3.1 Pollution-Induced Health Damage – Starting Point of the Air Pollution Problem

When looking back at Japan's air pollution problems, we must not forget the fact that damage to health was a frequent occurrence. Before we even begin to discuss Japan's "success" in pollution control, we must first consider its "failure" in having caused health damage to large numbers of pollution victims.

It is true that Japanese enterprise contributed to economic revival and high-pitched postwar growth, and it is also true that industrial and financial policies succeeded from the standpoint of economic development. However, the creation of pollution victims was a "market failure" whereby the external diseconomy of environmental pollution was not internalized. Furthermore, our inability to construct and implement a policy response system to prevent the occurrence of pollution health damage–much as we would for industrial location or pollution control – should be viewed as a "policy failure."

The following summary examines the framework of Japan's history of air pollution response from the viewpoint of the creation of pollution victims and measures to compensate them.

Frequent Occurrences of Health Damage

Respiratory diseases that developed among residents of the nation's main industrial towns are thought to have been caused by air pollution from the initial stages of Japan's rapid economic growth period. During the period from 1955-1965 when air pollution was at its worst, automobile headlamps had to be illuminated even during the day as contaminants such as sulfur oxides and dust and soot reduced visibility to 30-50m. Areas were sometimes shrouded with the overwhelming odor of sulfur oxides.

Many residents of the areas plagued with this cruel air pollution complained of various diseases, which were appearing at rates 2-3 times, or even higher, than those of non-polluted regions. Residents who suffered from disease caused by air pollution set out to make the problem known even to those who did not consider themselves victims of pollution, and while working to overcome prejudice and discrimination against pollution victims in regional society, worked gradually towards unity. Concrete, large-scale action was finally taken by victims in September of 1967 when a Yokkaichi pollution lawsuit was launched. As a result of the lawsuit, the true plight of the air pollution victims was brought to light (Box 3).

Box 3 Air Pollution and its Victims in Yokkaichi

Occurrence of Asthmatic Patients

Yokkaichi City, in Mie Prefecture had a population of approximately 200,000 in 1960. At the time, it was twelfth of 556 cities nationwide in terms of industrial production and produced 1/4 of Japan's petrochemical industry output. Large-scale petrochemical complex operations began in Yokkaichi around 1960, and residents complaining of asthmatic symptoms began to appear around 1961. The number of complaints rose significantly until around June, 1963, when the term "Yokkaichi Asthma" was finally coined and the issue moved into the spotlight.

A pollution victim compensation system to be introduced later came to specify "Yokkaichi Asthma" as including such diseases as chronic bronchitis, bronchial asthma and pulmonary emphysema. Among many symptoms, a correlation between symptoms such as dyspnea (shortness of breath) and sulfur dioxide concentration was recognized.

Yokkaichi's Air Pollution Situation

Air pollution in Yokkaichi reached its worst levels around 1963-1964, after the successive launch of two complexes, the Shiohama district industrial complex in 1960 followed immediately by the Umaokoshi industrial complex. As heavy oil sulfur content rates at the time measured 3% more-or-less, annual sulfur oxide emission volumes measured in terms of sulfur dioxide are estimated at 130,000-140,000 tons. Hourly measurements of sulfur dioxide concentrations in the Isozu district in 1964 show that the number of values exceeding 0.5 ppm amounted to 3% of all hours measured, occasionally rising above 1 ppm (more than 10 times the current environmental quality standard of 0.1 ppm), and even exceeding the upper detection limit of 2.5 ppm. The annual average sulfur dioxide concentration in this area was 0.075 ppm (almost four times more than the current environmental quality standards).

Actual Damage

Hard data on actual damage incurred did not surface until the 1970s, but even during the 1960s there were citizen complaints of symptoms and requests for transfers to different homes and schools. Particularly at schools adjacent to the industrial complexes, the odor was so offensive that it disrupted classes and kept windows shut even during the summer.

Statistical data indicates that after the compensation measures were introduced in the 1970s, the number of certified sufferers in Yokkaichi City totaled 1,738 with a peak number of 1,140. A new certification was not conducted following the 1988 cancellation of the designated areas, and the official 1995 figure was 674.

3.2 Onslaught of Air Pollution-Related Litigation

Pollution Lawsuits as Civil Affairs Disputes

Because air pollution damage is caused by human activity, victims sought damage compensation on the basis of unlawful acts by the polluter according to civil law. This was similar to a general civil dispute. When a civil lawsuit seeks damage compensation, the plaintiff must show damages, prove a causal effect between harmful acts and such damages, demonstrate intent and fault of the accused, and show illegal infringement of the victims' legal rights or property. However, the fact that in pollution lawsuits (including air pollution lawsuits), it is very difficult to scientifically demonstrate a causal relation between damages incurred and activity of environmental pollution leaves the defendant (corporate side) holding all of the data and the plaintiff holding none. This makes it difficult for the victim to provide evidence and puts him/her at a disadvantage. The path to reaching a court judgment was therefore a long, arduous one.

Even with such drawbacks in the administration of justice, there were many incidences where legal reaction viewed parties to the lawsuits impartially and established precedents and theories which decreased the burden on the victim to adduce evidence. On the scientific side, the Yokkaichi District Air Pollution Control Conference consigned Mie University professor Katsumi Yoshida to the plaintiffs of the Yokkaichi pollution lawsuit. Yoshida led epoch-making efforts during the air pollution trial and submitted epidemiological investigation results which proved, beyond other things, a causal relation between air pollution and the contraction of respiratory diseases. (Box 4).

Box 4 Epidemiological Investigation

Definition of Epidemiology

Epidemiology, the study of epidemics, takes humans as its object in comprehensively investigating the causes of health and health-related abnormalities as determined by hosts, etiology and the environment. This academic field is concerned with improvement and prevention. In contrast with clinical medicine's research into methods of diagnosing and treating each patient individually, epidemiology looks at the human race as a whole, including healthy persons, and primarily researches methods of disease prevention.

Epidemiological Investigation

Epidemiological investigation was employed as a scientific means of demonstrating a causal relation between air pollution and its effects on health. A famous study comparing the rate of consultations with physicians in Yokkaichi City (the pollution area) to that in Tsu City (the control area) is an example of investigations conducted during the early stages. This study showed that the rate of asthma consultations by insured elderly aged fifty years or above living in the pollution area exceeded those in the control area by 4-5 times, and also illustrated a high dose-response relationship between sulfur oxide concentrations and the rate of medical consultations in Yokkaichi City. In the 1960s, which witnessed a rapid worsening of the air pollution problem, pollution exacted high levels of effects on the human organism and there were many incidences where a relatively clear causal relation was successfully established.

Epidemiological Investigation's Usefulness

In response to the Yokkaichi pollution problem, Professor Yoshida worked with Yokkaichi City to conduct investigative research into effects on health based on pollution investigation and epidemiology. This study was the trailblazer for systematic and ongoing investigation into air pollution and its effects on health. At the Yokkaichi pollution trial launched in 1967, Yoshida employed many years of investigation based on epidemiology to prove a causal relation between sulfur dioxide and its effects on health. Based on results from such data as epidemiological investigation, the first judgment ever to legally acknowledge a causal relation was announced. It must not be forgotten that honest epidemiological studies conducted by such scientists provided the essential foundation towards advancing air pollution victim redress as well as policy to control air pollution.

