

## PART II FIELD SURVEY

For environmental assessment, it is necessary to study the present ambient concentrations of the pollutants as its first process. In this study, sulphur dioxide (SO<sub>2</sub>) has been taken up and monitored for a long term (one year) by the reason that SO<sub>2</sub> is the typical pollutant which is considered to be the most harmful to the human health.

And in order to identify the relation between SO<sub>2</sub> ambient concentration and meteorological conditions, the monitoring of wind direction & velocity, solar, net radiation and temperature has been carried out simultaneously.

In addition to the above, the vertical distribution of the wind direction and velocity has been studied for a short period (two days).

### CHAPTER 1 LOCATION OF MONITORING STATIONS

#### II-1-1 Guideline for Location of Monitoring Stations

The objectives of establishing monitoring stations for the measurement of ambient concentration of pollutants are generally considered to be as follows:

- (1) Validation of compliance to the environmental standards related to air pollution
- (2) Monitoring of the critical situation which requires emergency measures
- (3) Basic information and data for Governmental implementation of air pollution control administration
- (4) Basic data for the environmental assessment of the new emission sources
- (5) Post evaluation of the implementation of above (3) and (4)

For the site allocation of the monitoring stations, the consideration on the following matters is required, together with the meteorological, geographical conditions, distribution of pollution, land utilization and the present status of the emission sources.

- (1) peak concentration zone in the total survey area
- (2) densely populated area, particularly the area neighbouring to the peak concentration.
- (3) boundary area to evaluate the impact of interregional transport of pollutants
- (4) area proposed to be developed in future

- (5) area to evaluate the enforcement actions
- (6) the site whose data represent the area

The above is the general requirements for the site allocation of the monitoring stations. However, the advance application of those requirements are usually found difficult and so in most cases, the site selection is depending on the experiences. (\*) Ball<sup>1)</sup> has described the relation between SO<sub>2</sub> monitoring objectives and the spatial scale which is important for obtaining the data on the present pollution behaviour, as shown in Table II-1-1.

The spatial scale described in Ball's paper is defined and classified as follows:

- (1) Microscale --- Ambient air volumes with dimensions ranging from meters up to about 100 meters and associated with this scale.
- (2) Middle scale --- This scale represents dimensions of the order from about 100 meters to 0.5 kilometers and characterizes area up to several city blocks in size.
- (3) Neighbourhood scale --- Neighbourhood scale measurements would characterize conditions over areas with dimensions in the 0.5 to 4.0 kilometer range.
- (4) Urban scale --- Urban scale measurements would be made to represent conditions over areas with the dimensions on the order of 4 to 50 kilometers.
- (5) Regional scale --- Conditions over areas with dimensions of as much as hundreds of kilometers would be represented by regional scale measurements. These measurements would be applicable mainly to large homogeneous areas, particularly those which are sparsely populated.
- (6) National and global scale --- These measurement scales represent concentrations characterizing the nation and the globe as a whole.

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\* Industrial Pollution Control association of Japan (IPCAJ) has studied on the problems related to the optimal allocation of the monitoring stations and developed the methods for site allocation. But the methods are not applicable to this study as IPCAJ study is to evaluate the optimal allocation of the monitoring stations based on the measured data and diffusion simulation.

1) Ball, R.J., G.E. Anderson, Optimal Sites Exposure Criteria for SO<sub>2</sub> Monitoring, EPA-450/3-77-013(1977)

**Table II-1-1 Relationships among siting objectives and related data uses, site types, and scales of representativeness**

- (a) If the assumption is made that the peak concentration point will only rarely occur (within middle-scale limits) at the monitoring site, then the reading will better represent typical maximum values on the neighbourhood scale in the maximum impact area.
- (b) Microscale measurements may be required to define plume structure via either area network or mobile sampling to simulate plume or to estimate permanent middle scale site locations.
- (c) Under stagnation conditions, the maximum concentration zone will probably expand in area, in which case the reading may represent neighbourhood scale averages as well as middle scale averages.
- (d) Because of the multitude of scales on which models are designed to simulate air pollution, data on any scale may be required in model calibration/refinement work.

\* The "Spatial Scale of Representativeness" is keyed as follows: I - microscale; II - middle scale; III - neighbourhood scale; and IV - regional scale.

Siting Objectives/Data Uses	Site type	Spatial scale of representativeness*			
		I	II	III	IV
<b>1. Determination of Peak Concentrations in Urban Areas.</b> - Judging attainment/maintenance of NAAQS. - Evaluating progress in achieving/maintenance of NAAQS. - Developing/revising SIPs/evaluating control strategies. - Providing data to facilitate the ESCA of 1974. - Supporting enforcement actions. - Public information.	GL (P)		(a)X	X	
<b>2. Determination of the Impact of Individual Point Source in Multi-Source Urban Setting.</b> - Developing/revising SIPs/evaluating control strategies. - Reviewing new sources. - Developing/revising national SO <sub>2</sub> control policies (NSPS, SCS, tall stacks). - Providing data to facilitate ESECA of 1974. - Supporting enforcement actions.	Pr (P)		X		

Table II-1-1 Relationships among siting objectives and related data uses, site types, and scales of representativeness (Cont'd)

Siting Objectives/Data Uses	Site type	Spatial scale of representativeness*			
		I	II	III	IV
<b>3. Determination of the Impact of Isolated Point Sources.</b> <ul style="list-style-type: none"> <li>- Developing/revising SIPs/evaluating control strategies.</li> <li>- Reviewing new sources.</li> <li>- Developing/revising national SO<sub>2</sub> control policies (NSPS, SCS, Tall stacks).</li> <li>- Providing data to facilitate the ESECA of 1974.</li> <li>- Supporting enforcement actions.</li> </ul>	Pr (P)	(b)X	<u>X</u>		
<b>4. Assessment of Interregional SO<sub>2</sub> Transport.</b> <ul style="list-style-type: none"> <li>- Establishing baseline air quality levels for PSD planning and AQMP.</li> <li>- Evaluating progress in achieving/maintaining NAAQS.</li> <li>- Developing/revising SIPs to attain/maintain NAAQS.</li> <li>- Public information.</li> </ul>	GL (P)				<u>X</u>
<b>5. Determination of Base Concentration in Areas of Project Growth.</b> <ul style="list-style-type: none"> <li>- Establishing baseline air quality levels for PSD planning and AQMP.</li> <li>- Evaluating progress in achieving/maintaining NAAQS.</li> <li>- Developing/revising SIPs to attain/maintain NAAQS.</li> <li>- Public information.</li> </ul>	GL (F)		X	<u>X</u>	X
<b>6. Emergency Episode Abatement Initiation and Monitoring.</b> <ul style="list-style-type: none"> <li>- Documenting episodes and initiating episode controls.</li> <li>- Public information.</li> </ul>	GL (P)		X	(c)X	
<b>7. Assessment of Background Concentration in Rural Areas.</b> <ul style="list-style-type: none"> <li>- Establishing baseline air quality levels for PSD planning and AQMP.</li> <li>- Developing/revising SIPs to attain/maintain NAAQS.</li> <li>- Public information.</li> </ul>	GL (P)				<u>X</u>
<b>8. Determination of Pollution Exposure in Populated Areas.</b> <ul style="list-style-type: none"> <li>- Documenting populating exposure and health research.</li> <li>- Public information.</li> </ul>	GL (F)		X	<u>X</u>	X
<b>9. Diffusion Model Calibration and Refinement. (d)</b>	GL Pr (P)	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>

