

SUMMARY AND SIGNIFICANCE OF EPMS PROJECT

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SUMMARY

This paper introduces the significance and activities of the EPMS (Environment Protect Management System) project, which is aimed at alleviating traffic nuisances including air pollution, vibration and noise. First, this project prepared an algorithm for estimating pollution generated by auto emissions, and calling on drivers to exercise self-control over the use of their automobiles, by publishing the results of these estimates through the broadcast media. Second, it aims to reduce traffic pollution by evaluating the effects of traffic signals on the generation of auto emissions. It also provides traffic data, and values for statistically estimated as well as actual monitored pollution levels. Finally, analysis of the data obtained by the first demonstration experiment is almost complete. In future, EPMS is planning to obtain detailed pollution-related data, design a simulation system for pollution estimation, and study control methods in future.

1. INTRODUCTION

Given the ever-burgeoning volume of traffic, traffic jams have become a fact of daily life. This has created a situation in which the effects of automobiles on the social environment, in particular air pollution (due to automobile exhaust), vibration, and noise can no longer be ignored. This has led us to organize a subcommittee of the traffic pollution reduction component - EPMS (Environment Protect Management System) - in which we first aim to reduce the generation of traffic-related pollution to protect the health of people living along the roads; our second goal is to secure easy access to urban activities while avoiding any sudden change in social structures; our methods to accomplish this include proposing various traffic policies, including proper controls on traffic flow. Our activities are outlined below.

2. SIGNIFICANCE OF EPMS

In recent years, advanced socio-economic activities and improvements in the quality of life have led to increasing traffic flows resulting in traffic jams in daily life. This has created a situation in which air pollution due to automobiles is no longer tolerable. These conditions served as an impetus for the activities of EPMS, which can be considered to be a promising, socially significant, policy from the following standpoints.

2.1 Significance of improving the health of people living along the roadways

EPMS policies may be effective in improving the health of people, and protecting the environment, in a short period of time.

2.2 Reduction of traffic pollution over the short term

EPMS policies may produce excellent results in a comparatively short time without requiring any large scale construction work.

2.3 Concept of improving the social foundation

Road improvements are often accompanied by drastic changes in social structures that may lead not only to losing various conveniences of social living for a prolonged period, but also to increasing the economic burden on people. EPMS, by controlling traffic flow in an appropriate manner, will achieve similar results without creating new burdens, or adding to existing ones.

2.4 Concept of keeping pace with improvements in public organizations

It is important for this policy to win public consensus to ensure its viability over the long-term. However, notwithstanding this, EPMS is still considered to achieve excellent results in a short time without any consensus since it interlocks with the ITCS (Traffic Control System) in regulating a smooth flow of traffic.

2.5 Control and alleviation of pollution during the period required for auto improvements

It is undoubtedly necessary to improve the very automobiles that generate this pollution. However, accomplishing this will take a long time. EPMS is anticipated to control and even alleviate the generation of pollutants during the time required for the required improvements in automobiles.

3. MEASURES TAKEN THUS FAR AND PRESENT CONDITIONS

Air pollution has been aggravated due to increasing pollutant loads resulting from expansion in industrial production activities and development in economic activities. This has led to the installation of a station that monitors general air pollution, the Ambient Air Monitoring Station, as well as another that monitors air pollution along roads, the Automobile Exhaust Gas Monitoring Station. They have both been continuously monitoring air pollution levels since 1970. The regulations detailed below have been enforced. However, the present state has fallen far behind in meeting environmental quality standards.

3.1 Environmental quality standards

The Environment Agency has issued a notice prescribing environmental air quality standards as follows:

3.1.1 Environmental quality standard for nitrogen dioxide

In 1978 the standard for nitrogen dioxide prescribed that, "A daily average of values (recorded at one hour intervals) shall be in the range between 0.04 ppm and 0.06 ppm or below."

3.1.2 Environmental quality standard for carbon monoxide

In 1971 it was prescribed that the daily average value (of values recorded at one-hour intervals) shall be below 10 ppm (a long-term evaluation); the 8-hour average value (of values recorded at one-hour intervals) shall remain below 20 ppm (a short-term evaluation).

3.1.3 Environmental quality standard for particulate matter (SPM)

In 1972 it was prescribed that the daily average value (of values recorded at one-hour

intervals) shall be 0.10 mg/m³, with the one hour value remaining below 0.20 mg/m³.