The Yokkaichi Trial Judgment-Corporate Fault Established

Based on results of epidemiological investigation which indicated a clear causal relation, the July, 1972 judgment at the Yokkaichi pollution trial dismissed

claims by the corporate defendants that they had taken cautionary measures based on the latest technology at the time. The judgment stated that business, which understands that emissions and contaminants threaten the human body and life, must disregard economics and mobilize the world's most advanced technologies and know-how in its exercise of precautionary measures. If such measures are neglected, there can be no denial of fault.

3.3 Establishment of a National Victim Compensation System

Absolute Liability for Pollution Damage

Although the Yokkaichi trial judgment played a very important role in supplying victim compensation for sufferers of health damage, judicial decisions alone offer dim prospects for speedy victim compensation.

Therefore, in order to facilitate victim compensation, legal steps were taken in 1972 with the release of the *Law Partially Amending the Air and Water Pollution Control Laws*. This law established the responsibility of the perpetrator to provide victim compensation, even in the absence of intent or fault, when damage results from environmental pollution activity exceeding tolerable levels.

Establishment of a *Compensation Law for Pollution-Related Health Damage*

Even with the introduction of a system of absolute liability for pollution-related issues, victims are nevertheless required to litigate, and the above-mentioned legal revision does not apply to air pollution health damage induced prior to its establishment. So the civil law system of victim compensation was supplemented in June, 1973 by the passage of the *Compensation Law for Pollution-Related Health Damage*, whose intent was to dramatically consolidate the system of victim compensation. This law was put into effect on September 1 of the same year following the issuance of related cabinet orders.

The establishment of this law was actively promoted based on the belief that it was preferable to create a type of insurance system to respond not only to pollution victims demanding hospitable amends, but also to setbacks in industrial activity due to frequent occurrences of air pollution problems.

Victim Certification and Compensation

In designating certified sufferers, this law specified regions ("designated areas") where frequent occurrences of illness resulting from significant air pollution had occurred. When a person exposed to air pollution in the home or workplace beyond a specified period of time ("minimum exposure requirements") contracts chronic bronchitis, bronchial asthma, asthmatic bronchitis, pulmonary emphysema or their sequelae ("designated diseases"), a causal relationship between such disease and air pollution is systematically established.

A report by the Central Environmental Pollution Control Council defines "designated areas" as those where "significant air pollution results in a wide outbreak of disease." A model example would be that where air pollution levels surpass 0.05 ppm average annual sulfur dioxide levels and the rate of contraction of illness is roughly 2-3 times that of natural rates.

Victims certified by local governors based on the Compensation Law are entitled to reimbursement of medical expenses and compensation for other financial losses incurred as a result of pollution-related disease. Moreover, it was determined that pollution-related health and welfare activity vital to improving the welfare of certified sufferers would be conducted in order to help them recover, preserve and improve health lost as a result of specified illness.

Burden of Compensation Payments

Funds necessary to compensate air pollution victims were based on the rate of air pollutant emissions. Through consideration of nationwide air pollutants such as sulfur oxides and nitrogen oxides, the division of compensation burden between stationary emission sources (such as factories and business establishments) and mobile emission sources (such as automobiles) was fixed at 8:2. It was decided that liability for compensation due to stationary emission sources, which represent 80% of the total, would be assumed nationwide by all factories and business establishments beyond a certain size. A sulfur oxide index establishing liability of individual factories and business establishments based on emissions volumes was also established.

The number of designated areas under this system was expanded gradually from an original 12 to 41 in 1978. The number of certified sufferers exceeded 100,000 persons in 1988, and based on this figure total compensation provided over a certain period has exceed 100 billion yen annually.

3.4 Systemic Growth from Compensation to Prevention

Changes in Pollution's Character and System Revision

Following the advent of the compensation system, progress in air pollution control policy inspired remarkable improvement in levels of air pollution from sulfur dioxide, which was the primary target of this legislation. Environmental quality standards were consequently satisfied in most regions. On the other hand, levels of pollution caused by nitrogen oxides and SPMs continued to fail to meet environmental quality standards, and improvements in air pollution tapered off. Specifically, changes recorded in average annual air pollution conditions recorded by continuously-monitoring stations indicate that sulfur dioxide concentrations dropped from 0.030 ppm in 1973 to 0.010 ppm in 1987, nitrogen dioxide slightly rose from 0.025 ppm in 1973 to 0.028 ppm in 1987, and SPMs fell from 0.059 mg/m^3 in 1973 to 0.041 mg/m^3 in 1987.

On the other hand, since the last regional designation was performed in 1978 there have been approximately 9,000 new certified sufferers and 6,000 discharged sufferers per year, indicating an ongoing absolute annual increase of 3,000 persons.

Based on this situation, the Central Environmental Pollution Control Council convened in the autumn of 1983 to examine how this system should change.

In April, 1986, a report by the Council's Experts Committee had the following to say: "It is our opinion that the possibility that present (1986) air pollution's general influence on the natural history of chronic lung disease cannot be denied. From 1955-1975, areas where air pollution was high experienced chronic lung disease levels exceeding those witnessed in other areas. But unlike the past, such disease at present (1986) cannot be thought to be attributed primarily to air pollution."

The Central Environmental Pollution Control Council accepted the Committee's report and in October, 1986, implemented steps such as the following: (1) Cancellation of the designation on specified regions; (2) Continued payments to previously certified sufferers; (3) Promotion of integrated measures for environmental health preservation.

Cancellation of the Designation on Specified Regions

The *Compensation Law for Pollution-Related Health Damage* was revised in 1987, canceling the designation on all regions affected by air pollution effective March, 1988.

Based on this move, a new certification of sufferers which had been conducted over a 14-year period from 1974 to 1988 was completed. There were approximately 110,000 certified sufferers at the time of cancellation of area designations and around 180,000 sufferers certified during the 14-year period.

Continued Compensation for Previously-Recognized Patients

Sufferers certified under the former system of designated areas would continue to receive compensation as long as they suffer from a designated illness. At the end of FY 1995, there were approximately 74,000 certified sufferers and compensation payments during that year totaled approximately 86.9 billion yen. Further, the aggregate sum of compensation until that time had totaled 1.66 trillion yen **(Figure 3-1)**.

The Transition from Individual Victim Compensation to Pollution Damage Prevention Targeting Regions