The number of monitoring stations depends on the siting objectives and there will be no definite criteria but in some countries such as Japan and USA, a certain guideline is instructed by the Authorities concerned. Tables II-1-2 and II-1-3 show such guidelines of Japan<sup>2)</sup> and USA respectively.

Table II-1-2 Calculation method of number of monitoring stations for basic program of optimal distribution of monitoring stations

<p><b>Guideline for the establishment of monitoring networks based on Article 22 of Air Pollution Control Law.</b></p> <p>The monitoring networks for the inhabitable area are to be established, calculating the number of stations by following equations.</p> <p>(1) In case population density to inhabitable area exceeds 2,600 (national average)</p> <p>Inhabitable area ÷ 25 km<sup>2</sup> = Number of stations</p> <p>(2) In case of not exceeding 2,600</p> <p>Inhabitable area ÷ 25 km<sup>2</sup> × <math>\frac{\text{Population density of the area}}{2,600}</math> = Number of stations</p>	
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Table II-1-3 Number of SO<sub>2</sub> monitoring stations by EPA standard<sup>3)</sup>

Population	Number of stations		
	High Conc. Area <sup>a)</sup>	Medium Conc. Area	Low Conc. Area <sup>b)</sup>
Over 500,000	6 - 8	4 - 6	0 - 2
100,000 - 500,000	4 - 6	2 - 4	0 - 2
Under 100,000	2 - 4	1 - 2	0

Remarks: a) area exceeding primary ambient standard  
 b) area not exceeding secondary ambient standard or under 60% of primary ambient standard

2) Environment Agency, Japan Association for Public Hygiene, Study on optimal allocation of air pollution monitoring networks

3) Environmental Protection Agency, Ambient Air Quality Surveillance Regulations, 40CFR58, 44FR27571, May 10, 1979 Amended by 46FR44163, September 3, 1981

For the location of sampling inlet, the consideration should be given to the followings:

- (1) In order to avoid the impact by the turbulent air of all the directions and the obstructives such as buildings and so on, the location of sampling inlet should be installed at least 3 m apart from the obstructives.
- (2) The site for the sampling inlet should avoid the impact from the facilities emitting pollutants, such as stacks, exhaust pipes and so on.
- (3) The height of sampling inlet location is generally 3 to 20 m high from the ground.

## II-1-2 Outline of Survey Area

For the optimal allocation of the monitoring stations, the information and data on the topographic and climatic conditions of the area together with the information on the distribution of emission sources and long term developing plans. The outline of the survey area in this study is as follows.

### II-1-2-1 Topography

The Republic of Singapore is located at  $104^{\circ}$  east and  $1^{\circ}$  north, about 140 km from the equator, and the southern edge of the Malaysian Peninsula. The northern part of the Republic is bordered with the Straits of Johore and the southern part is fronting with Indonesia through the Straits of Malacca. The entire territory of the Republic is consisted by more than 50 islands, big and small, having the total area of  $616.3 \text{ km}^2$ . The main island of the Republic is extending 42 km from east to west and 23 km from north to south, and it is comparatively flat land, having the maximum height of about 150 m over the sea.

### II-1-2-2 Climate

There are almost no differences of temperature through the year, and its climatic condition belong to the tropical type, having the average yearly temperature  $27$  to  $28^{\circ}\text{C}$  and the humidity of about 80%. The wet and dry seasons are not discriminatable but during November to January, it has more rainy days. As for the wind directions, during December to March, north wind is dominant, June to August south wind is dominant, and the remaining months have no dominated directions. The wind velocity is generally rather weak, showing 1 to 3 m/sec. through the year, and having many calm days.

### II-1-2-3 Distribution of emission sources

The industrialization of the Republic has been concentrated into Jurong area. The major emission sources of  $SO_2$  are Jurong Power Station, oil refineries located in the southern islands, Pasir Panjang Power Station located at east of Jurong area, and Seneko Power Station, located in the northern part of the main island. Besides these major sources, the medium and small factories are located in Jurong area, such as petrochemicals, chemical, pharmaceutical, rubber, non-alloys, foods, textiles, machineries, electronics and so on.

### II-1-2-4 Long term developing plan

The long term development of industrial areas have been planned for aiming proper distribution of population, improvement of employment opportunity, alleviating traffic confusion by access plan of factory and housing, and so on. Among these plans, the large scale siting of new industries have been scheduled to construct coal firing power stations in Pulau Seraya and Tekong, and an integrated steel mill in Tekong by 1990.

### II-1-3 Location of Monitoring Stations

Taking comprehensively the monitoring objectives, land utilization, distribution of pollution sources, long term developing plan and so on into consideration, the monitoring stations have been established 5 in Jurong area and 2 in Changi area. The location of each station is shown in Fig. II-1-1 and Table II-1-4.

