influence, and promoted the research of new siting methods (impact assessment at the time of an accident of offshore/underground power stations ~ underground water / marine pollution), starting the operations for supporting all electric power companies with FEPC as a key player (continued as researches financed jointly by electric power companies [to be discussed later] until fiscal 1989).

Through the construction rush of domestic nuclear power stations that started in the early 1970s, 20 units (* 21 units including Fugen) started their operations in the 1970s. With this, our company improved its financial results almost continuously, and its annual sales expanded to more than one billion yen.

As described above, our company was founded as the first consulting company specialized in nuclear power generation in Japan, and using the high-level capability of gathering information on nuclear energy and environmental issues as its basic technology through the 1970s, our company developed, furthermore, our creative capabilities to make challenging proposals through deep understandings about such information combined with effective solutions. By doing so, our company ensured the brilliant growth in the 1980s.

III

Toward JANUS of investigations and analyses

1981–1990

Assumption of office of the second president and a business development as the third pillar

Since the establishment in 1971, our company had been managed by Yoshio Suzuki, who was the Representative Director and President of JGC and also served as the Representative Director and President of our company, and by Yasuo Sakakihara as the Managing Director. The management system was changed in 1986 with Suzuki as the Representative Director and President and Sakakihara as the Executive Vice President. Suzuki retired from the presidency in 1989 to become the senior executive advisor, and Sakakihara took office as the Representative Director and President. Just before the 20th anniversary of the establishment, the building of a new management system looking ahead to the next generation started here.

One of those efforts was to further focus on the "system development" to be discussed later, which led to the independence of the System Development Business Division in 1991. The conventional "System Development Office" of the Nuclear Energy Business Division carried out the survey-centered operations and analysis-centered operations. Those operations were divided into separate divisions, making it possible to challenge more extensive fields, which developed as the third pillar of our company.

Nuclear Energy Business Division

1. Introduction of superminicomputers and transfer of head office

The TMI accident, that occurred in 1979 was a severe accident with a partial but large scale meltdown of the reactor core, and was far more severe than postulated.

The Atomic Energy Commission (AEC), the predecessor of the Nuclear Regulatory Commission (hereafter called "NRC") in the U.S., systematized the probabilistic risk assessment (PRA) of nuclear power plants, and published it as the draft version in 1974 and the final version in 1975 in "WASH-1400[1] (the so-called Rasmussen report)." This report concluded that the risk of 100 nuclear reactor units was at the same level as the risk of meteorite accidents (that is, the probability was extremely low). However, the situation with such extremely low probability occurred in reality.

This accident can be classified into a Small Break LOCA (Small Break Loss-of-Coolant Accident: Loss-of-coolant accident with a small fracture of coolant pipe, which the coolant is lost moderately), but since the Rasmussen report already implied that the impact of the Small Break LOCA on the entire risk of commercial nuclear power stations was not so small, people strongly recognized the effectiveness of the probabilistic risk assessment.

1) Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants [NUREG-75/014 (WASH-1400)]

After this, the U.S. sought to change its policies to apply stricter regulatory standards for nuclear facilities. In such a situation, more people began to think that the probabilistic risk assessment was an important tool for building appropriate and rational regulatory standards without having to tighten up more than necessary. In addition, the radioactive exposure became an issue due to this accident, which led to the wide recognition of the importance of the environmental impact assessment at the time of nuclear accidents, or the safety analysis such as the assessment of the radiation exposure in peripheral environments, etc.

After the TMI accident, the electric power industry in Japan also enhanced the efforts for the PRA of NPSs and the environmental impact assessment at the time of accidents. The researches financed jointly by electric power companies were actively conducted, and our company was involved in several projects under the researches to focus especially on the development of the system making full use of mainframe computers. At that time, our company used the mainframe computers owned by JGC, which was the main shareholder of our company, but while the projects were expanding, it was obvious that our company needed to have its own high-performance computers that could be used without limitation.

Looking ahead to the business expansion, our company transferred the head office from Otemachi to Shinjuku in 1981. The organization was also greatly changed at this time. Adopting the proposal of the employee who played an active part as a leader at that time, the "System Development Office" was newly set up, gathering technological employees in their early 20s and 30s there. While the employment situation was severe due to the oil crisis, and heavy electric machinery companies and electric power companies reduced their employment, our company could obtain human resources with excellent technological skills.


Computer room with supermini (Managing Director Sakakihara on the left (as of 1985). ©Toshio Hataya)

At the same time as the establishment of the System Development Office, our company introduced its own computers for the first time. The investment was extraordinary and disproportionate to the capital at that time, but ECLIPSE MV/8000 made by the U.S. Data General, which was the latest superminicomputer (hereafter called the "supermini"), enabled large computation at the same level as mainframe computers, through its 32-bit processing. Our company set up the computer room equipped with dedicated air conditioners, and installed about ten terminals and large graphic displays. Starting with porting the PRA level 3 analysis code of nuclear power plants to the supermini, the computers fully operated at the implementation of research financed jointly by electric power companies such as building of the system for the assessment of the real-time surrounding environmental impact at the time of nuclear accidents (ACAS), off-site EP (emergency planning), decommissioning, etc. At the request of the JAERI risk assessment analysis research laboratory, the computer was also utilized for the analysis of the US-made MARCH code for severe accident behavior analysis, and for the development of the THALES code under the concept of JAERI for severe accident behavior analysis.

In this way, our company handled many analyses operations utilizing computers, which developed as the large pillar of our company. The year 1981 was an important turning point for our company to seize the opportunity for growth.

PRA stands for probabilistic risk assessment. In Japan, the term "probabilistic safety assessment (PSA)" was rather widely used to emphasize safety. The probability theory is a field of mathematics for analysis by applying a mathematical model to an accidental phenomenon.

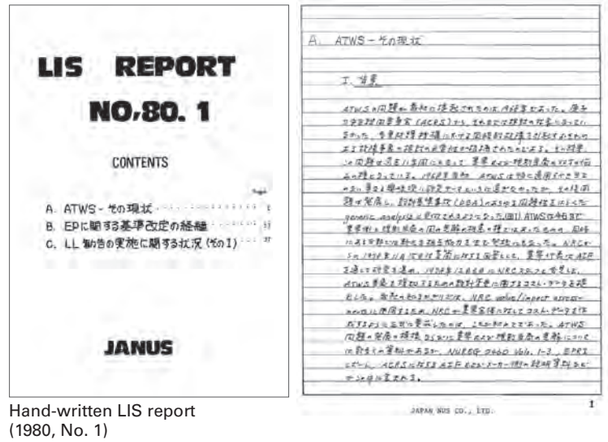
Probabilistic Risk Assessment (PRA)

PRA has three levels. Level 1 assesses the probability of occurrence of accidents. Level 2 assesses the amount of radiation to be released outside when an accident occurs. Level 3 assesses the consequences of the released radioactivity on the surrounding. NUPRA to be discussed later is an analysis tool for PRA level 1, and the MARCH code and the THALES code described above are the analysis tools for PRA level 2. The calculation code ported to the supermini is an analysis tool for PRA level 3 as described above.

2. Change of LIS operations

Among the trends of licensing and safety regulations and the experiences of accidents and failures of nuclear power plants in the U.S., many have a great influence on the development of nuclear power generation in Japan. From such a perspective, the LIS service regularly provides the latest information on the safety regulations of all commercial nuclear power plants in the U.S. and answers the questions.

NUS CORPORATION collected the information on the movement of regulatory authorities, electric power companies and manufacturers, and related documents by contacting the staff of NRC and having personnel stationed to collect data in the public document room of NRC, and prepared two types of reports: the "LIS NEWSLETTER," which was summarized as the latest information, and the "NRC MEETING SUMMARY," which summarized the outline of the important meetings between NRC and the applicants. Our company translated and provided them to the members as the Japanese version of the monthly report until 1981. There were needs for such service when the pipeline of information between Japan and the U.S. was thin, but the pipeline of information widened from the late 1970s, and the service gradually became obsolete.


LIS REPORT
NO.80. 1
CONTENTS
A. ATWS - その現状
B. EPに関する基準改定の経緯
C. LL 勧告の実施に関する状況 (その1)
JANUS
A. ATWS - その現状
Hand-written LIS report (1980, No. 1)

With the flood of information and its processing after the TMI accident, LIS came under pressure to change. From 1982, our company read the U.S. original documents based on the information obtained from NUS CORPORATION and summarized them in the monthly reports, etc. In this way, our company was able to understand the current trends of the U.S. nuclear regulations and systematically track the issues that drew strong interest in Japan. Our company boasts that the current LIS is a database with no equal in Japan, which was determined by the great change in 1982.

On the other hand, the research on severe accidents became active in the U.S. after the TMI accident. In response to this, our company started a membership information service (US SARP) in the early 1980s that was specialized in this theme and conducted technically intense surveys. The US SARP continued until 1996, and the results were absorbed by LIS.

In 1986, seven years after the TMI accident, the disaster that this time shook the entire European Continent occurred at the Chernobyl Nuclear Power Plant (hereafter called the "Chernobyl Power Plant") in Ukraine. With this as a trigger, European countries pushed forward countermeasures against severe accidents of nuclear power plants. Our company which had always felt the need for European information,

focused on the countermeasures against severe accidents in major European countries, and started the service called Nuclear Safety in European Countries (NUSEC) in 1987. It is a membership service like LIS and is still one of the main operations of the Nuclear Energy Business Division.

