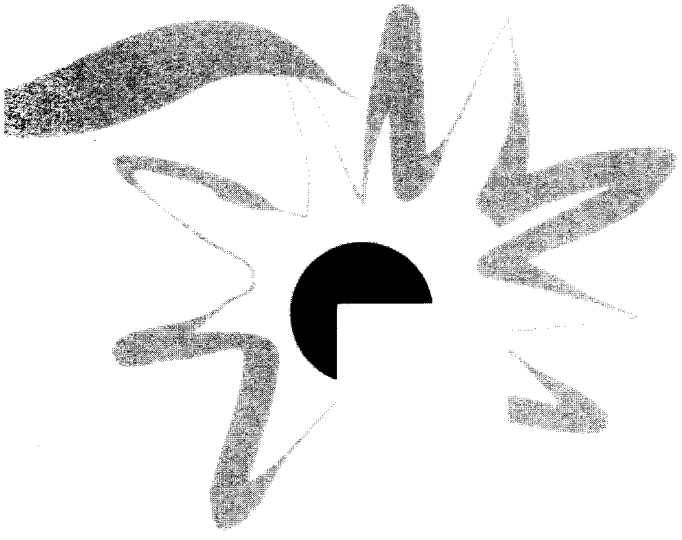

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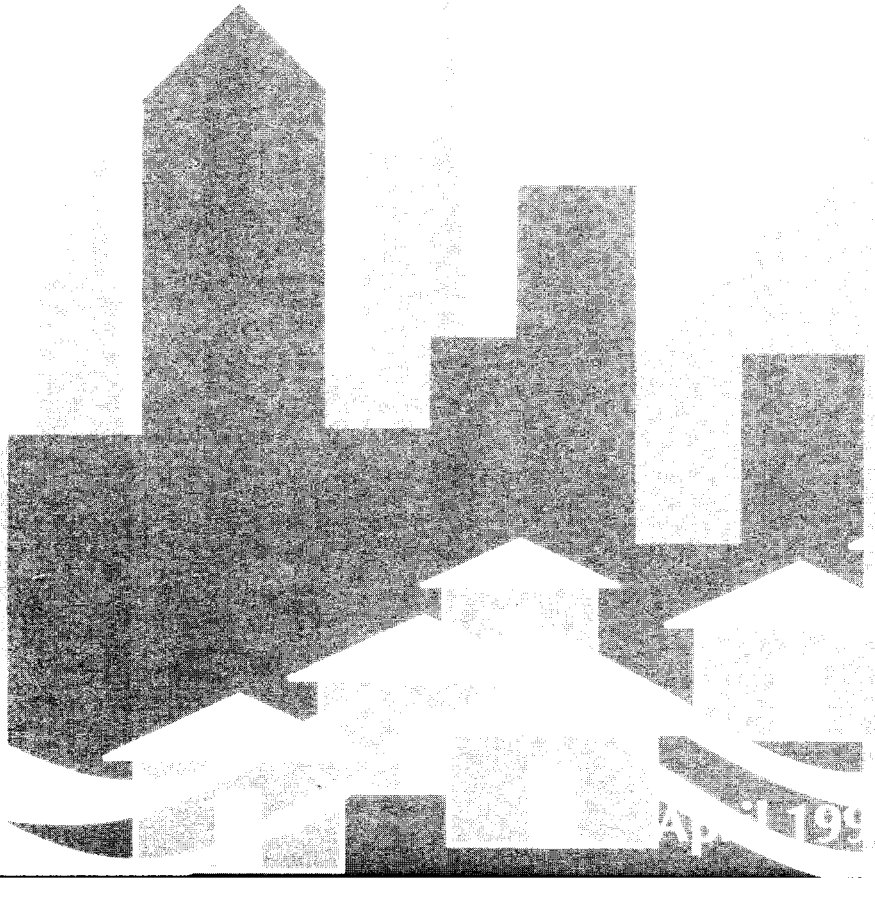

Japan's Experience in Urban Environmental Management

Kitakyushu

A Case Study

Metropolitan Environmental Improvement Program

April 1996

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MEIP: the Context for the Study

The UNDP-assisted, World Bank-executed Metropolitan Environmental Improvement Program (MEIP) began work in 1990 in five Asian metropolitan areas--Beijing, Bombay, Colombo, Jakarta, and Metro Manila. In 1993, this intercountry program began its second phase and Kathmandu joined as the sixth MEIP city. By 1996, MEIP will enter its third phase — with multi-donor assistance — and launch new programs in additional Asian cities.

MEIP's mission is to assist Asian urban areas tackle their rapidly growing environmental problems. The MEIP approach emphasizes the cross-sectoral nature of these problems and the failure of traditional, sectoral development strategies to adequately address urban environmental deterioration or the linkage between industrial and urban development.

The work program in each city is therefore guided by Steering Committees and technical working groups that reflect the cross-sectoral, interagency nature of urban environmental issues. The policy and technical committees develop Environmental Management Strategies (EMS) for their metropolitan regions; incorporate environmental considerations into the work of economic and planning agencies; contribute to the strengthening of environmental protection institutions; and identify high priority environmental investments.

The MEIP city office serves as secretariat to the Steering Committee and is managed by a local environmental professional, the National Program Coordinator (NPC). The NPC coordinates all MEIP activities and is responsible for developing the environmental network of government, private sector, non-governmental organizations (NGOs), research institutions, and communities. MEIP supports workshops, demonstration projects, and community environmental actions, and links these growing environmental network efforts with government policy and investment initiatives.

A further focus of MEIP is the exchange of experience and sharing of information among MEIP cities. This has been carried out through a series of intercountry workshops that review the city work programs, exchange useful experience, and develop intercountry projects.

MEIP has established the city programs, set in motion a variety of city subprojects, and mobilized the intercountry exchange. MEIP publications are intended to share insights and experiences developed from the MEIP process and its projects. The MEIP city programs work independently, with each other, and with international partners to reverse urban environmental degradation and provide useful and replicable lessons in urban environmental management.

MEIP and Urban Environmental Management Experience in Japan

To assist developing countries strengthening institutional capacity to control pollution and manage environmental resources, learning from countries and cities that have experienced similar problems is a particularly effective tool.

Japan has had a large measure of success in dealing with environmental problems associated with rapid industrialization and urbanization. As a developed country in Asia, its urban environmental management history affords an excellent opportunity to derive lessons and case studies.

This city case study of Kitakyushu is a companion piece and source document for the MEIP national study on Japan. In addition to the city reports on Osaka and Yokohama, MEIP has published a national report entitled, "Japan's Experience in Urban Environmental Management."

The studies undertake a detailed review of Japan's experience in urban environmental protection and clean-up. The focus was to elaborate experiences of particular relevance to MEIP cities, and to other cities in Asia and elsewhere in the developing world.

Some useful conclusions concerning the applicability of Japan's experience for developing countries can be drawn. The studies demonstrate that, while much of the technology and present management practice may not be easily transferable, the way in which Japan tackled pressing environmental problems during the 1960s and 70s is directly relevant to the environmental management challenge facing MEIP cities.

On behalf of the MEIP team, I would like to express appreciation to Shunsuke Aoyama and his colleagues at EX Corporation for their superb efforts in conducting the study. We are especially grateful to the report's principal authors: Shunsuke Aoyoma, Jeremy J. Warford, Kiichiro Sakaguchi, Nahoko Nakazawa, and Hiroshi Naito for their exacting work and careful analysis. Profound thanks are due to Professor Michio Hashimoto, Chairman, and to the other members of the Central Steering Committee, and to Mr. Y. Shiraishi, Chairman, and other members of the Kitakyushu Committee. Finally, we are indebted to the Government of Japan for the support that enabled us to undertake this project and to the unflagging efforts of Kazuhiko Takemoto of the Japan Environment Agency and of Katsunori Suzuki, our colleague at MEIP-World Bank.

David G. Williams
Program Manager

Summary of Environmental Protection Measures in Kitakyushu

Kitakyushu was born from the union on equal terms of five neighboring cities in 1963, and has developed into one of Japan's prominent heavy chemical industrial areas. The Kitakyushu area is home to many large iron and steel, chemical, ceramics, and electric power corporations. Before the Second World War, it was already a major source of air pollution and water pollution. The industrial smoke which was formerly the symbol of prosperity and called "the seven-colored smoke" was rich in dust and sulfur dioxide. Particularly after passage through the post-war reconstruction period and upon entry into the so-called high-level economic growth period of 1955-1965, air and water pollution markedly intensified. In districts surrounded by large factories involved in ceramics, chemicals, iron and steel there were many residents who suffered from the large quantities of dust fall, smoke and offensive odors. On the basis of fact-finding surveys of the damage, the residents repeatedly submitted requests to the corporations, as well as petitions to the administration for improvement. Moreover, in Dokai Bay, in the north-central part of the city and where the fish harvest had shown signs of recovery during one period after the war, fish catches dwindled to nothing from 1950 onward. This was caused by the large quantities of industrial waste water from neighboring corporations and sewage which flowed into the increasingly polluted Dokai Bay.

In response to this situation, various policies were devised in Kitakyushu. For example, the measurement of dust fall began in 1953 as a means of monitoring air pollution. Upon the birth of the city of Kitakyushu in 1963, a mature system was created by developing a pollution administration organization and establishing a Pollution Control Council. In 1967, the first Kitakyushu pollution control agreement was concluded between the city and a corporation. After the enactment of pollution-related laws by the "Pollution Diet" at the end of 1970, the pollution control policy of the city were markedly reinforced and implemented in a comprehensive, systematic and steady manner.

As a result, the air and water quality of Kitakyushu became markedly cleaner, so much so that Kitakyushu was introduced in a 1985 OECD's White Paper on the Environment as "city of gray" transformed into a "city of green." In 1987, Kitakyushu was selected as a "star light town" by the Environment Agency in view of its excellent air environment. Furthermore, the water quality of Dokai Bay greatly improved—it was confirmed that 115 species of fish inhabited its waters.

When the history of pollution control policy in Kitakyushu is reviewed, there are certain characteristic points which may be cited. First, there is the transfer of the authority of the prefectural governor to issue "smog alerts" to the city. In all Japan, this transfer of authority was made to Kitakyushu alone, and was permitted in view of the problems of distance from the city of Fukuoka which is the seat of the prefectural government. This transfer of authority to a self-governing community which was the site of pollution exerted major effects on pollution control measures. For example, it became an important factor in the development of the "Special Weather Information System" as a pollution prevention measure.

In order to understand the pollution countermeasures in the Kitakyushu area, one must consider the cooperative system of industry and government, and the existence of strong leadership in the business community which supported it. On the local level, the obligation of the local self-governing body was to seek industrial development while simultaneously protecting the health of the residents. Com-

prehensive administrative management was required to establish a balance between "industrial development" or "environmental protection". For this reason, it was indispensable to establish cooperative relations between the administration and the corporations that guaranteed implementation of the concluded pollution control agreements which were not based on laws or ordinances accompanied by strict regulations.

As the pollution countermeasures began to show their effectiveness, with the fish returning to Dokai Bay, another environmental problem arose, namely, the need to dredge the sludge containing inorganic mercury which had accumulated on the seabed of Dokai Bay. If neglected, the inorganic mercury in the sludge would become organic and be released into the seawater, whence biological accumulation in the fish would threaten the health of the citizenry by eating such fish. Thus, amid circumstances where it was difficult to scientifically estimate the degree of future organic mercury contamination and the degree of danger if the matter were neglected, the Dokai Bay dredging project commenced. This was not a policy measure based on a strict cost-benefit analysis, but rather a project executed from a risk-management perspective.

Conversely, the corporations, which followed strict local regulations, took the lead through various measures of their own, e.g., the sulfur oxide countermeasures based on the independent wind tunnel tests of the corporations. In this process, the maximum ground level concentrations to be observed by the corporations were presented by the administration, and each corporation formulated a reduction plan in its own preferred manner to develop the countermeasures. By this means, burden sharing among the various corporations was maintained, there was a large range of options in each corporation, and the persuasiveness, *vis-a-vis* the central corporate managers, was widespread—all of which contributed to the promotion of the pollution countermeasures.

Next, the pollution prevention technologies introduced by the corporations centered on cleaner production (CP) technology, with pollutant removal equipment playing a supplementary role. For example, in the iron and steel industry, such cases included the development and introduction of the precombustion desulfurization system for coke oven gas, and of the so-called OG system which conducted dust removal by a non-combustion system for converter gas. The conversion from a fuel oil single combustion system to natural gas which had no sulfur content whatsoever is another example of such technology. Thus, many of the pollution prevention technologies adopted by the corporations were low-pollution production technologies.

The Applicability of the Experiences of Kitakyushu to the Developing Countries

When applying the pollution prevention experiences of Kitakyushu to the developing countries, it is necessary to pay attention to the special social conditions in which Kitakyushu developed. The industry of Kitakyushu did not undergo the ordinary process of industrial development by passing from light industry to heavy industry, but began from the state-funded establishment of the Yawata Steel Works in a non-industrial area. In developing countries, as well, there are cases where gigantic corporations are established in areas without any industry in the form of either state-run enterprises or multinational corporations. In this case, as with the former city of Yahata, a "Castle town" is formed around this one gigantic corporation.

Yahata was succeeded by Kitakyushu, which developed as a government ordinance-designated city and which came to possess the issuance authority for smog alerts. There may be problems concerning limitations on local self-governing bodies in the developing countries regarding the transfer of authority to localities. In particular, even if there exists no authority for direct regulation of corporations by a local self-governing body as in Kitakyushu which has jurisdiction over the area in which the corporate giant is located, it can arouse the concern of the local citizenry and the mass media by issuing something similar to smog alerts, which might encourage adoption of pollution countermeasures. For this purpose, it is indispensable to build up a scientific monitoring system, conduct data collection and analysis, and train capable people to handle these matters.

With regard to the apportioning of responsibility for the pollution in Kitakyushu, in terms of the comparison of industry and domestic sources of pollution, industry played an overwhelmingly larger role. For example, considering the proportional amounts of the COD discharged into Dokai Bay, at the time more than 97% was of industrial origin. On the other hand, in the major cities of the developing countries, industry is responsible for 20-30%, while the major part of the pollution is derived from daily living. With regard to air pollution, the role of automobile exhaust gas is large, while with regard to water pollution, the sewage and refuse deriving from ordinary households and particularly from slums and squatter districts are the major factors. Concerning pollution countermeasures in such cities, even if it is an area where a gigantic corporation is located as in Kitakyushu, the experiences of Kitakyushu might not prove very useful. This is because, even if industrial pollution is overcome, there still remains the problem of the pollution deriving from urban living.

Next, we consider the introduction of low-pollution industrial technology. The introduction of terminal treatment devices for pollutants (End of Pipe, or EP technology) is expensive, but there are developing countries which are planning the development and introduction of low-priced and simplified devices which somewhat sacrifice treatment efficiency. As pollution countermeasures for existing facilities, the introduction of such EP devices may be unavoidable, but if there are factories where poor production efficiency due to deteriorated production equipment is to be improved and where the renovation of the production facilities themselves is being considered for this purpose, it may well be worthwhile to study the introduction of CP technology. The high costs of EP technology probably indicate the importance of planning and preventive measures by developing countries before the problems are too costly for them to rectify. In the case where it is planned to introduce CP technology to improve production facilities in developing countries, if an organization is established incorporating environmental ODA (Official Development Assistance) from the developed countries, a further impetus will surely be given to the introduction of CP technology in developing countries. For Japan which is a major CP technology country, and for Kitakyushu, there are not only the profits accompanying these technology exports, but also expectations for business undertakings of great advantage to both sides.

Chapter One: Profile of the City of Kitakyushu

The City of Kitakyushu

Introduction

The city of Kitakyushu was created in 1963 by merging the five neighboring cities of Moji, Kokura, Yahata, Wakamatsu, and Tobata. These cities had grown into one of the major heavy chemical industrial areas of Japan, overcoming wartime destruction, and changing the local industrial structure by converting its energy base from coal to oil. Taking advantage of its location close to the other Asian nations, the city has rapidly evolved from one based upon manufacturing to one in which tertiary industry is becoming increasingly important. In particular, it is becoming an international information center.

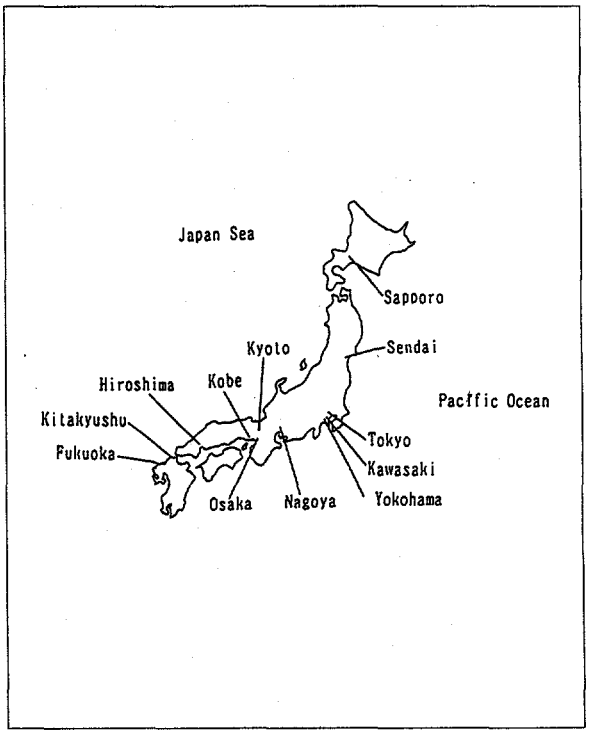
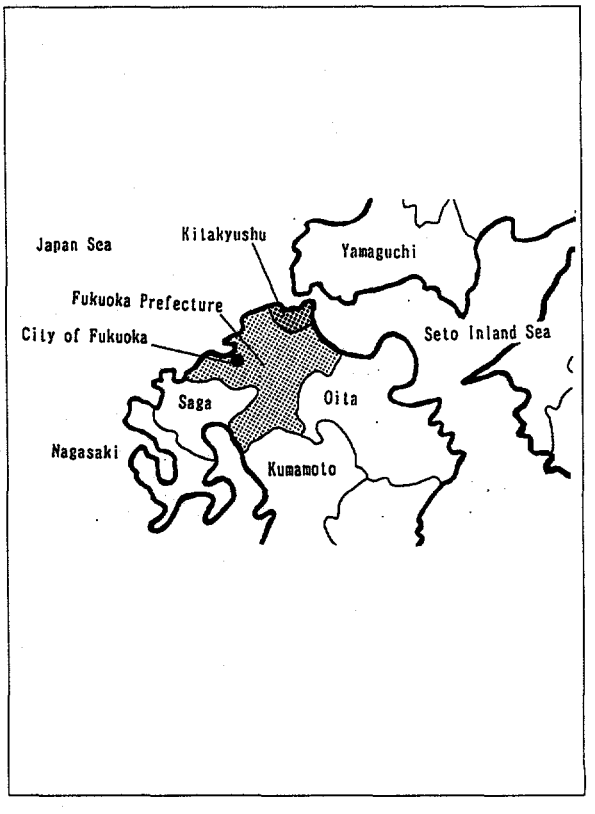


Figure 1-1: Location of Kitakyushu City

Location, Topography and Climate

Kitakyushu is located in the far northern part of Kyushu (the most westerly island of Japan's four main islands), and faces Honshu over the Kanmon Channel. The city area is 482 km^2 (32.5 km east to west and 33.5 km north to south), and comprises 9.6% of the land area of the Fukuoka prefecture (0.13% of Japan). A large part of the city lies on the Kiku Mountains in the east, and the Fukuchi Mountains which run from the center of the city to the south. These mountains are relatively low; the Fukuchi Mountain is the highest of them with a height of 900.8 m. Facing the north and the east-south sea, plains have less hinterland, and are dispersed.



In the coastal area, a large part of the lower land is artificially created or reclaimed land. The Kanmon Channel links the Sea of Hibiki and the Sea of Suou. The former is external ocean, at the south-western part of the Japan Sea, while the latter is an inland sea.

In 1991 average temperature of Kitakyushu was 16.4°C; the highest temperature being 34.9°C in July and the lowest -2.9°C in February. Annual precipitation was 1,850 mm. Although the city's climate is relatively warm, it is affected by seasonal winds, which blow from north-west/west in winter, and from south-east/south-west in summer. The average wind speed is 3.3 m/second.

Population

Over the period 1920-60, the population of Kitakyushu grew rapidly at a rate of 13.6-22.3% annually, except during the war period. Thereafter, the growth of population slowed down: in fact, it declined from its peak of 1,065,000 in 1980, to the current population (March 1993) being 1,020 thousand. The population density of Kitakyushu is 2,118 people per square km. Social factors such as the outflow of employers with relation of companies and emigration from the downtown area to the bedroom suburbs are the main causes of this recent trend.

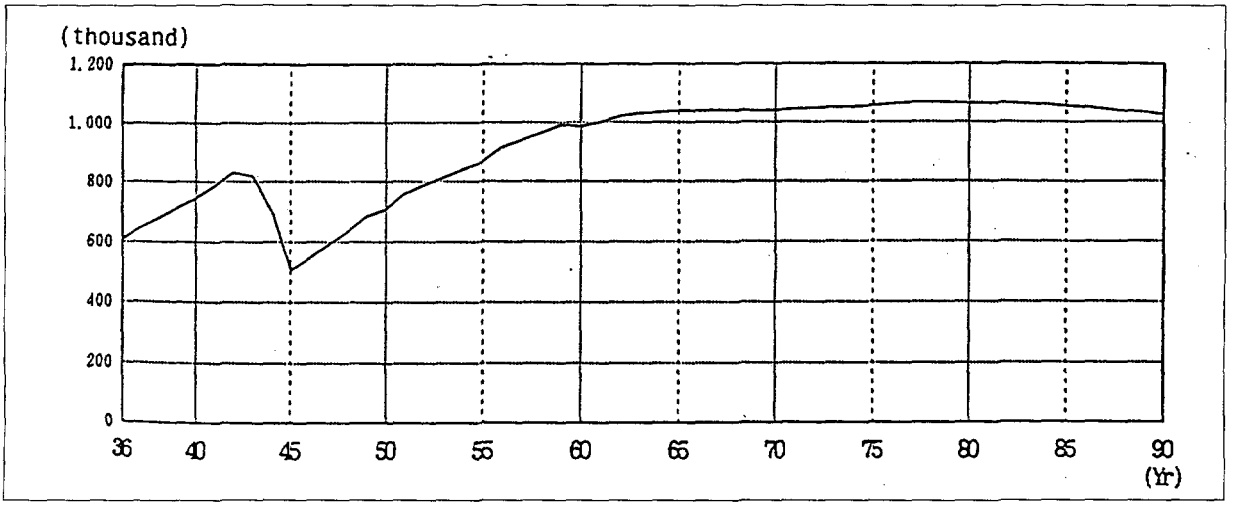
The city's work force in 1990 was 454,000. Primary industries now employ 1.2%, secondary industries 30.8%, and tertiary industries 68.0% of the total workforce. Currently, the workers in primary and secondary industries are declining slightly while tertiary industries are increasing slightly.

Industry

The gross regional product of Kitakyushu in 1991 was 2,724,600 million yen (0.8% of GNP of 340,609,500 million yen), about four times that achieved in 1970. In 1985, tertiary industries accounted for 57.4% of the city's total output (national level: 60.8% of GNP), secondary industries for 41.6% (national average: 36.2% in nation), primary industries 1.0% (national figure 3.1%).

Steel, chemicals, general machinery, food, and electric machinery are the main manufactured goods. Heavy industries account for 80% (national figure: 66.5%), and light industries 20% (national figure: 33.5%) of the value of manufactured goods. Material industries account for 73.4% (national figure: 43.7%), and processing industries 26.6% (national figure: 56.3%) of the value of manufactured goods. Recent trends indicate that the emphasis on heavy material industries has gradually declined, although steel is still a key industry, and hi-tech industries and general and precision machinery continue to grow.

Figure 1-2: Population Growth in Kitakyushu, 1936-90



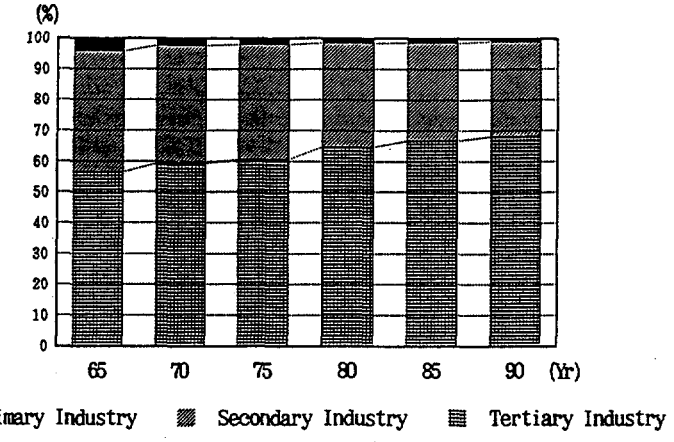


Figure 1-3: Industrial Employment in Kitakyushu, 1965-90

Commerce in Kitakyushu area prospered in the old castle town, Kokura. Thereafter, the city experienced growth of the industrial area, led by the steel industry. Covering the western part of Yamaguchi prefecture in the east, Chikuho/Onga in the west, and Kyochiku in the south, the commercial region has more than 2 million population, and shares two large commercial centers with the city of Fukuoka in Fukuoka prefecture. The Kokura-kita and the Yahata-nishi wards are at the center of the region.