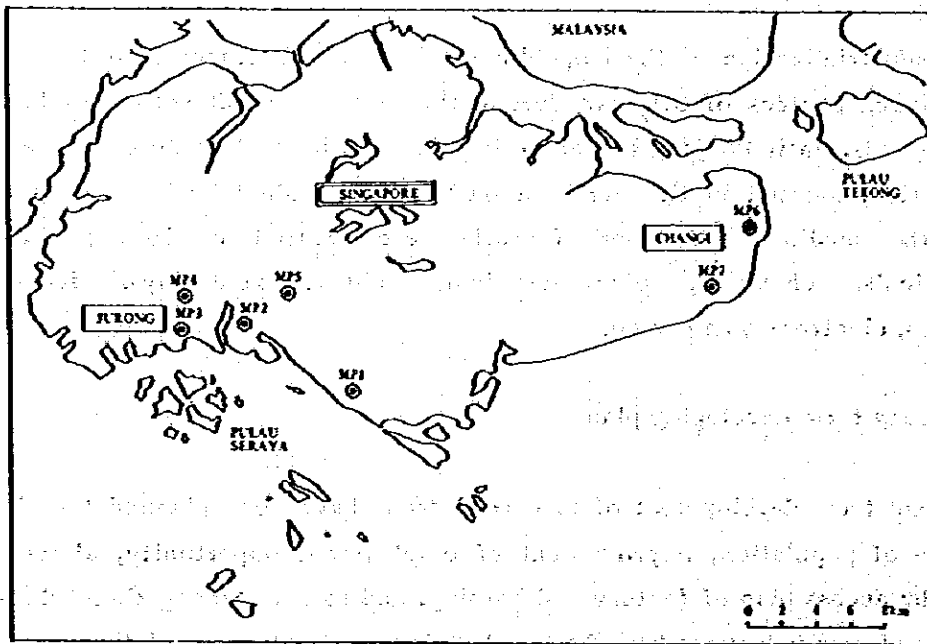


Fig. II-1-1 Location of monitoring stations (MP-1 to MP-7)

Table II-1-4 Location of monitoring stations

Jurong area	Changi area
MP-1 National University of Singapore	MP-6 Changi Airport
MP-2 JTC Town Hall	MP-7 Bedok Police Station
MP-3 JTC Soil Investigation Unit	
MP-4 Boon Lay Apartment	
MP-5 Bukit Timah Fire Station	

#### II-1-4 Measuring Items of Monitoring Stations

The measuring items of monitoring stations are shown in Table II-1-5. The instruments for SO<sub>2</sub> ambient concentration, wind direction and velocity have been installed at each station, and the instruments for solar, net radiation and temperature have been installed at MP-1. All these instruments are based on automatic and continuous systems by which through-year measurement have been carried out.



Table II-1-5 Measuring items of monitoring stations

Station	Measuring Items	Measuring method
MP-1 National University of Singapore (NUS)	SO <sub>2</sub> ambient concentration Wind direction & velocity Solar radiation Net radiation Temperature (+1.0 & 10 m)	Solution conductmetry Propeller type anemometer Radiation thermocouple - ditto - Nickel resistance
MP-2 JTC Town Hall	SO <sub>2</sub> ambient concentration Wind direction & velocity	Solution conductmetry Propeller type anemometer
MP-3 JTC Soil Investigation Unit	- ditto -	- ditto -
MP-4 Boon Lay Apartment	- ditto -	- ditto -
MP-5 Bukit Timah Fire Station	- ditto -	- ditto -
MP-6 Changi Airport	- ditto -	- ditto -
MP-7 Bedok Police Station	- ditto -	- ditto -

## II-1-5 Outline of Monitoring Stations

3 stations of MP-1, MP-3 and MP-7 have been established by constructing the prefabricated huts which have been transported from Japan, and the remaining stations have been established by utilizing the existing buildings. The establishment of stations and installation of instruments have been carried out under the entire assistance and cooperation of Jurong Town Corporation.

### II-1-5-1 MP-1, National University of Singapore (NUS)

National University of Singapore (NUS) is located about 10 km south/east of Jurong industrial area, and the campus is covered by green plantation surrounded by housing area.

The station has been established at the side of Meteorological Laboratory auspiced by Dr. Pakium, constructing a prefabricated hut. The SO<sub>2</sub> analyzer and the recorders of anemometers have been installed in the hut. The surrounding area of the laboratory is fully covered by turf and various instruments installed by Dr. Pakium. So the sensors for the meteorological conditions have been installed at the points which would not disturb Dr. Pakium's instruments.

Thus the installation of sensors and recorders have been conducted under the presence of Dr. Paklum, as shown in Fig. II-1-2.

The sensor of anemometer has been set on the top of the pole which has 10 m height, and the thermometers have been installed at 1.5 m and 10 m points of the same pole. For the pyranometer and net radiation meter, the sensors have been arranged at the places where would not be affected by the shadow of the existing buildings and trees. These sensors have been connected with the respective recorders which have been installed in the hut, by the cables passing underground. The station of the hut and instruments thereof are shown in Picture II-1-1.

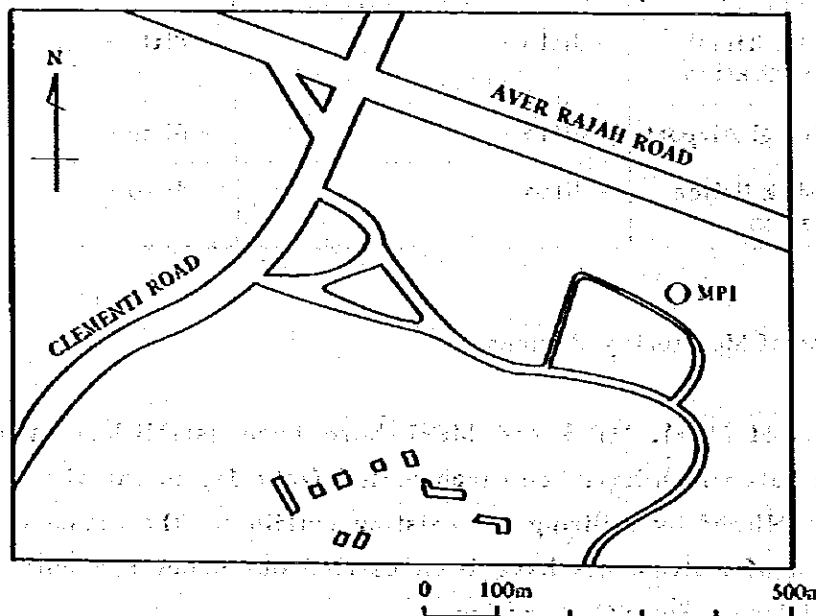


Fig. II-1-2-(1) Surrounding area of monitoring station (MP-1)