3. Starting operations by the multiclient system also in the radiation protection field

The influence of the accident of the Chernobyl Power Plant was sensationally reported by mass media in Japan at that time. In response to the information on deformities such as cows having two heads that were published in a weekly magazine with photographs and the news report of the increase of thyroid cancer and leukemia, electric power companies were urgently required to create a system for grasping the facts earlier than mass media to prepare for the inquiries from the heads of local governments concerned. At that time, our company worked energetically to create new operations using the business model of the multiclient system like LIS also in the radiation protection field. The supply and the demand were matched, and the radiation effect operations were started in 1989.

For the operations at that time, it was demanded only to capture and translate the information that seemed to draw interest from mass media in Japan before it was covered by them. Therefore, every day our company checked the overseas newspapers (British Sunday Times, British Guardian, US New York Times, Associated Press, TASS, etc.) that were referenced by the Japanese mass media, immediately translated the articles that might cause a sensation, read the cited references (mainly research papers) for particularly important articles, and obtained comments from experts.

After that, in order to further improve the added values of information, our company checked the latest research trends in the relevant academic societies, arranged the research papers with possible health effects by time and theme, and proposed the system that enabled clients to collect information as early as possible. In addition to the health effects, our company also included the contents that contribute to electric power companies lobbying the country such as the idea of radiation protection at nuclear power plants, radiation exposure reduction, etc. Not satisfied with the approach of relying only on foreign newspapers, our company proposed the rational approach in which information including the idea of protection should also be understood if there are radiation effects.

For the radiation effect operations, orders including those for related operations reached their peak in 2002, and the operations have been continued by the multiclient system by 12 companies for a long period of time up until the present day.

Environmental Business Division

Our Environmental Business Division started with environmental issues related to nuclear power plants, such as the impact of environmental radioactivity and discharged thermal effluent. After that, we began environmental assessment services related to thermal and nuclear power plants and general industrial plants at the coastal sites, and evolved into consulting services for solving a wide range of issues centered on sea areas such as coastal reclamation, oil pollution, and red tide.

1. The first consulting service contract from the Environment Agency (at that time)

In 1981, for the first time we were commissioned from the Environment Agency, entitled “Preparation of guidelines for evaluating the impacts of discharged thermal effluent from power plants”. This was because our knowledge and achievements in the environmental impact assessment of thermal effluent were highly evaluated. This contract was the first step toward expanding our business for the Environment Agency and the Ministry of the Environment since the 1990s.

A series of jobs to investigate the impacts of thermal effluent discharged from power plants on fishery resources, including the impacts of fish eggs and larvae in cooling water, began in earnest from the mid-1980s under the guidance of our technical advisor, Dr. Doi, as described later. This made full use of our skills in researches and analyses of fish eggs and larvae, as well as mathematical analysis of fishery resources, that we had built up by that time, and it became a symbol that embodied “JANUS is known for researches and analyses”.

2. Commencement of fishery resource management related services

Examination of the impact on fishery resources, which we worked on since the beginning of thermal effluent related services, requires knowledge of biology, but it was also thought to require numerical analysis technology called resource capability analysis for detailed understanding and prediction. Therefore, in 1981, we welcomed Dr. Takeyuki Doi, a leading expert in this field and director of the Population Dynamics and Statistical Division of the Fisheries Agency’s Tokai Regional Fisheries Research Laboratory (at that time), as a technical advisor.

Our technical advisor, Dr. Doi, provided us with excellent resource analysis tools (mathematical resource analysis, quantitative echo sounder, etc.). This became a great strength for us, because there were few consulting companies in Japan that could analyze marine resources. In addition, Dr. Doi's strong guidance and education for our existing employees who majored in fisheries biology and fishery resource analysis expanded their contribution to our new field of business for fisheries.

3. Full-scale fishery resource management related services

At that time, Japan’s pelagic fisheries were beginning to be viewed critically by international society, and there were issues such as management of walleye pollock resources in high seas of the Bering sea and the bycatch of seabirds and marine mammals (fur seals, etc.) by drift-net fishing. Tuna resources had also begun to show signs of decline on a global scale. With the Ocean Research Institute of the University of Tokyo (at that time) and our technical advisor, Dr. Doi, we joined an initiative to tackle these matters with the Fisheries Agency and the Fisheries Research Laboratory. Our achievements then helped us gain trust from the Fisheries Agency and the Fisheries Research Laboratory, and we have continuously received orders for new projects to this day. The Fisheries Agency set a policy for fishery resource management in 1984, and started allocating budget focusing on this matter. We were entrusted with a project related to this policy in a wide sea area along the coast of Japan.

4. More focus on fishery compensation consultation

Since 1978, we have been involved in the “monitoring survey related to fishery compensation for the construction of breakwater at the entrance of Kamaishi Bay”. Associate Professor Teiji Kariya, who was appointed as a technical advisor in 1972, had previously worked on this survey. This survey led us to new fishery compensation-related projects for various development work. As a large-scale development project, the Kasumigaura Water Conveyance Project started in 1982 and the construction of the Nagaragawa estuary barrage and the Trans-Tokyo Bay Highway started in 1984.

Essentially, the fishery targets fish and shellfish that are invisible in water, so it is difficult to grasp the actual situation and the impacts of natural variance in the habitat of fish and shellfish. Furthermore, since

statistical values such as fish catches are roughly classified, applicability of statistical values for grasping actual local conditions required in fishery compensation consultation was limited.

In order to deal with these issues, a wealth of knowledge and experience regarding the actual state of fish and shellfish, the fishery industry, fishermen, as well as the fishing ground environment are required. In that respect, we have experienced staff who were involved in the assessment of the impacts of discharged thermal effluent from power plants, and we were able to carry out this work smoothly. In 1988, we invited Mr. Keiji Watanabe, an expert on the theory of compensation for business and business loss, as a technical advisor from the Fisheries Agency (seconded to the Water Resources Development Public Corporation at that time). As a result, we were finally organized to be able to handle a series of elements required for fishery compensation, including surveys, prediction of impacts, and calculation of compensation amounts.

5. Growth of environmental assessment consulting services

After the Cabinet Decision on the implementation of environmental impact assessment (what is called "Assessment based on Cabinet") was taken in 1984, we received many orders in the field of environmental assessment from many companies, from HEPCO in the north to The Okinawa Electric Power Company in the south, Electric Power Development Co., Ltd. (J-POWER) and companies other than electric power generation. In addition, the scope of environmental assessment had expanded to include geothermal power generation, type 2 projects of thermal power plants (e.g., gas turbine power generation), and nuclear fuel reprocessing facilities. In 1985, we received an order related to an overseas project to conduct an environmental assessment for the first time (Bataan Export Processing Zone development project in the Philippines).

With the rapid expansion of our business in the 1980s, our organization also grew. In 1990, we decided to move our main office of the Environmental Business Division to Shin-Yokohama, where rapid development was taking place at that time.

Impact of intake of cooling water and discharge of thermal effluent at power plants

Nuclear power plants and thermal power plants in Japan are located along the coast while taking in a large amount of seawater as cooling water, and discharge the cooling water that has been heated by about 7°C from original temperature. The discharged seawater is called "thermal effluents", and there were concerns about the impact not only on the marine ecosystem in the diffusion area of discharged thermal effluent, but also on the weather (steam fog, snowfall on the Sea of Japan side, etc.). In addition, there is an issue with entrainment due to a large amount of water intake. Plankton, fish eggs and larvae entrained in water intake may be affected by a sudden temperature rise or mechanical shock when passing through equipments such as condensers.

There is also impingement risk of relatively large fish crashing into screens, such as waste prevention screens for cooling water systems.

As a result, there is concern that a large number of eggs, larvae, and fish will die, causing direct damage to fishery resources.

These factors necessitated the preparation of guidelines for thermal effluent of power plants and to predict the impacts on fishery resources.

6. Expansion into new services by application of artificial formation of seaweed beds and seaweed biotechnology

Since 1982, our Environmental Business Division has worked on technology development for artificial formation of seaweed beds (marine re-forestation) in the waters surrounding power plants. We successfully developed a technology in which spores collected from natural mother algae were attached to a transplantation substrate to produce seedlings, and seedlings grown to a few centimeters were intermediate-cultured in natural sea waters, followed by final plantation. This achievement brought us the seaweed bed formation projects in the coastal areas of Shizuoka and Wakayama Prefectures. We have also developed a technology to make use of sandy seabeds where large brown algae that abalones and turban shells feed on cannot grow, by installing concrete blocks on sandy seabeds and in some cases transplanting seaweed seedlings. This technology was applied in seaweed bed formation projects in the coastal areas of Aomori and Mie Prefectures.

In order to obtain academic and technical guidance on these technological developments, in 1990 we welcomed Dr. Hiroshi Tokuda as a technical advisor. He was a professor at the Center for Biological Environment Control System, Faculty of Agriculture of the University of Tokyo, and an expert in hydrophytology and studying the impacts of oil spill incidents on marine life in sea areas.

Under the technical guidance of technical advisor Dr. Tokuda, our seaweed-related business expanded rapidly. The achievements from this business were the development of land-based cultivation technology for marine green algae, Ulva prolifera to fix carbon dioxide, the creation of high water temperature resistant marine red algae Porphyra species by cell fusion applying the seaweed biotechnology that emerged at that time, the establishment of mass cultivation technology for gametophyte of brown algae, and the development of cultivation technology for the freshwater green algae, Prasiola japonica, which was traded at a high price but it is difficult to produce seedlings. These achievements were published in presentations at specialized academic societies in Japan and overseas, papers were submitted to international specialized academic journals, and domestic patents were acquired.

Yoshio Suzuki, the First Representative Director and President

Yasuo Sakakihara

I met Mr. Suzuki for the first time in September 1965, when I was appointed as the manager of the newly established Nuclear Sales and Development Office and was handed the letter of appointment in the president's office in the following year of my entrance in JGC.