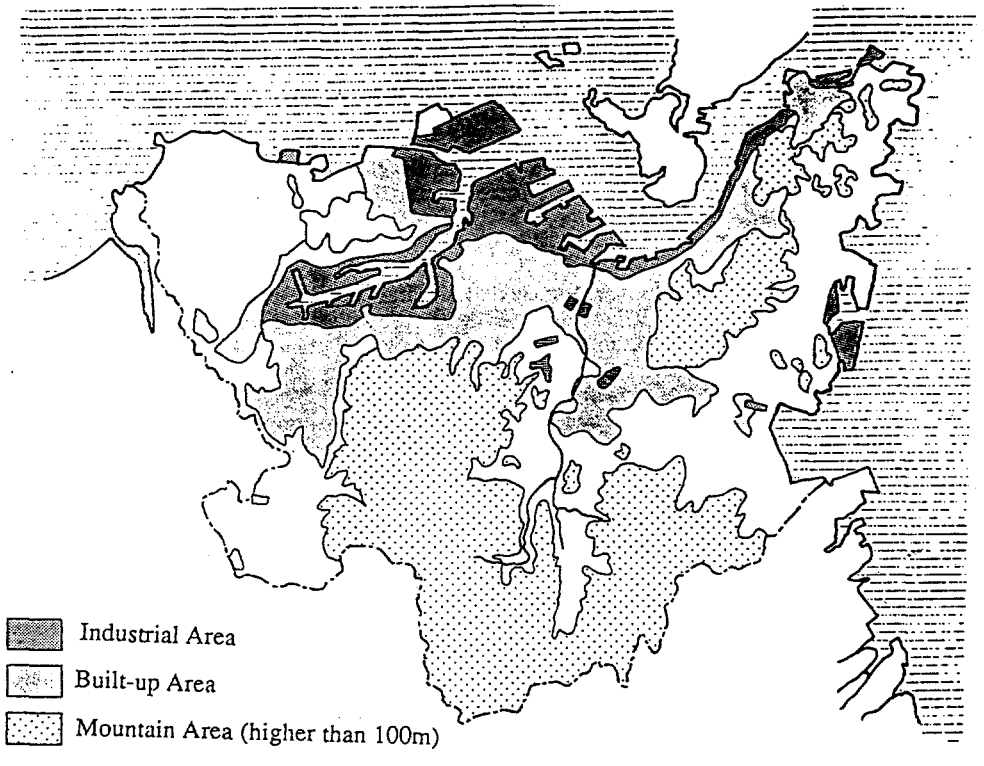
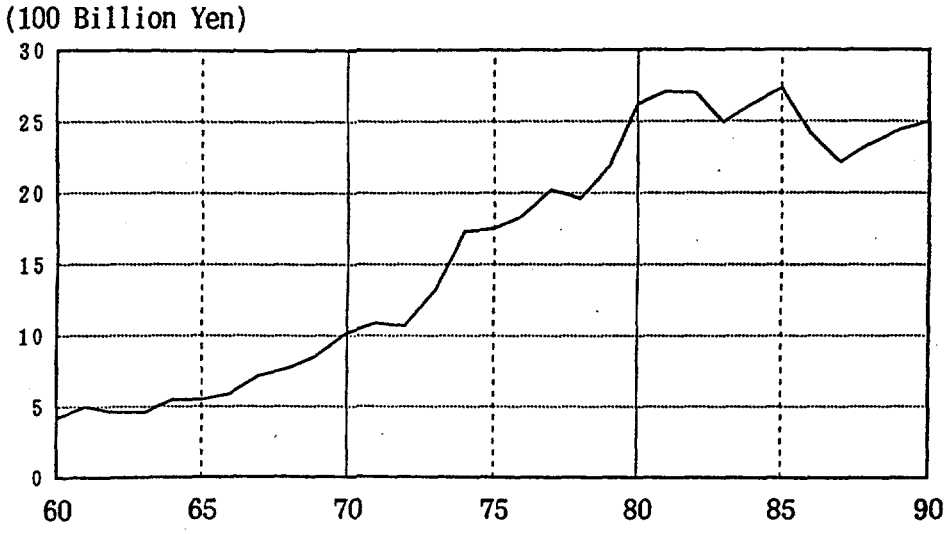


Figure 1-4: Map of Kitakyushu

Figure 1-5: Industrial Output (value added), 1960-90



The city of Kitakyushu has developed and prospered as an industrial city since the Meiji Era though agricultural, forestry, and fishery industries have not been well developed. However, pollution problems caused by the steel industry harmed fishery. In particular, fisheries in Dokai Bay were severely damaged around 1935, and some fishery rights were abandoned. The industry is now mainly coastal fishery rather than offshore or deep-sea fishery. The Sea of Hibiki and the Sea of Suou, separated by the Kanmon Channel, respectively have different fishery environments and fisheries.

Land Use

The land area of the city of Kitakyushu is 482 km^2, of which 8.3% is agricultural, 44.4% forest, 11.8% residential, and 6.0% industrial. A small part of the city lies on a plain. Factories are located on the northern coastal plain where railroads and trunk roads are concentrated. Extending from east to west, the built-up area extending from the mountains faces the factory areas on the coastal plain. At first, most of the city (479 out of 482 km^2) is designated as a city planning area. Urbanization promotion area accounts for 39.4% of the city planning area of which 61.3% is residential, 10.0% is commercial, and 28.7% is industrial use.

Urban Infrastructure

The first water supply works in the city of Kitakyushu was a partial supply in the former city of Moji in 1911. Facilitated by the development of the city, water projects were also implemented in the former cities of Wakamatsu, Kokura, Yahata, and Tobata. An administrative union (Kitakyushu water supply union, in which the former city of Moji did not participate) was established in 1952 under the "Local Government Act" in order to provide a comprehensive water supply system. With the establishment of the city of Kitakyushu in 1963, the water supply union and the water supply department in former Moji were dissolved in 1964 to form the water supply bureau of the city of Kitakyushu.

In order to keep up with the increasing demand for water due to urban development and the improvement in living standards, the city has tried to supply more water by expanding water sources such as the estuary of the Onga River and the Yabakei dam. The percentage of the population with public water supply in the city was 99.1% at the end of 1991, and the planned maximum water supply per day was 0.71 million m^3. Since 1957, the city has also implemented industrial water supply works to keep up with a rapid increase in demand for industrial water. In March 1991, 48 business establishments used industrial water, and the contractual water supply per day was 0.17 million m^3.

Public sewerage is fundamental for the improvement of the urban environment and public health and to achieve environmental standards for rivers. The city started full scale implementation of city sewerage in 1967 with the "The Second Five-year Program for Sewerage Construction." The Hiakari sewage treatment plant started to operate in 1970, and public access to sewerage became 20%. Thereafter, further expansion of the system took place, and percentage of seweraged population became 91.0% by 1993.

Night soil is regularly collected from all households which do not have access to sewerage. Collected night soil is treated in the sewage treatment plant. As for solid waste disposal, three incinerators and three crushing plants are installed to crush or burn the collected waste. Collected night soil was 136 thousand kl, and collected solid waste was 471 thousand tons in 1991.

The city is linked to Honshu by the Kanmon road and the Kagoshima Line which is one of the major national freeways and runs through Kyushu. Kitakyushu urban freeways I through IV are developed as the city motorways. Small airplanes only can fly between Tokyo and Kitakyushu Airports since March 1993. With respect to railways, the Sanyo bullet train runs to the city, which is at the terminuses of the Kagoshima, Nippou, Hitahikosan, and Chikuhou Lines. Kitakyushu has an important specialized port, which faces Honshu. Situated on the international sea route which links Japan with China and South East Asia, the port has geographical advantages. The volume of export/import freight is about 99 million tons.

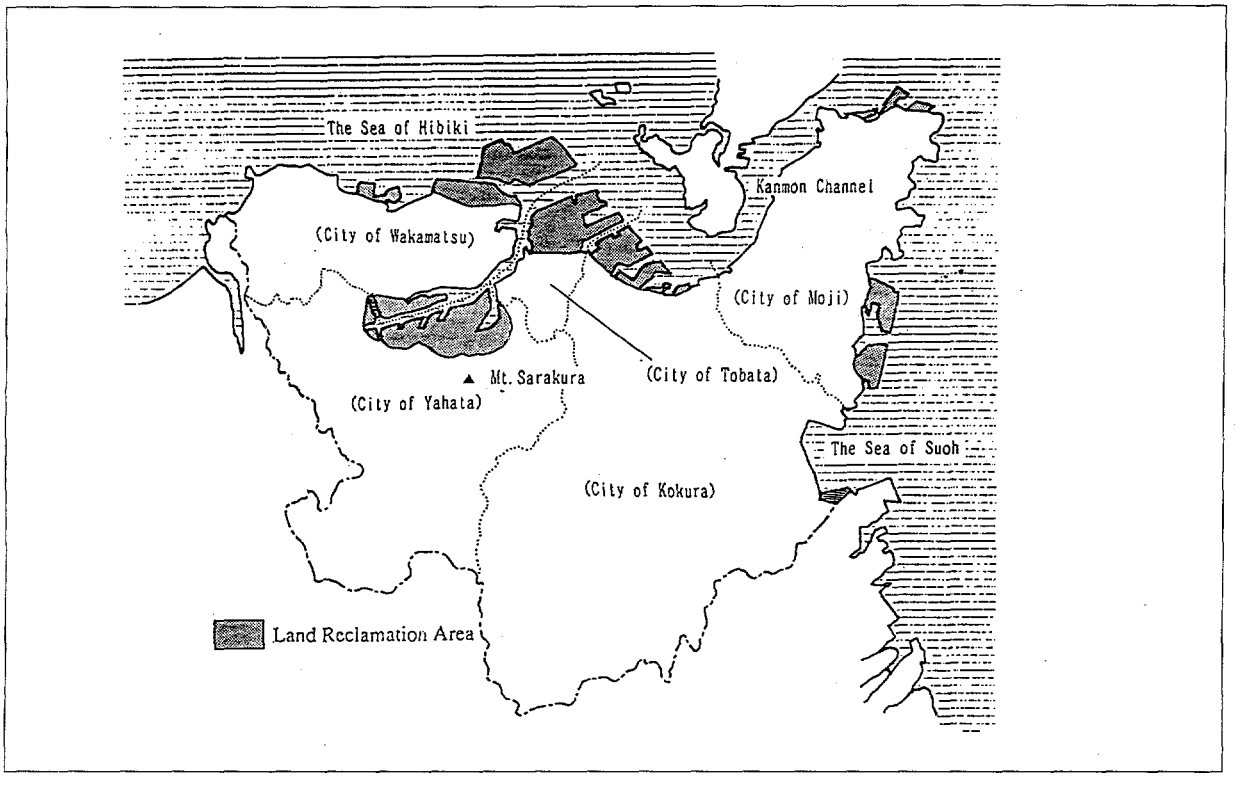
History of the City

From the Meiji Restoration to the End of World War II (1901-44)

Four out of five former cities, which consisted of the city of Kitakyushu, were small villages until the middle of the Meiji Era. Only Kokura is of major significance, Ogasawara's castle town with holding a fief yielding 150,000"koku[1]." In the latter half of the Meiji Era, modern industry grew, led by the Chikuho coalfield, and full-scale development of urban areas took place in some districts.

In the 1890s, Kokura was the largest city in the Kitakyushu area with a population of 15,000, and had many factories and war facilities. Designated in 1889 to export items such as coal, rice, barley, and sulfur, Moji, which faces the Kanmon Channel, was developed as an international port. The opening of Kyushu Railways (now the JR Kagoshima Line) at Moji in 1891 was an important step in this process, and further financial and trading functions were established there. Yahata was a small village, facing Dokai Bay. The national

Figure 1-6: Land Reclamation in the Coastal Zone



government-run Yawata Steel Works started its operations in 1901, and then Yahata experienced a rapid increase in population, which grew from 1,715 in 1897 when installation of the steel works was initiated to 6,460 in 1900. Tobata was also becoming industrialized with the installation of the steel works. Wakamatsu had been developed as a port for coal and a downtown area, since water transportation in the Onga River was concentrated on Wakamatsu.

In the Taisho Era, industry expanded in the coastal region of Dokai Bay, and construction and extension of factories, land reclamation, and the development of hill areas to secure industrial land occurred. Each city expanded its city area by merging with neighboring towns or villages. The urban areas of each city were converted into larger structures, and became increasingly interconnected. This was the period when the framework of the "Kitakyushu industrial area" started to take shape.

Post-War Reconstruction (1945 - 1959)

The urban areas of Yahata and Moji were extensively damaged in World War II. The national government introduced the "Guidelines for National Land Reconstruction" which aimed to rebuild the nation, and proclaimed the "Special City Planning Law" in 1946. Based on these plans, 112 cities undertook the war reconstruction project (which was completed in 1960). Designated as war reconstruction cities, Moji, Wakamatsu, and Yahata participated in this project in 1947. Kokura and Tobata, without being so designated, nevertheless started the project at almost the same time. As a part of the war reconstruction projects, harbor repairs started in 1947. Mine removal in the Kanmon Route and Dokai Bay were completed by the end of 1949.

National policy was to rebuild Japan's economy by a gradual increase in key productive sectors. This national policy established at the end

of 1949 aimed to increase steel production through an increase of coal output, then increased steel production was used for coal production. With its international port, Kitakyushu was one of four major industrial areas in Japan to receive funds from the national budget to assist it in achieving rapid economic recovery and development of urban infrastructure. Furthermore, the outbreak of the Korean War in 1950 created a special demand of war materials from the UN force. As a major supplier, economic revitalization not only in Kitakyushu but also in Japan as a whole was accelerated.

The population in Kitakyushu area almost doubled from 505,000 in 1945 to 986,000 in 1960. The increase was caused by a number of reasons, including the evacuees' and repatriates' return to the city.

High Economic Growth and Creation of Kitakyushu City (1960 - 1973)

During the period 1960-65, the five cities in the Kitakyushu area as well as Japan changed significantly. In 1960, the "National Income Doubling Plan[2]" was proclaimed, and the high economic growth policy was adopted. High economic growth in fact continued until the first oil shock occurred in 1973.

The "Comprehensive National Development Plan" established by Cabinet order in 1962 aimed at preventing people and industries from concentrating in large cities, and reducing regional differences in development by identifying areas for nodal system development. The Plan facilitated the development of urban infrastructure such as roads, harbors, and water supply and sewerage systems in Kitakyushu. However, the Pacific Belt Industrial Area, formed through the construction of new industrial cities and special area for industrial consolidation based upon the nodal system development program, degraded the position of the Kitakyushu Industrial Area, particularly following the energy revolution (conversion from coal to oil) in the 1960s. This phenomenon was symbolized in 1961 by the modernization of Yawata Steel Works, which involved the transfer of many employees to other steel works such as Hikari, Sakai, and Kimitsu.

In Kitakyushu around 1960, the traditional controversy since the early Showa Era over the desirability of merging the five cities was reignited. Eventually, the cities agreed to build a new large city by combining their administrative and financial power. Obtaining active support from the national government and Fukuoka prefecture, the five cities were merged in February 1963. Designated by a Cabinet order in April of that year, the city of Kitakyushu had five administrative wards based on the former five cities. The "Kitakyushu Comprehensive Long-Term Basic Plan" (so-called "Master Plan") was designed in 1965. The goal of the plan was a creation of a city by the citizens with a good living environment and higher productivity. In order to achieve this goal, large facilities appropriate to the city for millions of people were constructed. The Wakato Ohashi and Kanmon Bridges opened, the special station for national freight trains opened, and the city hall was constructed.

The city of Kitakyushu has since its creation been heavily involved in pollution control. In 1963, it became the first designated area under the Soot and Smoke Control Law, and in 1964, the city began to control pollution with the establishment of a Pollution Control Council. Since then, the city has taken actions to set standards for smog warnings and for SOx and NOx emissions, and strengthened the administrative structure by establishing the Pollution Control Bureau. In all

these areas it has sought cooperation from corporations and citizens. The city's population in this period slightly increased from 986,000 in 1960 to 1,042,000 in 1970.

Formation of an Advanced Welfare City (1974 - 1986)

Due to the first oil shock, growth in Japan's GNP in 1974 was negative for the first time in the post-war period. In the same year, the city of Kitakyushu designed a basic and long-term plan, and established seven wards by rearranging old administrative wards. While the recession nationally worsened, corporate reform and modernization in the city, led by the steel industry, took place. The term, "chill of steel[3]" became fashionable. Privatization was introduced to achieve administrative and financial efficiency.

The Kitakyushu Basic and Long-Term Plan (designed in March 1974) aimed to create an advanced welfare city which protects a better quality of life and with a safe and comfortable living environment; a city active in industry and trade, and a city run by its citizens. Based on the Plan, large public facilities such as a general gymnasium, museum, cultural center, library, historical museum, natural science museum, citizen's center, and traffic science museum were constructed. Other large public facilities are the Kitakyushu Central Wholesale Market, West Japan General Pavilion, and Kyushu Welfare Pension Center. This new urban infrastructure was facilitated by the New Comprehensive National Development Plan in 1969, and the Third Comprehensive National Plan in 1977, by cabinet order. The basic goal of these plans was to create an environment including the improvement of the quality of the citizens' lives.

During this period, in 1977 China's International Exhibition took place, and a Chinese city (Dalian) and Kitakyushu city became "friendship" cities: this coincided with the opening of the Tachinoura container terminal.

The city's population slightly increased from 1,058,000 in 1975 to 1,065,000 in 1980, but decreased again to 1,056,000 in 1985.

The Renaissance Plan (From 1987 to the present)

In 1987, the cabinet introduced the Fourth Comprehensive National Development Plan with a target year of 2000, which specified many decentralized functions to be carried out by local governments. Consistent with this, the Kitakyushu Renaissance Plan, designed in 1988, has five key themes: the "International Technological City with waterside, greenery, and community"; the "Welfare and Cultural City with a healthy and worthy life"; the "International Technological Information City for future industry"; the "City with active overseas exchange"; and "Asian Academic and Research City for the future." This Plan converted the old view of a city, namely, the "city with many functions," to the "city with balanced functions." Three projects for the 21st Century are 1) construction of the New Kitakyushu Airport with 2,500 m of runway on the Sea of Suou, 2) construction of the Eastern Kyushu Road, and 3) development of the academic research city.

Implementation of the first phase (1989 - 1993) of the Kitakyushu Renaissance Plan is now underway. Some projects such as the opening of the International Center for the Study of East Asian Development, the Kitakyushu International Conference Center, and the Space World Amusement Park which was introduced by private business have already been completed. Redevelopment projects

such as the JR Kokura station area, and the Hirano area of Yahata-higashi ward are underway, too. Expansion and upgrading of the urban infrastructure is also underway. Expansion of four lanes of the Wakato-ohashi Bridge has been completed. All lanes in the Kitakyushu City Freeway have been opened. Regular service at the Kitakyushu Airport, which had been suspended for a long time, resumed.

The city of Kitakyushu has taken actions against pollution since its establishment and its efforts were appreciated by the United Nations Environmental Programme (UNEP) with the "Global 500" award in 1990. In 1992, the city received the "UN Local Government Commendation Award" from the United Nations Conference on Environment and Development (UNCED).

Endnotes

[1] a "koku" = 5.119 US bushels of rice

[2] "National Income Doubling Plan": the plan aiming at doubling national income from 1960 to 1970, but was achieved in 1967.

[3] "chill of steel": decline of the steel industry

Environmental Pollution in Kitakyushu

This section summarizes the state of environmental pollution in Kitakyushu: air pollution, water pollution, noise, vibration, offensive odors, land subsidence, soil contamination and solid waste.

Pollution in Kitakyushu began with the "seven-colored smoke." Smoke, the symbol of selfish prosperity which was sung in songs such as "Murky Smoke Overspreading the Heavens" and "In the Sky Stands the Rainbow, Stands the Smoke," was transformed into dust fall and plagued the city residents. The Kitakyushu heavy chemical industry zone — where major corporations involved in iron and steel, chemicals, ceramics, electric power, etc. were situated — had also been a major source of air pollution and water pollution before the war. In particular, as the post-war reconstruction passed and upon entry into the so-called high level of economic growth period of 1955-1965, air pollution such as dust, soot, sulfur dioxide, offensive odors, etc. and water pollution due to factory waste water intensified at all sites.

In Dokai Bay, the fish harvest had begun to recover during one period after the war, but was once again eliminated from about 1950 onward, and fishing rights were abandoned in the area to the west of Wakato-ohashi Bridge in 1956. There occurred an inflow not only of large quantities of factory waste water from nearby corporations but also of urban sewage, and pollution advanced.

Air Pollution

Ambient air pollution Figures 2-1 indicates changes in the concentrations of NOx, SOx, suspended particulate matters (SPM), dust fall, and non-methane hydrocarbons (NMHC) in ambient air.

Since 1978, the concentration of NO_2 has met environmental quality standards in the long-term assessment based on annual 98% value of daily

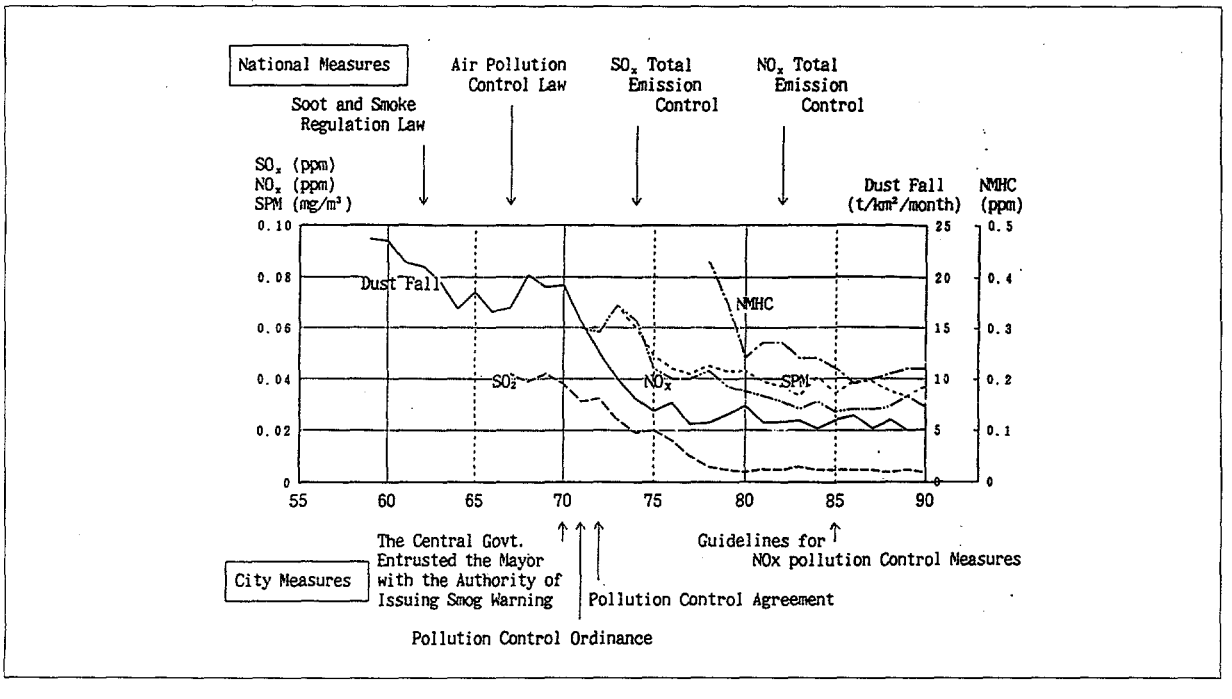


Figure 2-1: Ambient Air Quality: General Environmental Monitoring Stations, 1955-90

average, and has remained unchanged. However, due to the increase in vehicular traffic volume, NO_2 concentration has increased city-wide. SO_2 concentration has greatly decreased since 1970. Readings at all monitoring stations have satisfied environmental quality standards since 1976. SPM is not satisfactory at 6 out of 11 monitoring stations in the long-term assessment, and at any of the monitoring stations in the short-term assessment based on hourly and daily averages. Dust fall reached a peak in 1970; it drastically decreased until 1977, and since then has remained almost unchanged. NMHC, whose main sources are automobile exhaust gas and petroleum based organic solvents such as paint, has remained almost unchanged at all monitoring stations.

Automobile pollution Contained in automobile exhaust, NO, NO_2 and CO are major elements of air pollution. Figure 2-2 shows changes in the concentrations of these substances as recorded by automobile exhaust monitoring stations.

The concentrations of NO and NO_2 remained unchanged and tend to have increased slightly in recent years. With regard to environmental quality standards, NO_2 is not satisfactory at 1 out of the 5 automobile exhaust monitoring stations. This automobile exhaust monitoring station is situated along a trunk road. The concentration of NO_2 at automobile exhaust monitoring stations tends to increase overall. CO contained in exhaust gas is high, especially along the trunk roads or the crossings with heavy traffic. Due to the increase in vehicular traffic volume, the concentration of CO increased until 1972. However, because of strengthening of exhaust gas control measures, it decreased significantly. All automobile exhaust monitoring stations have satisfied environmental quality standards since 1976. The concentration of CO has remained almost unchanged in the last five years. The concentration of NMHC has also remained unchanged.