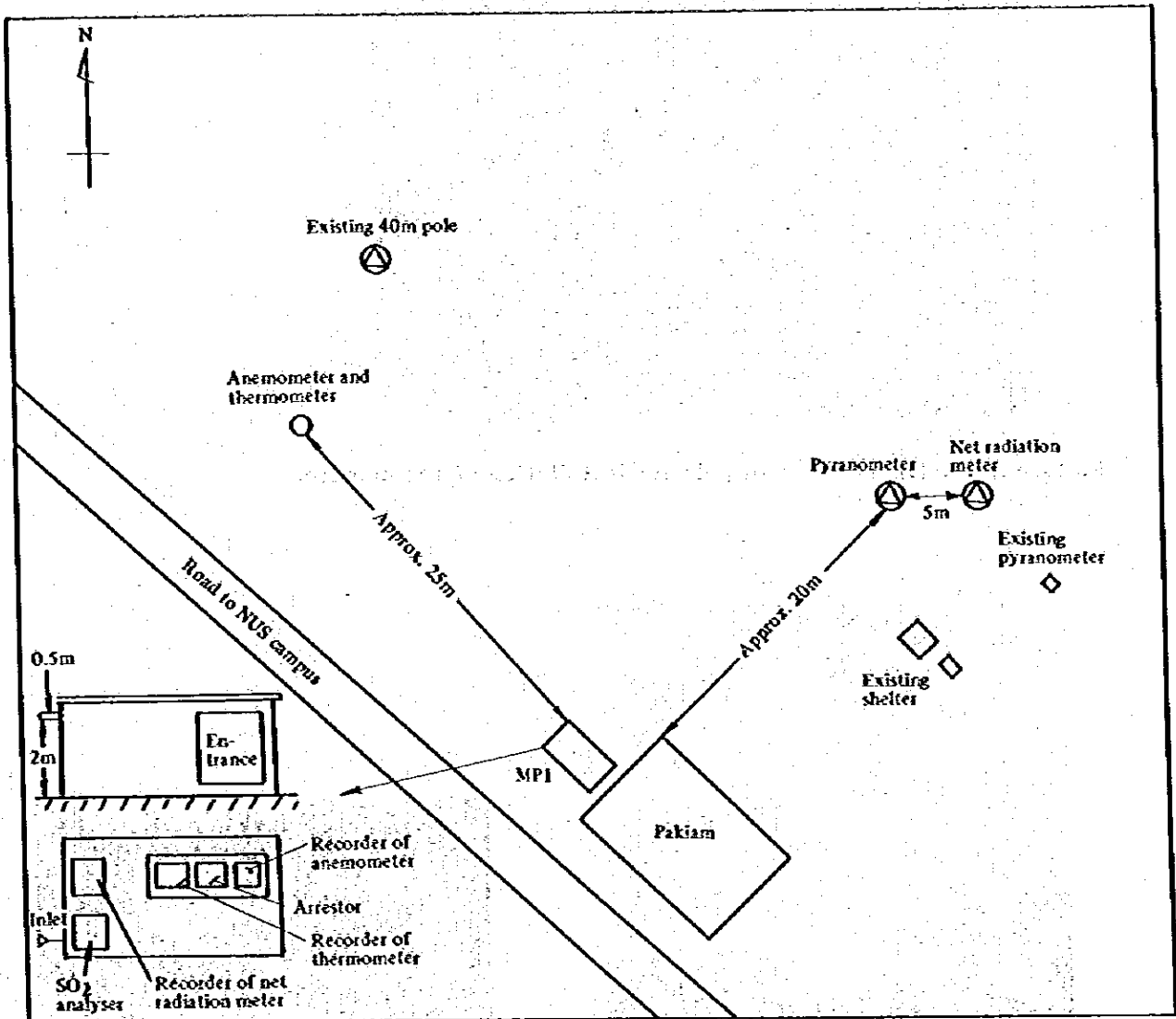
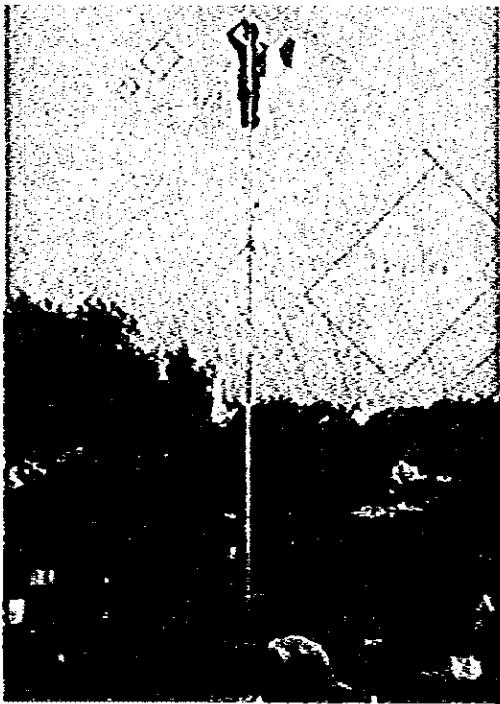


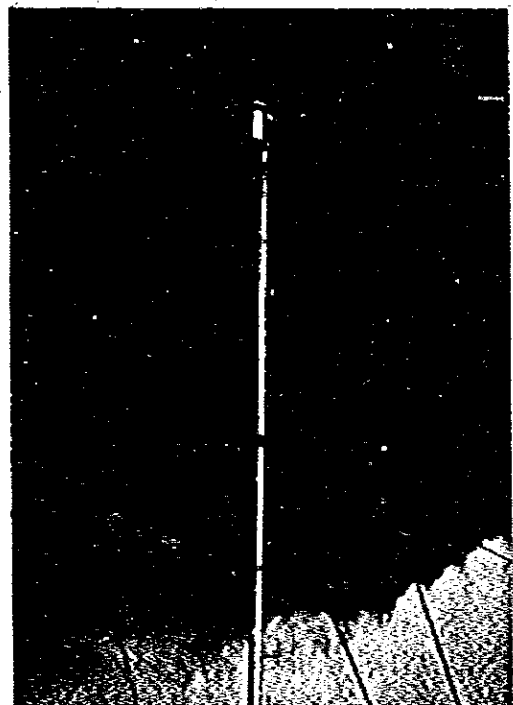
Fig. II-1-2-(2) Location of monitoring instruments at MP-1



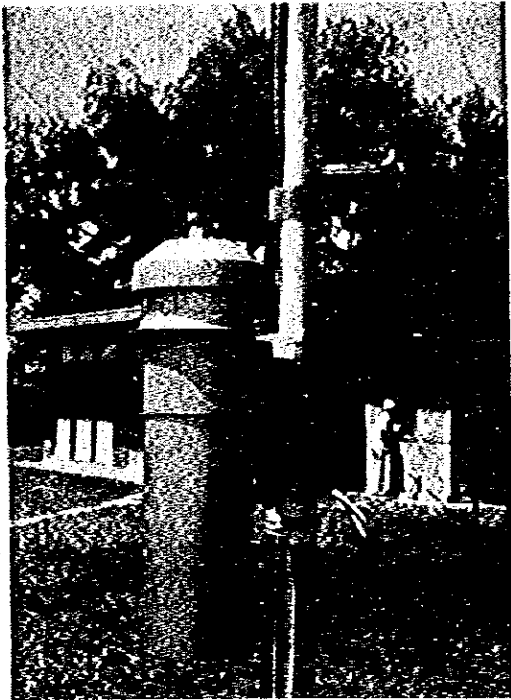
**Picture II-1-1-(1)** Erection of pole for installation of anemometer