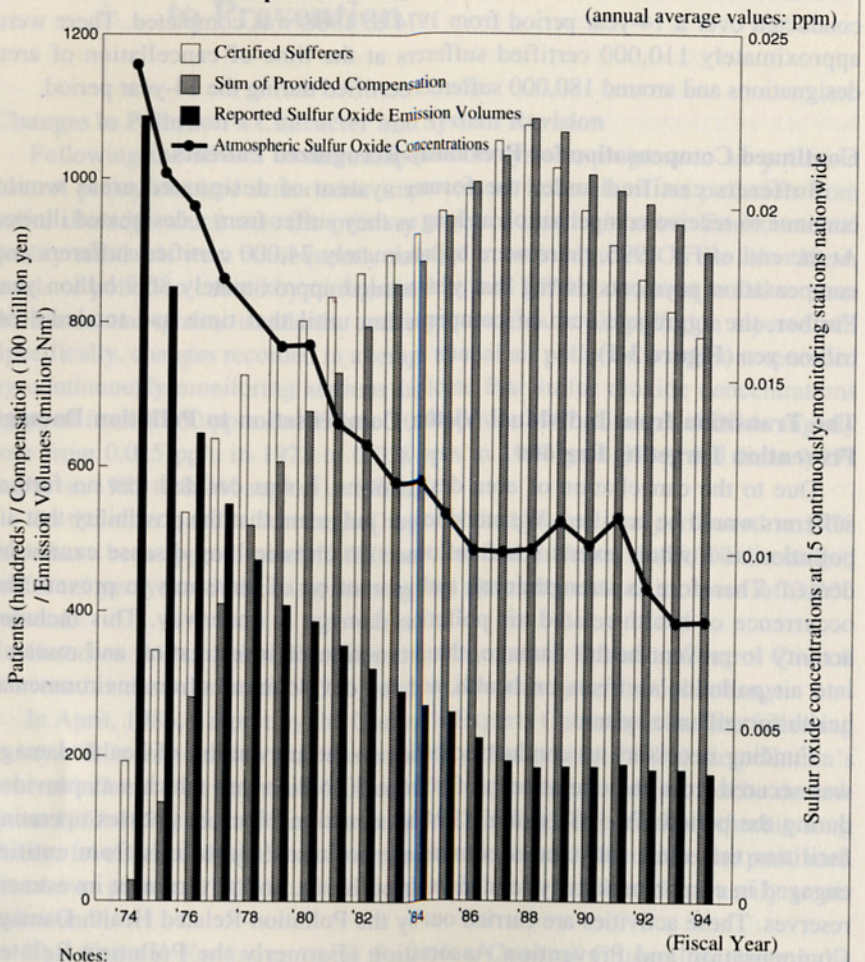
Due to the cancellation of area designations, it was decided that no further sufferers would be certified. We stand in our judgment that the possibility that air pollution as a whole exerts some influence on chronic lung disease cannot be denied. Therefore, a strengthening and promotion of measures to prevent the occurrence of health-related air pollution damage is underway. This includes activity to prevent health damage, the promotion of investigation and research into air pollution's effects on health, and the development of an environmental health surveillance system.

Funding necessary to conduct activities in the prevention of health damage was secured from the operation profits from 50 billion yen which was provided during the period FY 1988 to FY 1994 by donations from businesses operating facilities that emit substances causing air pollution, donations from entities engaged in corporate activity related to air pollution, and government investment reserves. These activities are carried out by the Pollution-Related Health Damage Compensation and Prevention Association (Formerly the Pollution-Related Health Damage Compensation Association) based on the legal revision titled, *Law Concerning Compensation for Pollution-Related Health Damage and Other Measures*.

Lessons Learned from Pollution-Related Health Victim Compensation

The creation of large numbers of air pollution victims was the result of both a "market failure" and "policy failure," whereby the cost of environmental response was not internalized by the economic system. Such failures must not be repeated

Figure 3-1 Movement in Sulfur Oxide Air Pollution vs. Legal Compensation Sums



Notes:

① **Reported Sulfur Oxide Emission Volumes** represent national totals based on data submitted by businesses legally obligated to pay charges based on pollutant load volumes

② **Atmospheric Sulfur Oxide Concentrations** represent average annual measurement data from 15 continuously-monitoring stations nationwide.

③ There have been no additional certifications since the cancellation of area designations in 1988.

Source: The Pollution-Related Health Damage Compensation and Prevention Association's Data

in any other countries.

In confronting the issue of creation of air pollution victims, trials representing a means of post-facto victim compensation and victim activity subsequently led

to industry's cooperation in the execution of regulations concerning severe air pollution. Moreover, atmospheric environmental quality standards and various administrative frameworks based on the *Basic Law for Environmental Pollution Control* (today's *Basic Environment Law*) were established towards the prevention of air pollution, under the precept that "it is preferable to protect and maintain human health." Further, industry compliance with legal judgments mandating damage compensation gave rise to a system of compensation for pollution-related health damage.

In order to avoid further incidences of health damage by air pollution in the future, we must be ever-attentive to pollution's changing character, continuously conducting various types of research and investigation into pollution's affects on human health. One such area for investigation is nitrogen oxides and other substances feared to impact the human organism.

Many nations should conduct the above-mentioned research and investigation specific to their unique air pollution conditions and social/cultural backgrounds so that their results may be compared internationally. It is important that we rise above domestic considerations and consider building a mutual exchange of information and discoveries.

4.1 Outcome of Each Sector's Various Approaches

Japan's confrontation against fierce industrial pollution and the health damage it caused has succeeded in rapidly reducing pollution by sulfur oxides. This is referred to today as Japan's "pollution policy success."

But along the road to success, the major players labored intensively within a framework of trial and error to reconcile the dilemma between preservation of a healthy environment and the pursuit of profit and economic prosperity. These included such phenomena as victim-focused citizen movements, the pioneering efforts of local governments working to protect the health of local residents, the consolidation of a national response system (belated though it was), and industry's development and deployment of response technologies.

This chapter surveys each player's role in the process in order to clarify how Japan's air pollution by substances such as sulfur oxides was overcome

4.2 The Role of Citizen Activism

Neighborhood Protests in Response to Individual Pollution Problems

During the period of rapid economic growth, the frequent occurrence of problems such as air and water pollution created many victims until pollution itself became a large social problem. The process did not simply end with the levying of enormous damage to people, but instead witnessed the rise of so-called "people power" which involved even ordinary citizens. This became the primary impetus for a promotion of policy response, and awareness regarding the necessity of some government regulation to promote proper industrial conduct rose.

The first laws in Japan to take pollution control as their direct goal were the *Law Concerning Water Quality Conservation for Public Waters* (1958) and the *Law Concerning Controls on Industrial Waste Water* (1958). They were born in response to confrontational incidents between fishermen and factories that year due to fishing industry damage caused by runoff from paper manufacturing factories into the Edogawa River.

Protest against the Construction of Mishima and Numazu Industrial Complexes

In areas like Yokohama since the 1950s, government petitions containing as few as 100 names have served as a means of neighborhood protest to prevent air pollution. However, the movement against the construction of industrial complexes in Mishima and Numazu from 1963 to the following year deserves special mention.

There were plans for the construction of petrochemical industrial complexes as special industrial consolidation areas in the Mishima and Numazu areas. Because the law regulating air pollution at that time (*Law Concerning Controls on the Emission of Smoke and Soot* (1962)) had previously limited applicability of the law to specified areas facing remarkable levels of air pollution, no law could regulate the new construction of industrial complexes in other areas. Among the multitudes of local governments which attached top priority to attracting the industrial complexes, an investigative committee including local high school teachers was formed by request of Mishima City, which was concerned about air pollution. Based on an investigation of air pollution levels as set forth in documents and blueprints for the industrial complex, the committee revealed problems in the complex's construction by using carp streamers to examine wind movement (later to become a famous method).

Against the backdrop of Yokkaichi pollution, which had already become aggravated, the pollution war generated widespread concern among ordinary citizens and grew beyond its previous scope as a fisheries/agriculture vs. industry issue. Resulting activity such as resolutions by the local assemblies of Mishima, Numazu and Shimizu Cities opposing the construction of industrial complexes effectively led to a halting of plans for the industrial complexes.