Water Pollution

Toxic substances (human health item) Water pollution in the city's public waters has drastically improved (Figure 2-3) due to the stricter municipal standards under the "Water Pollution Control Law" and the regulatory control over factory and business establishments and the construction

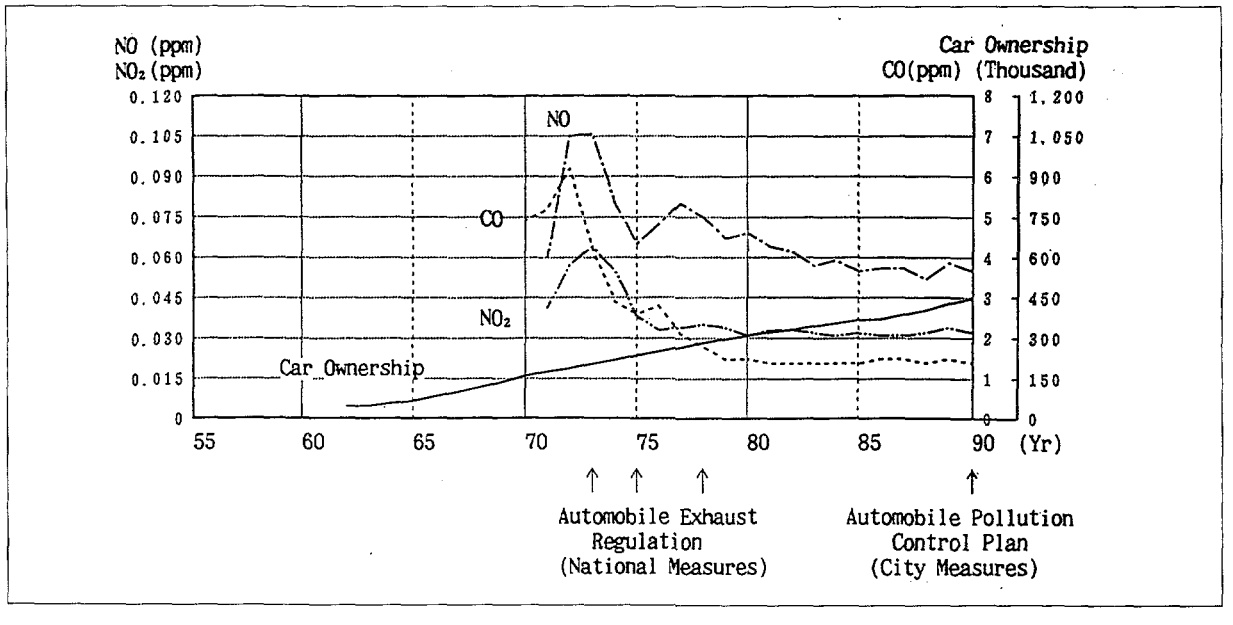


Figure 2-2 Ambient Air Qualtiy Recorded at Automobile Exhaust Monitoring Stations, 1955-90

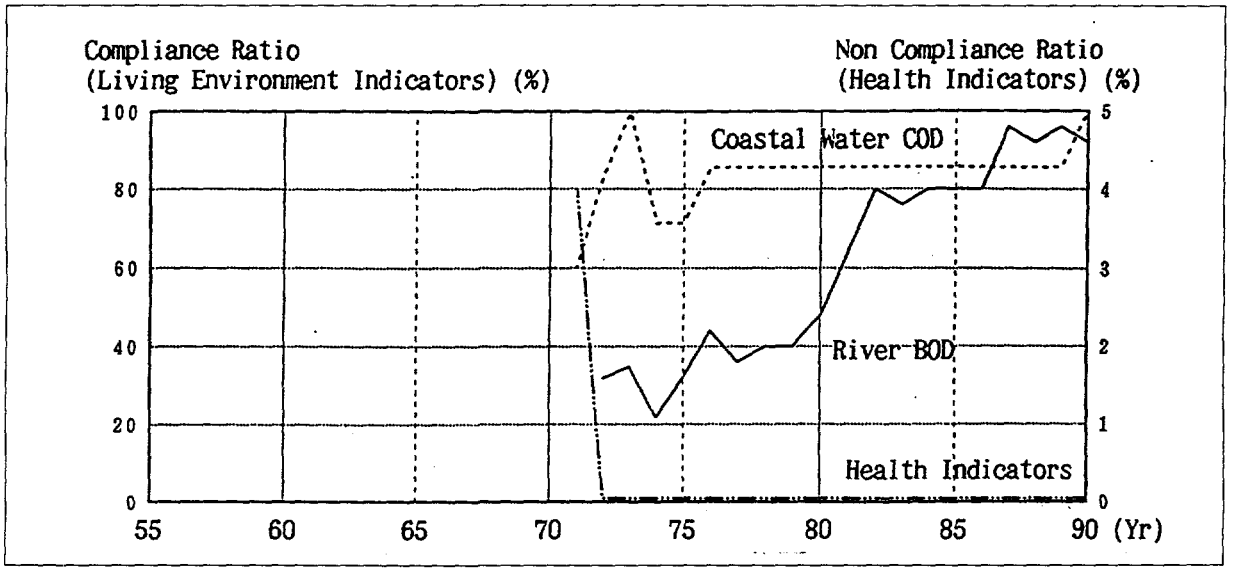
of public sewerage based on the Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea. Items of human health protection, such as cyanide have satisfied environmental quality standards in all water areas since 1972.

Living environment issues

Rivers Due to a rapid construction of sewerage, the number of monitoring stations, which meet environmental quality standards in terms of Biochemical Oxygen Demand (BOD), has increased annually and remained stable for the past several years. The compliance ratio for BOD was 88% in 1991.

Organochlorine chemical substance (ground water) The Kitakyushu city investigated ground water contamination caused by organochlorine chemical substance in 1984 and 1985. It has conducted research based on the plan for measuring ground water quality since 1989. The 1991 research revealed that 14 (7.8%) out of 180 wells contained trichloroethane, while 5 (2.8%) of these 14 wells did not meet national standards. Of all wells 13.9% contained tetrachloroethylene, while 10% of the wells did not satisfy national standards. However, 2.8% of all wells which contained 1,1,1-trichloroethane did meet national standards. There were some wells which contained 1,1-dichloroethylnene, cis-1,2-dichloroethylene, and trans-1,2- dichloroethylene.

Figure 2-3: Compliance with Environmental Quality Standards in Public Waters: Health and Living Environment Indicators, 1955-90



Coastal waters With regard to Chemical Oxygen Demand (COD), a representative indicator of coastal water quality, some monitoring stations in the Sea of Suou did not meet environmental quality standards in the 1970s and 1980s. However, all seven monitoring stations have satisfied them since 1990.

Noise and Vibration

In addition to factory or construction-oriented noise and vibration, city-oriented pollution such as noise from night businesses, and non-regulated noise in daily life have recently become major problems, and are associated with growing housing density and diverse life styles. The volume of traffic has increased in the city with development

of motorization, and the growth in road traffic has become a special problem; in particular, noise and vibration caused by automobile traffic has increased in trunk road areas with heavy traffic of large trucks.

Noise caused by flight training at the Air Self-Defense Force Base, which adjoins the city, and by the resumption of regular flight service at the Kitakyushu Airport adversely affects some parts of the city. Also, the increased speed of the bullet train creates noise and vibration problems along the lines.

Offensive Odors

The "Offensive Odor Control Law" designated the whole city as a regulatory area and regulates 12 offensive odor substances such as ammonia. Complaints about offensive odors rank second following after noise and accounted for 27.4% (97 out of 354 cases) of the total pollution complaints in 1991. A large part of these originate from food manufacturers, stores, and restaurants, etc..

Land Subsidence

The city has no subsidence problems.

Soil Contamination

The city has no soil contamination problems in agricultural land, and no designated area for controlling soil contamination in agricultural land.

Solid Waste and Night Soil

Domestic wastes The annual treated volume of domestic wastes was 471,330 ton in 1991, an 87.5% increase over the 1972 volume (251,424 t). With regard to treatment method, incineration accounts for 98.6%, landfill 1.3%, and recycling 0.1%.

Night soil Night soil generated by the 76,000 population without access to sewerage (7.4% of the total population in the planned treatment area: 27,600 households) was collected and the amount was 136,379 kl in 1991. This represents a 26.4% decrease compared to 1972 (516,800 kl). All night soil was treated at the sewage treatment plant. A part of sludge from sewage treatment plant and septic tank was dumped into the ocean.

Industrial wastes

The volume of industrial wastes was 8,276 thousand tons in 1990. Three major wastes are slag

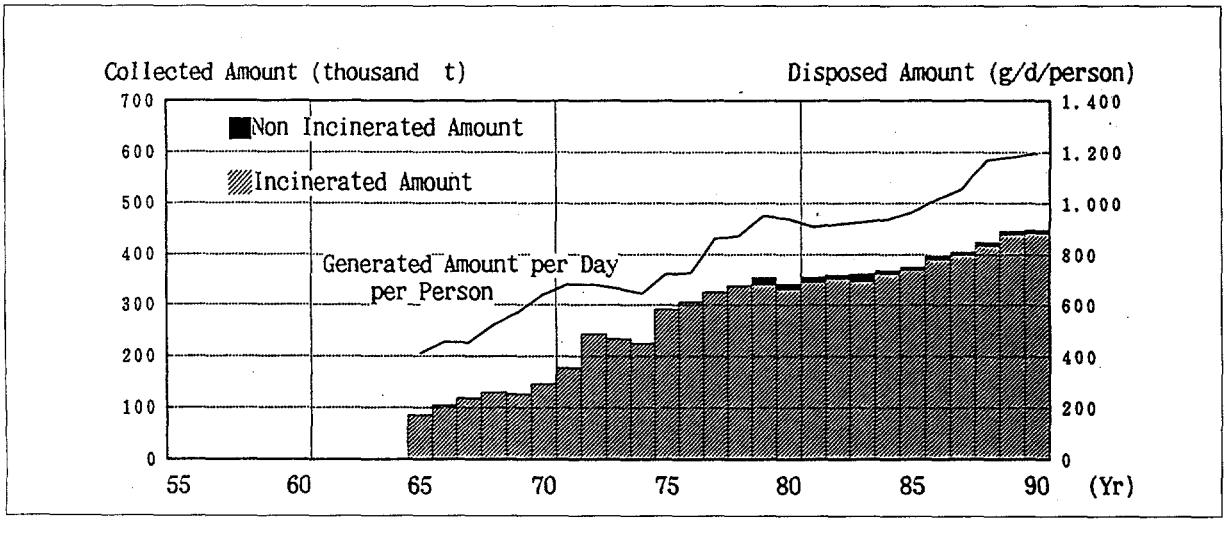
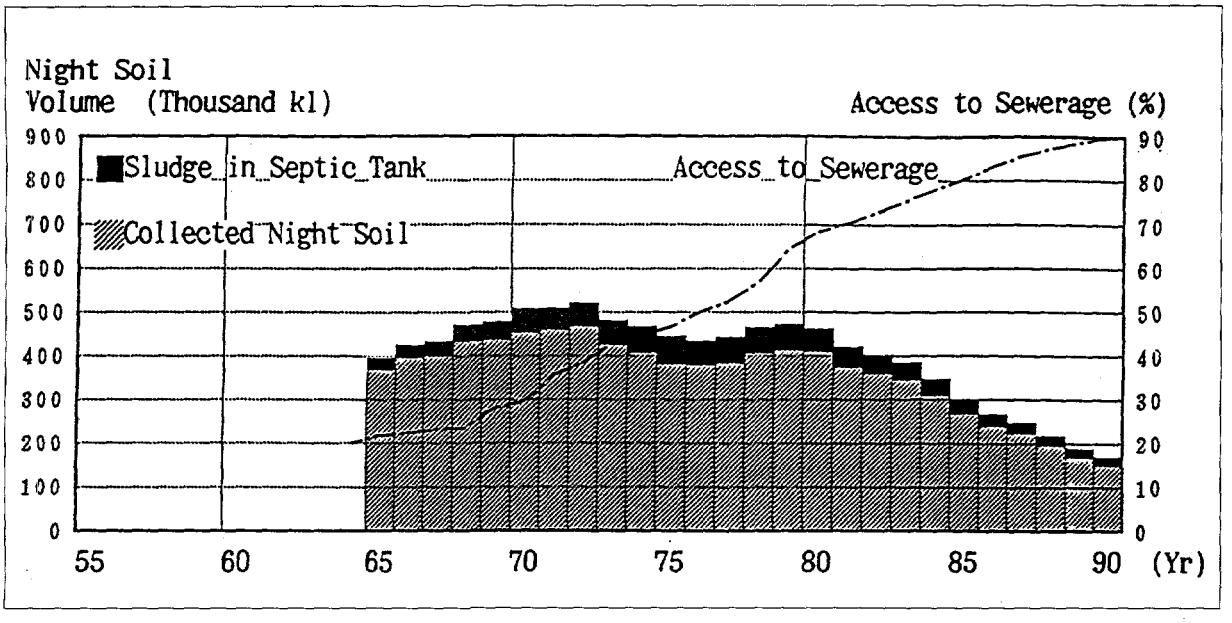


Figure 2-4: Solid Waste Disposal, 1955-90

Figure 2-5: Night Soil and Access to Sewerage by Residences, 1955-90



(41.8%), construction material (23.3%), and sludge (23.3%). With respect to treatment, 1,423 thousand tons (17.2%) was reduced by intermediate treatment and 33.7% of industrial wastes, especially slag, is utilized. Of industrial wastes, especially construction material, 39.9% is disposed by landfill while 9.2% of industrial wastes is dumped into the ocean or retained.

Outline of Environmental Protection Measures in Kitakyushu

The Response During Post-War Reconstruction and Prior to Union of the Five Cities (1950-1963)

After the Second World War, industrial reconstruction advanced centering on the major industrial zones. The national income doubling plan commenced from 1960, and Japan's economy underwent rapid high-level growth. On the other hand, accompanying this, air pollution, water pollution and noise pollution became manifest in all localities. In particular, the fuel conversion from coal to oil engendered extensive pollution problems due to sulfur oxides. Furthermore, rapid population growth, concentration of industry in urban areas, and refinement of consumer life gave rise to the baneful effects of overcrowding in large cities, and led to such problems as traffic noise, construction noise, and automobile exhaust gas. During this period, pollution not only increased in quantity and regional extent, but also its content grew more complex and serious.

Prefectural ordinances During the period after the war when the nation had yet to devise countermeasures, due to the worsening pollution problems and pressed by necessity, the local self-governing bodies came to successively enact pollution prevention ordinances. In 1955 in Fukuoka prefecture, the Fukuoka Prefecture Pollution Control Ordinance was promulgated with the objective of "preventing pollution and seeking improvement of public health, thereby contributing to the increased well-being of prefectural residents." Thus, in the period from 1945 to 1955, the awareness of pollution as a problem of regional society first developed in the established

large cities and existing industrial zones where regulatory action was taken by ordinance, and then from 1955 onward this awareness spread nationwide.

The national response In response to this situation, a national legal system of pollution countermeasures gradually began to take shape. The Waste Disposal and Public Cleansing Law was enacted in 1954 followed by the Sewerage Law in 1957, and the development of facilities for the living environment began to get underway. From the standpoint of pollution regulation, laws relating to the protection of public water areas and laws relating to the control of factory waste water were enacted in 1958, and the regulations based on these laws began in 1962. Accompanying the advance of heavy chemical industrialization, air pollution grew increasingly severe, and Japan's first law relating to air pollution prevention,"Smoke and Soot Regulatory Law,"was enacted in 1962.

The response of the former five cities The Kitakyushu heavy chemical industrial area had been a major source of air pollution and water pollution before the war and became more serious during the high economic growth period.

The Shiroyama district of Yahata was surrounded by large ceramic, chemical, and iron and steel factories, and many of its residents suffered from large quantities of dust fall and offensive odors. The Nakabaru and Sanroku districts of Tobata were located adjacent to a large group of factories, and there arose from about 1950 an antipollution campaign of a local women's group which had sustained damage due in particular to the dust fall from electric power plants and the soot from chemical factories. Based on surveys of the actual state of damage, demands for improvement to the pollution generating corporations and petitions to the local administration steadily continued. Thereafter, the citizen's movement underwent expansion, and an association composed from thirteen women's groups in Tobata ward mustered an organization of approximately 6,000 people, and developed approaches for tackling these pollution problems. The housewives were conscious of the problems of washed clothes blackened when left out to dry, the accumulation of dust indoors, and the harmful effects of this pollution on the body, and although they suffered from a dilemma between their husbands who were employed by the factories and the antipollution movement, they nevertheless proceeded to "seek for a blue sky" by conducting activities such as pollution fact-finding surveys and the submission of petitions to the administration.

With regard to the assessment of air pollution conditions in the area of the former five cities, with the cooperation of the Kyushu University Hygiene Department, measurement was conducted by the deposit gauge method of the dust fall quantity in ten places in Fukuoka prefecture beginning in 1953, and the first such measurement point was established in Tobata. For purposes of full-scale air pollution measurement across the entire area of the former five cities, in 1959, a total of fifty-three sites were selected by the Air Pollution Survey Committee of the Kitakyushu Five City Coalition and measurement was begun.

With regard to pollution conditions and weather conditions in the upper atmosphere which play an important role in the generation of smog, medium altitude pollution studies were incorporated into the activities of the Fukuoka Prefecture Air Pollution Control Council from 1951, and were executed by the Kyushu University Hygiene Department.

In 1951, in order to monitor the dust from corporations in the city, one full-time employee was provided in the former Yahata Public Health Center. The job of patrolling the city every day by

bicycle to monitor and measure the density of the smoke discharged from smokestacks using a Ringelman chart was continued until the founding of the new city. In the former city of Tobata, as well, one full-time employee was provided in the Hygiene Section, and the same monitoring work was conducted.

In order to actively advance with air pollution policies with the objective of correctly assessing the actual conditions of air pollution in Fukuoka prefecture, investigating the influence of air pollution on the human body and society, and proceeding with research into air pollution prevention methods as well as with propagation of pollution free facilities, the "Fukuoka Prefecture Air Pollution Control Council" was established in 1962 consisting of the local administration (Fukuoka Prefecture, Kitakyushu Five Cities Air Pollution Survey and Control Council, and Omuta city) and men of learning and experience (four people). The following epidemiological studies were implemented with the cooperation of the medical department of Kyushu University:

- In order to compare Yahata area with serious air pollution and the suburbs of Fukuoka city and rural area with rather less air pollution, the number of patients by disease was checked using health insurance and social insurance cards. As a result, the much larger number of patients with diseases of the nose, ear, and throat which are considered to be related to smoke and soot was found in Yahata area.

- In order to investigate the influence of air pollution on the chronic respiratory diseases such as bronchitis, asthma and pulmonary, women of 40-years and over in seriously air polluted areas and less polluted areas were interviewed on their symptoms and conditions of related diseases. The number of the patients in the high polluted area was more than twice that in other areas.

- For the investigation of the effects of air pollution to school children, the interviewing, clinical examination and physicochemical test were conducted on the students of primary and secondary schools in the areas with different air pollution level. The investigation found that the children of the school in the seriously polluted areas were suffering more from respiratory diseases, especially asthma than those in other areas.

Beginning with those epidemiological studies, epoch-making projects were implemented without interruption by Fukuoka Prefecture Air Pollution Control Council.

The Intensification of Industrial Pollution and The Counterstrategy of Smog Alarms mid-1960s to late 1960s)

From about 1960, large-scale regional development was promoted on a nation-wide basis for purposes of rectifying regional disparities, but since there were no effective pollution prevention policies accompanying this, the heretofore localized and scattered pollution spread and worsened across the entire country, and pollution problems became a major national issue.

In this city, as well, beginning with dust fall in the Shiroyama district, air pollution due to sulfur dioxide rapidly developed into a social problem, and Dokai Bay which was surrounded by an industrial belt along its periphery was portrayed as the "Sea of Death" in news reports. Pollution countermeasures were highlighted, but as the problems expanded in scope, they also grew in complexity. The number of complaints and petitions relating to pollution grew from 24 cases in 1960 to 168 cases in 1964 and to 386 cases in 1970, thus

reflecting the intensification of pollution and the rising concern of the local citizenry about pollution.

The number of complaints has increased since 1988. The reasons are :

1) the change of organization of 1988 dealing with pollution complaints from the consultation section to the different sections in charge of air, water and noise pollution, therefore, all the complaints can be dealt carefully:

2) change of the contents of the complaints from industrial pollution to pollution related to urban and living environment.

The national response Together with the development of society, pollution expanded both quantitatively and qualitatively, and grew in complexity and gravity, but the countermeasures of both the national and the local governments did not go beyond stopgap, individual policies. For purposes of overcoming pollution problems, the necessity of a planned and comprehensive administrative approach came to be recognized, and in 1967 the Basic Law for Environmental Pollution Control was enacted in order to establish basic policies relating to pollution prevention. The Basic Law for Environmental Pollution Control was characterized by the presentation of the nation's basic policies relative to pollution, and by its provisions relating to administrative measures for the setting of environmental standards and the formulation of pollution control program in specified regions.

The response of Kitakyushu In this metropolis, after the founding of the new city by the union of the five cities in 1963, it was continuously sought to fully structure a system by developing the pollution administration organization and establishing the Pol-

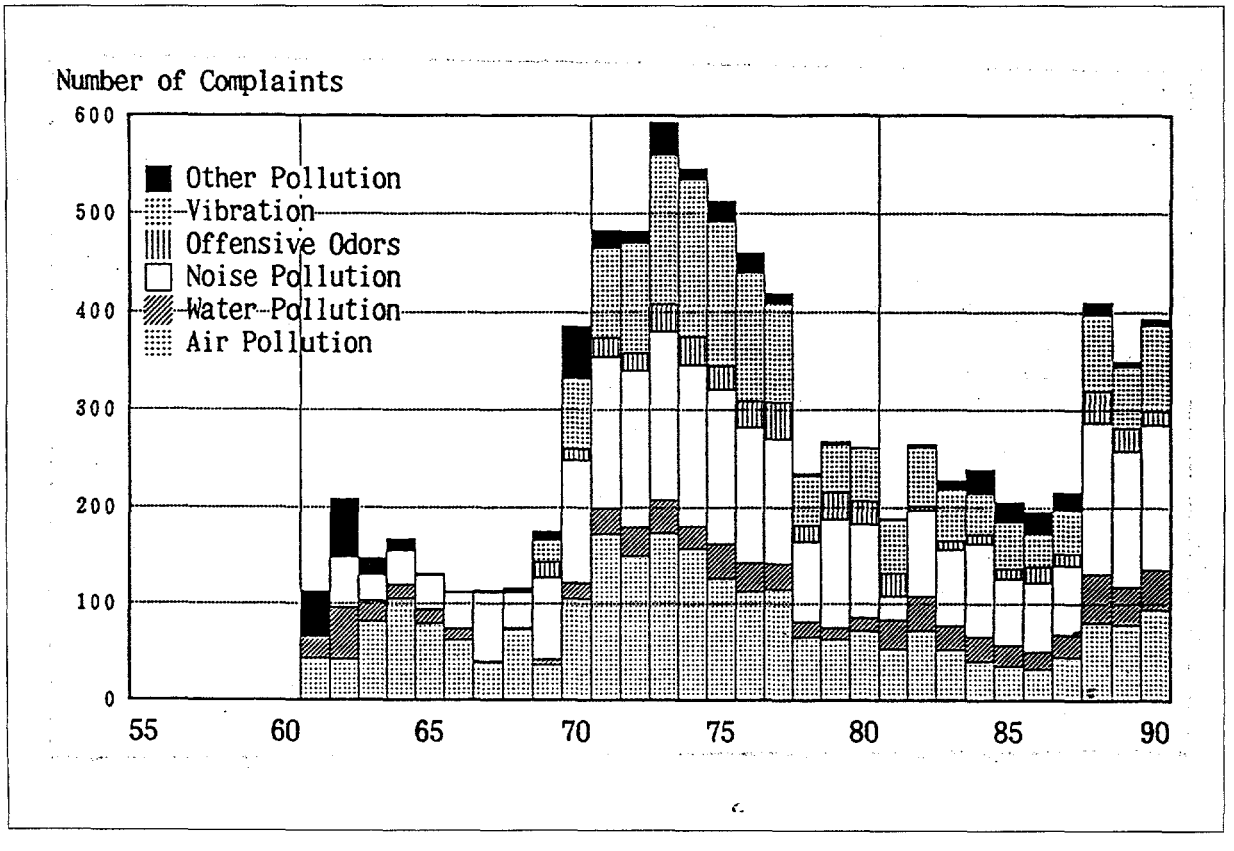


Figure 2-6: Number of Complaints for Environmental Pollution, 1955-90

lution Control Council. In order to establish appropriate pollution prevention measures, first, the accurate assessment of pollution conditions was a prerequisite, and since this need was acutely felt, basic studies such as air pollution surveys as well as studies of the influence of air pollution on health were continuously executed. Moreover, diagnosis and guidance of smoke generation facilities was conducted, air pollution emergency countermeasures were prescribed, and gradually the development and reinforcement of pollution prevention policies was sought.

Air pollution countermeasures Due to the necessity of monitoring conditions pertaining to the standards for emergency situations (smog alarms) prescribed in the Smoke and Soot Control Law, air pollution recorders and anemometers were set up in the three public health centers of Yahata, Wakamatsu and Tobata in 1964, and regular monitoring of pollution conditions was begun. In 1967, the state-sponsored Kitakyushu Air Pollution Monitoring Station was opened on the grounds of the Asahigaoka Hospital in Kokurakita ward.

Although required measures relating to smog situations were prescribed based on the Smoke and Soot Control Law, since they were inadequate, the city autonomously established preventive measures. That is, due to the fact that this city is located far from the prefectural government (situated in the city of Fukuoka) and that assessment of meteorological conditions was difficult since there was no government meteorological office in the city, as an autonomous policy of Kitakyushu aimed at a more accurate and rapid response, the "warning" was established as a measure preceding issuance of the smog alarm. That is, smog countermeasures were divided into preventive measures and emergency measures: it was the governor of Fukuoka prefecture who implemented the emergency measures (smog alarm), but it was the Kitakyushu mayor who announced the preventive measures (smog warning) which constituted the preceding stage.