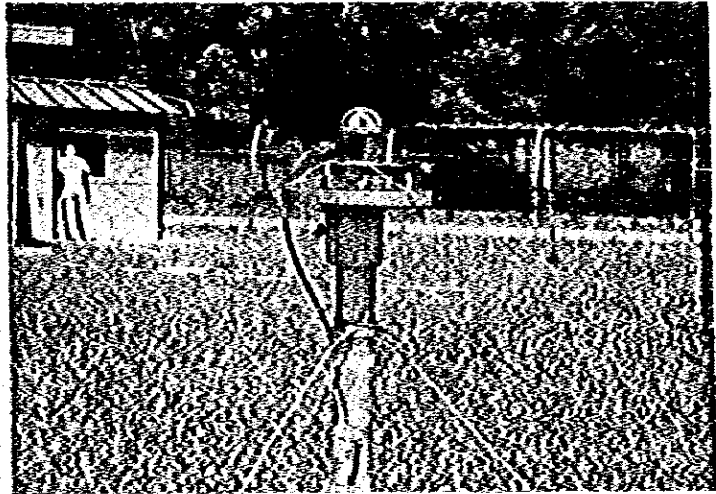
**Picture II-1-1-(2)**  
Installation of sensor of anemometer at MP-1



**Picture II-1-1-(3)**  
Sensors of anemometer and thermometer  
(10 m high) at MP-1



**Picture II-1-1-(4)**  
Sensor of thermometer (1.5 m high)  
installed at MP-1



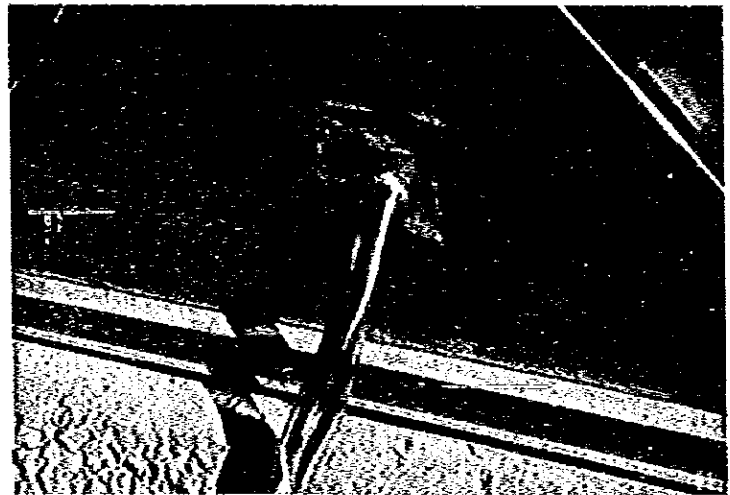
**Picture II-1-1-(5)**  
Sensor of pyranometer installed at MP-1



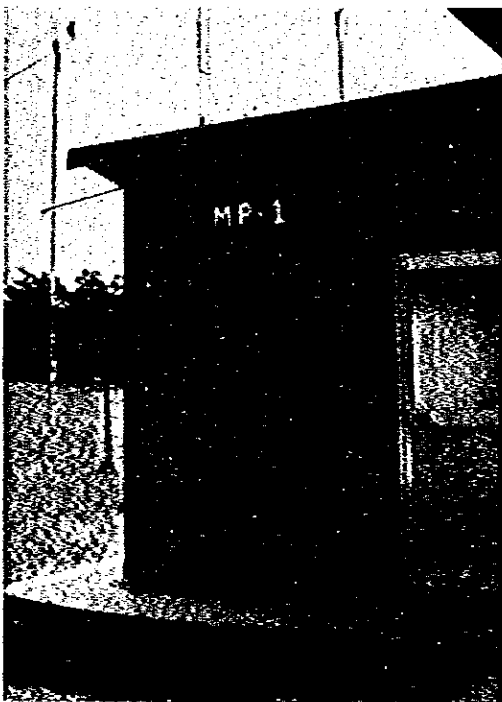
**Picture II-1-1-(6)** Sensor of net radiation meter installed at MP-1



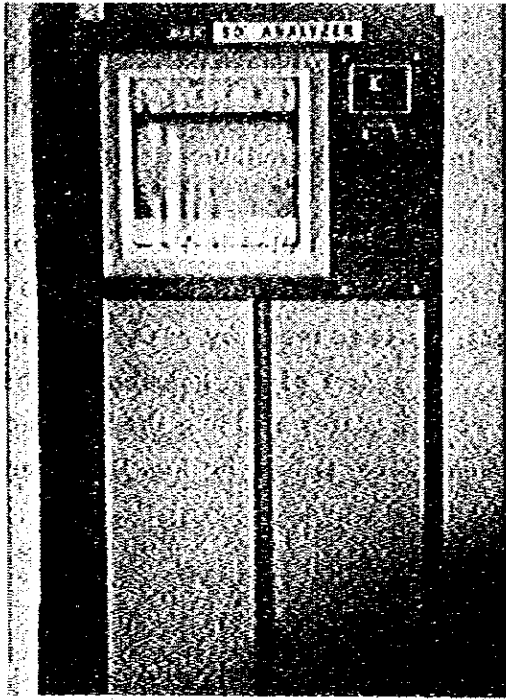
**Picture II-1-1-(7)**  
**Cable buried in the ground at MP-1**



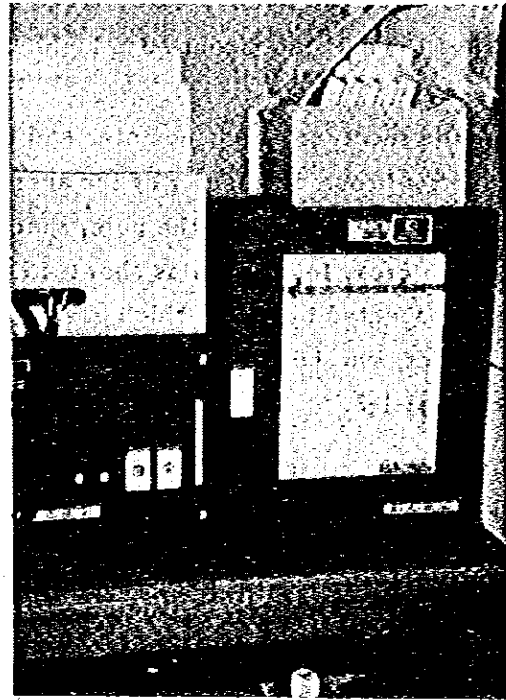
**Picture II-1-1-(8)**  
**Cable for meteorological instruments (MP-1)**



**Picture II-1-1-(9)**  
**Outview of monitoring station (MP-1)**



Picture II-1-1-(10)  
SO<sub>2</sub> analyzer installed at MP-1



Picture II-1-1-(11)  
Recorder of anemometer installed at MP-1



Picture II-1-1-(12)  
Recorder for pyranometer and net  
radiation meter installed at MP-1

## II-1-5-2 MP-2 JTC Town Hall

JTC Town Hall is located just in the center part of Jurong industrial area and the surrounding area is covered by trees and turfs. The station has been established on the roof of the building (about 20 m high), considering the impact of the building itself.