For the long 30 years since then, I had worked under him, but in my heart, he was like my older brother. However, since Mr. Suzuki looked gentle on the outside but was tough inside, I could not rely on his kindness not even slightly.

I wonder how many times I visited that windowless office of President Suzuki in the Shin-Otemachi Building from the time when I worked for JGC through the time when I managed JANUS. Every time I visited him, I expressed my opinions and sought instructions from him. Although he was very busy as a commander-in-chief of about 30 executive officers, managing the up-and-coming chemical plant manufacturer that produced annual sales of tens of billions of yen with 2000 employees, he listened to me, young and inexperienced, without showing an unpleasant face.

As far as I know, what President Suzuki worried most about JANUS was how he could make a soft-landing of the extremely vast idea about the joint venture of President Gray of NUS CORPORATION, who would become a new partner. President Gray put forward his ambitious idea that his company should absorb the entire JGC to establish an enormous Japan-US joint venture that would be able to receive direct orders for the construction work of nuclear power plants. It was Mr. Campbell, the Manager of the Nuclear Overseas Sales Department, who was dispatched to Japan on this mission. He was highly motivated, but since the persons in charge at JGC treated him tactfully, the negotiation was prolonged.

At that time, President Suzuki was hospitalized at Keio University Hospital for surgery to fix detached retinas, and was immobilized on the bed with heavy sandbags to prevent him from moving. He called me to his bedside, dictated the countermeasures he summarized on the bed, and reexamined the notes, thus completing the "Contract on the provision of services, information, etc." This draft contract was translated into English immediately, sent to President Gray, and became effective on June 4, 1971.

JGC had already cooperated with Saint-Gobain Techniques Nouvelles (SGN), the nuclear energy-related engineering company in France, to tender a bid for a spent nuclear fuel reprocessing plant of the Atomic Fuel Corporation, and had accepted the order for detailed design of the plant. With this momentum, JGC signed a contract with NUS CORPORATION for entering the market of nuclear power plants, actively accepting orders for consulting services as the sole agency of NUS CORPORATION in Japan.

In this way, JGC mainly entered the field of design and construction of radioactive waste processing facilities of nuclear power plants, and JANUS stepped forward as the company specialized in consulting.

President Suzuki and Chairman Gray

At the establishment, JANUS held the annual shareholders' meeting alternately in the head office of NUS CORPORATION in Washington D.C. and in the head office of JGC in Tokyo, so I accompanied President Suzuki when he visited the U.S. every other year. This visit to the U.S. greatly contributed to deepening mutual understanding between JGC and NUS CORPORATION, and it was also a very valuable opportunity for me to get to know Mr. Suzuki's personality.

Looking back, I had interacted with my supervisor Mr. Suzuki in various ways for 30 years since I joined JGC, and if I remember correctly, he reprimanded me only twice.

The first time was in 1981. Since JANUS achieved sales of more than one billion yen and had more than 50 employees, it considered transferring the office to a new location, and chose Shinjuku, where its development as a business district was being actively pushed forward on the wave of the fast economic growth of our country. The new office was set up in Shinjuku Dai-Ichi-Life Building. Mr. Suzuki asked me, "Did you choose such a faraway place for the office because you wanted to leave me?"

The second time was in May 1989. I was visited by a journalist of a chemical industry journal and answered his questions about JANUS, and when Mr. Suzuki discovered that my interview had been published in the said journal, he became angry at me for having given the interview to the journalist without permission.

In both cases, I explained the circumstances and apologized for having acted in a rough-and-ready manner. Mr. Suzuki calmly listened to my excuses, and after that, those happenings did not affect our relationship at all.

Mr. Suzuki was born as the fourth son among eight brilliant siblings whose father was the second president of "Ajinomoto (currently Ajinomoto Co., Inc.)." He graduated from the old First Higher School, and after graduating from the Faculty of Law at Tokyo University, he entered the Ministry of Commerce and Industry (current Ministry of Economy, Trade, and Industry) and worked as the Director of Heavy Industry. After that, he moved to the Export-Import Bank of Japan, and during his tenure as its Senior Director, he entered JGC as its vice president at the solicitation of President Masao Saneyoshi, who was his relative by marriage and the founder of JGC.

In this way, he was a gifted person who continued walking the elite career track, but not bragging about it at all, he was modest and full of humanity. I often accompanied him to "Nakagawa" in Akasaka, which he frequently used to treat internal and external clients, and I was able to get to know his humanity. I also learned about his connoisseur-favorite "Penthouse" - The International Magazine for Men, for the first time when I accompanied him to the U.S.

I think I was supremely happy to have had an opportunity to interact with such an excellent person and learn from him.

* The text is as written originally by Former President Sakakihara at our request around 2002 on recounting his memories at the company establishment.

IV

Solving the issues of energy, environment, and humans

1991–2000

Great change of the management system and transfer of the head office to Tamachi

In 1993, Eiji Watanabe, who was the president of JGC at that time, took office as the Representative Director and President and Chairman of our company, and Sakakihara supported the management as a full-time advisor. While maintaining the features of high neutrality and independence that were built by Sakakihara, the path to the cooperation with JGC widened little by little from here.

In 1993, the head office was transferred to the vicinity of JR Tamachi Station (Kaigan, Minato-ku, Tokyo) to reunify the Environmental Business Division. This transfer was not only to secure a space for the continuously increasing number of personnel, but also to set up an environment that would enable taking on the challenge of anew field which was the cross-cutting business project between the nuclear energy and environmental fields.

In 1996, Eiji Watanabe, who was the Representative Director and President of JGC, took office as the Chairman and Member of the Board (additional post), and Akio Okagami, who retired as the Executive Managing Director at JGC, took office as the Representative Director and President.


LOOP-X Building, where the head office had been located (1995)


Rainbow Bridge and Odaiba seen from the head office

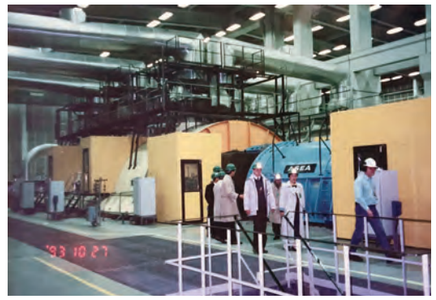
While the management system was strengthened in this way, an event affecting the organizational operation of our company occurred in September 1997. The U.S. Halliburton NUS Environment Corporation (former the U.S. NUS CORPORATION), which was the main shareholder of our company and was in a cooperative relationship mainly in the energy-related technology field, sold the energy-related business field to the U.S. Scientech, Inc. Our company immediately concluded a business partnership contract with the said company so as to be able to maintain the environment that would enable execution of the operations without change. The U.S. Halliburton NUS Environment Corporation, which held 40% of the shares of our company, transferred all the shares to JGC, and as a result, JGC held 80% of the shares of our company.

After that, since President Okagami had passed away suddenly in early 1998, Eiji Watanabe returned to the office of Representative Director and President and Chairman, and in the same year, Watanabe became the Chairman and Member of the Board again. Kosaku Ishimoto, who retired from the presidency of JGC Europe, newly took office as the Representative Director and President, and our company entered the 2000s.

Nuclear Energy Business Division

1. Increasing social interest in maintenance management of nuclear power plants

The operating nuclear power plants in Japan increased by 16 units during the decade of the 1980s. In the early 1990s, 38 units (including Fugen) operated across the country, already establishing the position as the main power source essential for the Japanese industry and citizen life. The lower accident rate in nuclear power plants in Japan attracted international attention, and the technologies were regarded as being at the world's top level. On the other hand, new issues began to arise.


Visit survey at nuclear power plant in Sweden (1993)


Visit survey at nuclear power plant in France (1993)

On February 9, 1991, one steam generator tube ruptured, automatically shutdown the nuclear reactor in Mihama Nuclear Power Station Unit 2 of KEPCO. At this time, the emergency core cooling system was actuated, which was the first case in the domestic nuclear power plants. As a result of the investigation, it was found that the metal fatigue of the tube was the cause of the fracture.

After this, interest in the maintenance and inspection of equipments of nuclear power plants increased rapidly not only among electric power companies, but also among governments and related organizations, and the media. Thus, there was a growing tendency to learn all over again from the U.S., which was the mature major nuclear power country, and the European countries which used their own technologies. To respond to this, our company planned many visit surveys of European and the U.S. nuclear power plants as part of overseas surveys, and supported the site visits of the nuclear power industry officials. Also there, our company exerted its strengths such as accumulation of information, personal connection, etc. Those strengths had been cultivated through the businesses of LIS, NUSEC, etc. handled from the establishment of our company, and were rare in other consulting companies.

In the U.S., the operating license renewal regulation was newly established in 1991 to enable the extension of the life of nuclear power plants. In response to this, our company started to conduct the survey and analysis for the trends of the NRC review related to this regulation, the industry's examination status, countermeasures against aging-related deterioration, operation experiences related to aging-related deterioration, etc. Since 1998, this has been continued up until the present day as the membership service for the operating license renewal survey (LR). While the role and the responsibility of nuclear power generation were increasing in the Japanese economy and civil society, issues and concerns about the operation and maintenance surfaced, which forced our company to take a different direction from the one we had taken in the past.

2. LIS operation corresponding to the Internet age

One event that decisively changed the subsequent world in the 1990s was the dawn of the Internet. In the field of information systems, network technologies became more important from the late 1980s. The Internet technologies that were born in that situation rapidly spread throughout the world by the Windows 95 operating system for personal computers, which appeared in 1995, enabling the search of and instant access to the information released to the public in companies, universities, research institutions, etc. throughout the world.