3.2 Present conditions from pollutants oxides of nitrogen

3.2.1 Transition in the average yearly values of nitrogen dioxide

The average yearly values of nitrogen dioxide are 0.017 ppm and 0.034 ppm respectively, as monitored by the continuous monitoring stations, i.e., 1160 General Ambient Air Monitoring Stations and 239 Automobile Exhaust Gas Monitoring Stations. High values are still prevalent. Figure 1 shows the changes over time in the average yearly average values of nitrogen dioxide.

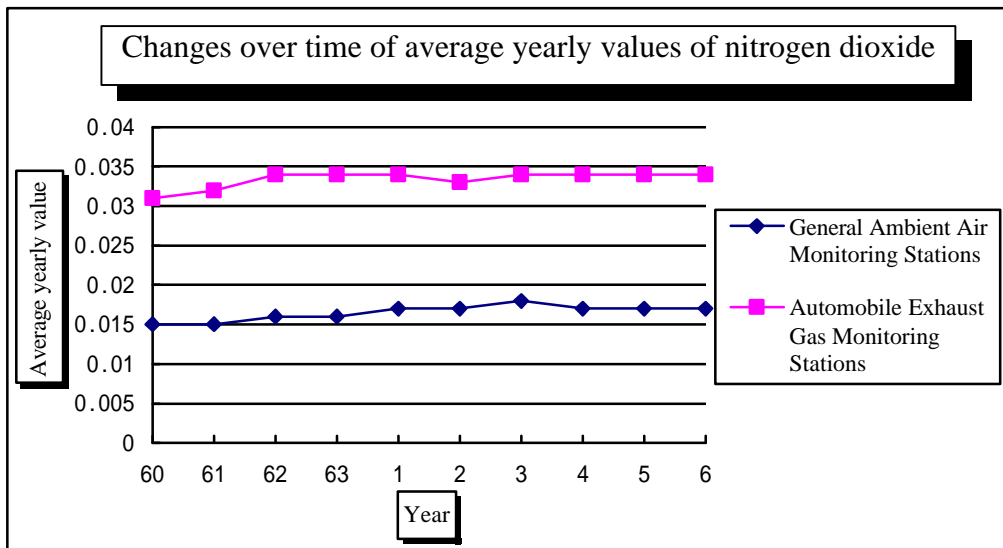


Figure 1 Changes over time of yearly average values of nitrogen dioxide (Source : White Paper of the Environment Agency)

3.2.2 Achievement of environmental quality standards relative to nitrogen dioxide in particular areas

Strict regulations and various accompanying measures have been applied to air pollutants from fixed generation sources, including factories and exhaust gases from automobiles relative to the pollution of air with nitrogen oxides (NO_x). However, little improvement has been made in large-city areas including Metropolitan Tokyo and Osaka Prefecture due to an increase in the volume of automobile traffic, an increase in the number of diesel-powered automobiles, and an extension in average service life. Given these circumstances, a special measure law was enacted in June, 1992 related to, "the reduction of the total volume of nitrogen oxides to be exhausted from automobiles in particular areas (hereinafter called "Automobile NO_x Law"). With this Automobile NO_x Law in force, any area where achievement of the environment quality standard has been deemed difficult relative to nitrogen dioxide has been specified as a designated area for the purposes of the legislation.

Figure 2 shows the transition in the number of stations that achieved the environmental quality standard relative to nitrogen dioxide in particular areas. Out of 113 total monitoring stations in particular areas of the Metropolitan Area, 66 stations failed to attain the environmental quality standard in 1995. In particular sections of Osaka and Hyogo Prefectures, 31 stations failed to attain environmental quality standards out of a total of 65 monitoring stations.

framework. A source of smoke that converges into a point (point source) is, at present, most effective as a model. The formula behind this model will be described later, for reference.

Concentration Calculations:

(1) When the wind blows at a velocity of over 1 m/s:

$$C(x, y, z) = \frac{Q}{2\pi \cdot u \cdot \sigma_y \cdot \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \left[\exp\left\{-\frac{(z+H)^2}{2\sigma_z^2}\right\} + \exp\left\{-\frac{(z-H)^2}{2\sigma_z^2}\right\} \right]$$

Where, C (x,y,z): Concentration (ppm) at respective coordinates (x, y, and z)

Q : Volume of emission at point source of smoke (mL/s)

u : Average velocity (m/s)

H : Height of emission source (m)

x : Leeward distance along the wind direction (m)

y : Horizontal distance vertical to axis x (m)

z : Vertical distance at right angles to axis x (m)