The recorder of anemometer and  $\text{SO}_2$  analyzer have been installed in the spare room of the roof top. The sensor of the anemometer has been set on the top of the pole of 10 m length. For erection of the pole, special arrangement has been made by JTC, preparing the iron cross foundation as shown in Picture II-1-2. The sensor of the anemometer has been connected by cable which has been covered by wooden plates avoiding the influence of direct sun beam. The station and its instruments are shown in Fig. II-1-3 and Picture II-1-2.

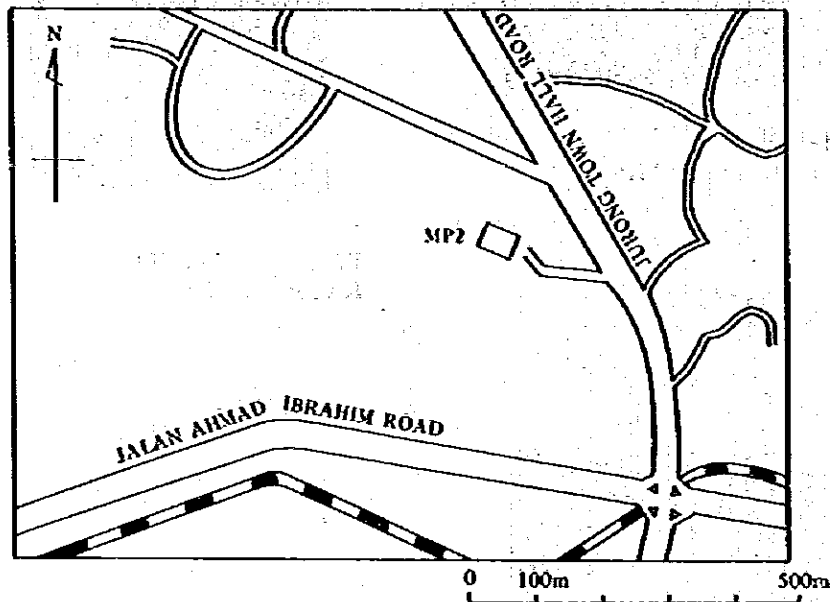


Fig. II-1-3-(1) Surrounding area of monitoring station (MP-2)



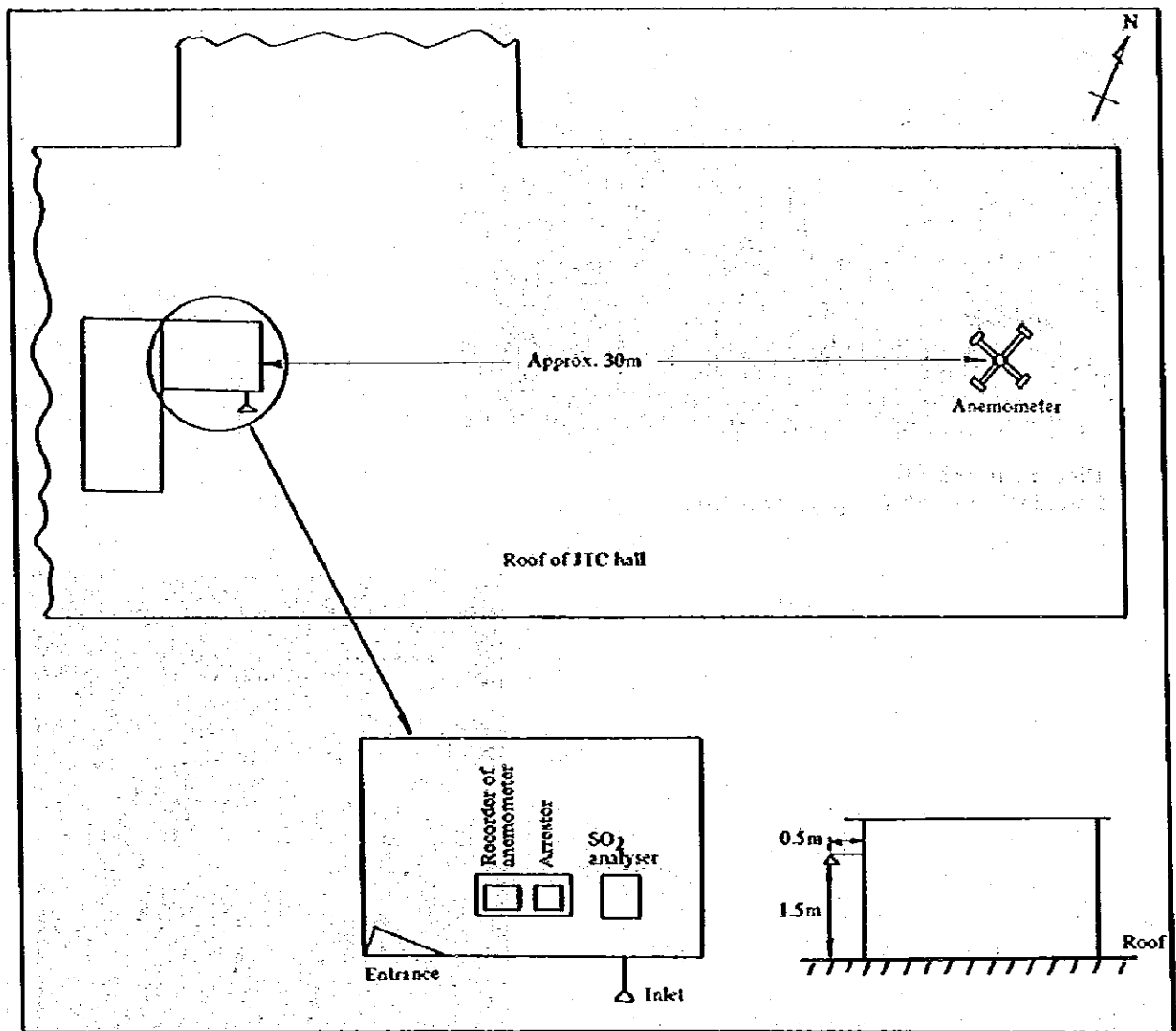
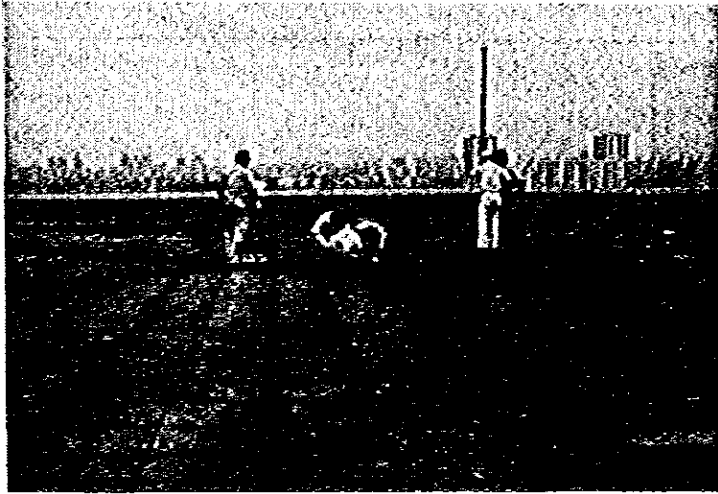