This was regarded as a critical situation in a sense for consulting companies like us which offers information provision services such as LIS, etc. as one of the main operations.

However, normally, the databases that have been accumulated and systematized by our company in the nuclear energy field for many years have completely different qualities from the information on the Internet, and do not compete against it. Instead, it was considered that the Internet could become a useful information tool for our company. This was because each employee of our company had extensive knowledge as an expert in a particular area. They could push their way through the information world in which there was a mixing of both the positive and the negative, and choose only the most reliable of those sources from there. Our company also launched a website for members at an early stage as the new window for arranging and providing accumulated information, and started its operation.

It is a fact that the global spread of the Internet brought the information provision service of our company to a crossroads, but we found a way to coexist with it, becoming its friend.

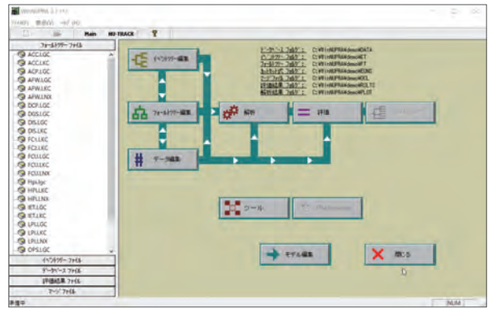
System Development Business Division

1. Positioning the System Development Business Division as the third pillar of business

The system development business of our company which was greatly developed by the introduction of the supermini in the System Development Office in 1981, steadily continued its growth after that, became independent as the departmental organization “Electric Power Engineering Group No.2” in 1990, and changed the name to the “System Development Business Division” in 1991 to be positioned as the third pillar of business along with the Nuclear Energy Business Division and the Environmental Business Division both in name and in reality.

The main projects in which the Division was engaged at that time are as follows: Reliability analysis of nuclear power plants using NUPRA (analysis evaluation tool for PRA level 1 developed by NUS CORPORATION); development of the THALES code series (the codes for analysis of thermal-hydraulic behaviors at the time of severe accidents), and analysis evaluation using them; analysis evaluation using RELAP (the code for analysis of thermal-hydraulic behaviors at the time of accidents); analysis evaluation using MACCS (the PRA level 3 analysis evaluation tool); development and installation of the systems (ACAS, AREDES) that perform the real-time emergency radiation exposure dose calculations in case of accidental atmospheric releases of radioactive materials; development of the normally released radiation exposure dose assessment system; development of the simulation tool for ocean dispersion of radionuclides, and the analysis evaluation using it, etc. These operations supported both the electric power companies promoting nuclear energy, and the regulating organizations and the research institutions supporting them.

The Division also developed the system (DRP) to support electric power companies doing the manufacturer design reviews and various other operation support systems (operation flow chart editor to support the creation and edition of the flow chart of periodical inspections, start-up/shut-down plant parameter chart editor to support the setting of the plant start-up/shut-down procedures before and after periodical inspections, etc.). In addition, the Division developed the analysis code (STAR) to simulate the amount of materials such as uranium, plutonium, waste, etc. according to the new construction schedule of nuclear power plants (including fast breeder reactors, etc.) and nuclear fuel facilities such as reprocessing facilities and interim storage facilities, etc. as well as the analysis evaluation using the code, the cost assessment (including the external cost) of power-generating plants, the analysis evaluation of air pollution due to vessel operation and its effects, etc. Around this time, our company started to enter fields other than that of nuclear energy.



Main screen of WinNUPRA31J

Meanwhile, our company also worked in the field of disposal of radioactive waste such as the spent fuels of nuclear power plants, and established a proven track record. Our company showed tenacity in the nuclear energy-related survey and analysis technologies and analysis evaluation technologies, and was expected to further strengthen the competitiveness by cooperation with JGC. Thus, in 1993, several persons from our company started to work with the software unit of JGC engaged in the disposal of radioactive waste. The cooperative relationship in this field has continued up to the present day.

2. Development of database system related to natural and social environments and the normal release radiation exposure assessment system

Here, some system developments are explained in detail.

One is the project of building and maintenance of the database system related to natural and social environments for the Institute for Environmental Sciences, which was a juridical foundation (at that time) located in Rokkasho-mura, Kamikita-gun, Aomori. This project started in 1993 and later led to the development project of the environmental transport model of environmental release radioactive materials from the nuclear facility. expected to contribute to the safety and security of local residents.

Another is the development of the normally released radiation exposure dose assessment system. Our company started to provide it to electric power companies in 1996 as a system developed from the environmental impact assessment system for radioactive materials that our company had worked on until then.

Electric power companies need to prepare an installation approval application to be submitted to the related organization to construct and operate nuclear power plants. To construct a nuclear power plant, the attached document must show the data of the environmental radioactivity exposure in the power plant site are lower than the standard values, and the normal release radiation exposure assessment system supports the analysis of such data.

The analysis targets are the data of the weather around the power plant and the data of the radiation dose obtained from the measuring equipment set up in the site. Since each power plant has a specific condition for such data, our company customized the system for delivery. Starting from the system for the Tomari Nuclear Power Station (hereafter called the “Tomari NPS”) of Hokkaido Electric Power Company, our company deployed the system successively to electric power companies in each region.

Furthermore, our company challenged the potential of various new businesses beyond the conventional frameworks. For example, our company made ambitious efforts for the semiconductor design support system and the remote sensor ground system using satellites, etc., but unfortunately, these did not take form as businesses.

Environmental Business Division

1. Increase in contracts for environmental assessment consulting

Survey of surrounding environment at the site for environmental assessment (visual investigation of terrestrial organisms in winter)

Survey of surrounding environment at the site for environmental assessment (noise level measurement of traffic with an integrating sound level meter) (2002)

The clarification of the position of environmental assessment in the Basic Environment Law enacted in 1993 helped us expand our business in this field. The Environmental Impact Assessment Act was enacted in 1997, and environmental assessment had been established as an important tool for society closely related to the industry and daily life.

In terms of our business performance, the sales increase in environmental assessment and related projects in the early 1990s was remarkable. The main factor was the rapid increase in projects of environmental surveys and environmental assessments associated with construction plans for coal-fired power plants. The issue of global warming caused by greenhouse gases was attracting attention. Therefore, it was believed that the construction of coal-fired power plants would not be approved in Japan after 2000. Consequently, all electric power companies rushed into announcing plans to build large-scale thermal power plants one after another.

2. Growth of fishery compensation consultation

Regarding the fishery compensation consultation that we had been working on since the 1970s, projects related to electric power companies and the Ministry of Construction (at that time) were expanded, such as the output enhancement of power plants and the construction of bypass road bridges on the coastline. Since 1995, we have conducted calculations of fishery compensation amounts and negotiations for compensation for various projects such as the construction of long span bridges of the Second Meishin Expressway that straddle the Kiso, Ibi, and Nagara rivers, the Kita Chiba water conveyance, and sea route of the entrance of Tokyo Bay.

Seaweed (Japanese Nori) farming equipment within expected impact area (1999)

3. Addressing new challenges for the relationship between humans and the environment

In the 1990s, the concept that precautionary measures should be taken even if a scientific cause-and-effect relationship is not sufficiently proven spread mainly in Europe and the U.S. This “precautionary principal” was applied especially for the case such as chemical substances that diffuse into the environment and genetic modification, where they could have a significant and irreversible impact on human health and ecosystems. The Environment Agency showed strong interest in this movement, and they started commissioning more projects to us, such as initial environmental risk assessment of chemical substances.

In addition, we started global environment consulting such as the development of methodology for impact assessment of ocean dumping of CO_2, air pollution analysis from ship operation, and basic surveys of marine environments from the first half of 1990. Furthermore, projects related to facilities that use sea water, such as nuclear power plants, and measures against fouling organisms adhered to ships and marine structures, also started in the 1990s.

As mentioned above, the expansion of business in various fields centered on environmental assessment, fishery compensation, and approaches addressing other new environmental issues greatly contributed to our business performance, and in 1994, our annual sales reached 4 billion yen.

However, in the latter half of the 1990s, environmental assessments related to power plants decreased sharply, and then, as if replacing them, large-scale projects including marine monitoring surveys commissioned by the Environment Agency became the main work of the Environmental Business Division. While the commissioned work from the Environment Agency had been continued, albeit on a small scale, since the early 1980s when the thermal effluent related projects started, we took forward the next step. We just invited Dr. Makoto Shimizu as a technical advisor in 1996, a professor of the Faculty of Agriculture of the University of Tokyo. And then we expanded our business fields such as global environment (e.g., marine environments), chemical substances management, and environmental assessment, with the guidance of Dr. Shimizu. So that the scale of our business had grown rapidly since the latter half of the 1990s.

4. Demonstrated strengths in fishery resource surveys

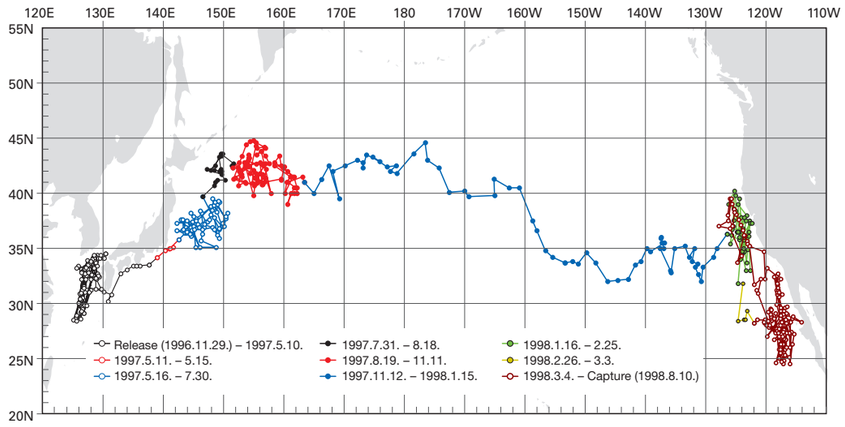
We have accumulated many achievements as an environmental consulting firm with strength in fishery resource analysis since the 1980s, under the guidance of our technical advisor, Dr. Doi. In 1996, Mr. Kume was newly invited as a technical advisor. He was a researcher engaged in tuna research for many years at the National Research Institute of Far Seas Fisheries (at that time) and also active in international fishery management organizations. With the guidance of Mr. Kume, we were able to open up a new business area in global tuna resource analysis.