At the time, regulatory matters pertaining to factories fell under the authority of the prefectural governor, and the city had no authority in this area. Yet, since pollution problems intensified, the city was pressed to develop it own autonomous response. In Kitakyushu, following the founding of the new city, as one element of administrative guidance, experts were entrusted with the conduct of studies and precision diagnoses concerning the structural, operational and maintenance conditions of smoke generating facilities and dust collecting facilities relating to factories and workplaces where there was risk of causing pollution problems and centering on the factories targeted by the Smoke and Soot Control Law. Studies were conducted with the factory management concerning the methods for improvement most suited to the particular facility, and guidance was continued concerning execution of these countermeasures to the extent possible. From the founding of the new city until 1966, facility diagnosis and guidance was applied to 140 factories and workplaces, and reached 813 facilities in real numbers and 1,302 in total numbers.

In place of the full-time "smoke monitoring personnel" who had been employed by the two former cities of Yahata and Tobata, and with the objectives of coping with pollution generation in the city from the standpoint of the city as a whole and seeking the safety of residential life in "emergency situations" and "accident situations," at any time each month the prefectural smoke measurement vehicle would be pressed into operation to conduct pollution patrols, thereby monitoring the dust collection conditions of smoke generating facilities at all factories in the city.

The response to water pollution In Dokai Bay, fishing rights were abandoned in 1956 (from Wakato-Ohashi Bridge to the bay interior), but pollution further progressed thereafter and from about 1965 complaints concerning offensive odors in the bay interior began to occur. The water was laden with pollutants which attacked the hulls and propellers of the ships and significantly shortened their life. With regard to pollution in Dokai Bay, the Municipal Hygiene Research Institute conducted the First Dokai Bay Water Quality Study in 1966. Ten measurement points were established inside the bay, and analysis and study were conducted with regard to twenty-three items. The severity of the pollution became apparent, since, from the center of the bay to its innermost parts, the dissolved oxygen (DO) was zero while the chemical oxygen demand (COD) was a maximum of 36ppm.

Amid worsening pollution in Dokai Bay, the Economic Planning Agency performed the Dokai Bay Study as a prerequisite for conducting water area designation in accordance with the Water Quality Protection Law and regulatory controls in accordance with the Factory Waste Water Control Law. Due to the extremely high COD of the water of the bay interior and the high level of contamination from toxic substances such as cyanogen and arsenic, the bay came to be called "Sea of Death: Dokai Bay" following this study. Based on the results of this study, in 1969, part of Dokai Bay (the bay interior part from Wakato-Ohashi Bridge) was established as a designated water area in accordance with the Water Quality Protection Law.

With regard to river pollution in this city, the major factories are set up in the littoral districts and there are almost no large factories to be found inland. Since the pollution source of the rivers in the city was municipal sewage consisting mainly of domestic wastewater, river pollution countermeasures were to center on improvements in the sewer system.

Transfer of Prefectural Governor's Authority and Establishment of a Pollution Prevention System (1970-1975)

The national response Upon entry into the 1970s, pollution problems took on the aspect of a societal crisis as new forms of pollution were generated due to photochemical smog, lead pollution from auto exhaust gases, cadmium contamination, industrial waste materials, etc. In this context, in the so-called "Pollution Diet" at the end of 1970, thirteen pollution-related laws were enacted or revised, including a partial revision of the Basic Law for Environmental Pollution Control. The first half of the 1970s was a time of major reform in terms of environmental pollution legislation and environmental administration. Internationally, in 1972, the UN Stockholm Conference was held under the slogan of "Our Common Future" and it became generally recognized that the sustainability of the environment was limited.

The response of Kitakyushu In Kitakyushu, as well, keeping pace with these internal and external developments, pollution prevention policies were further strengthened with the primary consideration being the health of the citizenry and the guarantee of a comfortable living environment. In particular, 1970 was placed in context as the "first year of pollution countermeasures," and the city actively tackled the enactment of municipal pollution control ordinances, including broad-based regulations pertaining to facilities not covered by laws or prefectural ordinances, as well as the development of the monitoring system. In February of the same year, a long-held desire of the city was fulfilled as the authority of the prefectural governor prescribed in the Air Pollution Control Law was transferred to the mayor of

Kitakyushu, thus enabling a more rapid and finely detailed response on the part of the city itself.

In 1971, the Pollution Control Bureau was established, and the organizational system for coping with the increasingly diversified pollution was expanded and developed.

On the occasion of the transfer of the prefectural governor's authority to the mayor, in order to seek a good mutual understanding concerning the details of the various air pollution prevention policies of the city as well as the views of the corporations, the "Kitakyushu Air Pollution Prevention Liaison Council" was established in 1970 with a membership consisting of the Fukuoka Trade and Industry Bureau, Fukuoka prefecture, Kitakyushu City, and business establishments. The participating corporations consisted of thirty companies and thirty-two factories (as of that time) which were subjected to controls on sulfur dioxide emission quantities at times of issuance of smog warnings and alarms, and accounted for 97% of the smoke emission quantity of the city. As a liaison organization of the administration and corporations, this council has played a major role with regard to the air pollution policies of Kitakyushu centering on emergency policies.

Pollution Control Agreements in Kitakyushu began with the one concluded with an electric power company at the time of construction of a thermoelectric power plant in 1967. The pollution control agreement was a non-binding administrative means based on the regulations of pollution control ordinances and accepting the agreement of the corporation as security. These agreements raised the efficacy of pollution prevention by dealing with the practical supplementary regulations not covered by law, measures pertaining to unregulated matters, and preliminary checks before commencement of construction. The number of pollution control agreements concluded until 1979 was 155.

In 1972, the "Kitakyushu Regional Pollution Control Program" was formulated, and the city came to comprehensively and systematically implement such policies as the reinforcement of regulations and guidance pertaining to pollution sources, the enhancement of the sewer system and of parks and greenery, the promotion of separation of residential and industrial areas, and the protection of the natural environment.

Air pollution In 1970, the Pollution Monitoring Center was completed inside the city government offices, and a simultaneous notification system was established for the factories targeted in emergencies by installing an air pollution alarm broadcast device inside the said Center. Accompanying this, a special meteorological information reporting system was begun in 1971. In the case where meteorological conditions arise under which it is anticipated that there will occur an inversion layer followed by an increase in the sulfur dioxide concentration and attainment of the emergency level of concentration (0.2ppm), this is reported as special meteorological information to the factories targeted in emergencies (thirty-two factories), which are then requested to reduce emissions of sulfur oxides (by 20%) as a preventive measure. This system is unique to Kitakyushu. Reporting of special meteorological information occurred 34 times in 1971, 37 times in 1972, 23 times in 1973, and once in 1974.

With regard to the emergency measures, notification would be to the factories targeted in times of emergency with use of the air pollution alarm broadcast device, and this would be carried out simultaneously by push-button operations at the Pollution Monitoring Center. The system was also designed so that the reports of completion of the measures at the factories which had received instructions would be displayed on this broadcast device. With regard to implementation of

emergency measures for sulfur oxides, smog alarms were issued nine times and smog warnings seventeen times, with the smog warning of 1972 being the final such occasion. From that time until today, circumstances corresponding to emergency situations have not occurred.

In 1970, pollution patrol cars were established, and along with reinforcement of on-the-spot inspection of smoke generating facilities based on the Air Pollution Control Law, a system was established in which immediate on-the-spot inspections could be executed at times of complaints or accident occurrence. Since strong requests were made from the local citizenry for nighttime monitoring of pollution sources, patrols outside the normal business hours such as nighttime patrols were regularly executed in this city from 1974 onward, and progress was made in the processing of complaints.

Water pollution In accordance with the Water Pollution Control Law which took effect in 1971, a transfer of authority occurred from the prefectural governor to the mayor of Kitakyushu. Not only was the obligation to conduct regular monitoring of public water areas imposed on the city, but also the authority was given to enter factories and workplaces, and the city itself came to conduct a carefully crafted water quality protection administration.

Along with contributing to the amelioration of the urban environment and the improvement of public health , the public sewerage system is an indispensable basic facility for purposes of attaining and maintaining the environmental standards of rivers. In particular, since the main source of pollution of the rivers of this city was domestic sewage, the improvement of water quality was largely dependent on the development of the sewerage system. Beginning with the 2nd Five-Year Program for Sewerage Construction enacted in 1967, public sewerage projects were tackled in earnest.

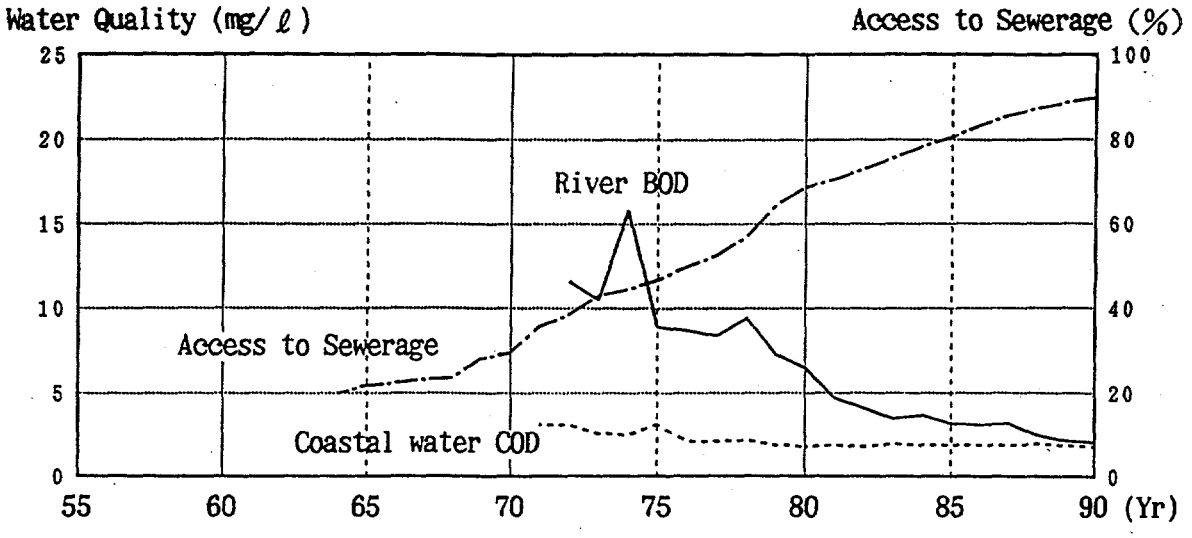
Moreover, the Dokai Bay cleanup project, which became one of the major undertakings relating to the pollution control policy of this city, was also executed. As a radical measure in the cleanup of Dokai Bay, in parallel with the regulation of industrial waste water and development of the sewerage system, dredging of the sludge which had accumulated in the bay interior for over half a century was conducted. With regard to the dredging costs, applying the Law Concerning Entrepreneurs' Bearing of the Cost of the Public Pollution Control Works as the portion of accumulated sludge dredging deriving from industrial waste water, 71% of the total project cost of 1.8 billion yen was borne by corporations; as the portion of dredging deriving from the domestic sewage and river water, the remaining 29% was borne by the nation (1/2), the prefecture (1/4) and the city (1/4). The dredging project was begun in 1973, and terminated in 1976. In addition to monitoring the dispersion of sludge accompanying dredging operations and the influence from the sludge disposal areas on runoff water and ground water, fish were extracted and the influence of heavy metals was studied, thereby aiming to cover all eventualities in secondary pollution prevention.

The Active Development of Pollution Control Policies (mid-1970s to early 1980s)

In the latter half of the 1970s, the effects of environmental pollution improvements gradually began to appear as the result of positive policies such as the enactment of pollution prevention laws and ordinances, the reinforcement of regulations, and the development of monitoring systems. In the atmosphere, first sulfur oxides and then nitrogen oxides reached the environmental standards at all observation stations, as contamination due to industrial pollution underwent major improvement.

Air pollution In sulfur oxide regulation by law and ordinance, the emission quantity was regulated ac-

Figure 2-7: Water Quality in Public Waters and Access to Sewerage by Residences, 1955-90



cording to the height of the exhaust port in each facility, which was so-called "K-value regulation[1]." For the facilities targeted by law which were newly established from April 1974 onward, the K-value was set at 1.75, which was the second strictest level in the nation.

By a legislative revision of 1974, as a measure for attainment of the environmental standards, a system of total pollutant volume control of sulfur oxide was introduced. Accompanying this, the district of Kitakyushu, etc. (including Kandamachi) was designated as a zone for regulation of the total volume controls of sulfur oxide. The regulatory standards pertaining to the total emission of smoke and the standards for fuel consumption were announced in the pertinent designation. Furthermore, in this city, in order to supplement the legislated regulation of total emission, the target for ground level concentrations of less than 0.007 ppm per company was established based on the results of wind tunnel tests and pollution control agreements relating to sulfur oxide were concluded in one batch with the fifty-seven major factories in the city in 1977.

With regard to nitrogen oxides, from the first Regulation of 1973 which targeted large-sized facilities to the fifth Regulation of 1983, there occurred an expansion in the types and scale of the targeted facilities and a strengthening of the emission standards. So as to control emissions in diluted concentrations, a method was adopted which compensated according to the residual oxygen concentration in the emission gas.

In this city, it was thought to be difficult to maintain in the future environmental standards pertaining to nitrogen oxide only on the basis of legislated uniform national standards, and in 1985 the "Kitakyushu Nitrogen Oxide Countermeasures Guidelines" was enacted. Based on the guidelines, the total emissions of nitrogen oxide from large-scale factories were regulated, while the other factories were guided to implement nitrogen oxide reduction measures such as the in-

troduction of low NOx burners. In this way, it was sought to maintain the environmental standards.

Water pollution In 1978 in the Water Pollution Control Law, a system of areawide total pollutant volume control was introduced as a water quality protection measure with regard to large closed water bodies and especially the Seto Inland Sea. In the Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea, measures were incorporated for the prevention of damage due to eutrophication and protection of the natural seashore. In 1985, the regulation of nitrogen and phosphorus in lakes and marshes was executed. In this city, twelve lakes and marshes were targeted for regulation, and the businesses establishments located within their basins were subjected to effluent standards for phosphorus. In this city, the "Kitakyushu Synthetic Detergent Countermeasures Promotion Council" was established in 1980, and the citizenry was guided and educated to use non-phosphorus detergents such as soap.

Projects for the separation of residential and industrial areas

In this city, there exist many large-sized corporations and their related small-and medium-sized corporations belonging to the iron and steel industry, chemical industry, etc. There are many so-called "mixed residence and industry districts" which consist of small-scale factories intermingling with residences and which exercise much influence on the life of the citizenry in terms of the serious problem of noise pollution. For this reason, in the "Kitakyushu Regional Pollution Control Program," the Tobata-Okidai district was taken up as a district for the promotion of "residence and industry separation," and from 1974 to 1984 the collective moving of factories occurred as a part of the pollution control project. Accompanying this, environmental development of roads, water supply and sewerage systems, public parks, etc. was conducted in relation to the creation of industrial parks in the city.

Furthermore, in the "Kitakyushu Regional Pollution Control Program," the Shiroyama district and Okudokai district of Yahata-nishi ward were taken up as areas for the execution of the Dokai Buffer Green Belt Project, and the creation of comfortable community was planned based on separation of residence and industry. It was decided to incorporate this project into the urban plan in 1979, the project was conducted by Japan Environment Corporation at a total cost of approximately 12.6 billion yen, and completed in 1985.

From Pollution Prevention to The Creation of a Comfortable Environment (1980s)

Accompanying the progress in urbanization and the change in lifestyles, traffic pollution beginning with automobile pollution as well as urban living type pollution such as neighborhood noise, have proliferated. The consciousness of the people has come to seek an affluent and comfortable environment. From a focus on pollution countermeasures, the emphasis of pollution administration has shifted toward the quest to actively create a comfortable environment and to seek the improvement of environmental quality as a whole.

In order to preserve a good urban environment, this city not only actively advanced with the prevention of industrial pollution, but also with the large-scale creation of urban greenery based on the "Green Kitakyushu Plan." As a result, in the 1985 environmental white paper of the Organization for Economic Cooperation and Development (OECD), Kitakyushu was introduced to the world as a city which had been transformed from a "city of gray" to a "city of green."

In 1986, from the viewpoint of appropriate protection and use of limited environmental resources such as air, water and living creatures, the "Kitakyushu Environmental Management Plan" was formulated with the goals of preventing pollution, protecting the natural environment, and developing a comfortable environment. In contrast to previous environmental policies which had been separate and curative, this plan based itself on the standpoint of actively raising urban comfort and possessed a more comprehensive and preventive character— with a long-term perspective, it presented the goals to be reached and the policies required with regard to the quality of the environment. In order to implement this plan concretely and effectively, "implementation guidelines concerning matters to be taken into account in use of environment" were prescribed. Based on the implementation guidelines, the number of cases reported and deliberated upon until 1991 was 397, and the number of those submitted in environmental deliberation reports was 96.

The "Kitakyushu Automobile Pollution Control Basic Plan" was formulated in 1989 to clarify the methods for comprehensively and systematically executing the various measures related to automobile pollution policy from the intermediate and long-term perspectives.

In the "Star Light Town Contest" conducted by the Environment Agency in 1987, this city was selected as a "star light town" due to its excellent air environment. At present, in Dokai Bay, more than 100 species of fish such as prawn and black porgy have been confirmed, and in the Murasaki River which flows through the city, natural sweetfish and the spawning of the white goby have been observed.

The Advancement of International Environmental Cooperation (1980s-1990s)

In this city, as a result of the process in which citizenry, corporations, universities and administration united to overcome the formerly severe environmental pollution, many experiences and technologies have been accumulated relating to pollution prevention, energy conservation, recycling of resources, etc. In order that these experiences and technologies might be of use to the developing countries which are struggling with the same problems, this city has actively advanced with international cooperation in the environmental field involving international group training, the dispatch of experts, the holding of international conferences, etc.

Overcoming pollution and the development of international environmental cooperation by this city has received global recognition, and in 1990 it was presented with the "Global 500" award by United Nations Environment Programme (UNEP). Moreover, at the "United Nations Conference on Environment and Development (UNCED/Earth Summit)" held in Brazil in 1992, it was awarded the "United Nations Local Government Honors."

Upon receipt of a commission from the Japan International Cooperation Agency (JICA), the Kitakyushu International Training Association (KITA) (which in 1992 changed its name to "Kitakyushu International Techno-cooperative Association") established an "Industrial Pollution Control Engineering Course" beginning in 1986, and an "Industrial Waste Water Treatment Technique Course" beginning in 1988. With regard to the management of these courses, this city has actively cooperated in executing the dispatch of instructors and practical training. Upon receipt

of a commission from JICA, beginning in 1990, this city established the three courses of "Domestic Waste Water Treatment Technique Course," "Air Pollution Source Monitoring Practice Course" and "Waste Management Practice Course." As for the degree of implementation of the international group training courses conducted by this city and KITA, 27 countries and 123 people had participated by 1991.

In this city, technical experts in the environmental protection field are being dispatched to Asia and Central and South America, and technical guidance is being provided locally. Since 1981, upon the receipt of requests from organizations such as the Japanese government, JICA, UNEP, WHO, etc., a total of thirty-three people have been dispatched to fourteen countries.

In order to advance still more effectively with international environmental cooperation in this city, in 1991, the Kitakyushu International Environmental Cooperation Study Committee proposed the establishment of a "Kitakyushu International Cooperation Center for Environment" which would constitute the core of such activity. On the basis of this proposal, and as the result of deliberations with the administrative organs concerned, it was concluded that it would be appropriate to reinforce KITA and to establish the said Center with KITA as the parent organization. Thus, in August 1992, the KITA Environmental Cooperation Center was founded. International environmental training, the dispatch of experts, and planning studies have commenced at the said Center.

Formerly a city of pollution, this city has come to achieve international recognition for its environmental protection efforts. Hereafter, as well, basing itself on the "Kitakyushu Renaissance Concept," this city will not only protect an excellent regional environment and proceed with a variety of efforts to create a comfortable environment, but will also continue to actively drive forward with international environmental cooperation targeting the developing countries.

Organization And Education Pertaining To Environmental Protection

In this section, the establishment and evolution of the organizations which have implemented the environmental protection policies of Kitakyushu are described.

Hygiene Administration During the Period of the Former Cities of the Kitakyushu Area

As a result of the wave of industrialization and urbanization which swept over the Kitakyushu area, in each of the former cities there occurred urban hygiene problems involving the water supply system, sewer system, refuse, and night soil. With regard to the water supply system, with the exception of the city of Moji which could seek its water source in the immediate vicinity, each city suffered distress and agonized over how best to handle the situation. In Tobata, Wakamatsu and Yahata, it was ultimately necessary to cope by using part of the industrial water of the Yawata Steel Works in the water supply system. In Wakamatsu, a filter basin and a distributing reservoir were set up in Tobata on the opposite shore, and an underwater iron pipeline was laid which traversed Dokai Bay from there in order to supply the water. At the time, water quality inspection of the tap water were being conducted by the prefectural agencies and the municipal hospitals.

With regard to the sewerage system, there were no final treatment plants such as now exist, and the raw waste water was discharged into the ocean without treatment, although sewer pipes and ditches were developed in each city. For example, Wakamatsu commenced development of a sewerage system in 1918, while Tobata undertook to do so upon receipt of authorization to construct a sewerage system in 1958. As for refuse disposal, it began to become a problem from about 1900 when the Filth Cleaning Law went into effect, and a shift occurred away from methods involving landfills of raw refuse and open burning to the incinerator method. Incinerators were constructed in 1904 in Wakamatsu, in 1922 in Tobata, and in 1927 in Moji. In response to these trends, the administrative organization was also developed. For example, in Wakamatsu, refuse disposal had previously been under the control of the General Affairs Section, but in September of 1932 the Sanitation Section was established to exclusively handle this matter. In Tobata, the development of a sewage treatment system was sought from 1931 onward. Moreover, with regard to treatment of night soil, although it had previously been treated as manure in the neighboring farming villages, this type of treatment became increasingly difficult since the amount produced increased along with rises in the population density, and other methods were introduced such as removal to farming areas outside the city by transport vessels and disposal by discharge into the sea.

Thus, the capable personnel required to maintain the urban sanitary environment existed in the sanitation administration organs of each city. As a result, when the severe industrial pollution occurred from the 1950s onward, the responsible people in the waterworks administration came to handle the pollution countermeasures, and were able to function as competent personnel.

The Organization and Education Pertaining to Environmental Protection

The evolution of the administrative organs dealing with pollution countermeasures The departments having jurisdiction over pollution countermeasures in Kitakyushu have the following history. As an air pollution prevention measure, the Kitakyushu Five City Air Pollution Prevention Policy Committee was organized in May of 1959, and commenced studies of the amount of dust fall and pollution distribution of sulfur oxides and iron oxides. It also conducted liaison coordination among the cities and sought the integration of measurement methods. Full-time "smoke monitoring personnel" had been employed by the former cities of Yahata and Tobata, but their functions were abolished due to the union of the five cities. Thereafter, with the objective of dealing with pollution generation in the city from the standpoint of the city as a whole, and seeking the safety of residential life in times of emergency or accident, the dust collection conditions of smoke generating facilities at all factories in the city were monitored by sending out a prefectural smoke measurement vehicle to conduct pollution patrols at any time each month. In February 1963, simultaneous with the union of the five cities, a pollution unit was established in the Public Health Section of the Sanitation Bureau, and pollution administration was unified. The pollution unit was launched with four staff members under the unit head.

On September 1, 1963, Kitakyushu received the first regional designation of the "Smoke and Soot Regulatory Law." There were loud voices calling for the reinforcement of pollution countermeasures, the necessity of which was also emphasized in the report of the "Kitakyushu Master Plan Basic Program," and further pointed out in the preliminary report of

Kitakyushu Pollution Prevention Policy Council. As a result, the Pollution Control Section was established in the Sanitation Bureau on September 10, 1965, consisting of eight staff members under the section chief. Thereafter, the number of personnel was gradually increased accompanying the intensification of pollution across the entire city. Furthermore, due to the enactment of the Basic Law for Environmental Pollution Control (1967), the implementation of the Air Pollution Control Law (1968), the regional designation based on the Noise Control Law (1970), and the transfer of the authority of the governor of Fukuoka prefecture to the mayor of Kitakyushu in 1970 based on the Air Pollution Control Law, it became necessary to effect the further reinforcement of the pollution administration organization. As a result, on April 1, 1970, the Pollution Control Department (twenty staff members under the department head) was launched with a two-section organization.

In 1970, there occurred the promulgation of the Law Concerning the Settlement of Environmental Pollution Dispute, the establishment of the Central Pollution Control Headquarters, and the approval of fourteen pollution-related bills in the "Pollution Diet." The incorporation of pollution countermeasures into legislation advanced nationwide, and the Environment Agency was established as part of the national government on July 1, 1971. Five days prior to this, on June 26, 1971, the Kitakyushu Environmental Pollution Control Bureau was launched. The organization of the Environmental Pollution Control Bureau at the time of its inception followed the three-section system, with forty-seven staff members under the Bureau chief. Thereafter, the organization of the Environmental Pollution Control Bureau expanded, and at its peak in 1975 it had come to number some seventy-nine staff members under the Bureau chief. In April 1990, the Environment Bureau which integrated Environmental Pollution Control Bureau in charge of pollution control measures and the Environmental Services Bureau which integrated the waste treatment administration were unified, and began anew as the Environment Bureau.