The establishment of coastal industrial complex zones was a main pillar of rapid economic growth policy, and its discontinuance due to the pollution problem had a severe impact on the nation, industry and local governments. It is clear that in this particular case, government came to aggressively respond to the air pollution threat.

Growth of the Pollution Victim Protest Movement

Inhabitants who actually suffered from air pollution led a movement by judicial trial. The Yokkaichi pollution trial is a typical example, where residents litigated in 1967 and won the case in 1972.

Almost simultaneous to enactment of the *Compensation Law for Pollution-Related Health Damage*, the victim organizations, which had been established in various regions during the rise of pollution trials, tied up nationwide. Their

spirited activity exerted an influence on national public opinion as well as the national administration regarding environmental preservation. Further, the trials revealed to the public the current condition of air pollution and played a role in crystallizing public consensus regarding measures that should be taken by business, and what measures the state and local governments should take to prevent it.

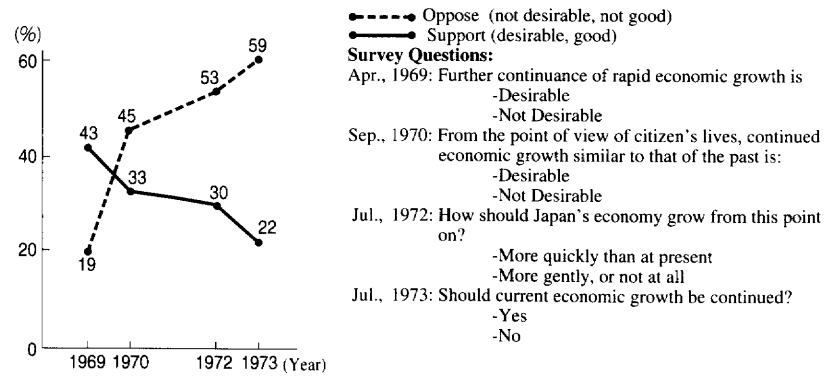
Crystallization of National Consensus

As the job of politics and administration is to devise policy based on citizen needs, the existence of strong national and local demand is essential to the planning and execution of pollution countermeasures by the national and local governments.

Political protests first appeared on a national scale in 1970 with events such as "Pollution Mayday" and the convening of the "Pollution Diet." It was a year when the pollution issue filled the air. Not only appearing in newspapers but also widely taken up in television, radio and magazines, the pollution problem was the number-one topic of journalistic interest.

With this as a backdrop, massive numbers of victims were also being created by new pollution phenomena such as photochemical smog. The public was further impacted by other issues such as the suspicion that lead poisoning was being caused by automobile exhaust gas (it was later determined not to have been lead poisoning). Moreover, the number of pollution-related complaints submitted by citizens to local governments increased more than threefold, from 20,000 in 1966 to 63,000 in 1970. **Figure 4-1** shows levels of public support and opposition

Figure 4-1 Support of and Opposition to Continued Rapid Economic Growth



Source: *Environment Agency 10-Year History* (1981, Environment Agency of Japan)

for continued rapid economic growth. (Source: NHK Broadcasting Culture Institute).

The citizen protest movement against the threat of successive environmental pollution gradually grew more systematic and expanded its ties on a national level. Against this backdrop public consensus was achieved, calling for the attachment of an equal or higher priority to pollution measures than to economic growth.

The Role of Citizen Movements in Japan

In Japan, the neighborhood pollution protest movement became the driving force for the pollution control efforts of local governments, the state and industry. This movement by those who had undergone tragic suffering earned the sympathy of many and gained significant strength as a result.

The citizen movements originating from this pollution protest movement have expanded to such broad activities as the revitalization of areas damaged by pollution as well as recycling.

4.3 The Pioneering Role of Local Governments

Development or Environment? The Problems Facing Local Governments

The strong orientation of local governments towards rapid economic development leads to the enactment of ordinances to attract enterprise and the unfolding of "petition wars" in their efforts to earn designation as new industrial cities or special industrial consolidation districts. But as preliminary investment to attract industry weighed down on local finances and before desired results materialized, pollution problems began to appear and such local governments became the object of local citizen criticism and movements.

Pioneering Responses by Some Local Governments

Falling dust and soot measurements have been conducted in Tokyo and Osaka since prewar days, and since around 1955 such measurements and investigations have been independently conducted in areas such as Kanagawa Prefecture and Sapporo City. Further, many local governments enacted various pollution control ordinances such as:

- *Tokyo Prefecture Factory Pollution Prevention Ordinance*, Japan's first, in 1949;
- *Osaka Prefecture Industrial Plant Pollution Prevention Ordinance* in 1950;
- *Kanagawa Prefecture Industrial Plant Pollution Prevention Ordinance* in 1951;
- *Fukuoka Prefecture Pollution Prevention Ordinance* in 1955; and the
- *Tokyo Prefecture Smoke and Soot Control Ordinance* also in 1955.

However, these ordinances were attacked by residents because they included no emission restrictions based on quantitative standards, but merely specified procedures for writing reports on factory installation and other items feared to generate air pollution. While we must admit the fact that local governments took the initiative in pollution administration, it is also true that substantive control was not achieved and that environmental pollution was allowed to proceed. At the same time, the nation had not yet arrived at the creation of an effective policy response.

The National System and Original Systems by Local Governments

After around 1960, air pollution finally surfaced in areas such as Keihin, Hanshin, and Kita-Kyushu and came to be considered a nationwide problem. As the national government was also aware that the situation was deteriorating, it enacted laws directly aimed at pollution control.

The first legislation concerning air pollution control, the *Law Concerning Controls on the Emission of Smoke and Soot*, was enacted in 1962. However, this law conflicted with laws already put into effect by local governments. To resolve the conflict, this law was revised the following year (1963). And as a result, it was clarified that the government shall issue ordinances concerning smoke-generating facilities and that local governments have the right to issue ordinances for facilities other those which generate smoke. Subsequently, the local governments issued pollution control ordinances of compelling, expansive content and in effect came to take the lead in guiding the national government's pollution control measures.

In 1969, the *Tokyo Prefecture Factory Pollution Prevention Ordinance* was revised to become the *Tokyo Prefecture Pollution Prevention Ordinance*, which not only designated a system for preparing factory and facility reports, but also contained regulation related to the establishment of emission standards and planning for pollution prevention. Moreover, total pollutant load controls, later to be implemented nation-wide, were substantially introduced into the pollution prevention ordinances of several local governments, including Kanagawa Prefecture, beginning 2-3 years later.

Pollution Control Agreements and Technical Deployment

Besides the enactment of pollution prevention ordinances, local governments also promoted original pollution measures. Pollution control agreements with industry represent one such measure (Box 5). The first of its kind in the world, this model spread among local governments as a valuable means of pollution response to supplement laws and ordinances. Many pollution control agreements were concluded solely between local governments and industry, but in some cases the conclusion of agreements also involved the participation of local residents. In order to maximize the potential for their enforcement, pollution control agreements demanded stricter measures for newly-constructed factories than for previously-existing factories and also aimed for the execution of flexible measures adapted to regional conditions (**Table 4-1 and Figure 4-2**).