Tuna is a large, open-ocean, and migratory fish that is known to inhabit tropical and temperate waters worldwide. However, it was not well understood where tuna actually swim and how the fishing grounds were formed. The Commonwealth Scientific and Industrial Research Organization (CSIRO) started a survey of southern bluefin tuna using a tool called “Archival Tag” that can be attached to the body of tuna to collect various data.

Bluefin tuna with an Archival Tag

A plan to grasp the population distribution of young bluefin tuna launched in Japan, and we were commissioned by the Fisheries Agency to conduct a survey of bluefin tuna stocks using Archival Tags. We could track the behavior of bluefin tuna worldwide by analyzing data from Archival

Tags. For example, it made it easy to predict the stock size for the next fiscal year because it was possible to roughly grasp the marine environment in which overwintering ground for young bluefin tuna (0 to 1 year old) was formed.



Track of a young Pacific bluefin tuna that traversed the Pacific Ocean, estimated with an Archival Tag.(Source: Itoh T. *et al*. Fish. Bull. 101:514–534, 2003)

As mentioned above, we have accumulated knowhow on fish resource surveys and analysis as part of the impact assessment for cooling water intake and discharge from power plants since the 1970s. We were engaged in a wide range of fish catch surveys and resource analyses of the coastal fisheries, making use of our knowhow even in the 1990s. Although we collected fish catch data from fishery experimental stations and fish markets nationwide, we went directly to survey areas such as Nagasaki Prefecture where the catch of small bluefin tuna was particularly high. Because there are many remote islands in Nagasaki Prefecture, we set up bases in those places to visit every year and collect data. Our persistent effort on research and analyses like these has led to our strength in the environmental consulting business.

5. Participation in conferences of international environmental treaties

In the 1990s, many global environmental issues caused by human activities became more apparent and at another level from the pollution problems that used to occur in limited areas and industries. For example, we conducted a survey on the distribution of plastic waste drifting offshore in the latter half of the 1990s, but it evolved into the investigation of the actual state of marine litter, which became a major social problem in the 2000s.

Multilateral cooperation including treaties is indispensable as a measure for global environmental issues. We have started providing support for the Japanese government delegates attending international environmental treaties with the knowledge and information on various environmental issues that we have acquired. The beginning was attendance at the London Convention[2] (Protocol adopted in 1996), which was entrusted by the Environment Agency in 1996. This Convention is a treaty that regulates and manages the dumping of waste generated on land into the ocean, and deals with the entire marine environment from the coast to the deep offshore, which is our field of expertise.

2) 1972 Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter

This work can be summarized into the following three points.

(1) Reading the documents submitted by each country and considering the content of comments that the Japanese delegates make at the meeting.
(2) Considering answers to the questions the Japanese delegates received at the meeting, if necessary.
(3) Support in reflecting on what has been decided by the international treaty, based on the outcomes of the meeting.

Consultative Meeting of Contracting Parties to the London Convention at the headquarters of the International Maritime Organization (IMO) in London (2009)

In addition to the London Convention, we were also involved with other treaties, including the MARPOL Convention (Protocol adopted in 1978)[3] to prepare various documents (regarding antifouling paint for ships, emissions from ships [NOx, SOx, CO_2] and ballast water) for submission to the IMO's Marine Environment Protection Committee (MEPC), the POPs Convention (adopted in 2001)[4] in relation to hazardous chemical substances, and the Washington Convention (adopted in 1973)[5] in relation to wildlife conservation. These have become very long-term jobs and are still ongoing.

6. Earnest expansion into overseas markets

Our efforts to expand into overseas markets, which began in 1985, started to show progress in the 1990s. Participation in projects of the Japan International Cooperation Agency (JICA) was one of them. We have continued to receive orders to conduct environmental assessments for site selection of overseas power plant since 1991. Starting with the Oltu River Hydroelectric Power Development Project in the Republic of Turkey, we carried out projects in the Republic of Indonesia, the Democratic Republic of São Tomé and Príncipe, and the Republic of Cameroon. In 1998, the coastal fishery resource evaluation (dispatch of expert) expanded projects with JICA to the fisheries field, which later bore fruit in the form of projects such as fishing ground development and fishery resource surveys.

Overall, the 1990s was a major turning point for our Environmental Business Division. The sales structure has changed significantly due to the sharp increase in chemicals and global environment related projects and the significant decrease in electric power company related projects, which had been the main driver until then. It set a clear path as an environmental consulting firm, although it was accompanied by a great deal of pain.

3) The Protocol of 1978 relating to the International Convention for the prevention of pollution from ships, 1973
4) The Stockholm Convention on Persistent Organic Pollutants (POPs)
5) The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

V

Adopting a global environment perspective 2001–2010

Great change of the management system

The 2000s was a time of great change for the management system of our company. In 2002, Yoshizo Fukuda took office as the Chairman and Member of the Board, and Masataka Kotake assumed the role of Representative Director and President. In 2003, Yutaka Kono took office as the Representative Director and President (Fukuda remained as the Chairman and Member of the Board.) And in 2009, Yukio Kishimoto, who was part of the top management team of the Environmental Business Division took office as the Representative Director and President. A dyed-in-the-wool employee became the president for the first time since the establishment of our company.

Nuclear Energy Business Division

1. Increasing interest in review of the nuclear power plant inspection system

Regarding nuclear power plants in Japan, 12 units newly started the operation in the 1990s, but only 5 units were newly constructed in the 2000s. Since Tomari NPS Unit 3 started the operation in 2009, no other nuclear power plants have newly started the operation.

Looking at the existing nuclear power plants, Hamaoka Nuclear Power Station Unit 1 (the operation started in 1976) and Unit 2 (the operation started in 1978) of Chubu EPCO ended the operation on January 30, 2009. The company judged that there was no choice but to decommission the units, given the economic burdens of improving earthquake resistance and addressing aging-related deterioration, etc. required to maintain safety for aged facilities of more than 30 years from their construction.

Meanwhile, the review of the inspection system in nuclear facilities became a large issue following the leakage of coolant (metallic sodium) of the Prototype Fast Breeder Reactor "Monju" and the subsequent fire accident in 1995, as well as the criticality accident that occurred in the nuclear fuel fabrication facility of Tokai-mura JCO in 1999, etc. In the U.S., the new inspection system by NRC was started in 2000, and electric power companies and regulatory authorities became more interested in developing an optimum inspection method.

2. Expanding the information provision for nuclear energy regulations

While the market environment was such that no nuclear power plant was newly constructed and decommissioning was started for existing reactors in Japan, the business related to the nuclear power generation of our company received more orders mainly for survey from organizations related to government offices such as the Japan Nuclear Energy Safety Organization (formerly; hereafter called "JNES"), which was established in 2003, in tandem with the regulation rationalization of nuclear power plants.

JNES conducted operations for the "inspection related to nuclear facilities and reactor facilities," "analysis and evaluation of safety for design of nuclear facilities and reactor facilities," "prevention of nuclear disasters, prevention of their expansion, and recovery," etc. in order to develop the infrastructure for securing nuclear safety. Our company accepted the order from JNES for the survey for the overseas nuclear safety review information with the approval of electric power companies. Taking this opportunity, our company received more orders to provide information to the nuclear regulatory side.

3. Utilization of the information network that had been established

Japanese regulatory agencies and electric power companies began to require more detailed and timely information on the nuclear safety regulations. Our company had conducted overseas visit surveys (regulatory agencies, nuclear operators, power plants, etc.) to check the reality in more detail based on public information surveys until then, but also started to invite experts from overseas and hold meetings. The trigger was the synchronized terrorist attack that occurred in the U.S. on September 11, 2011.

Overseas visit surveys became difficult because the Japanese government imposed a voluntary ban on traveling overseas, but the U.S. did not put a limitation on traveling to Japan, so our company asked the experts who lived in the U.S. to visit Japan. After that, our company also started to invite experts from Europe. In this way, our company was able to provide more diverse services such as inviting experts who conducted inspections at overseas nuclear power plants to deliver lectures and reporting the matters about the inspections conducted in Japanese nuclear power plants identified through the eyes of the persons with the experience as overseas inspectors. By providing the service of inviting overseas experts to various clients, our company was able to make more effective use of the information network that had been established by our company not only with the U.S., but also on a global scale.

As a voluntary project, our company also held the maintenance optimization seminars for power plants (annually; continued from 2001 to 2010). Our company invited one nuclear energy consultant and two nuclear power plant engineers as lecturers from the U.S. to hold the seminars on maintenance technologies that would improve the operating performance of power plants, for the persons related to nuclear power plants in Japan.

For other topics related to the nuclear energy business, our company accepted the order for the project related to the nuclear fuel reprocessing plant in Rokkasho-mura in 2006, and prepared the standards for closure of the repository for low-level radioactive waste, etc. As a new business, our company started the "social science consulting-related business" and received orders from electric power companies for the surveys on the nuclear energy trends in the electric power market deregulation environments in Europe and the U.S.