The beginning of research institute of hygiene On June 1, 1965 approximately three months before establishment of the Pollution Control Section in the Sanitation Bureau, the Research Institute of Hygiene was set up in the same Bureau (nine staff members under a Deputy Director). In addition to conducting studies and research for hygiene administration, it also commenced analyses, studies and research in the pollution field in order to respond to the intensifying pollution. As a result of the establishment of this research institute, it became possible to conduct autonomous studies in Kitakyushu for purposes of elucidating the true state of affairs with regard to pollution. Thereafter, in order to cope with the wide-ranging demands of the local citizenry, the said research institute was reorganized in March 1974 as the Municipal Institute of Environmental Health Sciences, and expanded and developed its functions to cover studies and research, test analyses, guidance training, as well as the collection, analysis and distribution of information materials; it has continued in this form to the present day. In April 1993, the Municipal Institute of Environmental Health Sciences, which had until then been attached to the Public Health Bureau (the former Sanitation Bureau), was placed under the control of the Environment Bureau in order to better respond to the needs of a new era of global environmental protection.

The evolution of the waste treatment administrative organization At the birth of Kitakyushu in February 1963, the administrative organization relating to waste treatment began as the Public Cleansing Section in the Sanitation Bureau of city hall; there were eight staff members under the section chief. The collection and transport divisions belonged to the ward offices which preserved the names of the former cities and the old organization continued without alteration; there was no integrated organization for the new city. Thus, the job of the newly launched organization was to correct the disparities between wards which constituted the legacy of the former five cities, and it was necessary to reinforce the organizational system in order to have a unified development across the entire city. In 1964, the Public Cleansing Section of the Sanitation Bureau was raised in status to the Public Cleansing Department, and the public cleansing sections attached to the various ward offices were modified into cleansing operation offices.

In the following year of 1965, in order to seek development of an organization which had become a dual system of city hall and the ward offices, the city hall organization became independent of the Sanitation Bureau; a Waste Management Bureau integrating refuse and night soil treatment projects was established, and was launched with a three-section organization. The cleansing operation offices which had been attached to the ward offices and the incinerator plants were transferred to the control of the Waste Management Bureau, and a system of centralized integration of sanitation projects was put in order. In 1968, the three-section organization of city hall was expanded into a two-department and four-section organization.

The 1960s was a period of high-level economic growth which resulted in a marked increase in industrial waste, and the waste treatment process engendered environmental pollution which developed into a grave societal problem. The Waste Disposal and Public Cleansing Law was put into effect in order to respond to these problems, and, in conjunction with this, the Industrial Waste Management Section was established in Kitakyushu in 1972. In 1982, the name of the "Waste Management Bureau" was changed to "Environmental Services Bureau." In April 1990, this was integrated with the Environmental Pollution Control Bureau, and was newly launched as the Environment Bureau, in which form it presently operates.

The education of personnel involved in environmental protection With regard to the education of personnel involved in environmental protection, as with the other self-governing communities of Japan, the main method followed in Kitakyushu is the OJT(on-the-job-training) method, that is, the method in which one follows one's senior colleagues in their daily duties to acquire knowledge of the law, and participates in on-the-spot inspections of corporations in order to learn the proper inspection procedure. In this context, new personnel gain practical administrative knowledge and learn the methods of technical guidance, and later transmit them, in turn, to other junior personnel.

Moreover, in order to study the administrative system of the national government and to put this knowledge to use in local administration, an educational program has been conducted in which several staff members are dispatched for one to three year periods to the Environment Agency, for example, where they learn its administrative practice.

Endnotes

[1] "K-value regulation": Standard for SOx emission decided using the following equation by inserting a value K, specified for the region that the facility is located. The smaller the K-value is, the stricter the regulation is.

$Q = K \times 10^{-3} \times He^2$ Q = hourly volume of SOx emitted (Nm^3)

K = The number fixed for each area

He = effective height of smoke stock

In this chapter, among the environmental protection measures of Kitakyushu described in summary form in Chapter 2, we select some cases characteristic of Kitakyushu, some cases of effective operations, and other important cases, and describe the factors which influenced the policy decision-making.

Major Countermeasures Pertaining to Environmental Protection

This section, considers the characteristics of the environmental protection measures executed in Kitakyushu, and the factors which induced their adoption.

The Transfer of Authority to the Local Self-Governing Bodies and Its Effects

The following passage is excerpted from "The History of Pollution Administration," published in 1981 by the Kitakyushu Environmental Pollution Control Bureau.

"With the occurrence of dense fog from about 8:00 pm, we have had a flood of telephone complaints from the residents of the various wards, and one person cannot handle them all. You are requested to report to work. It seems that the bureau, department, and section chiefs are also coming to work." This telephone summons from the Pollution Monitoring Center occurred at 10:30 pm. on a certain day of April 1973. Outdoors, all was covered by a milky white fog. Visibility was only several tens of meters, and by the time the taxi approached Kokura, it had become only several meters.

At the Pollution Monitoring Center, we feverishly responded to the telephone complaints. "The odor is terrible," "my eyes hurt," "my throat is sore," "it's suffocating" or "this fog is terrible; is it smog or what?"— such telephone calls were received in quick succession for a period of almost 2 hours, amounting to a total of 30 cases centering on Kokura, Tobata and Yahata. At the time, a fog warning had been issued in the prefecture, and a forecast had been made that "we have weak wind and poor visibility; hereafter, this situation will further worsen." Moreover, the observation from Mt. Sarakura had noted the occurrence of a large inversion layer across the entire stratum. A 20% reduction in sulfur oxides had been requested from all observation stations; 24 hours later, an emergency reduction of 40% was requested.

These circumstances show the struggle with severe air pollution, but what is here noteworthy is the authority which enabled a local self-governing body on the city level to demand that corporations reduce sulfur oxides which are directly connected to the production process. This "smog alert issuance authority" which was transferred to Kitakyushu alone— the only such case in Japan— has been touched on in Chapter 2. The following sections are the circumstances which led up to the transfer of this authority to the city, and at the effects thereof.

Smog warnings based on the Smoke and Soot Regulation Law In the "Smoke and Soot Regulation Law" enacted in June 1962, measures to be taken at times of smog occurrence are prescribed. In Kitakyushu, due to the distance from Fukuoka which is the seat of prefectural government and to the lack of any government meteorological office, the assessment of meteorological conditions was difficult. For this reason, although emergency measures at times of smog occurrence were conducted based on the law, as a preliminary step, a warning system unique to this city was established wherein the cooperation of each factory was requested. Thus, countermeasures were developed with the emphasis placed on prevention.

That is, the so-called "smog-control measure" was divided into preventive measures and emergency measures; at the level of preventive measures, it was enforced at the request of the Kitakyushu mayor, while in the case of emergency measures, it was enforced on the order of the governor of Fukuoka prefecture based on the law. With due consideration to the social repercussions of the semantic nuances pertaining to emergency measures, the former was termed "smog warning" and the latter "smog alert."

In the case where there is judged to be an emergency, the prefectural governor must publicize the situation in the form of a smog alert and must obtain the cooperation of smoke emitting facilities with regard to the reduction of smoke emissions. According to the ministerial ordinance, this emergency situation occurs when the content of sulfur dioxide and sulfuric anhydride in the atmosphere is at or above 0.2 ppm for a continuous period of three hours, or at or above 0.3 ppm for a continuous period of two hours, and applies to one of the following cases. That is, (1) when a dense fog warning has been issued by the Meteorological Agency; (2) when a marked inversion in atmospheric temperature has been noted; (3) when the mean wind speed at ground level is 3m/sec or less during early morning or evening, and when it is forecast by the Meteorological Agency that the wind will be continuously weak; (4) when it is clear from meteorological conditions that the content of sulfur dioxide and sulfuric anhydride in the atmosphere will continuously exceed 0.2 ppm.

In contrast to this, internal regulations permitting the mayor of Kitakyushu to issue smog warnings were instituted in 1964. According to these, this occurs in the case where a concentration of sulfur dioxide and sulfuric anhydride in the atmosphere at or above 0.2 ppm continues for two hours at two or more measurement points among the standard measurement points (the public health centers of Yahata, Wakamatsu, and Tobata), and applies to one among the following cases. That is, (1) when a dense fog warning has been issued; (2) when wind speed is at or below 1.5m/sec.

With regard to the content of the cooperation requested of corporations when an alert or warning is issued, in the case of an alert, it is provided that "upon consultation with the prefecture and the Trade and Industry Bureau, specific items will be presented, and cooperation be requested respectively." In the case of a warning, it is provided that "(1) good-quality fuel will be used, there will be no unwarranted burning, and suitable heat control will be conducted; (2) self-restraint will be practiced with regard to unnecessary nonurgent combustion."

Smog alerts based on the Air Pollution Control Law In the "Air Pollution Control Law" enacted in 1968 in order to reinforce the Smoke and Soot Regulation Law, as an emergency measure, it is stipulated that "when a situation occurs which falls within the purview of a case prescribed in government ordinance as a case in which air pollution has rapidly become prominent due to the influence of weather conditions so that serious damage is inflicted on human health or the living environment, the prefectural governor may order smoke emitters to reduce the quantity or concentration of the smoke, limit the use of the smoke generating facilities, and implement any other required measures." Following the pattern of the Smoke and Soot Regulation Law, this authority relating to the so- called "smog alert issuance" is made the authority of the prefectural governor. The practical application of the law was conducted according to the "Fukuoka Prefectural Air Pollution Emergency Countermeasures Execution Guidelines" issued in July 1969.

According to these guidelines, the issuance standards for smog alerts are stipulated as the case in which any one of the following (1) to (4) applies to the sulfur oxide concentration and when it is recognized based on meteorological conditions that this situation will continue. That is, (1) in the case of 0.2 ppm or more for a continuous period of three hours at one measurement point, and when 0.2 ppm or more is reached at one or more other neighboring measurement points; (2) in the case of 0.3 ppm or more for a continuous period of two hours at one measurement point, and when 0.2 ppm or more is reached at one or more other neighboring measurement points; (3) when 0.5 ppm or more has been reached at one measurement point; (4) when the average value over forty-eight hours at one measurement point has reached 0.15 ppm or more. In the case where an alert is issued, measures for smoke quantity reduction of 20-50% can be recommended to smoke emitting corporations.

As during the time of the Smoke and Soot Regulation Law, in order to resolve problems of distance from the prefectural government, this city was limited to the capability of issuing warnings which constitute the stage preceding smog alert issuance. The issuance standards for smog warnings were somewhat strengthened, but the content of the requests made to corporations at the time of issuance remained the same as under the Smoke and Soot Regulation Law. It was an important development that twenty-six municipal employees were commissioned by the prefectural governor to conduct on-the-spot inspections and assessments of corporations during emergency situations, thus enhancing the response system.

At such times, a crisis situation developed in Kitakyushu with regard to whether or not smog alert issuance should be sought. For residents, the issuance of an alert was an announcement that special care needed to be taken concerning health, and was akin to a martial law decree. The mass media would be certain to sensationalize it, and the demands of the local citizenry *vis-a-vis* the administration would become great. In response to this, administrative guidance of the corporations would have to become severe. Thus, the matter of whether or not to issue an alert not only concerned publicizing the gravity of the actual situation, but also the necessity of raising the level of response.

The first issuance of an alert occurred on May 8, 1969. On the morning of this day, the concentration of sulfur dioxide reached the value designated for alert issuance. Prior to this, there had been other cases of attainment of high values, but although on such occasions this was reported to the prefecture, there had been no smog alert issuance since it was decided in view of the meteorological conditions to await further developments. On this day, however, Kitakyushu made the major decision of requesting the prefecture to take action, and the first smog alert issuance occurred. The alert was issued over a continuous period of three days, and the city was in an uproar. It was reported in large front-page headlines in the press, and the telephones rang incessantly in the responsible administrative offices. The responsible administrators of that time recall that staff members ran about as if a war had started. One effect of the alert issuance was to impart a shock which awoke everyone in the city and created a feeling of solidarity among the city council, city executive, and the local citizenry.

Transfer of smog alert issuance authority to the city At that time, the view emerged in Kitakyushu and at the national level that, in the case of Kitakyushu alone, it would be beneficial to transfer the smog alert issuance authority of the prefectural governor to the mayor. In those days, it took more than an hour to travel from Fukuoka city the seat of the prefectural government in Fukuoka, and entry

onto the premises of a pollution generating source could not be done without the arrival of a prefectural official. There was thus a time loss problem such that effective on-the-spot inspections could not be conducted. This was because it was often the case that atmospheric conditions had changed by the time of arrival after one hour.

Thus, in order to effectively and efficiently conduct issuance of smog alerts, the city strongly requested to the prefecture and the national government that the issuance authority be transferred to the mayor of Kitakyushu which was the locality of the pollution generation, and that it be allowed to create the required organizational system to implement the countermeasures. The Kitakyushu City Council also began to work in this direction with the city executive. By this time, the city had some practical experience of alert issuance, had seen its great effect, and had come to understand somewhat its method of implementation. The city had thus begun to feel confident that, if it came to actually possess the issuance authority, it would be able to execute it. The national government immediately began a study of the matter. At that time, Dr. Michio Hashimoto, who was head of the Pollution Control Division of the Ministry of Health and Welfare, visited Fukuoka prefecture and took upon himself the job of persuasion. On the way back to Tokyo, he stopped at Kitakyushu and summoned the head of the Sanitation Bureau to whom he spoke as follows: "I have gone to the prefectural government, and have obtained their consent to transfer the emergency issuance authority to the city. But does Kitakyushu have the confidence to do this? I'm returning now to Tokyo to draw up the government ordinance, but before I do, I want to confirm this." In response, Kitakyushu expressed its confidence with regard to the performance of this task. In this way, in February 1970, the transfer of smog alert issuance authority to Kitakyushu occurred, the only such case in the nation.

Establishment and operation of a special meteorological information system In the city, upon receipt of this authority, the "Kitakyushu Air Pollution Emergency Measures Implementation Guidelines" were immediately enacted, and were put into effect on April 1, 1970. This was enacted for the case of actual issuance of the alert in order to determine the details of the required issuance standards, the liaison and guidance system, and the publicly recognized methods for cancellation, and to seek smooth implementation. That same month, the "Air Pollution Telemeter Central Monitoring Station" was established, the number of personnel handling on-the-spot inspections was increased, and an organization capable of responding to emergency situations was prepared.

Since the generation of high concentrations of air pollution is influenced by meteorological conditions such as the occurrence of an air temperature inversion layer and weak windspeed, a remote-reading thermometer which measures air temperature according to altitude was set up on the slope of Mt. Sarakura, and observation of air temperature inversion layers was commenced. Thus, a so-called mini-meteorological station was established which supplemented the observation data of the Fukuoka District Meteorological Observatory and the Shimonoseki Meteorological Station, and the system for assessing the weather conditions of Kitakyushu was fine-tuned. The weather information from the Fukuoka District Meteorological Observatory and the Shimonoseki Meteorological Station, the results of observation of inversion layers on Mt. Sarakura, and the wind direction, wind speed, and air pollution concentration given by the air pollution monitoring stations were all collated in the "Air Pollution Telemeter Central Monitoring Station." From the evolution over time of this data, it became possible to forecast to some degree the occurrence of high concentrations of air pollution.

On the other hand, once high concentration air pollution had occurred, there was little immediate improvement from the reduction of smoke emissions, the alert and warning would continue over a long period, and not only would there be a major influence exercised on the health of the citizenry, but also restrictions on corporate industrial activity would occur. As a result, the necessity of preventing occurrence of high concentration air pollution by taking early countermeasures came to be recognized by both the administration and the corporations. For this reason, when there occurred an air temperature inversion layer along with weak wind speed, this was simultaneously reported as "special weather" to the factories targeted in emergency situations with the request that preparations be made for a reduction in smoke emission quantity. If a uniformly high concentration were then to occur, a 20% reduction in smoke emissions would be requested.

Based on the experiences obtained from the observation of meteorological conditions and the circumstances of air pollution occurrence as well as the different effects caused by reduction timing, preventive measures were enforced while consultations between the administration and corporations advanced, and fixed rules were developed and established as the "Special Meteorological Information System." This was the key policy incorporated into the 1971 revision of the "Kitakyushu Pollution Control Ordinance."

As a result of the thirty-four notifications of "special weather information" made in 1971, there was only one "smog warning" issued that year compared to the twenty-six issued in the preceding year. Compared to the standard for warning issuance which was 0.15 ppm sulfur dioxide concentration, the standard for issuance of "special weather information" was 0.07 ppm. From the corporate viewpoint, this might appear to be simply a matter of substituting management by stricter standards, but there was a good reason for the corporations to follow this method.

The characteristics of the Kitakyushu air pollution of that time were the common ones of old industrial cities with many low smokestacks; in the evening, when the wind is weak and an air temperature inversion layer occurs, pollutants accumulate under the inversion layer; the following day, when an atmospheric convection current arises due to the sunlight, the pollutants are stirred up and fall to the ground, causing occurrence of high concentration pollution. Consequently, once high concentrations occurred, reductions in smoke emission quantities had little effect, and since this high concentration pollution would continue over a long period, not only would the expense of countermeasures be extremely large for the corporations, but also there was the danger of the actual curtailment of operations. In contrast to this, focusing on the occurrence of special weather conditions at low levels of pollution, it became possible to prevent the occurrence of high concentration pollution by taking steps to reduce emissions in advance, and this effectively reduced the expense of countermeasures for corporations.

The matter of the reductions was a request and possessed no clear legal force; they were agreed upon as the result of discussions between the corporations and the administration. Finally, it may be said that effective application was achieved when the mayor came into possession of the authority to issue emergency measures. As a result of thorough on-the-spot inspections of factories during ordinary times, the system was made known to every workers at the factory sites targeted by smoke emission reduction measures, and the conditions of execution were confirmed; this process became the motive force supporting the system.

The effects occasioned by the transfer of authority to a local self-governing body The transfer of

authority to a local self-governing body which was the site of pollution generation brought about major effects in terms of antipollution policy. Notably, there began to develop a sense of involvement among the city council, administration, corporations and residents, and that a feeling of solidarity was fostered. Japanese culture has been referred to as a "shame culture." In this type of culture, with regard to the social reaction in a community, it is rather difficult to initiate action due to the conservative character of the society, but great progress is made once something has been authorized within the community. With the consignment of authority from the national government pertaining to smog alert issuance authority, Kitakyushu had taken in hand a so-called "weapon of last resort." With this in hand, it adopted effective countermeasures one after the other, and its ability to steadily implement them was, in fact, conditioned by the above-mentioned characteristics of Japanese society.

A "weapon of last resort" is brandished behind one to tacitly communicate to the adversary that it is a powerful weapon to be used when all else fails. This is its effect. Accordingly, the repeated issuance of smog alerts would not only dilute this effect, but would also tend to damage the trust of the local citizenry. Moreover, it would induce a questioning attitude on the part of the citizenry and the municipal council with regard to the city's policy, regulations and guidance vis-a-vis the corporations. Above all, it would lend itself to the judgment by the national government, which had made the transfer of authority because it trusted in the city's executive ability, that the city's actions were "unwarranted." Practically speaking, it was necessary that the emphasis be shifted to countermeasures at the stage preceding smog alert issuance. This was the background to the birth of the "special weather information system" which is a system unique to Kitakyushu.

With regard to the effects of the transfer to Kitakyushu of smog alert issuance authority, in addition to the adoption of such preventive measures, the system of responsibility pertaining to pollution prevention became clearly defined between the administration and the corporations, and the consciousness of government staff and corporate personnel regarding pollution management was much enhanced. For example, in some corporations, pollution monitoring personnel were provided who conducted visual pollution monitoring, and a system was established capable of responding rapidly to requests for pollutant reduction from the city which could occur at any time. It may also have been the impetus for the establishment of pollution prevention systems in corporations. In this way, the transfer of authority to the local self-governing body controlling over the pollution generation sites was able to produce many effects.

Table 3-1: Issuance Standards for Smog Alarms

Name of proclamation	Issuance standards	Zone of issuance	Issuer	Measures vis-a-vis smoke emitters smoke quantity		Cancellation standards
				above $10Nm^3/h$	below $10Nm^3/h$	
Smog Warning	In the case where any of the following (1) to (3) apply, and it is deemed based on meteorological conditions that this condition will continue. (1) When 0.2ppm or more (refers to sulfur dioxide concentration; hereinafter the same) continues for 2 hours at 1 measurement point, and when 0.15ppm or more continues for 2 hours at 1 or more other neighboring measurements points. (2) When 0.3ppm or more is reached at 1 measurement point, and 0.15ppm or more continues for 2 hours at 1 or more other neighboring measurement points. (3) When the 24 hour average value of 1 measurement point becomes 0.15ppm or more.	districts where the pertinent concentration has appeared	Mayor	smog warning issuance; request for 10% reduction in smoke emission quantity		When it has become less than 0.15ppm at the pertinent measurement point, and it is deemed based on weather conditions that there will be further decrease
Smog Alert No. 1 Regulations	In the case where any of the following (1) to (3) apply, and it is deemed based on meteorological conditions that this condition will continue. (1) When 0.2ppm or more continues for 3 hours at a measurement point, and when 0.2 ppm or more is reached at 1 or more other neighboring measurement points. (2) When 0.3ppm or more continues for 2 hours at 1 measurement point, and 0.2ppm or more is reached at 1 or more other neighboring measurement points. (3) When the 48 hour average value of 1 measurement point becomes 0.15ppm or more.	districts where the pertinent concentration has appeared	Mayor	issuance of smog alert No. 1 regulatory measures; 20% reduction in smoke emission quantity is recom-mended	request for general cooperation	When it has become less than 0.2ppm (less than 0.15ppm in the case of issuance standard (3)) at the pertinent measurement point, and it is deemed based on weather conditions that there will be further decrease
Smog Alert No. 2 Regulations	(1) When, despite the reduction steps taken based on issuance of smog alert No.1 regulatory measures, 0.5ppm or more is reached at 1 measurement point. (2) In the case where 0.5ppm or more continues for more than 2 hours at 1 measurement point, and it is deemed on the basis of meteorological conditions that this condition will continue.	districts where the pertinent concentration has appeared	Mayor	issuance of smog alert No. 2 regulatory measures; 50% reduction in smoke emission quantity is recom-mended	request for general cooperation	When less than 0.5ppm is reached at the pertinent measurement point and it is deemed based on weather conditions that there will be further decrease, there occurs a shift to measures based on No. 1 regulatory measures issuance

(Source) Kitakyushu Hygiene Bureau "The Pollution of Kitakyushu (No. 4)," 1970

Year	Smog Warnings	Smog Alert No. 1 regulations	Smog Alert No. 2 regulations
1969	8	4	0
1970	17	8	1
1971	1	0	0

(Source) Kitakyushu Pollution Control Bureau "The Pollution of Kitakyushu (No. 6)," 1972

Table 3-2: Condition of Smog Alarm Issuance in Emergency

The Cooperative System of Industry and Government Toward Pollution Prevention

The establishment of the Air Pollution Prevention Liaison Council In February 1970, on the occasion of the transfer of smog alert issuance authority to the mayor of Kitakyushu, in order to seek mutual understanding concerning the details of the various air pollution prevention policies of the city and the views of the corporations as well as to attain the pollution prevention objectives, the "Kitakyushu Air Pollution Prevention Liaison Council" was established consisting of the City of Kitakyushu, the Fukuoka Trade and Industry Bureau, Fukuoka Prefecture, and thirty corporations located in the city. These thirty corporations accounted for 97% of the smoke emissions of the city. The city used this council as a forum to strive for air pollution prevention in the metropolitan area and to seek the cooperation of corporations in initiating voluntary restraints for the reduction of sulfur dioxide to 10-20% below the levels of the emergency policy and smog policy guidelines. For the corporations, as well, the existence of this type of council was necessary. This is because it provided such advantages as a forum where the corporations could hold preliminary consultations with the administration, and where, while seeking the exchange of necessary information, the corporations could present to the administration their honest opinions concerning the feasibility of regulations. By this means, when consultative matters including regulatory measures were decided, the administration was able to guarantee the feasibility of the measures.

This council was established in a comparatively smooth manner, which resulted from the following background circumstances. In Kitakyushu, in order to ensure future industrial development and the land it required, there existed the "Hibikinada Development Plan" which was aimed to conduct reclamation of the city's northern coastal area and thereby

Name of proclamation	Factories targeted during emergency	Smoke emitters (excluding factories targeted during emergencies)
Sulfur oxide air pollution warning	request for 20% reduction in normal smoke emission quantity	
Sulfur oxide air pollution No. 1 alarm	request for 30% reduction in normal smoke emission quantity	request for cooperation in making autonomous restrictions for the reduction of smoke emissions
Sulfur oxide air pollution No. 2 alarm	recommendation of 50% reduction in normal smoke emission quantity	request for cooperation in making autonomous restrictions for the reduction of smoke emissions
Sulfur oxide air pollution alarm by order	order of 80% reduction in permissible emission quantity of sulfur oxides	request for cooperation in making autonomous restrictions for the reduction of smoke emissions

(Source) Kitakyushu Pollution Control Bureau "The Pollution of Kitakyusha (No. 6)

Table 3-3: Reduction Proportions Requested in Emergency Situations

create land for industrial use. Since an environmental impact study relating to sulfur oxides was required before implementing this development plan, in 1969, the Ministry of International Trade and Industry (MITI) designated Kitakyushu as the target area of a "Comprehensive Preliminary Industrial Pollution Study," and this study was executed by the three parties of MITI, the prefecture, and the city. In order to conduct this study effectively and efficiently, corporate representatives were added to the three parties and a liaison council was established on December 3 of the same year. This was the precursor to the Air Pollution Prevention Liaison Council. This council was established in order to facilitate implementation of a development plan which would very likely have direct links to the growth of their own companies, and since its organization was led by MITI which was in a position to directly guide the corporations, the cooperation of the latter was easily obtained. When the smog alert issuance authority was actually transferred to the mayor of Kitakyushu in February 1970, the city required the establishment of a similar liaison council in order to seek mutual understanding with the corporations concerning the promotion of air pollution prevention policies. Consequently, this council was changed to a council under city leadership in which most of the members, who had become very familiar with each other, remained the same, although the corporate membership was increased. It was launched on the 13th of the same month.