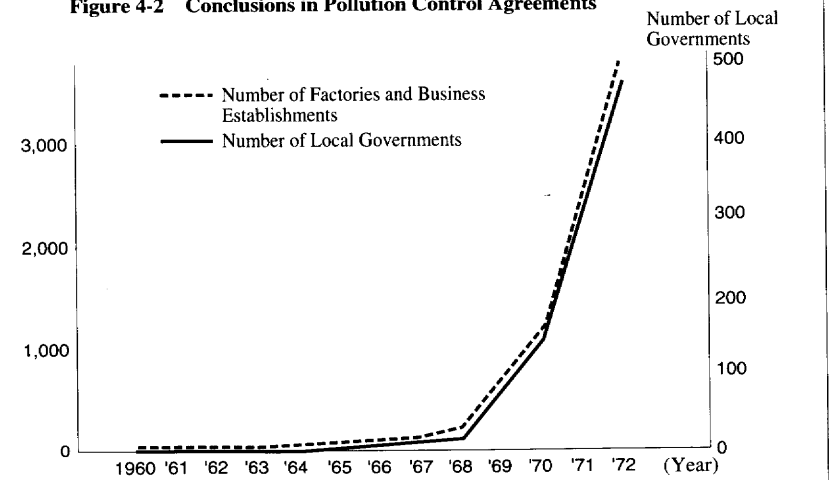
Moreover, during the early stages when industry response to the pollution problem was insufficient, engineers within local government played a significant role in such areas as the development of measurement technologies and technical solutions.

Table 4-1 Number of Prefectural Pollution Prevention Ordinances Passed in Japan

	Through 1962	1963	1964	1965	1966	1967	1968	1969	1970	Total
Number of Prefectures	1	(4) 3	(6) 2	(9) 3	(13) 4	(18) 5	(23) 5	(32) 9	(46) 14	46

Source: *Environment Agency 10-Year History* (1981, Environment Agency of Japan)
Note: Numbers in parentheses indicate accumulated numbers of prefecture-issued ordinances.

Figure 4-2 Conclusions in Pollution Control Agreements



Source: *Japan Pollution Document, Volume 2* (1988, Ryokufu Publishing)

Box 5 Pollution Control Agreements

The Yokohama Model

In 1964, before legal pollution regulation was solidified as a system, the city of Yokohama conducted an independent environmental investigation on the occasion of the establishment of the Isogo thermal power plant of the Electric Power Development Company within Yokohama's seaside industrial zone. Based on the results of that investigation, it demanded as a condition for the sale of the development grounds the conclusion and observance of an agreement on air pollution concerning the area's development. This has come to be called the "Yokohama Model," and became a model for future pollution control agreements.

Many subsequent agreements on pollution control were "gentlemen's agreements" which stopped only at administrative guidance. But under the Yokohama model, in the event that business did not exercise measures to fulfill the city's specifications, the city assumed this role, carrying out appropriate measures and requiring industry to pay for it. Especially noteworthy is the fact that a security deposit towards the fulfillment of these measures was required.

Character of Pollution Control Agreements

Pollution control agreements represent a response to business, which local governments view as the source of pollution. They are documents of accord reflecting the mutual agreement of both parties following discussions of pollution control measures such as regulatory standards for pollution and compulsory talks prior to the addition of new production facilities. Legal interpretation of pollution control agreements covers both agreement theory and contract theory, and although there is debate regarding interpretation of the agreement's binding legal authority, the pollution control agreement has substantially arrived as a uniquely Japanese and effective means of supplementing existing restrictions by law and ordinance.

Even recently, this method has been employed in response to environmental pollution by advanced industries such as the semiconductor industry, to which prior legal ordinances are difficult to apply.

Decisions at the Top of Local Governments and Efforts of Those in Charge

Local governments are in the precarious position that they can do nothing but respond on an emergency basis to urgent local citizen demands regarding various forms of pollution problems, which arise from each region's uniquely local natural and social character. They therefore preceded the government in developing a broad spectrum of measures. We must take special notice of the decisions made by local government leaders and the efforts of the people in charge of negotiating with business and local residents in this process. In particular, the person in charge at the site was well-versed in all matters of industrial activity, broadly mobilized his/her experience and wisdom to propose various ideas for pollution control to win over the business side.

This sort of pollution control measure employed by some local governments contributed to the promotion and establishment of national pollution control measures which put national minimums into effect.

4.4 National Government Efforts

Start of a Belated Response

Compared with local governments, the national government was slow to launch pollution control measures. In fact, nothing remarkable can be pointed out between the period lasting from the end of the war until 1955.

In December, 1955, the Ministry of Health and Welfare announced that it had written a *Living Environment Pollution Control Standards Bill* and negotiated for the support of related parties over the following year. However, strong opposition from various groups representing industry and related ministries made submission of this bill to the Diet impossible. Industry and related ministries viewed the environment as conflicting with economic development and therefore attached priority to the economy. The Ministry of Health and Welfare revised the bill in part and presented it once again in December, 1957 to related ministries, but once again it failed and ultimately never did become law.

Meanwhile, the problem was growing more aggravated due to increases in energy consumption volumes and the construction of petrochemical complexes. The Ministry of Health and Welfare promoted investigations towards new legislation, and the Ministry of International Trade and Industry began to investigate new legislation from the viewpoint that a resolution of the air pollution problem was essential not only to public health but also to the healthy development of industry. From 1961, the two ministries engaged in negotiations and as a result the *Law Concerning Controls on the Emission of Smoke and Soot* was enacted in June, 1962. This law regulated emissions of "soot and other powder dust" (specified as "dust and soot" in the *Air Pollution Control Law*) and sulfurous acid gas and sulfuric acid anhydride in regions officially designated by

the national government.

This regulation was considerably effective in controlling dust and soot, but the level of regulation concerning sulfur oxides was relatively lax and as a result the air pollution problem was not resolved.

National Governmental Investigation of Pollution Countermeasures

In response to air pollution in Yokkaichi, the Ministry of Health and Welfare and MITI in 1963 jointly organized a committee of experts (the "Kurokawa Investigation Committee"), dispatched the committee to affected areas and conducted investigations into the harmful effects of pollution and means of responding to the sources of pollution. The Committee submitted its findings on Yokkaichi pollution to the government in 1964, and played a definitive role in promoting pollution measures.

Next, in its investigation of the industrial complex construction problem in Mishima and Numazu, the Committee examined pollution's sources and conducted preliminary forecasts and evaluations using wind tunnel experiments and computer simulations. This wind tunnel experiment represents the first time that atmospheric simulations were used to conduct a preliminary investigation of industrial pollution. This method was also the forerunner to preliminary research techniques combining analysis and measurement of air pollution with climatic investigation.

Consolidation of an Integrated Legal System

Starting at that time, it was strongly felt that pollution control policy must focus on an integrated effort unifying various methods while working towards preventative planning starting with temporary emergency measures. Moreover, there were more and more calls for the clarification of a basic principle that would set a precedent for promoting measures based on a designation of pollution's target range, liability of the polluter, and responsibilities of the national government as well as local governments. As a result, the *Basic Law for Environmental Pollution Control* became effective in July, 1967.

The Pollution Prevention Plan

Based on the *Basic Law for Environmental Pollution Control*, the Pollution Prevention Plan took as its object those regions exposed to serious pollution or the threat of serious pollution. It established integrated preventative planning in response to a wide diversity of pollution phenomena, and represented a new administrative method whereby the national and local governments worked together towards its realization.

In order to encourage the promotion of the Pollution Prevention Plan's measures established by local governments, special fiscal measures that raised the national aid burden were introduced in 1971 and the consolidation of a system for environmental monitoring of air pollution by local governments was promoted.