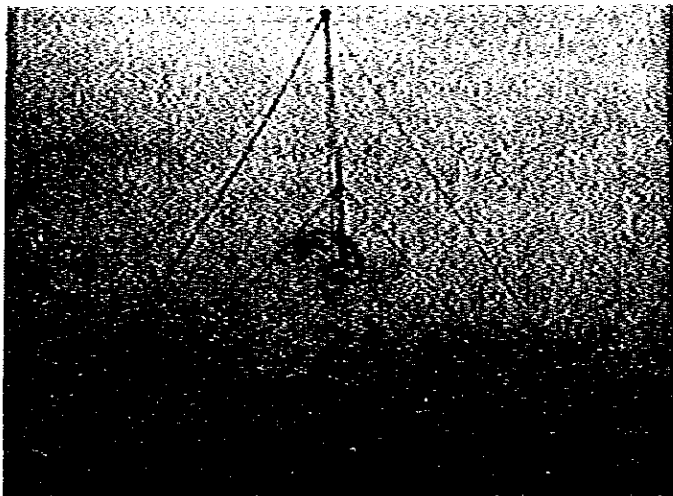
Fig. II-1-3-(2) Location of monitoring instruments at MP-2



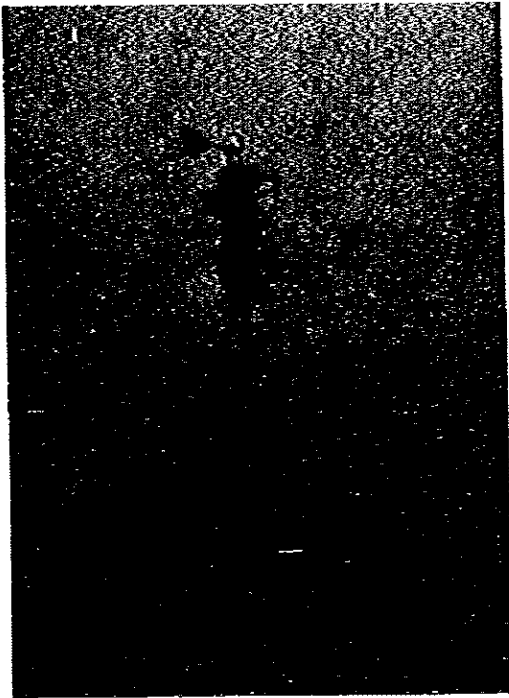
**Picture II-1-2-(1)**  
**Foundation work for pole erection**



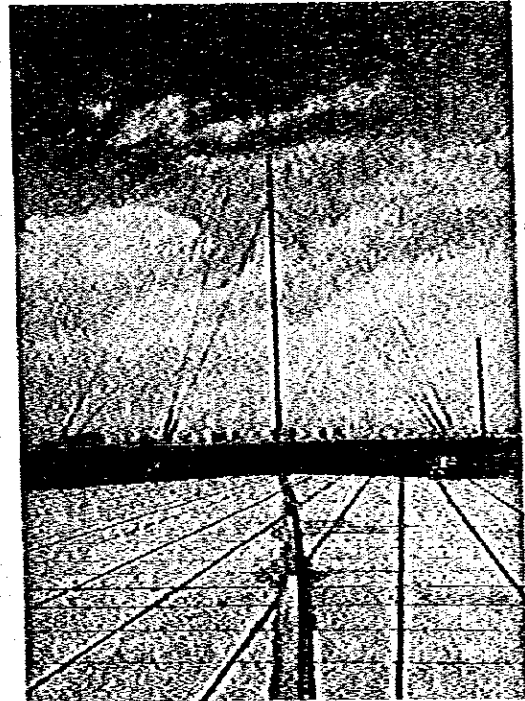
**Picture II-1-2-(2)**  
**Erection of pole for anemometer**



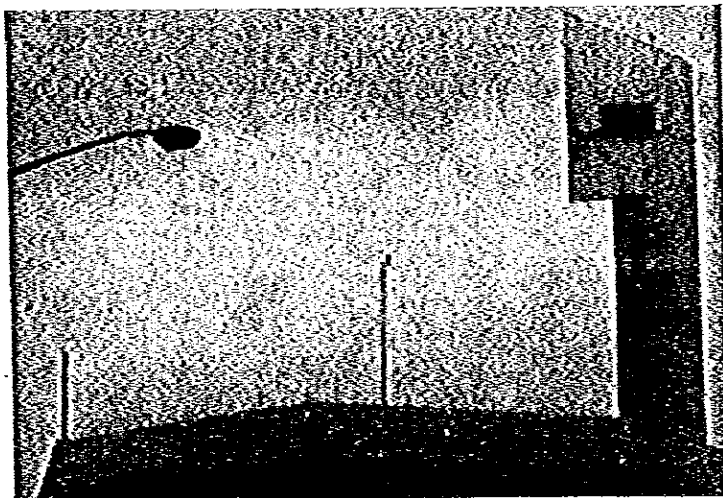
**Picture II-1-2-(3)**  
**Erection of pole for anemometer at MP-2**