This Air Pollution Prevention Liaison Council played a major role in the city's execution in rapid succession of the following pollution prevention countermeasures. That is, (1) enactment of the Kitakyushu Pollution Control Ordinance (1970); (2) enactment of the Air Pollution Emergency Countermeasures Implementation Guidelines (1970); (3) establishment of an alert broadcast device (1970); (4) the conclusion of agreements relating to the prevention of sulfur oxide pollution (1971); (5) enactment of the Emergency Countermeasures Implementation Guidelines on Photochemical Smog (1972); (6) the introduction of a system of the pollution-related health damage relief (1972); (7) the review of environmental standards and adoption of improvement measures (1972); (8) enactment of the Pollution Control Program (1972); (9) implementation of new policies on environmental standards for sulfur oxides (1973), etc.

Here, we take the example of the conclusion of pollution control agreements. As soon as a rough draft of the agreement was drawn up, a council meeting was convened, with information concerning the rough draft being offered to the corporations in advance. The views of the corporations concerning the rough draft were obtained, and its feasibility was discussed. Of course, not all of the views were favorable to the administration, and there occurred many opposing views and intense debates. Yet, based on the relations of trust between the two sides, there was ultimately a convergence of minds in the direction requested by the administration, albeit with some modifications. These pollution control agreements, which had no legal backing and which were no more than requests for cooperation from the administration, thus emerged from these discussions and were concluded as measures with a high degree of feasibility.

With regard to the introduction in February 1973 of a system of the pollution-related health damage relief based on the law, since it was introduced as the result of an administrative determination, there was much opposition to its implementation. A council meeting was immediately convened, preliminary explanations were conducted regarding the particulars of the contents of the system and its introduction as well as the future financial burden for each corporation, and an appeal for cooperation was made. In August 1974, Kitakyushu introduced its own victims relief system relating to aid for the residents of outlying districts who had been cut off from the relief system based on this law. In this case, as

well, a council meeting was similarly convened; information was offered to the corporations in advance, and a full discussion was held, after which an appeal for cooperation was made with regard to implementation.

Yet, there never occurred, for example, a raising of the pollutant emission standard as a result of consultations between the administration and the corporations. This was because the standard was uniformly determined by the national government, and, basically, the localities could only request the corporations to strive for stricter standards.

The framework for the effective operation of this type of consultative system had, in fact, long existed in Japanese society. For example, in flood control measures such as antiflood afforestation and riparian improvement projects, its effectiveness had been most satisfactorily demonstrated. It is, therefore, understandable that the same type of system would operate with success with regard to so-called crisis management involving matters such as pollution countermeasures. In short, the local government body and the pollution-related corporations belonging to the same community create a "circle," and sit together to discuss their common problems. With regard to the matters decided there, as members of the "circle," both the administration and the corporations are bound by a tacit commitment to surely implement the decisions. Viewed from foreign countries, this type of consultative system might appear as a scene of collusion between the administration and corporations, but in Japanese society, it is an extremely effective system.

The establishment of various liaison and consultative organs In addition to the above-mentioned "Kitakyushu Air Pollution Prevention Liaison Council," the following consultative organs were launched, and there unfolded a variety of activities oriented toward pollution prevention in the Kitakyushu area:

1) The Japan Air Pollution Prevention Liaison Council: accompanying the enforcement of the Smoke and Soot Regulation Law, this council was formed in December 1963 by a nationwide total of twenty local public bodies which had become designated areas, including Kitakyushu; since then, it has maintained close mutual liaison for purposes of promoting air pollution prevention measures, and has strongly advanced with information exchange and requests to the national government.

2) The Kyushu Regional Industrial Pollution Countermeasures Council: this organization was formed in July 1965 by all the prefectures of Kyushu, the city of Kitakyushu, and various academic and professional experts, with the Fukuoka Trade and Industry Bureau playing a central role; it has conducted comprehensive studies of pollution prevention measures in the Kyushu region, exchanges of views, etc.

3) The Dokai Bay Seawater Pollution Prevention Measures Council: in order to eliminate the damage caused by refuse and waste water and the obstacles of scrapped vessels and driftwood in Dokai Bay, this council was formed in June 1965 by related administrative organs and private sector groups, with the Wakamatsu Maritime Safety Headquarters playing the central role; it has developed a variety of activities oriented toward environmental protection in Dokai Bay.

In addition to consultative organs composed of administration and corporations like the Air Pollution Prevention Liaison Council, organizations were also established for purposes of conducting cooperation and information exchange among local administrations, as mentioned above. Organizations with a heavy academic coloring were also established, as were organizations capable of conducting exchange of scientific information concerning

pollution prevention and sophisticated debate concerning problem resolution. In these forums, the central role was played by technicians who had acquired practical experience at pollution sites; information was exchanged concerning their efforts at problem resolution and the implementation of measures based on their own original ideas, and information concerning successful cases was offered to other cities in the form of detailed reports. Thus, these groups were able to function as useful organizations relating to pollution countermeasures.

The presence of strong leadership in the business community In order to understand the effective cooperative system of industry and government with regard to antipollution measures in the Kitakyushu area, the existence of strong leadership in the area business community is important. This is because, in the case of consultations concerning the conditions of pollution prevention measures presented by the administration in the various consultative organs, the existence of this leadership greatly contributed to the attainment of agreement among the corporations.

The presence of this strong leadership in the business community owes much to the history of the development of Kitakyushu, and is something not found in other localities. The industry of Kitakyushu did not undergo the normal process of industrial development from light industry to heavy industry, but began from nothing with the establishment of the Yawata Steel Works with state funding. Thereafter, affiliated companies and subcontractors established themselves around the steelworks, and other corporations moved to the Kitakyushu area. Approximately 60% of the population of Yahata at the time of establishment of Yawata Steel Works consisted of employees of the steelworks and their families. Many of the mayors and city council presidents were people with interests in the steelworks. The residents of Yahata, Tobata and Wakamatsu, which had no water sources of their own, lived from the water supplied by the steelworks. In Yahata, which suffered from a chronic lack of revenue sources, the city's budget deficit was covered by the funds collected from the steelworks. Thus, the state-founded steelworks had come to play a supporting role *vis-a-vis* the local administration.

As a result, this gigantic steelworks took pride in having given life to this locality, and had responsibility for the local society and responsibility for uniting the local corporate group. Even when this steelworks changed from a government-managed corporation to a private sector corporation, it inevitably had the duty of assuming leadership status in the corporate community of the area. This was accepted as a matter of course by the local citizenry, the administration, and also by the other corporations. It may also be said that when the need to respond to pollution problems became undeniably urgent, this leading corporation found that it could not permit itself to adopt antisocial actions. It was from this context that a cooperative system developed between industry and government toward pollution prevention in the Kitakyushu area. With the help of this strong leadership, the cooperation of corporations with regard to smog alarm issuance also proceeded smoothly.

Environmental protection and the advancement of regional development On the regional level, the local self-governing bodies have the obligation both to seek industrial development and to safeguard the health of the residents. It is necessary to seek an integrated administrative operation which does not lean toward either of the alternatives of "industrial development" and "environmental protection." Moreover, the existence of councils consisting of the related administrative organs and the corporations is indispensable.

For example, with regard to the above-mentioned "Comprehensive Preliminary Industrial Pollution Study," its pollution prevention applications

were stressed, but it was originally executed as a study for purposes of implementing a development plan. At the time, the many corporations in the city which were experiencing remarkable industrial growth sought a new site for business development, and planned to reclaim the maritime area of the Hibikinada district in the northern part of the city, and to move into new factories or construct new branches there. The city was also hoping to create new incitements for other corporations to move into the city. This constituted part of the industrial policy of the local administration, and one must not forget that industrial growth was also the earnest wish of the local citizenry. On the other hand, the city as the local administration also had the duty of considering the impact on the health of neighborhood residents and the changes in the environment due to the advance of factories into Hibikinada. If damage due to pollution were to occur, regardless of where the final authority lay, the residents would appeal directly to the city; circumstances were now such that an administrative management which neglected such possibilities could no longer be tolerated. The above-mentioned liaison council was established with the objective of executing this preliminary study and, as a matter of course, its members included not only the representatives of the administrative organs and corporations which were to be responsible for the development, but also the administrators responsible for the antipollution measures of the city.

The reclamation of the Hibikinada district had been planned from the time when Wakamatsu was still an independent city. In Japan, the decline of the coal industry due to energy conversion became conspicuous from about 1955. Amid these circumstances, Wakamatsu, which possessed the Chikuho coal field— one of the most prominent in all Japan— in its hinterland area and which at the time was exhibiting signs of prosperity as a coal shipment base, decided upon the large-scale development of the Hibikinada district as a future development plan. In 1958, the "Wakamatsu Northern Coast Reclamation Promotion and Realization Committee," which would become the parent organization in the promotion of the development of the Hibikinada district, was jointly established by the government and private sector. In 1960, the city of Wakamatsu decided upon the Hibikinada District Development Plan. According to this plan, including the future plan portion, approximately 3,700 hectares of reclaimed land was to be created. From 1962 to 1971, the private corporations in the city, the national government, and the city acquired the rights to conduct reclamation work in the said district, and the reclamation gradually proceeded.

In 1973, the said realization committee was dissolved in order to move forward, and Hibikinada Development, Inc. was founded. This corporation belonged to the tertiary sector with 51% public funding (Kitakyushu 49%, prefecture 2%) and 49% private sector funding (eight corporations, two financial institutions), and it had the two founding objectives of promoting the development plan which aimed to create land in the Hibikinada district and conducting landfilling of waste materials and dredged earth and sand. Hibikinada Development, Inc. and the private corporations were able to make good use of the extensive tracts of reclaimed land as suitable disposal sites for the huge quantities of industrial waste generated by business activities. As a result, Kitakyushu was able to become an advanced city with regard to waste disposal, in a manner unmatched by any other city. This is one case where the promotion of development actually contributed to environmental protection. Thus, the two objectives of industrial development and environmental protection were not contradictory, and were seen to be both necessary for the well-being of the area.

The Dokai Bay Sedimentary Mud Dredging Project

The history of Dokai Bay Dokai Bay is situated at the western mouth of the Kanmon Channel. It is a long and slender bay at the northern part of Kitakyushu surrounded by Yahata, Tobata and Wakamatsu, and has its mouth at Hibikinada. Long ago, Dokai Bay was much wider than it is now, and sandbars underlay most of its area where reeds would grow in profusion. A small channel twisted and turned its way through this. The bay interior was free of waves and possessed extensive shallows, and these characteristics were utilized to develop salt fields— salt manufacture has long been conducted here. In the Edo era, the development of new rice fields flourished along the shores of Dokai Bay, and the beaches of Dokai Bay were turned into arable land.

For the Meiji government which sought economic wealth and military strength, the development of iron manufacture was the top priority. When it was decided to establish a steelworks at Yahata, it also became necessary to hurry the development of Dokai Bay. In 1898, the first stage of a large-scale construction project commenced. The said project was completed in 1906, having made possible the navigation of 3,000 ton class vessels. Thereafter, as well, expansion work on the navigation channel continued, and dredging of the bay interior, harbor construction, and reclamation work progressed until 1938. The earth and sand which was dredged was used in reclamation work on the sandbars of the coast, and new factories were built on the extensive tracts of land which were created. The once wide Dokai Bay was reduced to the central navigation channel, with new factories occupying the rest. From 1950 onward, reclamation of the bay interior part was conducted, and Dokai Bay was further narrowed, reaching its present form.

An outline of the Dokai Bay of today runs as follows: Width of bay—1.2 km at the bay mouth and 0.3 km at the bay interior part; length of bay— 13 km; average water depth—7m; average tide range during flood tide—1.7m; water area of bay— 1,044 hectares. All along the bay coast, approximately 1,000 factories and workplaces are located centering on materials industries such as iron and steel manufacture, cement manufacture, metal products manufacture, chemical products manufacture, and ceramics. With the exception of a small portion in the vicinity of Wakato-ohashi Bridge, the entire area is an industrial or quasi-industrial zone.

Several rivers flow into the bay interior, but other than two first class rivers (the Egawa and Horikawa rivers) and two second class rivers (the Kinzangawa and Warikogawa rivers), there are no rivers of any consequence. It is estimated that the amount of water which flows into Dokai Bay from these rivers is 200,000 to 300,000m^3/day, and the catchment area is 10,777 hectares.

The response to the water pollution problems of Dokai Bay As of 1969, with regard to the flow of polluted waste water into the bay, factory waste water accounted for a daily quantity of approximately 4.02 million m^3 and household sewage for a daily quantity of 60,000 m^3, so that the great majority derived from the waste water of corporations. Considered in terms of the COD load, 135 tons/day of factory waste water and 3.7 tons/day of household sewage were produced. The proportion accounted for by household sewage pollution was 1.5% in terms of the total drainage quantity and 2.6% in terms of the COD load. Furthermore, waste water accounting for 98% of total factory waste water was discharged from thirteen major factories. As causes for the worsening water quality in Dokai Bay, one might conceive of factory waste water, household sewage, river water inflow, waste water from ships,

the scattering of cargo materials during loading and unloading of cargo, dust fall, etc. Although it was difficult to make a precise calculation apportioning the responsibility for pollution, it was assumed that the contribution of factory waste water was great. In the water quality study executed by the Economic Planning Agency in 1968-1969, COD in the interior part of Dokai Bay was 36 mg/liter.

In November 1970, Dokai Bay became a designated water area based on the Water Quality Protection Law, and regulation of factory waste water was first begun. Furthermore, as a result of the Water Pollution Control Law enacted by the "Pollution Diet" at the end of the same year, full-scale regulation of factory waste water in Dokai Bay was begun in earnest. As mentioned above, since there were only a few corporations discharging large quantities of factory waste water into Dokai Bay, the administrative response was comparatively easy. This is because it was sufficient to obtain the cooperation of these major corporations. Moreover, the development of the sewer system was systematically advanced, and the water quality of Dokai Bay underwent rapid improvement from 1971 onward.

The activities of the Dokai Bay Sedimentary Mud Research Committee When the water pollution countermeasures in Dokai Bay began to show some effect, expectations were raised concerning the return of fish to the bay interior. A problem then arose concerning the treatment of the mud which had accumulated on the seabed of Dokai Bay. This was because there existed many places which showed high concentrations of heavy metals in the accumulated mud of Dokai Bay. For this reason, in January 1971, the Kitakyushu Harbor Management Association launched the "Dokai Bay Accumulated Mud Research Study Committee" with the objective of executing a research study of various problems such as the nature of the sedimentary sludge, the dispersion of sludge particles, the elution of the harmful components into the seawater, the selection of sludge removal methods which do not cause secondary pollution, and the selection and design of sludge disposal sites. The membership of research council was mainly composed of academic and professional experts, with a total of thirteen people including nine university professors (sewer engineering, coastal engineering, hydraulic engineering, soil engineering, chemical engineering, chemistry, fisheries science, sanitary engineering, analytic chemistry); three persons from related government agencies (the Ports and Harbors Bureau of the Ministry of Transport, the Maritime Safety Agency, and the Kitakyushu Hygiene Research Institute), and one other person (a harbor technician).

As a result of the vigorous conduct of research activities over approximately one year from January 1971 to February 1972, this research committee reached the following conclusions. "There exist many places in the sedimentary mud of Dokai Bay showing mercury concentrations above 40 ppm in the form of sulfide. The mercury in the sedimentary mud of Dokai Bay is found under conditions of concentration which generate methyl mercury. The mercury concentration in the sedimentary mud of Dokai Bay is 49.5 ppm, in contrast to the average of 22.6 ppm in Tokuyama Bay. In the hair of people who frequently consumed fish from the waters of Tokuyama Bay, 31.9 ppm of mercury was detected, which is a borderline quantity for the outbreak of Minamata disease. There is a strong probability that Dokai Bay has become the most dangerous site of methyl mercury generation. If the sedimentary mud of Dokai Bay is left as is, methyl mercury will gradually be generated from the inorganic mercury contained in the mud, leading to the contamination of marine products, and eventually to the damaging of human health. Another perplexing point is that the purification of the bay interior by enforcement of the Water Pollution Control Law would allow the inhabitance of this bay by sea creatures which would be linked to the impairment of human health. As a radical policy for preventing the occurrence of such

circumstances, we think there is no other method but to conduct dredging removal of the sedimentary mud of Dokai Bay."

The research committee estimated the total amount of sludge which had accumulated in Dokai Bay in the period from the opening of Dokai Bay Harbor in July 1898 until March 1972 at approximately 4.8 million m^3, and proposed that, among this, approximately 350,000 m^3 of sludge containing more than 30 ppm of mercury be dredged and treated inside the bay.

The basis for this proposal was that if it is given that the Tokuyama Bay maritime area is a borderline area in terms of the outbreak of Minamata disease, it would seem that they must not exceed the mercury concentration in the sedimentary mud of Tokuyama Bay. The average mercury concentration in the sedimentary mud of Dokai Bay is 49.5 ppm. If this is considered in terms of the arithmetic mean, in order to bring the average mercury concentration of the sedimentary mud of Dokai Bay to below 22 ppm, it would be necessary to remove the sedimentary mud containing mercury of more than 60 ppm. If this is done, the average concentration of the sedimentary mud of Dokai Bay can be held below 22 ppm. For safety reasons, when half of it is above 30 ppm, a "cautionary concentration" is deemed to exist.

Thus, amid circumstances where it was difficult to scientifically predict the degree of organic mercury pollution in the future and the degree of danger relating to neglect, the Dokai Bay Sedimentary Mud Dredging Project began to get underway. This was not the result of a process in which the expenditures required for the dredging project were compared to the profits to be derived from it, followed by a decision in favor of execution as part of a profit-oriented policy. Rather, at the time, the issue of Minamata disease was at the forefront of the antipollution movement, and mercury had become a synonym for pollution. The realization of the Dokai Bay dredging project was the result of this type of crisis-management and risk-management way of thinking.

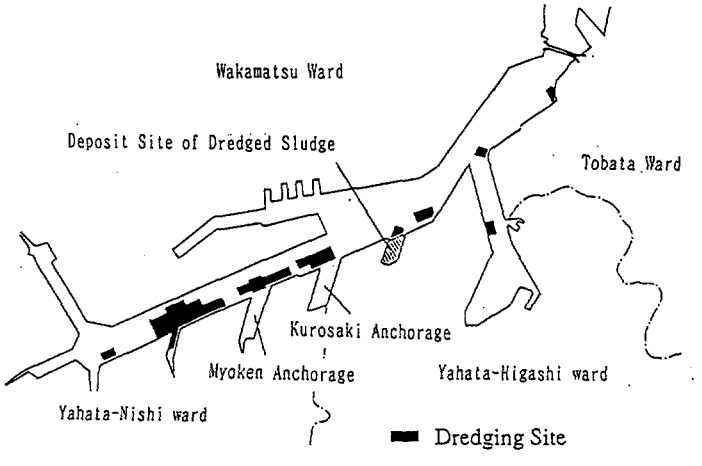
Dredging project costs With regard to the bearing of the dredging project costs, the Law for concerning Entrepreneurs' Bearing of the Cost of Public Pollution Control Works was applied, and the Pollution Prevention Industrialist Liability Council of "Kitakyushu Harbor Management Association" was launched in March 1972, which was consulted about the dredging project plan. In November 1972, the results of the deliberations were reported. According to the report, of the 1.8 billion yen in total project costs, as the sedimentary sludge dredging portion deriving from factory waste water, nineteen corporations were liable for 1,278 million yen equivalent to 71%, and as the sedimentary sludge dredging portion deriving from domestic sewage and river water, 522 million yen equivalent to 29% was to be borne by the nation (50%), the prefecture (25%), and the city (25%).

With regard to the calculation of the cost liability proportions of the corporations and the public institutions, calculations were conducted for the removal of the sedimentary sludge of the bay interior which was a pollution source and of the health impairing substances which it contained. Based on project objectives which considered both the suspended solids and the health impairing substances as pollution generation sources, half of the project costs in each case were allotted to the dischargers of the suspended solids and health impairing substances. That is, the half of the contribution rate of the administration accounting for the total quantity of suspended solids and the half of the contribution rate of the administration accounting for the

total quantity of health impairing substances were added together, and this was made the liability percentage of the administration, with the remainder becoming the liability percentage of the corporations. Bankrupted corporations and businesses whose polluted waste water quantity was less than 50 m^3 were exempted, and the public institutions took their place. With regard to the particulars of the liability amounts and liability rates, see Table 3-4.

The dredging work and the use of the removed sludge in reclamation The dredging project commenced in February 1973, and, first, shore protection work was conducted for approximately one year for purposes of preventing the seepage runoff of waste water. With the exception of the existing quays, synthetic rubber sheets were spread over the entire area around the sea wall in order to guard against all emergencies. A water quality check was performed every hour at the discharge mouth handling the treated waste water, and comprehensive water quality monitoring was conducted in conjunction with the dredging operations in Dokai Bay. A system was followed in which operations would be suspended if any abnormalities were noted. The disposal site was covered with 1.5m of sand and mountain soil until March 1976, when dredging operations were terminated. Eventually, in 1981, the soil-covered disposal site was sold to a corporation.

This dredging project for mercury contaminated sludge was without parallel anywhere in the world and was highly rated both at home and abroad. It was to become a model for organizations wishing to conduct similar projects.



(Source) Kitakyushu Environmental Pollution Control Measure Bureau

Figure 3-2: Dredging Sites of Sludge Sediments in Dokai Bay

Table 3-4: Liability Rates for Dokai Bay Sedimentary Sludge Degredging Project Costs

	Breakdown	Quantity of suspended solids		Quantity of health impairing substances		Total liability rate	Project cost liability (thousand yen)
		Quantity of pollution attributed	Liability rate	Quantity of pollution attributed	Liability rate		
Liability of industries	factory waste water	2,254t	54.11%	4.623t	87.03%	71%	1,278,000
Liability of public	sewage/river water	1,432t	34.37%	0t	0%	17.1%	307,800
	exempted corporations	2t	0.05%	0.045t	0.84%	0.1%	1,800
	exempted portion	350t	8.39%	0.644t	12.13%	10.5%	189,000
	bankrupt corporations	128t	3.08%	0t	0%	1.3%	23,400
	subtotal	1,912t	45.89%	0.669t	12.97%	29%	522,000
Total		4,166t	100%	5.312t	100%	100%	1,800,000

Breakdown of liability holders		Project cost liability (thousand yen)	Breakdown	
			1972 (thousand yen)	1973 (thousand yen)
Liability of industrialists		1,278,000	823,600	454,000
Liability of public	subventions of the national treasury	261,000	168,200	92,800
	prefectural liability amount	130,500	84,100	46,400
	city liability amount	130,500	84,100*	46,400
	subtotal	522,000	336,400	185,600
Total		1,800,000	1,160,000	640,000

(Source) Kitakyushu Harbor Management Association
"Kitakyushu Harbor Dokai Bay Sedimentary Sludge Dredging Project"

The Relation Between the Environment and the Economy of Kitakyushu

With regard to the relation between the economic situation and environmental pollution and its countermeasures in Kitakyushu, this section considers and analyzes the case of the sulfur oxide in the atmosphere.

The Indicators Used in Analysis and Their Changes

Economic indicators As the economic indicators, the "Value of Shipments, etc." of the Industrial Statistical Study are used here. The Industrial Statistical Study consists of designated statistics based on the Statistics Law and, at present, is conducted every year on December 31 by the Ministry of International Trade and Industry (MITI). It is the basic survey of the manufacturing industry of Japan, and its data is widely used in policies and research studies pertaining to the economy.

Environmental indicators As the environmental indicators, the ambient concentration of sulfur oxide in the air, which is a representative substance of environmental pollution, is used.

Environmental concentrations As the environmental concentration of sulfur oxide in the air, measurement values of sulfur oxide concentration obtained by the lead dioxide method, which has been

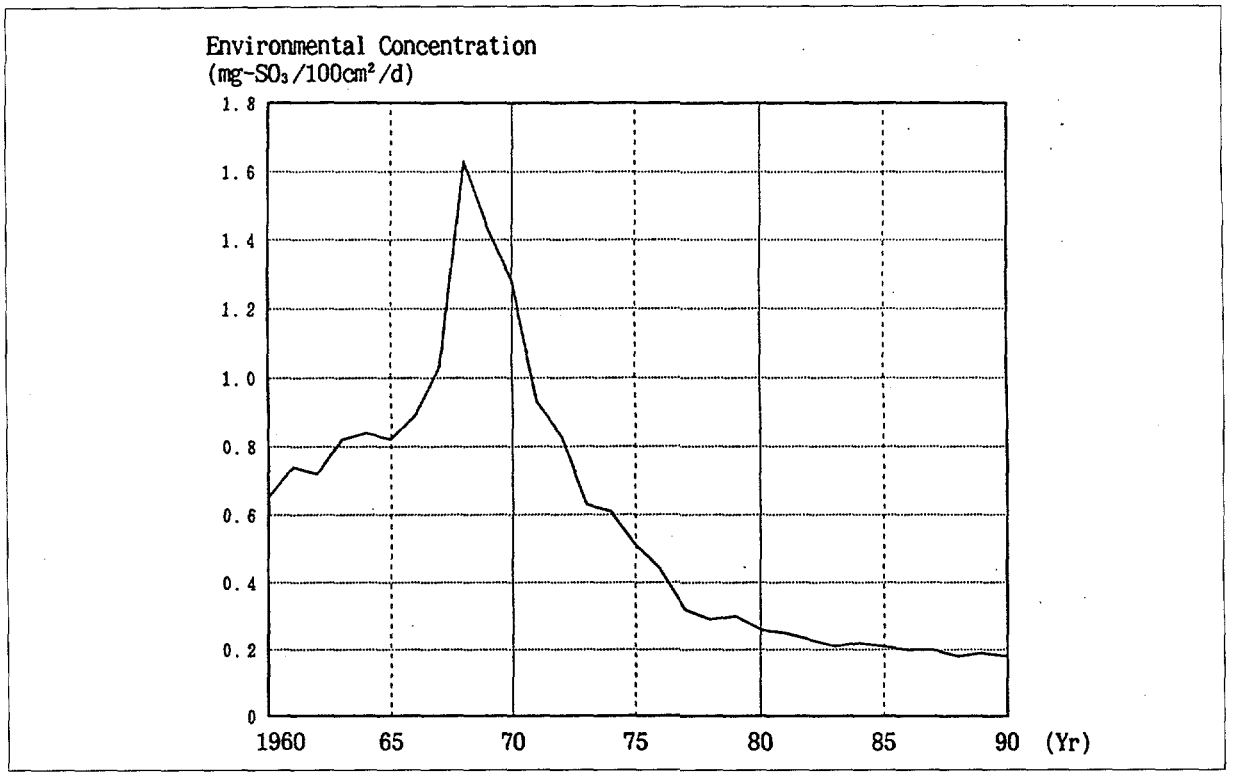


Figure 3-3: SO_x Concentration, 1960-90

continuously used in environmental studies for many years since 1959, were adopted.