Policy Target Decisions

The *Basic Law for Environmental Pollution Control* established environmental quality standards designating target environmental states and ordained the issuance of regulations and other measures with the intent of fulfilling such standards. In 1969, atmospheric quality standards targeting health problems were announced, addressing sulfur oxides with the specification that "average values measured hourly over a one-year period not exceed 0.05 ppm."

Against the backdrop of a 1970 revision of the *Basic Law for Environmental Pollution Control* and a 1972 trial judgment in Yokkaichi, scientific discoveries were applied to a revision of these environmental quality standards in 1973 to address sulfur dioxide, which must "fall below an average level 0.04 ppm measured hourly over one day, or below hourly levels of 0.1 ppm."

Sulfur Reduction Measures and Fuel Conversion

In order to satisfy environmental quality standards regarding sulfur oxides, a planned and rapid drive to lower sulfur content in fuel, the primary cause of sulfur oxide generation, was necessary. Therefore, the Ministry of International Trade and Industry installed a Low Sulfur Measures Committee in the General Energy Investigation Committee. The Committee's deliberations resulted in the enactment of the following types of measures.

First, a reduction in crude oil sulfur content was planned by increasing imports of low-sulfur oil from Southeast Asia and the Middle East. As a result, the average sulfur content rate of imported crude oil was reduced from 2.04% in FY 1965 to 1.68% in FY 1969.

Second, heavy oil desulfurization was begun in 1967. The capability of heavy oil desulfurization processing vs. heavy oil shipped (for domestic use) rose from 3.3% in FY 1967 to 20.6% in FY 1969, and over 60% after FY 1975.

Third, crude oil itself was used as fuel for preventing air pollution in the electric power industry.

In addition to the above measures focusing on reduced sulfur content in fuel, independent efforts conducted primarily by business included the introduction of LNG (liquefied natural gas) and the implementation of district air conditioning using municipal gas (Box 6), both of which contained no sulfur. Although difficulties in transportation means and supply stability of LNG existed, it became

an extremely effective means because it contained no sulfur. Likewise, regional air conditioning using city gas proved to be an effective means of controlling air pollution in urban areas.

Box 6 The Introduction of LNG (Liquefied Natural Gas)

A Clean Energy Source

Natural gas generates no sulfur oxides when burning because it is a sulfur-free fossil fuel. Moreover, it emits almost no falling soot or dust, and compared with coal and oil emits relatively low levels of carbon dioxide. Natural gas is therefore one excellent energy source towards preventing air pollution.

Towards LNG Use in Power Generation

Based on a proposal submitted by the Tokyo Gas Corporation, the Yokohama thermoelectric power plant of the Tokyo Electric Power Company in 1970 became the world's first power plant to use LNG.

But there were drawbacks. When compared to heavy crude oil, LNG used as fuel for power generation was about 30% more expensive, its countries of production were limited, it had to be liquefied at ultra-low temperatures at the site of origin, and required large-volume transportation in specialized vessels.

However, these economic and technical difficulties were overcome and LNG introduction launched because the power company valued decentralization and diversification of energy sources and wished to respond to society's demand for environmental preservation.

Further, because Japan relies on imported energy resources to fulfill most of its energy needs, there existed a background which made the choice of LNG possible. It can also be pointed out that Japan had already achieved sufficient economic and technological strength to absorb the additional cost.

Execution and Strengthening of Legal Regulations

Following enactment of the *Basic Law for Environmental Pollution Control*, the *Air Pollution Control Law* was established in June, 1968, and the *Law Concerning Controls on the Emission of Smoke and Soot* was retired. K-value controls were also introduced in response to sulfur oxides (Box 7).

Under this method, emission standards were determined based on the region and height of the emission outlet. Standard emission values for each region were calculated by looking at the concerned region's current levels of air pollution and

forecast for fuel demand. Accordingly, emission standard values were established, mandating a reduction in each region's gross sulfur oxide emission volumes so that they fall within the maximum volumes permitted by environmental quality standards. This emissions standard was strengthened almost annually (the first-the eighth Regulations) through 1976.

In 1970, legal revision by the "Pollution Diet" strengthened regulations by canceling the designated areas (expanding regulatory coverage nationwide), adding five new regulated substances, including cadmium, to sulfur oxides and dust and soot already targeted by regulation, clarifying the roles of the national and local governments, and enabling local governments to establish more stringent emissions standards than national ones. A total pollutant load control system was also established by 1974 legal revisions. In regions specified as suffering from severe air pollution, local governors were permitted to draw up their own total pollutant load reduction plans, in effect leading to total pollutant load regulatory standards stricter than the norm.

National Government Role and Response

This successive reinforcement of regulations also touched upon energy policy, and as a result air pollution by sulfur oxides steadily improved **(Figure 2-2)**.

While it cannot be denied that the nation's response in some aspects actually followed behind certain local governments' progressive efforts, the prevention of air pollution's effects on health needed to be secured equally for all citizens, not just for those of a specific region. In order to establish a national minimum for the preservation of public health, the national government legally provided for a uniform national regulatory standard. Because industry was compelled to observe this standard, the enforcement of air pollution control measures was ensured.

Box 7 K-Value Controls and Total Pollutant Load Controls

What are "K-value Controls"?

K-value controls represent a regulatory model incorporating sulfur oxide emission standards into the *Air Pollution Control Law*. Determined by effective chimney height (He), tolerable limits of pollution per hour among facilities generating smoke and dust are calculated based on the following formula:

$$q = K \times 10^{-3} \times He^2$$

Because the value of the constant "K" varies from area to area, emission standard levels also vary accordingly. Hence, the name "K-value control." In determining "He," modification factors based on the rising momentum of exhaust

gas and temperature differences with the air are calculated and added to the actual height of chimney. Based on the "Sutton equation," this model specifies the maximum landing concentration on the ground for sulfur oxides diffused from the chimney as proportional to the volume of sulfur oxides and inversely proportional to the second power of the effective chimney height.

Background on Deployment of the K-value Controls

This regulatory method was implemented in 1968. As flue-gas desulfurization technology had not yet gained in popularity, the promotion of high chimney diffusion measures towards sustained realization of environmental quality standards was essential. However, this method was not effective in regulating a large number of facilities emitting small quantities of smoke and soot, and the high chimney diffusion approach was criticized for reducing only emission concentrations and not actual total pollutant loads.

Regarding the former criticism, supplementary fuel usage regulations mandating the use of low-sulfur fuel were introduced in 1970. The latter criticism was also managed by the introduction of total pollution load controls in 1974.

Total Pollutant Load Controls

Sulfur oxide regulations began with outlet concentration controls and were repeatedly revised and reinforced as they shifted towards K-value controls. But while the sulfur oxide air pollution condition tended generally towards improvement, the situation particularly among factory-concentrated regions remained serious from the standpoint of environmental quality standards.

In response to this, Mie Prefecture (home to Yokkaichi City) enacted an ordinance specifying total pollutant load controls in 1972, and the national government followed with its own version in 1974. These restrictions check regional gross emissions by allowing local governors in each designated area to determine total pollutant load control standards for particular factories and fuel use standards for factories in general. Over the next three years (1974-1976), 24 designated areas were specified as targets for total pollutant load controls. In such areas, new factories were subjected to more severe regulatory standards than existing factories, effectively controlling new factory construction in overcrowded regions.