System Development Business Division

1. Version upgrade of the emergency environmental impact evaluation system

The development of the accidental exposure assessment system related to nuclear power plants that was started by our company under research financed jointly by electric power companies in the early 1980s following the TMI accident evolved into the emergency environmental impact evaluation system

(ACAS) in the 1980s, which was introduced successively to nuclear power plants across the country.

This result led to the next challenge of the System Development Business Division of our company. ACAS performs 2D simulations of the dispersion of radioactive materials released into the atmosphere from a nuclear power plant, and our company started to develop AREDES, which could perform more accurate 3D simulations. In the 1990s, the operation of the introduction of AREDES to nuclear power stations across the country was started, recording the surprising result that ACAS and AREDES were introduced to all of the NPSs.

The emergency environmental impact evaluation system for nuclear power plants is customized for each power plant. This is because the geographical and weather conditions around each power plant are different. In a normal time, the system performs online monitoring of the weather observation data and the values of environmental radioactivity measured in the site, and when it detects an abnormal value of the environmental radioactivity, it starts the calculation immediately. To assess the effects (radiation exposure dose) on the surrounding of the power plant, it quickly checks various weather conditions such as the wind direction, wind speed, stability of atmosphere, rainfall, etc., analyzes those data, and simulates how the radioactive materials released from the power plant disperse in the atmosphere. While ACAS performs 2D simulations, AREDES performs 3D simulations, enabling more accurate simulations. At that time, AREDES had the function approximately equal to SPEEDI (system for prediction of environmental emergency dose information) developed under the leadership of the government, but our company updated the function after the Fukushima Daiichi Accident and achieved further improvement of the performance as discussed below. This system is the fruit of the analysis evaluation technology that our company had improved continuously over the years.

System configuration of AREDES

2. System development in various fields and expansion of the analysis operation

The normally released exposure dose assessment system provided to the first electric power company in 1996 was successfully introduced to six electric power companies by the early 2000s. The following operations were also in place: exposure-related operation due to the extension plan of Tomari NPS Unit 3; operation related to the development of the SuperSTAR code, which is the evolutionary form of the fuel cycle-related material amount simulation code STAR; safety analysis due to the adoption of high burnup fuels; examination of PRA level 3 for earthquakes and internal events; safety analysis processing operation for the Fukushima Daiichi NPS; improvement and maintenance of the exposure dose assessment code of nuclear fuel reprocessing facilities, etc.

In the late 2000s, various calculation operations and assessment operations outsourced from electric power companies, and the operations outsourced from the government agencies including JNES also increased gradually. The entry into the field of radioactive waste disposal in cooperation with JGC that was started in the 1990s also began to get on track, increasing the operations to be implemented by our company.

Environmental Business Division

1. Growth in the field of chemical substance management

Since its establishment, our Environmental Business Division has been engaged in the research and investigation of marine environmental issues, particularly the impacts of cooling water intake and discharge from power plants. Since the latter half of the 1990s, understanding the actual state of trace amounts of hazardous substances in the marine environment and investigating their impacts were growing as a major pillar of our work. In 1999, just before the 21st century, we were commissioned by the Environment Agency a comprehensive study on endocrine disrupting chemicals, so-called "environmental hormones", which had become a hot topic in around world at that time. This was the consequence of solid achievements such as surveys on trace amounts of hazardous substances.

With this as a starting point, we rapidly expanded our services for chemical substance management, for example, revision of environmental quality standards for air pollutants, pre-assessment of environmental risks of chemical substances, epidemiological surveys on the effects of atmospheric particulate matter ($PM_{2.5}$) on human health, national study on children's health and the environment, and compliance with the Stockholm Convention on Persistent Organic Pollutants (POPs). In this field of work, the initial tasks were environmental pollution and biological impacts caused by trace amounts of hazardous substances in the ocean, and we proceeded mainly with the guidance of our technical advisor, Dr. Shimizu. However, since hazard assessment of chemical substances was added as a new task, we welcomed Dr. Osami Nakasugi, a former director of the Chemical Substance Environmental Risk Research Center of the National Institute for Environmental Studies, as a technical advisor in 2004 to improve our technical capabilities and develop human resources in this field.

2. Efforts to address environmental issues attracted attention from overseas

Our specialty has been targeted at the atmosphere and water bodies, such as simulation of atmospheric diffusion of radioactive substances and surveys of tuna resources. Since the 1990s, our Environmental Business Division has been actively utilizing such knowhow not only in Japan but also overseas. In the 2000s, our efforts in the environmental field started to attract attention from overseas.

In 2003, we received an order from an overseas company for a site assessment related to soil pollution within Japan. The problem of soil pollution began to be highlighted in Japan from around 2002. We had been participating in investigations into soil and groundwater pollution. At that time, investment from overseas to domestic facilities became active and, accordingly, we started receiving orders for site assessments as part of environmental consideration (due diligence) from overseas companies.

3. Research activities on increasing overseas projects

In 2005, we were commissioned by the Japan Bank for International Cooperation (JBIC) to examine environmental considerations on the nuclear fuel cycle from uranium mine development to uranium enrichment. The number of projects commissioned by financial institutions related to overseas projects increased thereafter. Financial institutions such as banks and insurance companies were in need of outsourcing for "confirmation of environmental and social considerations" to ensure that project proponents have applied appropriate considerations to the local environment and society in the process


Surrounded by local children during noise level measurements in Bangladesh (2008)

of reviewing loan and insurance contracts for overseas projects. It was a project that could demonstrate our full potential.

In 2006, we received an order from the Nippon Export and Investment Insurance (NEXI) for an environmental review project for the world's largest nickel mine (Ambatovy) in Madagascar. Our employees visited the site and ensured environmental and social considerations by conducting hearings with project proponents and the government agency in Madagascar involved in the permit process.

During this period, the number of environmental assessment projects for site selection of JICA's overseas power plants increased again, mainly in countries such as Bangladesh and Uzbekistan. Since we are familiar with the content of such reviews, we have started to accept orders to support application processes for project proponents, including trading companies and electric power companies as long as there is no conflict of interest.

4. Started investigation to address the issue of marine litter

"The air cannot be divided." "Earth is the Water Planet."

Ideas like these suggest that environmental issues should be viewed from a broader perspective of the global scale environment, transcending national and regional boundaries. One such environmental issue that has become a global problem in recent years is marine plastics pollution. As a pioneer, we started providing various consulting services on "marine litter" (drifting and drifted marine litter) since 2006.


Setting up frames for survey of objects washed up on the beach
(Source: Model Survey on Measures for Reducing Domestic Marine Litter, Material for the 6th Regional Study Group in Ishikawa Prefecture, February 9, 2009, Ishikawa Prefecture)


Example of analysis of some marine litter on the beach
(Source: FY2014 Report of Comprehensive Study on Measures against Marine Litter, March 2015, JAPAN NUS Co., Ltd.)

The main effort was to investigate the actual state of marine litter accumulated on coasts and seabeds. In addition, we prepared a manual for the collection and disposal of marine debris, investigated and examined countermeasures for hazardous substances contained in marine litter and recycling, and created a cooperative scheme for local stakeholders for collection and disposal, as support for formulation of a regional plan for addressing marine litter to be established by local governments. In order to solve the issue of marine litter, it is necessary to raise public awareness of the issue. We created teaching materials for environmental education and dissemination, implemented environmental education targeting a wide range of age groups, fostered human resources responsible for marine litter countermeasures, held workshops, and conducted exchange programs for the purpose of cooperation with overseas organizations.

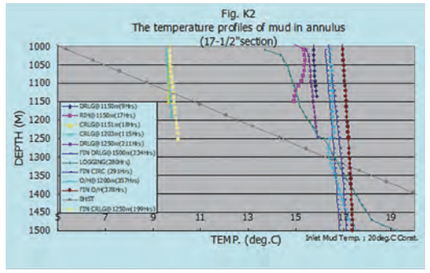
Furthermore, since we had a track record of marine environment surveys and ocean simulations related to ocean dumping of waste, we were given the mission of grasping the drift routes of PET bottles in the ocean. We made epoch-making efforts at that time, such as grasping the actual state of drifting waste using tagged bottles made of biodegradable plastic and acquiring positioning data from moment to moment using a testing bottle equipped with a mobile phone. In 2010, a fixed camera was installed on a beach to monitor changes over time in marine litter that drifted ashore.

5. Initiative for environmental impact assessment of methane hydrate

Throughout the 2000s, our Environmental Business Division gradually expanded its area of business. In the field of marine environments, we expanded from coastal to offshore and deep sea. The environmental impact assessment of methane hydrate, which we have been working on since 2010, is one of them.

Methane hydrate is a crystalline solid that consists of methane and water, and is present in large quantities in deep-sea sediment where a low temperature and high pressure environment is maintained. Methane hydrate is also called "burning ice" because methane burns and only water remains when it is brought close to a fire, and it is expected to be used as a new energy resource.

During drilling of methane hydrate, it was expected that a large amount of sediment on the seabed would be suspended in the deep sea area. To understand how sediment diffuses and settles, how it affects the surrounding environment and ecosystem when turbidity occurs near the seabed, and how the turbid water released during the mining process diffuses into the ocean, our System Development Business Division conducted an environmental impact assessment using a diffusion simulation. Taking advantage of our experience in methane hydrate project, we were also involved in the environmental impact assessment for the development of hydrothermal deposits, which is a deep-sea mineral resource, in the 2010s.