Figure 3-3 shows the evolution of sulfur oxide concentration according to the lead dioxide method. Average concentrations are given for all measurement points in the city.

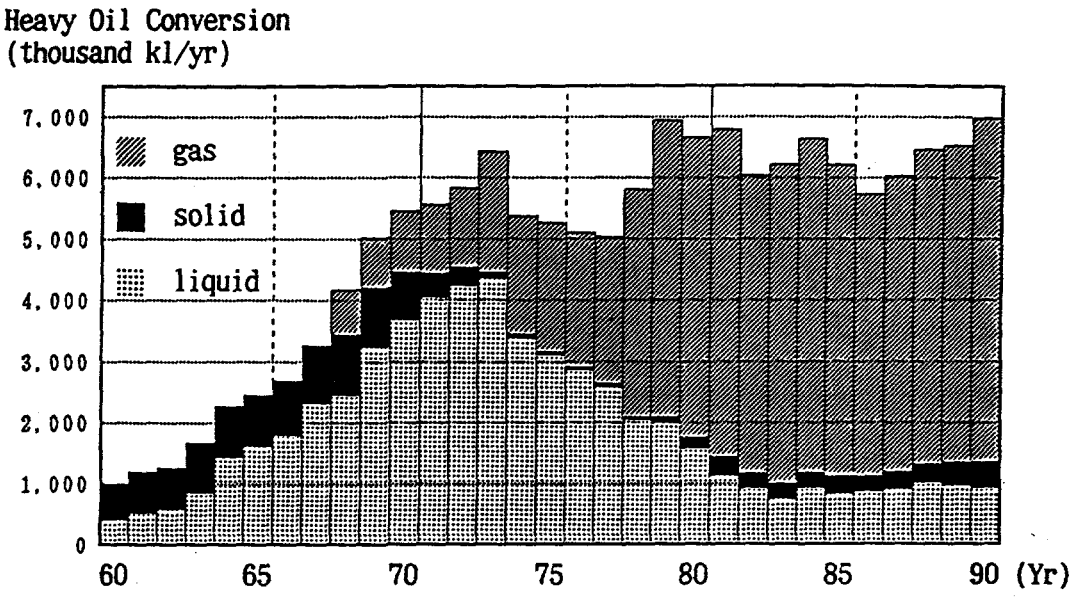
Fuel consumption quantities Fuel consumption quantities according to fuel type are shown in Figure 3-4. The data prior to 1967 was obtained by studies of the Fukuoka Trade and Industry Bureau, and thereafter it was based on reports submitted in accordance with the Air Pollution Control Law. Solid fuels include coal, coke, and wood, while gas fuels include blast furnace gas, coke oven gas, LPG, and LNG. As the consumption quantities for gas fuels, values are shown beginning from 1968 when such data became obtainable. With regard to solid fuels and gas fuels, consumption quantities are shown which have undergone fuel oil conversion by the energy quantity in accordance with the total pollutant load control method for sulfur oxides of the Air Pollution Control Law.

The Relation Between Economic Indicators and Environmental Indicators

The relation between value of shipments of manufactured goods and environmental concentrations of sulfur oxide With regard to the environmental concentrations of sulfur oxide, as shown in Figure 3-3, when the evolution of the past approximately thirty-year period is considered, one finds that increases continued until 1968 which constituted the peak year, and that thereafter there occurred rapid decreases until 1977. Subsequently, there occurred mild decreases in environmental concentrations, and recently they have held steady.

Figure 3-5 shows the relation between value of shipment of goods and environmental concentra-

Figure 3-4: Fuel Consumption by Type, 1960-90



tions of sulfur oxide. During the period from 1960 to 1968 when the government's income doubling plan was being actively promoted and economic activity was quite vigorous, a direct correlation is shown since as the value of shipments increased so also did the ambient concentrations of sulfur oxide.

Yet, despite the fact that value of shipments increased after 1968, the sulfur oxide concentrations decreased. In this city, on the occasion of the construction of a thermoelectric power plant, the first pollution control agreement was concluded with the pertinent electric power company. In 1971, the Kitakyushu Pollution Control Ordinance was promulgated. Furthermore, in 1972, in order to reach the environmental standards pertaining to sulfur oxide, pollution control agreements were concluded en bloc with the fifty-four leading factories. On the national level, the Air Pollution Control Law was promulgated in 1968.

In this way, laws, ordinances and agreements were instituted, and an atmosphere developed in which pollution control policies were vigorously implemented with the cooperation of the national government, the local self-governing bodies and the corporations. Specifically, the various types of countermeasures — such as the low-sulfurization of fuels, the higher smokestacks accompanying K-value regulations, and the introduction of stack gas desulfurization facilities — began to show their effectiveness, and the areas of high sulfur oxide concentration grew smaller while the city-wide concentration decreased. From 1970 onward, while the Plan for Remodeling the Japanese Archipelago was being advocated, economic activity in this city became still more vigorous, but the sulfur oxide concentration declined. Furthermore, the improvement and accumulation of economic strength engendered the multiplier effect of not only inciting the renovation of corporate production facilities but also spurring

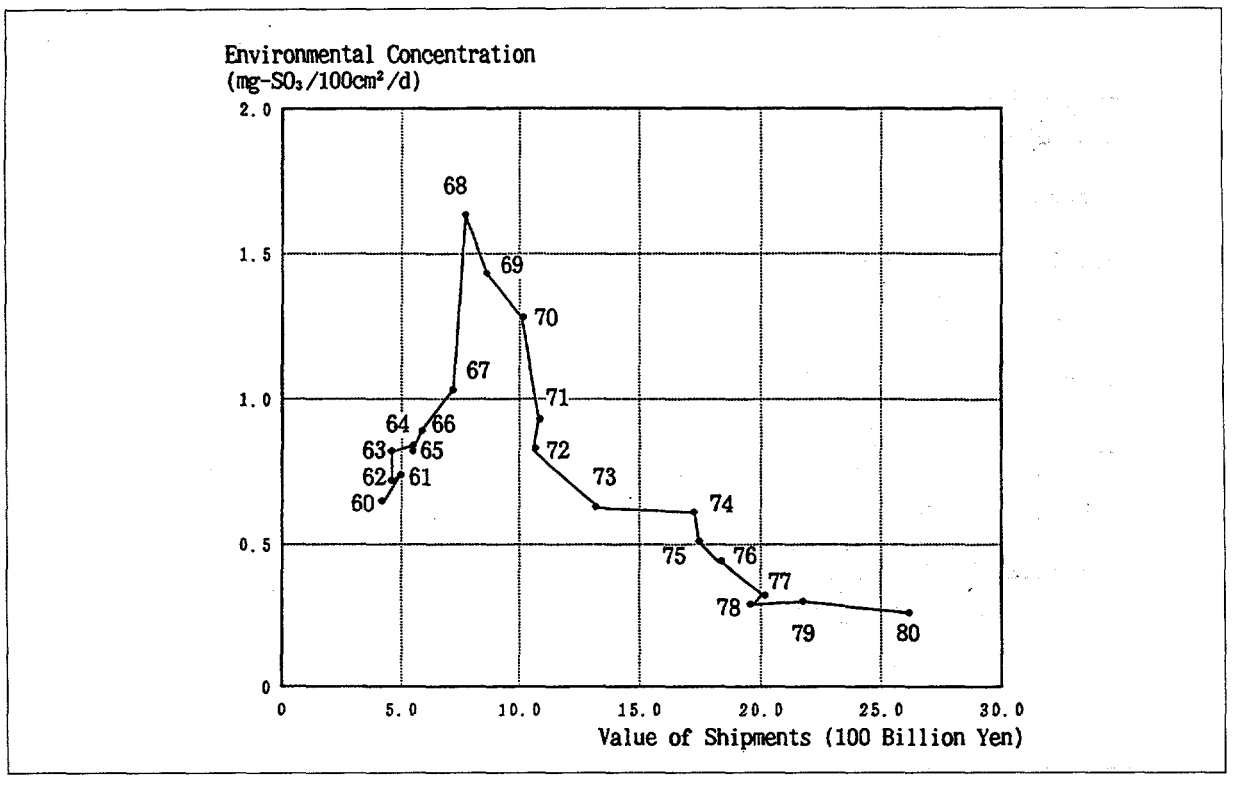


Figure 3-5: Value of Shipments and SO_x Concentration, 1960-80

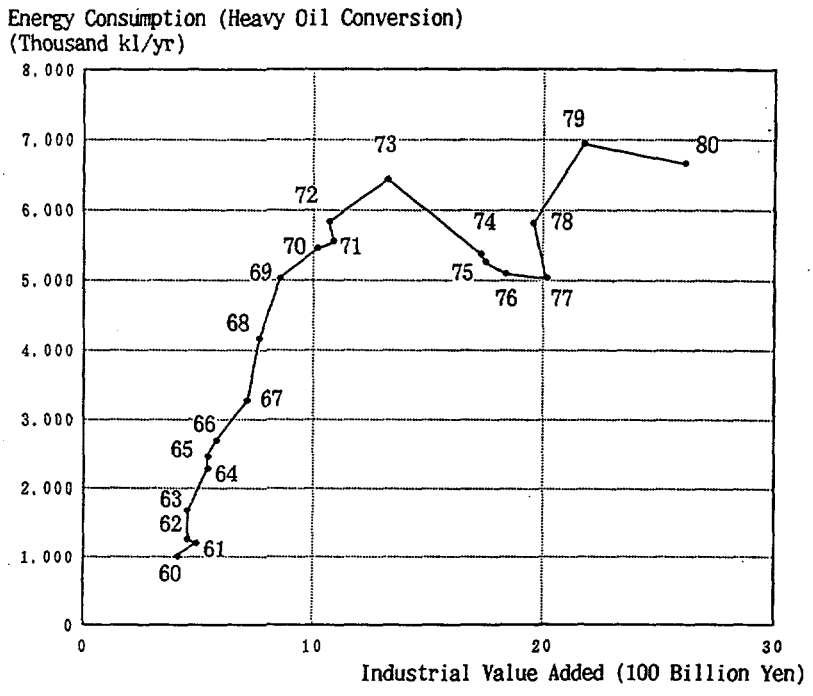
investment in pollution control facilities, and unprecedented qualitative changes occurred connected to the creation of a more comfortable environment.

In this city, from 1972 to 1991, the amount of investment required for pollution prevention reached 253 billion yen for private corporations and 552 billion yen for the administration, yielding a total of 805 billion yen.

The relation between value of shipments and fuel consumption quantities Figure 3-4 shows fuel consumption according to fuel type in this city. Until the beginning of the 1960s, coal played a major role as an energy source, but the consumption quantity of coal as fuel underwent a rapid decline as a result of the government's coal-to-oil energy conversion policy, and coal had been almost entirely replaced by oil and gas fuels by the middle of the 1970s. Due to the two oil shocks of 1973 and 1979, the oil consumption quantity began to decrease. In this city, the gas fuels which had been used heretofore were blast furnace gas and coke oven gas; they occupied a large share of more than 90%. Accompanying the policy of diversification with regard to energy sources, liquefied natural gas (LNG) was introduced in 1977, and came into large-scale use in the city's thermoelectric power plants as clean energy. Moreover, as a result of the two oil shocks, the use of coal once more came to be favored, pulverized coal fluidized bed boilers were introduced in thermoelectric power plants, and coal consumption quantities have gradually increased.

The relation of value of shipment of goods and fuel consumption quantities is shown in Figure 3-6. According to this, from 1960 to the beginning of the 1970s, fuel consumption increased roughly in proportion to the increases in value of shipments—the vigor of production activities were being directly translated into increases in fuel consumption. After the oil shock at the beginning of the 1970s, how-

Figure 3-6: Value of Shipments and Environmental Concentration, 1960-80



ever, the oil dependency mentality rapidly changed; energy conservation was fully embraced, particularly in production facilities such as the iron-making plants in the city. As a result, although fuel consumption quantities decreased, value of shipments increased, as economic efficiency was raised. From the end of the 1970s to the beginning of the 1980s, value of shipments registered major growth. During the 1980s, fuel consumption quantities generally remained at the same level, although there were some fluctuations. With the beginning of the 1990s, due to the large-scale growth in economic activity, fuel consumption quantities again show a tendency to increase.

The relation between sulfur oxide concentration and fuel consumption quantity The relation between sulfur oxide concentration and fuel consumption quantity is shown in Figure 3-7. From 1960 to 1968, accompanying the increase in fuel consumption, the concentration of sulfur dioxide in the air also increased. From 1968 onward, despite the increases in fuel consumption, sulfur oxide concentrations rapidly decreased due to environmental protection measures such as the low-sulfurization of fuel and the development of exhaust gas treatment facilities. Following the first oil shock, fuel consumption declined for several years. The use of LNG in thermoelectric power plants commenced

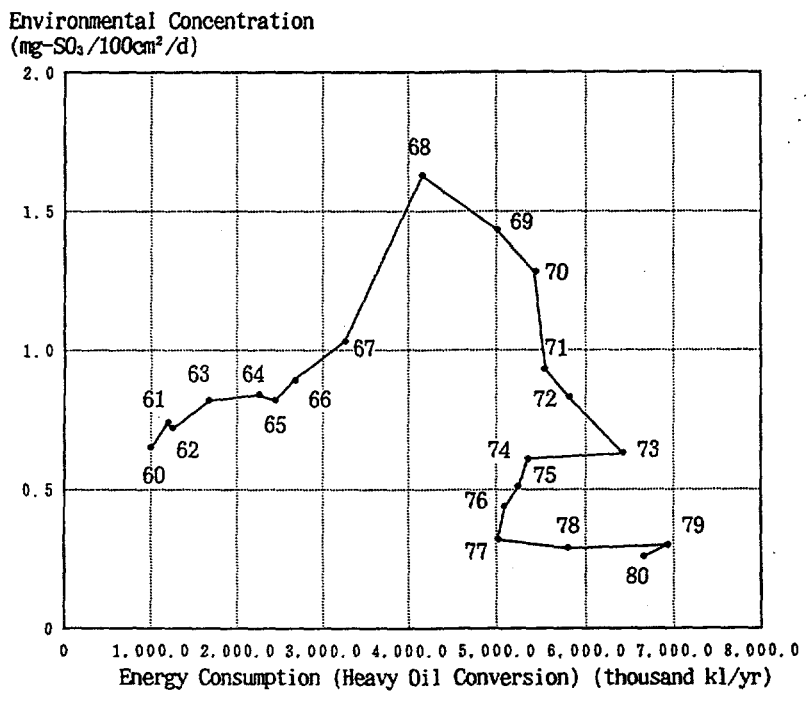


Figure 3-7: SO_x Concentration and Energy Consumption, 1960-80

in 1977, and fuel consumption underwent major increases, but since the LNG was desulfurized and refined in advance and contained no sulfur components, and since conversion to low-sulfur fuels was progressing, the sulfur oxide concentration in the atmosphere did not increase. Thereafter, as well, while fuel consumption underwent increases and decreases, the growth in the proportion of gas fuels and the low-sulfurization of liquid fuels further progressed, and the sulfur oxide concentration continued to show a tendency to remain steady or to slightly decrease.

Improvement Plan for Sulfur Dioxide Based on Wind Tunnel Tests (The Case of the Yawata Steel Works of Nippon Steel Corp.)

Amid the rapidly rising interest of society in pollution problems, the Basic Law for Environmental Pollution Control was promulgated in August 1967, and environmental standards pertaining to sulfur oxide were the subject of a cabinet decision in February 1969. The national government made the attainment of the environmental standards in its air pollution policies into a priority goal, and conducted a strong administrative guidance vis-a-vis the corporations which included major changes in corporate plans. Specifically, preliminary surveys were conducted of the overall combined pollution caused by industrial pollution in the Kitakyushu area. On the basis of this, the permissible limit of the polymerized maximum ground level concentration for each corporation was prescribed, and with regard to the improvement of the individual facilities in order to bring them within the assigned limit, a system was adopted in which each corporation was expected to conduct its own independent studies. At the time, in its master plan for the future of the Yawata Steel Works, Nippon Steel decided to advance with an "Environmental Master Plan" due to its realization that environmental protection measures constituted an extremely important problem in the context of the expansion of production through the Hibikinada development plan, etc. For purposes of formulating the master plan, master plan subcommittees of the related corporate divisions were established under a corporate "Environmental Management Committee." To support these subcommittees, air pollution policy working groups (facilities policy, raw fuel policy teams) were set up to conduct studies of specific improvement measures. In this process, estimates of sulfur oxide were made, and used as the base for intermediate and long-term improvement plans relating to facilities, fuel, and sulfur oxide treatment. With regard to the method of estimating polymerization pollution, since the atmospheric diffusion of sulfur oxide is a complicated phenomenon influenced by topographical, meteorological, and smoke source conditions, it is essentially difficult to accurately estimate its true state. Yet, based on the theoretical model adopted by the national government, the method of calculation which seemed to have the largest degree of universality was used to provide academic estimates, and planning studies were conducted. The implementation of the "Environmental Master Plan" subsequently required renewed study when administrative guidance went into effect due to the establishment of permissible concentrations by the national government, but in its conclusions concerning future approaches, one finds written the following:

The ensuring of environmental standards is one of the nation's major policies. On the other hand, our corporation constitutes a sulfur oxide smoke source of considerable magnitude in this area, and in view of the responsibility which we bear as a leading corporation, it is no longer enough to simply passively accept pollution prevention measures, as has occurred heretofore. Hereafter, freely using our technological capabilities to the extent possible, we must consolidate a system which develops active policies designed to reconcile national goals and corporate profits.

In these circumstance, since air pollution was still progressing in the Kitakyushu area and since the various corporations were embracing production expansion plans for the future, Kitakyushu was designated as the Industrial Pollution Comprehensive Preliminary Study Implementation Area of 1969 by MITI. The preliminary study was commenced by MITI, Fukuoka prefecture, Kitakyushu, and the corporations (the fifty-four major corporations with heavy oil consumption of more than 5 kl/day), with the objective of attaining the environmental standard for sulfur oxide (0.2 ppm or less in all districts

of the city) by the target year of 1975. This study conducted pollution estimates by wind tunnel tests based on the future planning data submitted by each corporation. With regard to the experimental facility, a 1/2500 topographical model and models of the principal buildings were set inside a wind tunnel of 15m length and 3m width. After conducting adjustments so that the air current turbulence resembled atmospheric diffusion, sample gas was released from model exhaust flues, and the actual pollution pattern was obtained by measurement of the concentration at each point on the model ground surface. Accordingly, down-wash and downdraft as well as the influence of topography, which could not be taken into account in theoretical calculations, were able to be reproduced to a certain degree, and the experiments for the Kitakyushu area were conducted with the northwest wind as the main wind direction. Since this comprehensive preliminary study impacted upon the future plans of each corporation, their interest in the project was intense. With regard to the wind tunnel tests, fifteen major corporations formed the "Kitakyushu Regional Air Pollution Prevention Policy Research Committee," and conducted their own independent wind tunnel tests.

The Yawata Steel Works of Nippon Steel conducted its first wind tunnel test based on improvement plans assuming the projected industrial structure of 1975 and involving the changeover to low sulfur content raw fuels as well as the clustering and raising of many low smokestacks. Since the results yielded concentrations greatly exceeding the estimates of the theoretical formulas, a full-scale review of the improvement plans was conducted. Particularly with regard to determining the problems of introducing low-sulfur fuel oil as well as LPG (liquefied petroleum gas) and LNG for gas balancing purposes, determining the facilities and technology for COG desulfurization, and determining the balance of running costs and equipment investments, etc., time constraints were so tight that sufficient analysis of overall economic feasibility proved difficult. In May 1970, the pollution concentration limits per company were presented as the views of MITI, and raw fuel sulfur content reductions, the further clustering and raising of smokestacks, and partial COG desulfurization were submitted as input data for the second wind tunnel test. With these test results, the target values were still not reached, and it was necessary to conduct studies for the further reinforcement of pollution countermeasures. Accordingly, with regard to the high concentration pollution sources identified in the tests, strengthened improvement measures were proposed involving the stepwise reduction of fuel oil sulfur content in the manner of stage 1 = 2.0%, stage 2 = 1.0%, stage 3 = 0.2%; the improvement of COG desulfurization; and the introduction of LPG. With regard to these proposals, more independent follow-on wind tunnel tests were conducted at the steelworks, and the attainment of the target values was confirmed. As for the Kitakyushu area as a whole, it was anticipated that the environmental standard would be reached at an estimated value of 0.158 ppm.

Regarding the study process at this steelworks, report deliberations were conducted each time in the "Environmental Management Committee," and were reflected in the "Yawata Steel Works Master Plan." In the Environmental Management Committee at corporate headquarters, instructions were given for corporate-wide adjustments in plant and equipment investment, raw material plans, and fuel plans; corporate headquarters showed adequate consciousness of the necessity to actively move toward reinforcement of the improvement plan on a company-wide scale, and developed proposals which it submitted to MITI. This type of improvement plan was requested of each corporation. In particular, by planning the completion of the smokestack clustering and raising measures by 1973, it became possible to attain the environmental standards in 1973. Furthermore, in order for Kitakyushu and Fukuoka prefecture to pledge the complete implementation of the improvement plans which

had been submitted, the "Pollution Control Agreement Pertaining to Sulfur Oxide" was concluded in a blanket manner with each corporation. With regard to this agreement, this steelworks conducted preliminary deliberations with the administrative organs through the wind tunnel tests of its improvement plan scenarios which passed through several stages; the contents of the plan were, in fact, independently formulated by this corporation, and the conclusion of the agreements proceeded smoothly without major problems.

With regard to the formulation of this sulfur oxide improvement plan, it is true that there was the fear of regulatory reinforcement by the administration. Yet, amid the severe social scrutiny carried on mainly by the mass media following the smog alarm issuances of the time, the rational establishment by wind tunnel tests of the maximum ground level concentration per corporation relative to the goal of environmental standards attainment, the preservation of fairness among the corporations, and the respect of the independence of the corporations in the selection of countermeasures were all important points contributing to the smooth and quick enactment of plans with a high degree of feasibility. Moreover, these wind tunnel tests greatly contributed to decision-making at the steelworks and corporate headquarters concerning the necessity of investing in pollution countermeasures, since they reproduced in visual form the diffusion conditions which could not be estimated by the company's theoretical calculations of air pollutant diffusion, and particularly the actual state of pollution due to the degree of influence of downwash and downdraft.

Pollution Countermeasures and the Introduction of Cleaner Production Technology (The Case of the Yawata Steel Works of Nippon Steel Corp.)

The quantity of sulfur oxide emitted by this steelworks in 1990 was 607 tons/year. When one attempts to calculate the sulfur oxide emission quantity in 1970 before the adoption of serious sulfur oxide countermeasures at the same production level as 1990, one arrives at a figure of 27,575 tons/year. With regard to the sulfur oxide countermeasures which yielded a reduction of approximately 27,000 tons/year in this twenty-year period, their respective proportional effectiveness is as follows: a 42% effect due to energy conversion; a 33% effect due to energy conservation and resource re-saving technology, and a 25% effect due to desulfurization treatment of exhaust gas and gas by-products. It is clear that the pollutant reduction effects of energy conversion and energy/resource conservation/resource recovery have exceeded the effect of pollutant removal methods at the terminal parts of the production facilities. This steelworks has actively advanced with the introduction of this type of cleaner production technology (CP technology), and a simple presentation will here be made of some examples thereof.

The Background to the Introduction of CP Technology

In response to the industrial reconstruction and the subsequent high-level economic growth which occurred from 1950 onward, this steelworks sought to increase and renovate its plant capabilities, and promoted a rationalization plan beginning in 1962 which was to construct an integrated works with three main blast furnaces in the Tobata district. Yet, from the management view point, it became necessary to further increase production capabilities and

raise efficiency, and in 1967, a study began which was to plan the future of Yawata Steel Works for the next 10 years. This resulted in the formulation of the "Yawata Steel Works Master Plan" in 1969, which went into effect from 1970. Its main aims were to rapidly advance with technological innovation and, (since the expansion of facilities in the Yahata district had become difficult due to pollution problems beginning in about 1965) to concentrate the blast furnaces and steel-making factories of the Yahata district and Tobata district (that is, the division which manufactures steel and pig iron) in Tobata, thereby building up a large-scale and efficient production system. Moreover, in conjunction with this master plan, an "Environmental Master Plan" had been formulated which incorporated radical environmental protection measures.