Regulations and Policy Funding as Bounty

In addition to these efforts, the national government also implemented low-interest financing policy as a means of promoting and supporting industrial pollution measures.

It established the Environmental Pollution Control Corporation in 1965 (reorganized as the Environment Corporation in 1992), endowing it with responsibility for the construction of pollution control facilities and supplying necessary funding (by the Japan Development Bank and the Japan Finance Corporation for Small Business) for investment in industrial pollution control. These activities served an especially meaningful function for small- and medium-sized enterprises weak in capital.

Japan-Style "Polluter Pays Principle"

The "Polluter Pays Principle" (PPP) was first specified by the OECD in 1972 as a means of allocating the burden of payment for pollution measures.

According the OECD, PPP's main objective is to restrict government subsidies and other means of support for the cost of pollution measures, which should originally be borne by the private sector. By internalizing the external "diseconomy" of environmental pollution resulting from industrial activity into the economic system , "polluter pays" is a basic principle towards realizing a proper allocation of resources. At the same time, PPP was submitted as a principle of international trade, preventing distortions arising in international transactions as a result of government subsidies for private pollution control activities.

In Japan, however, the "Polluter Pays Principle" has come to incorporate additional interpretations due to the fact that serious pollution had already occurred. The cost to restore polluted environments and compensate victims must also be borne by the polluter. This is the so-called "Japan-Style Polluter Pays Principle." The above-mentioned *Compensation Law for Pollution-Related Health Damage* was also enacted based on this concept.

4.5 The Role of Politics

Political Decisions

Pollution became a large topic for politics as well, with even the Diet conducting concentrated discussions starting around 1970. As a result of these discussions, the opinion grew stronger that it was necessary to reinforce mechanisms serving to support integrated pollution measures. As a start, the Cabinet Council decided in July, 1970, to install in the Cabinet a Pollution

Measures Headquarters, to be headed by the Prime Minister and consisting of 15 members loaned from related organizations as well as 19 staff members to support them.

In addition, a Cabinet Committee for Pollution Measures, consisting of Cabinet ministers, was also founded. Within this framework, the "Pollution Diet" was convened in November of the same year to hold concentrated deliberations for the purpose of forging a drastic consolidation of the pollution-related legal system. As a result, 14 broad, epoch-making bills related to pollution were passed.

In his 1970 policy speech, then Prime Minister Eisaku Sato declared that "...various forms of pollution and the rise in social tensions we are witnessing result from our inability to maintain a social environment that keeps pace with the rapid development of industry and technology..." Moreover, the "Pollution Diet's" Statement by the Prime Minister announced, "in this keynote speech, we wish to uphold the ideal of 'no growth that neglects welfare' It goes without saying that economic growth was originally intended as a means to achieve social welfare, but Japan's economic growth has been acutely rapid, and it is necessary to aggressively improve the living environment for a society that has rapidly enlarged this scale."

Regarding pollution, the Prime Minister positioned this issue as "the number-one point of concern of the nation's citizens." Moreover, a 1971 policy speech had the following to say about the pollution problem: "We will establish an Environment Agency charged with confronting the important issues of the future. In doing so, we will unify pollution administration and devote our full energies to the preservation of a rich living environment while preserving the nation. Further, we will develop new technologies to overcome pollution and express our desire to contribute to the advancement of international society."

Establishment of an Environment Agency to Unify Regulatory Authority over Industrial Pollution

Under the strong initiatives taken by Prime Minister Sato, the Environment Agency was launched in 1971 as one point of unification for regulatory authority concerning pollution, which had previously been distributed among various government ministries.

This Agency was charged with administration touching upon environmental preservation and endowed with the capacity for planning and coordination in governmental policy on the environment. The Environment Agency was charged with the determination of environmental quality standards and unification of factory pollution emission controls, which responsibility had previously been

divided up among various ministries. However, with the exception of activity related to natural parks, activity beyond the realm of regulations, such as that intended for pollution prevention or environmental improvement, remained under the jurisdiction of its related ministries.

The establishment of an Environment Agency led to the advancement of measures against industrial pollution such as that caused by sulfur oxides, but its authority to develop measures beyond this frame was limited and it can be said that the breadth of administrative authority among various ministries posed a difficult challenge to the integration of environmental policy.

4.6 Industrial Response and Efforts

Awakening of Industry

We cannot say that industry made an aggressive effort to control pollution from 1955 to 1967. Private pollution control investment in 1967 remained small at 29.7 billion yen (only 3% of all private capital investment). Moreover, the industrial world played a passive role regarding the establishment and deployment of the *Basic Law for Environmental Pollution Control* in 1967, the *Pollution Crime Law* in 1970 and regulations on absolute liability for damage compensation in 1972.

However, industrial awareness regarding pollution quickly rose against the backdrop of negotiations with victim inhabitants, the launch of regulations by local governments and the national government, as well as losses in pollution lawsuits. Industry actively accepted its social responsibility, enacting pollution measures as a result of decisions by industrial leaders.

Aggressive Pollution Control Investment

Private pollution control investment thereafter increased rapidly, showing an increase of 34% in FY 1966 over the previous fiscal year, and 69% in FY 1971 over the previous fiscal year. The rate of pollution control investment as a percentage of total capital investment rose to about 5% in FY 1970 and about 6% in FY 1972, achieving a level on parity with that in other advanced, industrial nations. In FY 1975, after the first oil shock, pollution control investment rose to 960 billion yen – 17% of all private capital investment – as pollution became one of industry's top investment priorities.

The Role of Engineers

Industry adjusted to severe emissions standards by applying its pollution control investments to the development of various sorts of pollution prevention technologies and know-how. On this occasion, it also installed engineers, based on a previously-existing system of heat management experts and newly-established pollution control managers, into the internal company organization. Thereby, a technological base for pollution response was laid (Box 8)

Box 8 Air Pollution Control Measures in the Steelworks Industry

The Steelworks Industry and Air Pollution

Steelworks is one key industry that supported Japan's rapid economic growth while acting as a typical polluter during the initial stages of that growth.

In iron and steel serial production facilities, iron ore is sintered in a sintering machine and transferred into a blast furnace along with coke obtained from carbonized coal. Resulting deoxidized pig iron is refined in a basic oxygen furnace (BOF) and cast into billet. This billet is heat-processed in a heating furnace and then rolled to produce final products such as thick and thin steel sheets. Iron ore and coal, the raw materials used to produce steel, are accompanied by particulates and contain sulfurous elements. Further, large volumes of by-product gases are produced as a result of energy conversion of coal used as fuel at serial steel production facilities. Consequently, massive volumes of falling dust and soot, sulfur oxides and nitrogen oxides were generated by such facilities.

Advanced Air Pollution Control Measures

Today, however, the situation has undergone dramatic improvement due to advance control of air pollutant emissions. For example, there were instances reported where sulfur oxide exhaust levels at steel production facilities fell 20% between 1970 and 1987. But to what can these improvements be attributed?

Response to Regulation

One factor was the introduction of emission standards specifications and total load controls set forth in ordinances and laws for pollution prevention. Other factors include the conclusion of pollution control agreements between local governments, raw material and fuel conversion, the installation of desulfurization facilities, denitration facilities and dust-entrapping devices, as well as efforts in cooperation with local governments to design continuously-monitoring systems for exhaust gas volumes, sulfur oxide concentrations and such.