Simulation results of underground muddy water temperature during drilling in the methane hydrate bearing zone
(Source: Kawamura K. *et al.* Journal of the Japanese Association for Petroleum Technology. Vol. 65, Issue 5, pp.391-392, 2000.)

VI

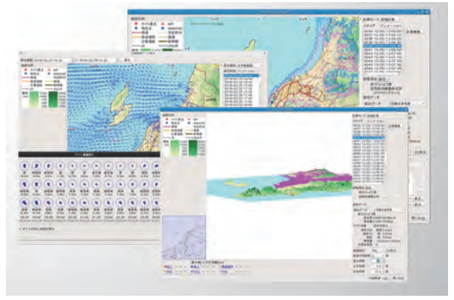
Facing the world after the Great East Japan Earthquake

2011–2020

Round-the-clock operation of the emergency environmental impact evaluation system at the time of the Great East Japan Earthquake

On March 11, 2011, the Great East Japan Earthquake occurred. Due to the influence of the tsunami damage, meltdown of the nuclear reactor was triggered by the power loss at the Fukushima Daiichi NPS of TEPCO. A large quantity of highly-concentrated radioactive materials released into the atmosphere from the power station contaminated a wide peripheral area. This accident became an opportunity for our company to unite the Nuclear Energy Business Division, the Environmental Business Division, and the System Development Business Division to address the same issue.

In the chaos that immediately followed the earthquake disaster, the enormous amount of information related to nuclear safety in Europe and the U.S. that had been accumulated through LIS / US SARP / NUSEC was fully exploited to deal with the accident. The emergency environmental impact evaluation system, which performs 3D simulations of the atmospheric dispersion of radioactive materials released into the atmosphere, had been introduced in the Fukushima site and the Head Office of TEPCO, but neither the radiation monitor data nor the weather observation data of the site were input into the system due to the power loss of the site. However, the system was operated round-the-clock through the support of the employees of our company, using the separately obtained weather data. The system with the performance upgraded by improving the weather prediction accuracy and the usability after the accident has begun to be introduced in nuclear power plants across the country.



Example of display screen of nuclear power plant surrounding dose prediction assessment system

Undertaking the one-stop operation related to interim storage facilities

The radioactive materials dispersed into the atmosphere due to the accident descended to the ground and contaminated the soil. The contaminated soil was removed for environmental restoration and was transported to the interim storage facilities for temporary storage. For the construction of the interim storage facilities, there were two points that had to be considered from the environmental and safety aspects: the environmental assessment associated with development activities, and the radiation effect assessment among the items of the safety assessment of the facilities. These assessments are generally entrusted to separate experts, but with the Environmental Business Division for the environmental assessment and the Nuclear Energy Business Division for the radiation effect assessment, our company was able to receive orders for the one-stop operation for impact assessments.

In this way, our company applied all its extensive human resources, information, knowledge and experience of nuclear energy, environment, and system to effectively perform business related to the Fukushima Daiichi Accident.

Survey of air quality with protective wear in Fukushima (2014)

Nuclear Energy Business Division

1. Action for the world's strictest nuclear safety regulatory standards

Following the Fukushima Daiichi Accident, the nuclear regulation system of our country was pressed for a fundamental review. The need for survey and analysis of overseas information supporting the system increased, and our company accurately responded to those needs to contribute to the world's strictest nuclear safety regulations and the action for them.

The Japanese regulatory authorities aimed at a higher level according to the nuclear safety regulations in the U.S. and Europe. They intended to adopt all the good aspects of the nuclear safety measures in Europe and the U.S. into the domestic regulations. The abundant overseas information held by our company responded to the needs for action for these new regulatory standards.

After the Fukushima Daiichi Accident, overseas nuclear power plants started to add further safety improvements. Therefore, Japanese electric power companies needed to visit overseas nuclear power plants to compare the safety measures between Japanese power plants and overseas power plants as a so-called benchmark. This is because such practice (practical method) can only be obtained on site. For this purpose, our company conducted more visit surveys at nuclear power plants in Europe and the U.S. Our company also held seminars inviting overseas experts more actively than before.

Workshop inviting IAEA experts for LR (2013)

2. Activity for the restart of nuclear power plants while securing safety

Following the Fukushima Daiichi Accident, all nuclear power plants in Japan stopped operation in 2011.

In such a situation, the new Strategic Energy Plan established by the government in 2014 positioned nuclear power generation as the "important baseload power source" once more from the perspectives of energy security, global warming countermeasures, and appropriate electricity price, etc. assuming that safety was ensured, and indicated the direction for maximum introduction of renewable energy.

Meanwhile, the electric power system reform led by the government such as the company split-up of local electric power companies, full liberalization of electricity retail business, abolition of the total cost method, etc. also progressed. Therefore, it was predicted that the environment surrounding the electric power market would change significantly.

While focusing on such a trend, the Nuclear Energy Business Division supported the safety improvement for the restart of nuclear power plants by responding to the needs for action against severe accidents, PRA, and sophisticated survey, analysis, and evaluation related to the review of emergency preparedness that had increased after the Fukushima Daiichi Accident. In 2015, Sendai Nuclear Power Station Unit 1 was restarted for the first time since the new nuclear regulatory standards became effective, and after that, nine units across the country were restarted by 2019.

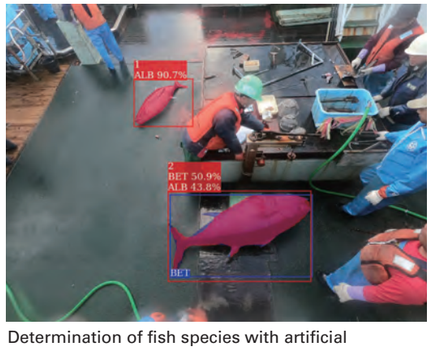
System Development Business Division

1. Expansion from radioactive waste disposal to other fields

Through cooperation with JGC that started in the latter half of the 1990s, our company was able to deepen its knowledge about radioactive waste disposal and also to experience various analysis operations such as the heat analysis of waste disposal containers in repositories, simulation of solidification mixing radioactive waste and mortar, detonation analysis in disposal containers, etc., successfully expanding the technological area of analysis operations. This changed the consciousness of our company to consider not only the analysis related to radioactive materials, but also the application of the technologies that had been cultivated until then to fields other than that of nuclear energy.

2. Deployment of IT solutions

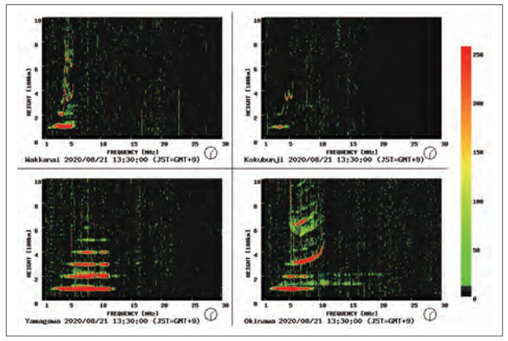
The System Development Business Division had conventionally been strong in the nuclear energy-related analysis evaluation system, but greatly changed its focus on the fields to be managed in the 2010s. The Division accepted excellent system engineers (SE) from the cooperating company which had been in charge of the system building operation for many years, and took over the projects for which the system engineers had been engaged in the development. The Division have been developing the following systems: the ship collision avoidance system (ship operation simulator), integrated database system for notice to mariners, navigational warnings issuance system, etc. for the Japan Coast Guard and National Maritime Research Institute; the real-time ionospheric observation system for the National Institute of Information and Communications Technology; and the fish species determination and fish size estimation analysis system using artificial intelligence (AI) for the Japan Fisheries Research and Education Agency.



Determination of fish species with artificial intelligence

In 2018, some employees were appointed to work at the Yokohama Office of our company, which was established in JGC, and developed the plant failure predictive diagnosis system (P-SADS) through further cooperation with JGC. Our company is also working on the development of the system with VR (virtual reality) technology and MR (mixed reality) technology incorporated in P-SADS, and is continuing to grow to contribute to the construction of plants and various sales and marketing scenes of JGC.


Ship movement prediction result



Ionospheric observation data

Environmental Business Division

1. Initial response to the Fukushima Daiichi accident

The initial response of our Environmental Business Division after the Great East Japan Earthquake and the Fukushima Daiichi NPS accident (the Fukushima Daiichi accident) was by no means faster than that of other companies. We spent several months exploring how we could contribute, making business proposals and holding study groups with clients. The first participation into the reconstruction project was in May 2011 to draft an emergency monitoring plan for the sea area around the Fukushima Daiichi based on the accident. It wasn't until September that the number of projects increased. Many of the contracts were from the Ministry of the Environment, which became deeply involved in the response to the earthquake and nuclear power plant accident, and it mainly tackled the following challenges.

– Examination of the recycling of automobiles damaged by the nuclear power plant accident

For the purpose of recycling automobiles damaged by the Fukushima Daiichi accident, we conducted a risk assessment of radioactive substances for workers and utilization of recycled materials.

– Supporting a committee of the Ministry of the Environment that established implementation policies for decontamination and others

The Ministry of the Environment needed to immediately consider the standards and methods for decontamination of soil contaminated with radioactive substances. As a consulting firm specialized in both fields of nuclear power and the environment, we supported administration of the Investigative Committee on Remediation.

2. Full-fledged support for environmental remediation in the disaster-affected area of Fukushima Prefecture

At that time, construction and environmental consulting companies were providing manpower mainly to tsunami-stricken areas such as Iwate and Miyagi Prefectures. However, since we are a consulting firm specialized in the fields of nuclear power and the environment, we organized a Reconstruction Project Team for Fukushima within the Environmental Business Division with the aim of contributing to

society by responding to the Fukushima Daiichi accident. In January 2012, we opened the Fukushima Office near JR Fukushima Station as a base for activities in Fukushima and participated in earnest in the activities for environmental remediation. The Ministry of the Environment was promoting the restoration of Fukushima centered on the implementation of decontamination and the construction of interim storage facilities. We took part in various large-scale projects in relation to the action of the Ministry of the Environment and played a role in the environmental remediation of Fukushima. The environmental surveys and environmental assessments related to the interim storage facilities mentioned above was one of them.