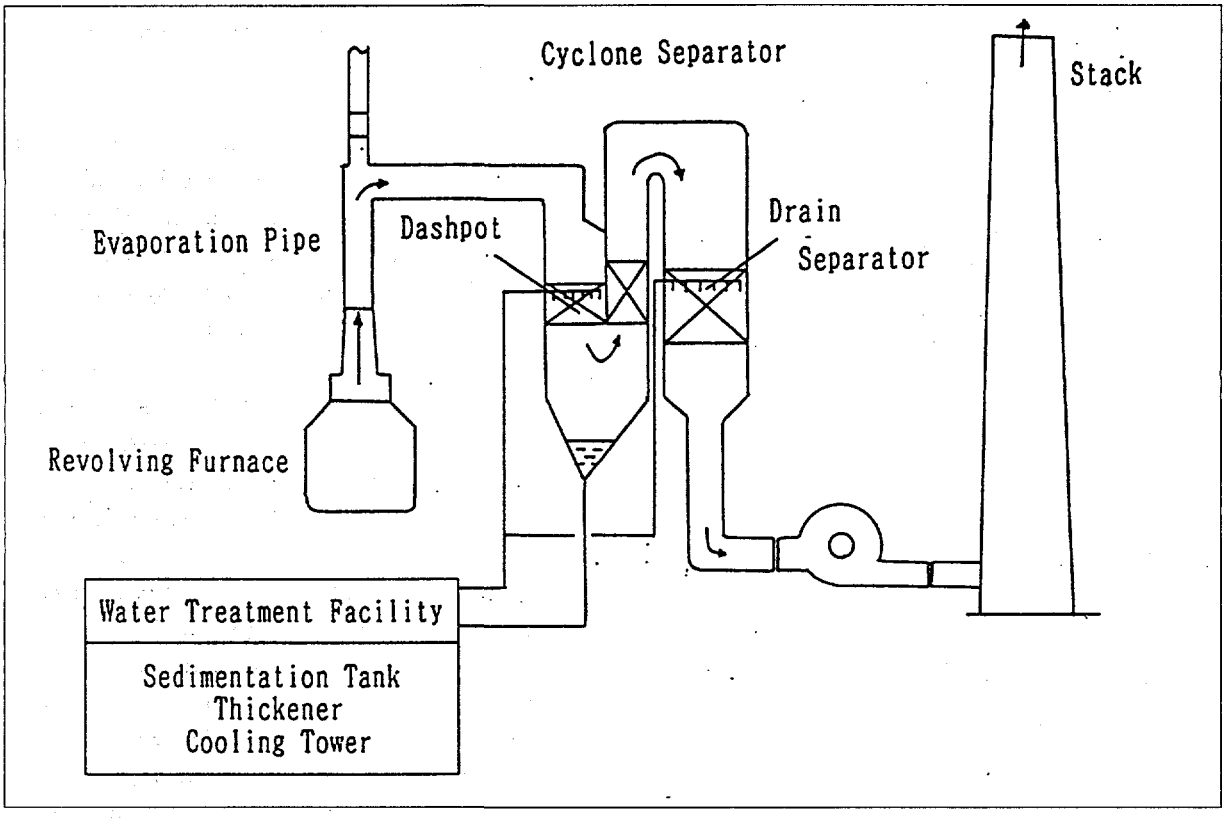
The "Environmental Master Plan" prescribed target values for the exhaust concentrations of pollution sources, sought to concentrate small-scale facilities so as to reduce the number of pollutant generating sources, and simultaneously aimed to devise detailed environmental protection measures in the latest large-scale facilities and to raise their efficiency as pollution prevention facilities. As measures designed to prevent the generation of pollutants, there were the "production technology" countermeasures which involved innovative manufacturing processes which reduced the quantity of raw fuel consumption, or changed the properties of the pollutants; and the "environmental technology" countermeasures which recycled the generated pollutants or rendered them harmless, or which used raw fuels of small pollutant content. These countermeasures were steadily realized and put into practice. These environmental improvements were made possible by the ceaseless technological development and technological innovation which enabled the appropriate technical responses.

The Introduction of the Converter Steel making Method and the Development of the OG Method

From 1945 onward, the open-hearth furnace steel-making method came to flourish at this ironworks, and, during the 1950s, it was sought to raise productivity by fuel oil and oxygen consumption. The smoke and dust of this period became the symbol of industrial development as "seven-colored smoke," and also became a major source of air pollutants. In 1957, as part of the rationalization plan of this steelworks, the technology of the 60 ton LD converter, which was the first to use pure oxygen in Japan, was introduced from Europe. Thereafter, as the superior productivity of this converter steel-making method was demonstrated, the open-hearth furnace steel-making method could not keep pace with the wave of technological innovation, and the fires of the open-hearth furnace were extinguished at this steelworks in 1970. On the other hand, the converter gave birth to further technical innovations, producing global technological development. In 1955, the steel-making facilities of that time operated thirty-six open-hearth furnaces and five electric furnaces, and the crude steel production capability was 2 million tons/year; at present, four large-sized converters have a crude steel production capability of 6 million tons/year. The concentration of facilities in this manner has certainly improved production efficiency, but since it has also enabled a shift from environmental measures dealing with a multiplicity of small-scale pollution sources to concentrated and effective environmental measures, its return on investment has been excellent, and it has yielded great results.

The initial converter followed the combustion system; since the exhaust gas generated as a result of the oxidation reaction inside the LD converter contained carbon monoxide as its primary compo-

Figure 4-1: Normal Dust Collecting System of the Revolving Furnace



nent, this exhaust gas was made to undergo complete combustion by the supply of secondary air, and after effecting heat recovery at the boiler tube wall, wet dust collection was conducted, followed by diffusion into the atmosphere. Since this exhaust gas was a high-temperature and high-speed gas containing large amounts of iron oxide, boiler tube wear and wet dust collector malfunctioning frequently occurred. There was also limitation of converter operations which did not lead to favorable results from the environmental viewpoint.

On the other hand, if the generated gas were to be treated in a non-combustible state, many advantages could be anticipated such as an extremely small quantity of treatment gas, low temperature, simplification of the equipment, improvement of dust collection efficiency, and ability to use the recovered gas as fuel. Yet, with regard to methods for conducting isolation from the atmosphere of high-temperature gas rich in carbon monoxide, there were many uncertain technical points concerning explosion prevention and gas poisoning prevention, and there were no corporations anywhere in the world conducting full-scale industrial application. Consequently, immediately after introduction of the LD converter, basic theoretical research was conducted at the Technology Research Institute with regard to a method for treating converter exhaust gas in a non-combustible state without huge waste-heat boilers, and gradually a concept for its concrete introduction was developed. For purposes of research and development oriented toward industrial application, it was indispensable to integrate a variety of knowledge relating to gas properties, heat exchange, dust collection, etc., and the "OG Development Committee" was accordingly established in 1959 to advance with development. The OG system was an abbreviation for the Oxygen Converter Gas Recovery System. As the result of various re-

search efforts, an OG system was introduced into the Tobata No. 3 converter in 1962.

Figure 4-1 shows a dust collector of the conventional combustion system, while Figure 4-2 shows the outline of the OG system. Compared to the combustion system, the OG system possesses the following characteristics: 1) the treatment gas quantity is 1/4; 2) the gas temperature is low; 3) the degree of oxidation of the dust is low and the particle size is comparatively large; 4) it is possible to recycle gas whose main component is carbon monoxide. These characteristics enabled the economical design of the facilities for the converters and the equipment pertaining to gas treatment, reduced the electric power requirements due to the small quantities of cooling water and dust collection water, and increased the ease and efficiency of dust collection due to the larger size of the dust particles. Since the recovered gas is stored in the gas holder by a quantity of heat of approximately 2000 Kcal/m^3, compared to the intermittent combustion system steam recovery resulting from the converter operational pitch, the energy value is far higher from the standpoint of the freedom of use and the stability of supply.

From the pollution prevention and energy conservation standpoints, this OG device garnered much attention as being suited to the needs of the times. At these steelworks, as well, there successively occurred the adoption of this system in the new converter facilities, and the renovation of the existing boilers to make them compatible with the OG system. Simultaneously, there occurred a remarkable diffusion of this system, not only within the corporation and the country, but also to foreign steelworks through technology exports.

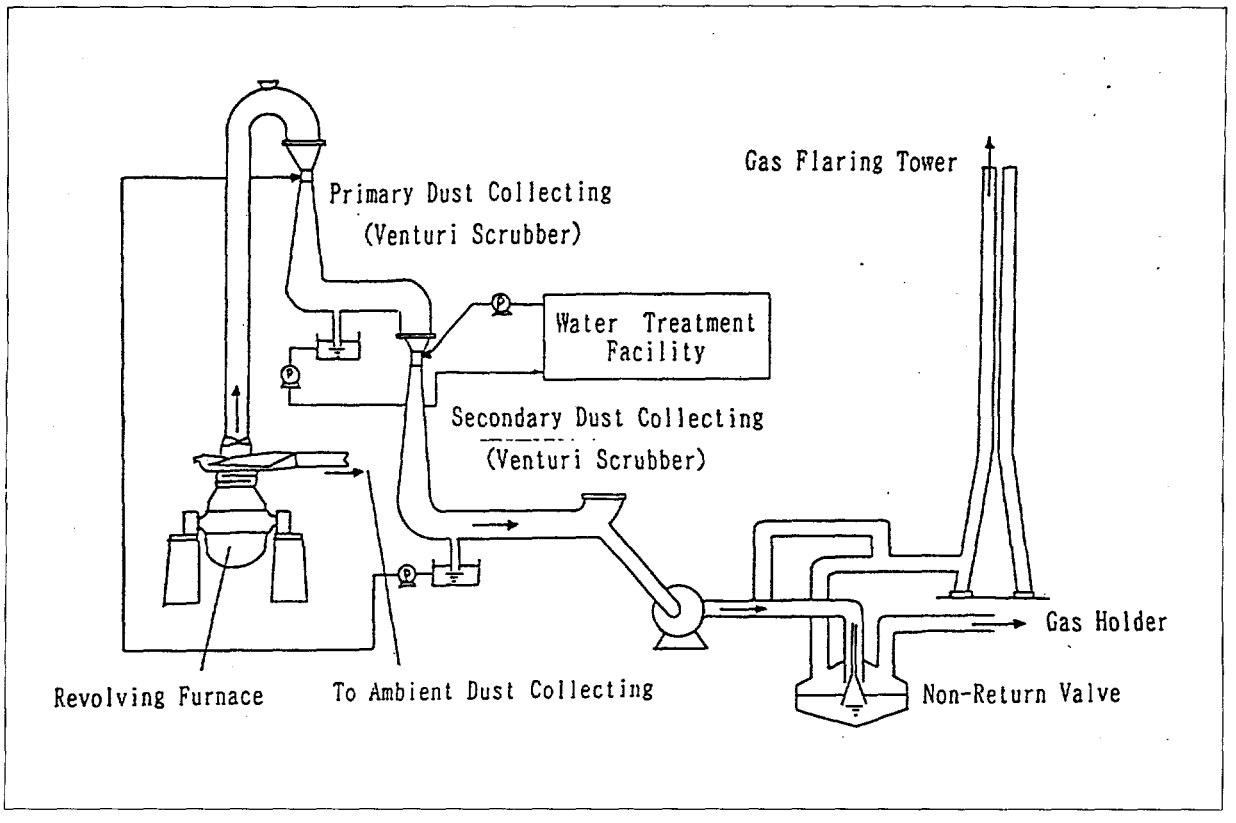
The Introduction of the Continuous Casting System

Since the foundation of this steelworks, in order to conduct plastic working, molten steel would be injected into molds called ingots and, after a long cooling period, removed from the molds to produce steel ingots. After re-heating these steel ingots to about 1200°C, they were rolled in a blooming mill and semi-finished steel products such as slabs and blooms would be manufactured. (This was called the ingot-making single blooming system.) In contrast to this, the continuous casting system injected molten steel into slab-sized or bloom-sized molds, conducted forced cooling of the mold from the exterior corresponding to the cooling pattern, and continuously manufactured the semi-finished steel products. The first continuous casting machine went into operation in West Germany in 1950. The continuous casting system was a facility representative of production process simplification which omitted the heating furnace and the blooming mill, and enabled major energy conservation as well as improvement of yield.

At this steelworks, the "Continuous Casting Development Section" was established in 1964 to study the introduction of the continuous casting machine, and continuous casting facility No. 1 was introduced in 1967. Thereafter, the number of continuous casting machines gradually increased, and the proportion of continuous casting grew rapidly as a result of the concentration of iron sources in Tobata beginning in 1978. Today, most such production is performed by continuous casting.

With continuous casting, there occurred a large-scale reduction in the energy of the heating furnace, enabling energy conservation of approximately 150,000 to 200,000 kcal/t compared to the conven-

Figure 4-2: The Introduction of the Continuous System of the Revolving Furnace Using OG (Oxygen Converter Gas Recovery System)



tional ingot-making-blooming system— this amount was the equivalent of approximately 70% of this production process. Major contributions were also made to the reduction of the pollutant emission quantity.

In the iron and steel production process, there is a great deal of repeated heating and cooling, and the water for cooling, as well as the fuel for heating, become sources of environmental pollutant generation on each such occasion. In addition to the continuous casting method, with regard to technological developments omitting unnecessary cooling and heating and reducing the number of manufacturing stages, the "continuous annealing facility" and the "direct rolling system" were applied. These techniques not only realized energy conservation, but also large-scale reductions in the manufacturing time of the products, thereby making major contributions to both environmental improvement and cost improvement.

The Introduction of Natural Gas By Both the Electric Power and Iron and Steel Industries

From 1960 onward in Japan, the energy supply structure, which depended on imported oil for a large part of its primary energy supply, contained much latent instability. The drive to escape from this situation of excessive oil dependence became a major national policy. On this basis, energy conversion studies came to be conducted. Liquid Natural Gas (LNG) was first introduced in 1969 in Tokyo Electric Power Co. and Tokyo Gas Co., and became a prominent energy source for purposes of diversi-

fying energy supply and promoting environmental protection.

At the Yawata Steel Works of this time, in order to advance with the concentration of iron sources in the Tobata district and with the improvement of environmental protection measures, the expansion of numerous facilities was planned. As a sulfur oxide countermeasure, Liquid Petroleum Gas (LPG) was introduced in the Yahata district as a clean gas in 1971, but studies concerning environmental standards for nitrogen oxides were continuing and focused attention on LNG as an effective means against them. Tobata Kyodo Thermal Power Co., which was established by the joint funding of Nippon Steel and Kyushu Electric Power, conducted electric power generation by the mixed combustion of fuel oil and the gas by-products generated at the steelworks. As a result of the growth in electric power needs due to the expansion of facilities at Yawata Steel Works, it became necessary to construct a 375,000 kw electric power generation facility. Furthermore, since Tobata Kyodo Thermal Power also had a high emission quantity of sulfur oxide, it was striving to use low-sulfur fuel oil, and keenly felt the necessity of clean energy.

With regard to Kyushu Electric Power, the Kitakyushu district was Kyushu's largest electric power consumption area, and in order to provide a stable supply to meet the growing electric power demand, two 156,000 kw coal boilers were set up in the Kyushu Electric Power Shinkokura Power Plant which commenced operations in 1961, and later in 1975 the addition of two 600,000 kw generators was considered. Moreover, as a result of the energy revolution beginning in 1958, the mixed combustion of fuel oil progressed, and a changeover to mono-fuel combustion with fuel oil occurred in 1973 accompanying the reinforcement of pollution prevention. Thus, environmental problems became the most important issue, and energy diversification including LNG became desirable. With regard to the introduction of LNG, research efforts were growing and a gas handling study group was begun in 1972. During this period, discussions concerning a project to introduce LNG from Indonesia were being conducted at Kyushu Electric Power. For purposes of realizing this idea, a site needed to be found which could serve as an LNG storage base in the environs of the Shinkokura Power Plant, and, as luck would have it, a suitable vacant lot which was a green tract of land belonging to Yawata Steel Works was found at the tip of a coal yard in the Yawata Steel Works in Tobata district. Just then, in October 1973, the oil shock caused by the Middle East war occurred, and the introduction of LNG as a fuel diversification policy at once began to move toward realization.

In December 1973, in addition to the conclusion of an agreement between Nippon Steel and Kyushu Electric Power for the introduction of LNG, five user companies on the Japanese side and the Indonesian state-run oil and gas company signed a sales contract. This contract covered a 23-year period beginning March 1977, and called for the importing of 7.5 million tons annually. In consideration of the circumstances in the exporting country, this contract had a "take-or-pay" provision whereby the contract quantity of LNG would either be taken without fail or, if not, its price would be paid without fail. With regard to the Kitakyushu district, this contract led to the introduction of a total of 2.1 million tons/year of LNG by Nippon Steel and Kyushu Electric Power.

For the administration, which had enacted a sulfur oxide reduction plan based on the total pollutant load control system, the introduction of LNG was a welcome development. In particular, major environmental improvement effects could be expected if fuel conversion to low smoke sources at Yawata Steel Works were to progress. Yet, in 1973, an extremely strict environmental standard was es-

tablished which set the hourly value of nitrogen oxide averaged over one day at less than 0.02 ppm. Since the administration considered that its attainment appeared difficult in light of the actual situation pertaining to nitrogen oxide, it undertook studies of large-scale cuts in emission quantities. For this reason, it was a matter of concern that the plan for large-scale power generation facility expansion involving mono-fuel combustion of LNG would constitute an impediment to the attainment of environmental standards for nitrogen oxide, and the administration showed strong disapproval of this plan. Great difficulties were experienced in concluding this pollution control agreement, and negotiations extended over numerous sessions; but it was finally agreed to adopt nitrogen oxide countermeasures by installing exhaust gas denitrizers and improving the combustion system, and the agreement was finally concluded.

In 1977, the first LNG transport ship entered port, and the No. 1 and No. 2 generators of the Shinkokura electric power plant were converted to LNG use. Yawata Steel Works conducted gradual changeover beginning from the rail factory and the Kukigaoka electric power plant No. 2 generator in the Yahata district, and Tobata Kyodo Thermal Power also carried out LNG conversion. In the period from 1978 through 1979, the Shinkokura electric power plant No. 3 and No. 4 generators as well as the Tobata Kyodo Thermal Power No. 4 generator commenced operation. Furthermore, the Shinkokura No. 5 generator (600,000 kw) was added in 1983 to give the present-day electric power configuration.

Evaluation of the Antipollution Policies of Kitakyushu

With regard to the transfer of authority to a local self-governing body, one can point out the effects on the city's own policies due to the smog alarm issuance authority which was given to Kitakyushu in February 1970. This type of transfer of authority to the locality not only raised the consciousness of the local administrative officials, but also of a wide range of the local citizenry including the corporations, and this resulted in the stepped-up promotion of local pollution prevention initiatives. For example, one may cite the establishment of the "special weather information system" and the requests to corporations for pollutant reduction based thereon, which effectively shifted the emphasis from after-the-fact countermeasures to preventive measures. With the introduction of this system, it became possible to execute substantive pollution countermeasures without issuance of a smog alarm. On the corporate side, efforts toward in-house pollution prevention advanced, as evidenced by the provision of pollution monitoring personnel who conducted visual pollution inspections, and the development of a system capable of rapidly responding to pollutant reduction requests from the city which could come at any time. Thus, the effects of the transfer of authority to the local self-governing body responsible for the pollution sites may be said to have been large.

The next point relates to the existence of a cooperative system of government and industry, and its effective operation. Viewed from the standpoint of foreign countries, this type of consultative system might appear to constitute collusion between the government and the corporations, but it was an extremely effective system with regard to industrial pollution prevention. Once an agreement was reached in such a consultative forum, the administration and the corporations who were its members felt bound by these decisions despite the lack of any legal measures, which was an attitude rooted in the particularities of Japanese society. Moreover, in Kitakyushu, since there existed a strong leadership in the business community which served to bring together the corporations, this type of government-industry cooperative system was built up relatively smoothly compared to other localities.

The basic countermeasures adopted by the pollutant emitting corporations were characterized by the improvement of the manufacturing equipment and the manufacturing process, as well as the raising of productivity while striving for thorough-going resource conservation and energy conservation— it was from these efforts that the pollution countermeasures developed. This led to the introduction of so-called cleaner production technology (CP technology). This concept did not involve the addition of equipment for waste water treatment and waste gas treatment (end of pipe or EP technology), but sought pollution prevention by replacing the existing production technology itself with low-pollution production technology, and signified the reduced consumption of raw materials and fuels which constituted sources of pollution, as well as the reduced generation of by-products which constituted sources of pollution. Here, it is necessary to give special mention to management policy which, even in the chilly economic climate occasioned by the oil crisis, held to a long-term view of corporate development by daring to strive for the introduction of CP technology. In the Kitakyushu area, representative examples of this are the joint introduction of natural gas by electric power and iron and steel corporations, and the introduction of the OG system in the iron and steel industry.

Furthermore, as one example of the "non-economic approach" which is cited as a characteristic of Japanese antipollution policy, there is the sedimentary sludge dredging project of Dokai Bay, which was once called the "Sea of Death" and which

is located in the central part of Kitakyushu. The sludge which accumulated in Dokai Bay from the opening of Dokai Harbor in July 1898 until March 1972 was estimated at approximately 4.8 million m^3. Of this amount, the project dredged 350,000 m^3 of sludge containing more than 30 ppm of mercury, and buried it in a special-use disposal area established in the bay. Of the total project costs of 1.8 billion yen, 71% was borne by the corporations and 29% by the administration. Amid circumstances where it was difficult to scientifically estimate the degree of future organic mercury contamination and the degree of danger if matters were left unchanged, the sedimentary sludge dredging project of Dokai Bay was conducted. Thus, this project was not executed based on economic principles which gave priority to profit considerations after a comparison of the costs of dredging and the profits to be derived therefrom, but rather, it was a crisis-(risk-)management policy designed to cope with future risks and to control the actual sense of crisis among the local citizenry which was not necessarily based on a scientific underpinning. In this context, it is highly significant that, as a result of these pollution countermeasures, the fish taken in the cleaned up waters of Dokai Bay can now be eaten with peace of mind.

The Applicability of the Experiences of Kitakyushu to the Developing Countries

When applying the pollution prevention experiences of Kitakyushu to the developing countries, it is necessary to pay attention to the special social conditions in which Kitakyushu developed. On the other hand, for the cities of the developing world which have traveled a historical course similar to Kitakyushu, these experiences may prove very useful. The industry of Kitakyushu did not undergo the ordinary process of industrial development by passing from light industry to heavy industry, but began from the establishment of the Yawata Steel Works by state funding in circumstances where no industry existed at all. In the developing countries, as well, there are cases where gigantic corporations are established in areas without any industry in the form of state-run enterprises or multinational corporations. In this case, as with the former city of Yahata, a "Castle town" is formed around this one gigantic corporation.

Yahata was succeeded by Kitakyushu, which developed as a government ordinance-designated city and which came to possess the issuance authority for smog alarms. There may be problems concerning limitations on local self-governing bodies in the developing countries, and if the transfer of authority to localities specializing in pollution countermeasures becomes possible hereafter, they might be able to execute the types of policies adopted by Kitakyushu. In particular, even if there exists no authority for direct regulation of corporations by a local self-governing body which has jurisdiction over the area in which the corporate giant is located, it can arouse the concern of the local citizenry and the mass media by issuing something similar to smog alarms, which might create good prospects for subsequent pollution countermeasures. For this purpose, it is indispensable to build up a scientific monitoring system, conduct data collection and analysis, and train capable people to handle these matters.

With regard to the apportioning of responsibility for the pollution in Kitakyushu, if considered in terms of the comparison of industry and domestic sources of pollution, it must be noted that industry played an overwhelmingly larger role. For example, considering the proportional amounts of the COD discharged into Dokai Bay, at the time more than 97% was of industrial origin. On the other hand, in the major cities of the developing countries, it is reported that industry is responsible for 20-30%, while the major part of the pollution is derived from

daily living. With regard to air pollution, the role of automobile exhaust gas is large, while with regard to water pollution, the sewage and refuse deriving from ordinary households and particularly from slums and squatter districts are the major factors. Concerning pollution countermeasures in such cities, even if it is an area where a gigantic corporation is located as in Kitakyushu, the experiences of Kitakyushu might not prove very useful. This is because, even if industrial pollution is overcome, there still remains the problem of the pollution deriving from urban living.

Next, we consider the introduction of low-pollution industrial technology. The introduction of terminal treatment devices for pollutants (End of Pipe, or EP technology) is expensive, but there are developing countries which are planning the development and introduction of low-priced and simplified devices which somewhat sacrifice treatment efficiency. As pollution countermeasures for existing facilities, the introduction of such EP devices may be unavoidable; but if there are factories where poor production efficiency due to deteriorated production equipment is to be improved and where the renovation of the production facilities themselves is being considered for this purpose, it may well be worthwhile to study the introduction of CP technology. The high costs of EP technology probably indicate the importance of planning and preventive measures by developing countries before the problems are too costly for them to rectify. In the case where it is planned to introduce CP technology to improve production facilities in developing countries, if an organization is established incorporating environmental ODA (Official Development Assistance) from the developed countries, a further impetus will surely be given to the introduction of CP technology in developing countries. For Japan which is a major CP technology country, there is a mutual benefit for Japan and developing countries to promote such technology transfer, considering the possible profits from technology exports, as well as its international responsibility for environmental protection.

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