(2) When the wind is light:

$$C(x, y, z) = \frac{Q}{(2\pi)^{3/2} \cdot \alpha^2 \cdot \gamma} \left[-\frac{1 - \exp(-\frac{1}{to^2})}{2t} + \frac{1 - \exp(-\frac{m}{to^2})}{2ta} \right]$$

$$t = \frac{1}{2} \left[\frac{x^2 + y^2}{\sigma^2} + \frac{(z-H)^2}{\gamma^2} \right] \quad m = \frac{1}{2} \left[\frac{x^2 + y^2}{\alpha^2} + \frac{(z+H)^2}{\gamma^2} \right]$$

$$\sigma_z = 1.5 \quad \sigma_y = (\text{Driveway width}) / 2$$

$$to = (\text{Driveway width}) / 2\alpha$$

$$\alpha = 0.3$$

$$\gamma = 0.18(\text{Daytime}), 0.09(\text{Nighttime})$$

3.4.2 Present state of roadside traffic pollution

The automobile exhaust gas monitoring stations are continuously monitoring air pollution in compliance with the environmental quality standards stipulated by the Environment Agency. However, air pollution along roadways is not monitored. According to the results of monitoring by the automobile exhaust gas monitoring stations, air sampled by 71% of stations in the Tokyo area failed to meet environmental quality standards. In addition, the number of retained automobiles (including two-wheeled vehicles) increased from 18.92 million in 1970 to 70.11 million in 1995. The foregoing indicate that air pollution values will become even higher than those monitored by the automobile exhaust gas monitoring stations even considering effects of the exhaust gas regulations.

4. DETAILS OF EPMS ACTIVITIES

This subcommittee is working with the following concepts and proposed targets so that EPMS can achieve its objectives, and effect improvements in the present situation, where pollution from auto emissions pollution is only increasing.

4.1.1 Concepts

- To give priority to maintaining the health of people living along the roadways.
- To make proposals in a manner that will not bring about drastic changes in social structures and increase economic burdens on the people.
- To avoid duplicating proposal already carried out (or expected to be carried out).
- To reduce automotive emissions over a short time period.

4.1.2 Proposed targets

- To propose EPMS
- Preparation of a manual teaching how to deal with the generation of pollution.
- Prepare proposals, and draft manuals, on how to provide terminal devices including pollution sensors.
- To draft a proposal on a system for simulating of pollution levels.

5. BASIC CONCEPTS

As a means of alleviating automotive emissions, two measures can be considered:

- 1) Long-term measures: To extend roads and improve public traffic-related facilities.
- 2) Short-term measures: To lower automotive pollution resulting from situations in which traffic is converge locally, or by relieving traffic jams by properly distributing traffic flow.

Since various proposals have already been made on long-term measures including the improvement of public traffic facilities, this subcommittee has focused on the study of short-term measures. Let us consider the basic concept now under consideration using the conceptual figure outlined in Figure 1. In addition to its general functions, EPMS is composed of a pollution count simulator, a pollution control method, and a function to perform statistical analyses and reports. EPMS takes as inputs the on-line traffic pollution data monitored by the stations to be installed along the road as well as meteorological data collected by respective meteorological observatories and other organizations. It then retrieves information on the volume of traffic, traffic flow, and occurrences of traffic jams from the traffic flow data to the Control Center. The above information is input into the "pollution count simulator" to verify and estimate the generation of pollution at all times. When high pollution counts are expected to be generated, AMIS conveys this information to drivers via their on-board equipment or via an information board on traffic conditions including the location of traffic jams, the degree of road congestion, and traveling time. In the same manner, measures are taken to announce traffic conditions through the mass media, urging drivers to exercise greater control over the use of their cars thus avoiding traffic tie-ups. Next, when traffic-related pollution is generated, traffic conditions concerning this pollution are announced to drivers through their on-board equipment, public information board, and mass media to urge drivers to control the use of their cars. In addition, measures are taken to control traffic signals by which the numbers of incoming cars are controlled, and outgoing cars are given priority traffic so that traffic congestion and pollution can be alleviated, and the volume of traffic in the polluted area can be reduced. Furthermore, traffic signal control is tightened so that the frequency of start and stop of automobiles in that particular area can be lowered to smooth out traffic flows. The author firmly believes that all the above measures, when properly used, will help cope with the generation of local traffic pollution. The author will also continue preparing statistical pollution generation data, and presenting these them to road administrators to help them make decisions on long-term measures.