In 2014, we upgraded the Reconstruction Project "Team" for Fukushima to a "Unit" that is our organizational unit, and opened a new Fukushima Hamadori office (Iwaki City, upgraded to larger office in 2019). A structure to pursue projects for Fukushima has been set up with a unit within the head office and two local offices in Fukushima Prefecture. We invited Dr. Shigeo Uchida from the National Institutes for Quantum and Radiological Science and Technology as a technical advisor to strengthen the technical aspects of these projects in Fukushima.

It seems that Fukushima Prefecture is finally transitioning from the stage of restoration and reconstruction to the stage of revitalization of local people's lives and industries after finishing decontamination. Our Reconstruction Project Unit for Fukushima will continue to contribute to the recovery of the environment in Fukushima Prefecture by properly carrying out the tasks we've worked on since 2011, and will further carry out activities to revitalize local people's lives and industries in Fukushima.

3. Aiming to contribute to environmental conservation in Asian countries

Even in China and Southeast Asian countries, where environmental pollution is becoming serious, effective legislation and its implementation finally began in earnest in the 2010s, and awareness of environmental conservation is gradually spreading. Based on such background, we started gathering information from Southeast Asian countries in 2013 for developing new business opportunities overseas. Considering factors such as the emergence of environmental problems, potential market size, competition, barriers to entry for foreign capital, and local business experience, Vietnam was selected as the target country for market entry, and we started market research and networking. In 2015, we opened a representative office in Hanoi as our first base overseas. Using this as a foothold, we are taking on the challenge of developing new business opportunities not only in Vietnam but also in other Southeast Asian countries, and are promoting the development of overseas markets centered on environmental consulting and export of environment-related materials.

In 2018, we established a local subsidiary, JNK Environmental Research & Consulting Co., Ltd., in Vietnam together with KANSO Co., Ltd. (currently KANSO Technos Co., Ltd.), a group company of KEPCO to further develop activities. We welcomed Dr. Koji Arizono, a specially appointed professor from the Graduate School of Pharmaceutical Sciences, Kumamoto University, as a technical advisor. He is specialized in chemical pollution in Asian countries and has been active for many years in the study group for endocrine disruptors by the Ministry of the Environment. He provided us with support for the formation of our overseas projects, which boosted our overseas expansion.

The first environmental survey commissioned from a Vietnamese company (2015)

Work scene at JNK office (2020)

4. Expanding our business area to protect the earth from environmental pollution

In 2016, international efforts in the field of global environmental protection entered a new phase. The Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) entered into force, and approaches to reduce greenhouse gas emissions have begun in earnest involving countries that emit large amounts of CO_2 as well as emerging countries. Furthermore, the UN's "Sustainable Development Goals" (SDGs) and ESG investment (environmental, social, and corporate governance investment) expanded rapidly, and the global trend toward a low carbon society and the introduction of renewable energy have also been accelerated. Global environmental issues are often represented by global warming caused by greenhouse gases, but there is actually the more classic case of global pollution by plastics and persistent toxic substances in the ocean where everything is connected.

In light of these circumstances, we are putting our efforts into the examination of carbon capture, utilization and storage (CCUS) technology, adaptation to climate change, marine plastics pollution, and environmental assessments for development of marine mineral resources. Regarding CCUS, we have created content called "JANUS CCUS News" on our website, and we disseminate information related to CCUS around the world that is in the news almost every day. In 2009, we welcomed Dr. Makoto Akai, a leading expert in the field of CCUS at the National Institute of Advanced Industrial Science and Technology (AIST) (at that time), as a technical advisor. In 2020, we also invited Dr. Toshifumi Matsuoka, a former chairman of the Fukada Geological Institute, as a technical advisor. He is a leading expert in the field of geology and geological formation and familiar with CCUS. Now, we can continue to strengthen technological capability and appropriate performance in the field of CCUS. Moreover, in 2018, we welcomed Dr. Yoshihisa Shirayama, a former Executive Director of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and a leading expert in deep-sea ecosystem research, as a technical advisor, and we are trying to improve our technological capability in the field of marine ecosystems, including the deep-sea environments.

We continue to take on challenges both in Japan and overseas with the aim of establishing a non-labor-intensive business that is different from existing businesses, with a focus on the development of renewable energy power generation within Japan. We are also working to contribute to initiatives by manufacturers and users in the fields of climate change, and marine plastics pollution and recycling systems for plastics, which are expected to expand in Japan as well as overseas.

In Conclusion

Toward solving a trilemma

We will further strengthen collaboration as a member of JGC Group and continue to take on bold challenges without resting on our laurels of present accomplishments.

Our Nuclear Energy Business Division aims to expand new business fields to fulfill the advanced and increasing needs related to decommissioning of nuclear power plants. In view of the global energy supply and demand balance, the need for nuclear power generation is expected to increase, especially in emerging countries, in the medium to long term perspective. Although we have participated in new construction support business in the Middle East and Europe as a member of the JGC Group to accumulate experiences in overseas projects, we continue to reinforce the foundation for developing the nuclear power business overseas in the future. We will further grow into an "Energy Business Division" for a new era focusing on measures against global warming by going beyond the field of nuclear power, collaborating with the Environmental Business Division, and expanding into the renewable energy field.

Our analysis technology in the System Development Business Division has already crossed the field of nuclear power and begun rising to the challenges of new fields. The modern society represented by terms such as artificial intelligence (AI) and digital transformation (DX) has just entered the phase where our system development capability is fully utilized. Our System Development Business Division will definitely contribute to the creation of a "new JANUS" consulting not only on nuclear power and the environment but expanding our business domain in various directions.

The world will change drastically toward 2050 which is the target year of the Paris Agreement on Climate Change and 2030 for the SDGs. Issues of the global environment and climate change are at the core of this change, and in the fall of 2020, Japan announced worldwide the goal of realizing a carbon-neutral and decarbonized society in 2050. Business related to global environmental issues and climate change will be major pillars of JGC Group in the future. Our Environmental Business Division will continue to take on these major issues by making full use of the experience and networks we have gained over the years.

The appropriate use of nuclear energy while ensuring high level safety and promotion of renewable energy must go hand in hand for economic growth in Japan and the world with a view to the latter half of the 21st century. Contributing to clients and society while aiming to solve a "trilemma" consisting of energy supply, economic development, and environmental conservation is in line with our philosophy of energy and environmental consulting.

Our long-term strategy is "to become a consulting firm with the top technological capabilities in Asia within the field of resources and energy centered on nuclear power and the field of the environment centered on global environmental conservation". Under this strategy, JANUS is determined to make every effort to solve the global scale "trilemma" by bringing advanced consulting capabilities together in various fields and uniting as one with the JGC Group.

Afterword

The issuance of this "JANUS Trajectory of 50 Years - With the change of energy and environment" on the 50th anniversary of the establishment of our company has been made possible only through the cooperation of many people. Shortly after we started editing this booklet, the world was hit by the COVID-19 crisis, and we the Secretariat were forced to conduct face-to-face interviews and discussions while paying close attention to infection prevention, or to change the scheduled plans. In addition, it was very difficult to find the necessary information from hand-written records and hardcopy photographs/materials, which was an opportunity for us to keenly realize the importance of accumulation and storage of historical documents.

Some operations of our company have been continued since its establishment until the present day. As we read about the history, we saw the lively figures of the pioneers that had been busy since the establishment of our company come to life. They were able to solve problems through their agility and vitality to capture the trends of the time and by their technological capabilities and integrity to respond to the expectation and trust of clients. At the same time, we felt that since the "standing position" of our company founded by the pioneers was most exquisite both in the nuclear power generation field and the environmental field, their successors only had to make efforts from that already established standing position, and we could not help but develop a feeling of awe and gratitude to them once more.

We hope that on these limited pages you can feel the passion and dynamism of the pioneers and the DNA of JANUS that have been inherited by the working generations that support the present day. We also hope the employees of our company will feel pride as an employee of our company once more through this booklet and make it the source of energy to move forward into the future.

Last but not least, we would cordially like to thank everyone including the seniors that contributed to this booklet, the employees that actively cooperated with us during their busy work days, and the staff at Toyo Keizai Inc. that cooperated with us on the entire production.

January 2021

Staff at the Secretariat of the Company History Editing Committee

From the left, Masahiro Toyoda, Moeko Sakuragi, Daiki Kurita, Chie Arimatsu, Yoshitaka Ichikawa, Tomoko Tasaki, NorihisaWatanabe

JANUS Trajectory of 50 years 1971– 2021 - With the change of energy and environment

Issued in June 2021

Issued by JAPAN NUS Co., Ltd.
Nishi-Shinjuku Prime Square 5F, 7-5-25 Nishi-Shinjuku, Shinjuku-ku, Tokyo
Edited and produced by the Secretariat of the Company History Editing Committee
Daiki Kurita, Norihisa Watanabe, Moeko Sakuragi, Yoshitaka Ichikawa, Masahiro Toyoda, Tomoko Tasaki, Chie Arimatsu
Editing provided with the cooperation of TOYO KEIZAI INC
Documents provided with the cooperation of Curtiss-Wright Nuclear, Tokyo Electric Power Company Holdings, Incorporated, Naofumi Hataya

June 2021