Promotion of Energy Conservation Measures

An even more noteworthy factor was the promotion of energy conservation, whose opportunity was created by the 1973 oil shock. As the steelworks industry is characterized by vast energy consumption levels, the role that energy conservation played cannot be understated. It should also be pointed out that the previous organization within companies of technician groups of experts in heat management and technology, based on the former *Heat Management Law*, also provided a technical base that contributed to energy reductions.

Important applications of energy conservation technologies can be ranked in the following order:

1. Improvements in operations technologies, such as reductions in energy consumption volumes, by conducting heat flow analysis and applying its results to computerized operation of thermal devices such as coke furnaces, sintering machines and blast furnaces;
2. Elimination and concatenation of production processes;
3. Recovery of waste heat.

For example, the Kawasaki Steel Corporation organized at Mizushima steel production facility an "Energy Use Rationalization Committee" whose membership consisted of department heads from various factories. This committee set energy conservation as its goal, established the precedence of policy investment and promoted broad-scale energy conservation at steel production facilities As a result, energy consumption volumes were decreased by over 24% compared to 1974.

This sort of energy conservation promotion achieves energy cost reductions and improvements in productivity and quality while at the same time contributing significantly to a reduction in air pollutants.

Appropriate Heat Management in Factories

Heat management lies at the heart of factory air pollution control measures. Adequate heat management attacks the proverbial "three birds with one stone" by reducing energy expenditures and energy consumption per unit of production, decreasing air pollutant exhaust volumes, and moreover leading to improvements in product quality. Satisfactory results are first made possible through the use of adequate means of heat management, such as supplementary pollution prevention equipment including flue-gas desulfurization facilities and dust-entrapping devices.

During the postwar period, a system of heat management exercises and experts was introduced. The large numbers of technicians and skilled heat-workers, who were able to engage in adequate heat management at the factory site, effectively promoted Japan's air pollution measures. Further, they enabled the manufacture of high-quality products using as little energy as possible.

Development of the Pollution Control Device Industry

Further, in response to rising demand for pollution control devices, several companies began to develop and produce electric dust-entrapping devices and flue-gas desulfurization facilities that reduce smoke and soot emissions. These manufacturers of pollution control devices also contributed to a reduction in pollution (Box 9).

Box 9 Flue-Gas Desulfurization Facilities

About 2000 flue-gas desulfurization facilities are now operating across Japan, with total processed volume exceeding 200 million m^3/hour. Total processed volume for all flue-gas desulfurization facilities in the world is estimated at about 700 million m^3/hour, with Japan, the U.S. and Germany alone accounting for over 90% of this amount. Flue-gas desulfurization technology was one central technology that made it possible for Japan to overcome its severe pollution problem. But in order for this technology to be developed and accepted, there was more in the background than just the enforcement of strict sulfur oxide emission restrictions.

A Technical Base

On the occasion of the Besshi copper mine smoke pollution incident, flue-gas desulfurization facilities employing sulfuric acid production and ammonia washing were developed during the 1920s and 1930s, based on the Petersen method of sulfuric acid production. This contributed to a resolution of the problem.

Further, in 1955 (when Japan's rapid economic growth period began), Tohoku University began developmental research using limestone – an abundant mineral resource in Japan – to render sulfur oxides environmentally safe, and applying the resultant plaster by-product in a method of lime-plaster flue-gas desulfurization. The research was completed in 1960. Once this sort of foundation was laid, practical flue-gas desulfurization facilities capable of responding to severe emission regulations were developed.

Problems such as By-Product Materials

As flue-gas desulfurization facilities themselves are expensive and require large quantities of electricity to operate, the problems of introducing proper counteragents and benefiting from by-products were extremely important ones.

In Japan, abundant limestone was adopted and the gypsum it generated as a by-product was used in the plaster and cement industries. For example, when one ton of coal containing 4% sulfur is burned, emission gas processed by a lime-plaster flue-gas desulfurization facility will yield 0.21 tons of plaster.

However, this introduces the new headaches of lime and gypsum transport. Thus, it is important to note resource-related problems accompanying the application of pollution technologies, and to devise pollution measures accordingly.

4.7 Factors of Success

As the above points illustrate, the efforts of various sectors in Japan to overcome the dilemma between economic development and environmental preservation, and much trial and error produced substantial results in controlling industrial air pollution. The factors responsible for this success can be summarized as follows:

① Achievement of a national consensus that pollution's damage to health be stopped.

As vicious pollution inflicted repeated damage to health, citizen pollution protest movements and the mass media broadly and rapidly raised awareness regarding the pollution problem. Pollution was taken up as an important political issue and national consensus regarding the eradication of pollution causing damage to health was achieved. As a result, swift response ensued among legislatures, administrations and businesses.

② Distinction between perpetrator and victim, and relative clarification of their relationship.

Those primary initiators of fierce air pollution were the factories installed in

areas such as coastal industrial complexes. As victims and perpetrators were relatively clear and comprehensible to the people, industry was required to respond to the problem. National consensus regarding the execution of measures was achieved.

③ Progressive efforts by some local governments.

In spite of the fact that local governments have come to assume a welcoming posture towards industry, some local governments facing severe pollution problems forged ahead with their own solutions without waiting for the national government to respond. Their creations served as forerunners to the national government's subsequent measures to fulfill national minimums.

④ Consolidation of a nationwide system based on national minimums.

The *Air Pollution Control Law* clarified the roles of national and local governments, and in order to fulfill its responsibility towards enforcing national minimums, the national government applied regulations nationwide as it developed a system to secure every citizen's health. The government further implemented environmental monitoring and positively enforced it. Moreover, it charged industry with the responsibility of monitoring its environmental pollutant emissions and consolidated a system whereby health damage by industrial pollution was contained. The nation's energy policy, as well, promoted measures to reduce sulfur in oil with a view towards pollution control.

⑤ Establishment of the "Polluter Pays Principle" as a system to allocate the burden of funding for pollution measures.

A Japan-style "Polluter Pays Principle" was established, mandating that polluters bear the financial burden not only for measures to prevent environmental pollution, but also for restoration of the environment and compensation to victims of environmental pollution. Under the PPP, enactment of the *Compensation Law for Pollution-Related Health Damage* as well as the conclusion of pollution control agreements by local governments, contributed to the smooth promotion of pollution measures.

⑥ Satisfactory organizational and technical response by industry.

Industry, which at first did not necessarily pursue pollution measures with

enthusiasm, implemented aggressive measures in response to local citizen and government demands for "social responsibility among industry." It also invested in pollution control in order to encourage the active development and deployment of pollution response technologies. This was made possible by the high capital investment and technological development investment which supported rapid economic growth. Further, the national government devised tax and policy finance measures to support pollution control investment.

⑦ Cultivation of engineers to support the development and deployment of pollution response technologies.

Technological measures are indispensable to pollution response, and one noteworthy example of the engineering research that made a visible difference is the development of flue-gas desulfurization technologies, which played a valuable role in sulfur oxide reductions. The presence of engineer groups with abundant experience in heat control and energy conservation enabled the implementation of pollution responses based on technologies such as combustion control (boilers are one example). Supporting these technical measures was a tradition of technological research dating back to before World War II, as well as the cultivation of large numbers of engineers under Japan's post-World War II education system.