6. PRESENT AND FUTURE

6.1 Present state of EPMS

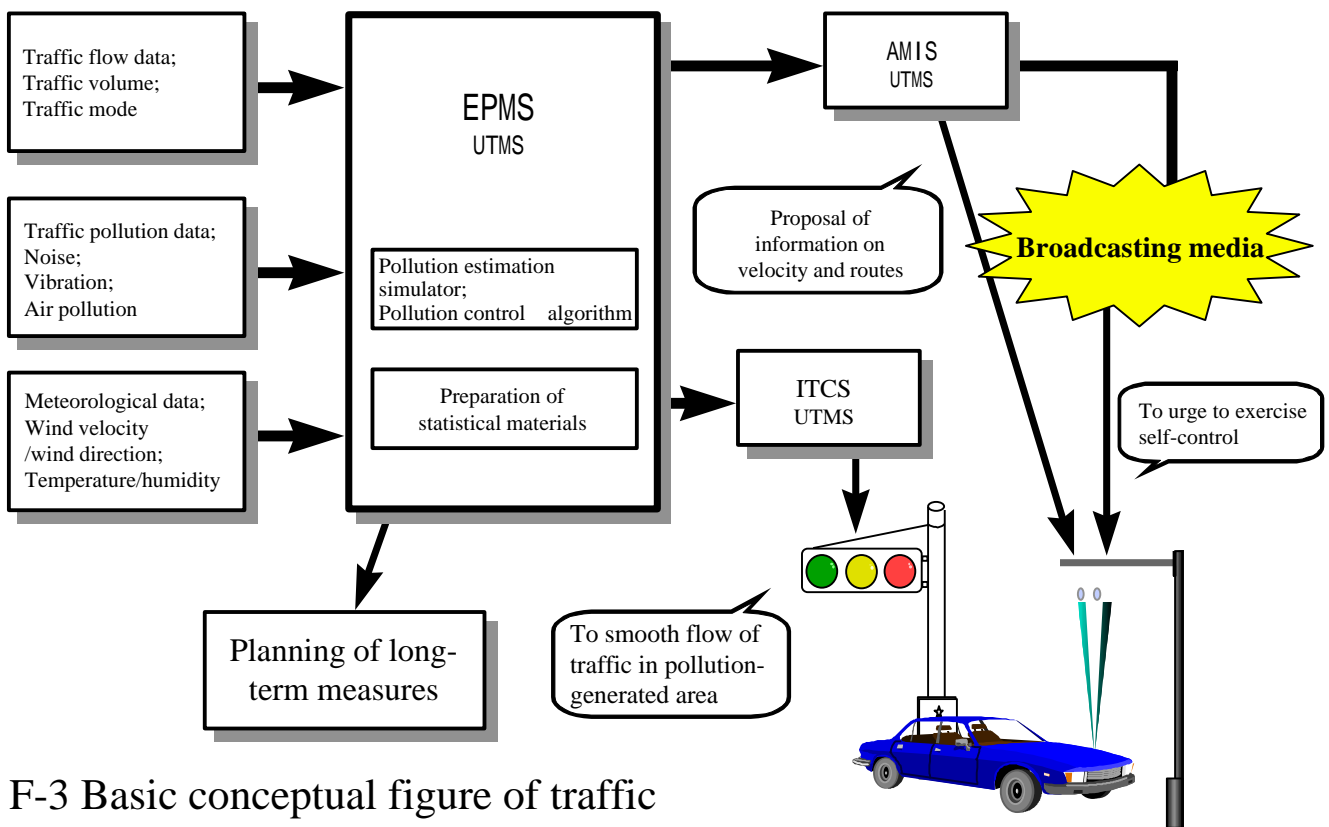
The third year has just begun since this subcommittee was organized. This subcommittee has just completed its first pilot project, and analyzed part of the data therefrom.

6.2 Themes of this subcommittee

- To specify types of traffic pollution.
- To specify types of air pollution.
- To extract relationships between traffic pollution volumes and traffic volumes.
- To prepare pollution count estimation methods.
- To study signal control methods.

6.3 Prospects of EPMS

The fact that the number of retained automobiles increased from 18.9 million in 1970 to 70.11 million in 1995 suggests that the demand for automobile traffic will only increase. Auto-makers should be held responsible for improvements in their own products without resorting to regulations which set a target for exhaust gas reductions. The Government and every organization body are working on many measures over the long term to extend and improve roads to cope with the increasing traffic-related pollution levels resulting from the increases in traffic. However, EPMS has advantages over other systems, because it can cope with the situation in a short time without increasing the burden on the nation independent of the above-described long-term measures. Particularly noteworthy is the immediate effect EPMS has on the control of traffic flows by interlocking with the ITCS (Traffic Control System) as evidenced by the pilot project. EPMS is therefore expected to play an important role in the reduction of traffic-related pollution in future.



F-3 Basic conceptual figure of traffic pollution reduction system

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