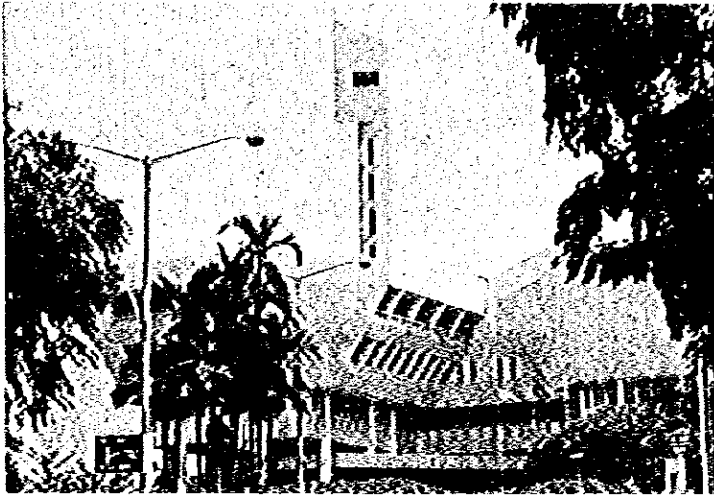
**Picture II-1-2-(4)**  
Installation of sensor of anemometer  
at MP-2



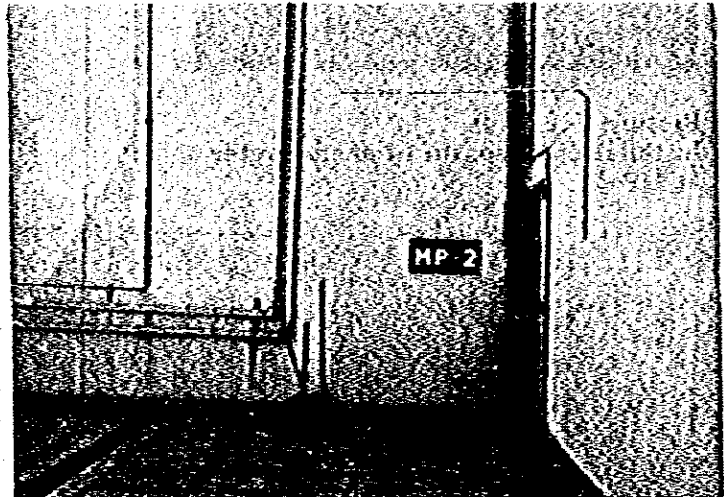
**Picture II-1-2-(5)**  
Sensor of anemometer installed at MP-2



**Picture II-1-2-(6)**  
Sensor of anemometer installed at MP-2



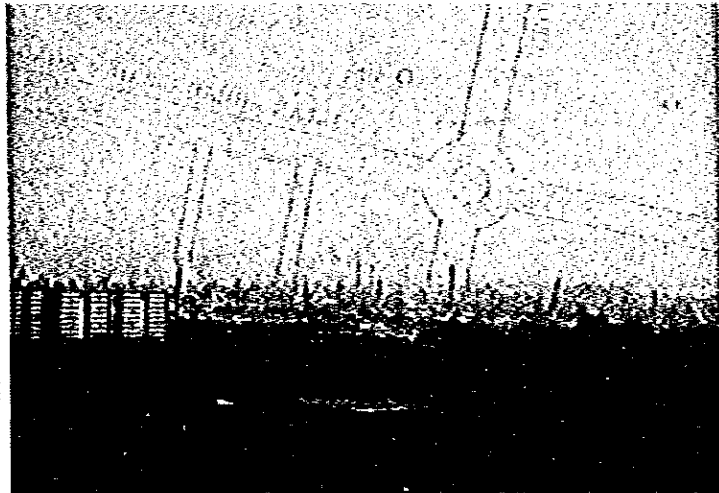
**Picture II-1-2-(7)**  
**Grand view of JTC hall (MP-2)**



**Picture II-1-2-(8)**  
**Monitoring station MP-2 (roof of JTC hall)**



Picture II-1-2-(9) SO<sub>2</sub> analyzer and recorder of anemometer installed at MP-2



Picture II-1-2-(10) Jurong industrial area over-viewed from MP-2

### II-1-5-3 MP-3 JTC Soil Investigation Unit (SIU)

JTC Soil Investigation Unit (SIU) is located in the midst of Jurong industrial area and is not far from the coast. In the south way of the coast, so-called southern islands are located where the major oil refineries are sited.

A prefabricated hut has been established about 50 m away from the laboratory building of SIU, in which SO<sub>2</sub> analyzer and the recorder of the anemometer have been installed.

The station has been set up in the premises of SIU and the heavy traffic road is running at about 10 m south and west side of the station. The sensor of the anemometer has been set at the point which could avoid the impact of the trees. The pole has been erected at the point, about 30 m away from the station. The length of the pole is 10 m and on the top of the pole, the sensor of anemometer has been installed. The cable connecting the sensor and the recorder has been buried down in the ground. The station and the instruments thereof are shown in Fig. II-1-4 and Picture II-1-3.

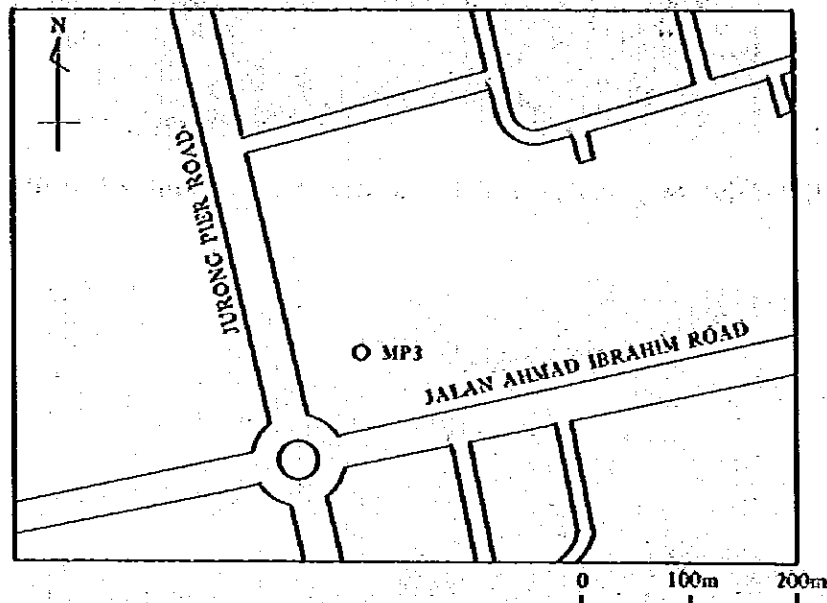
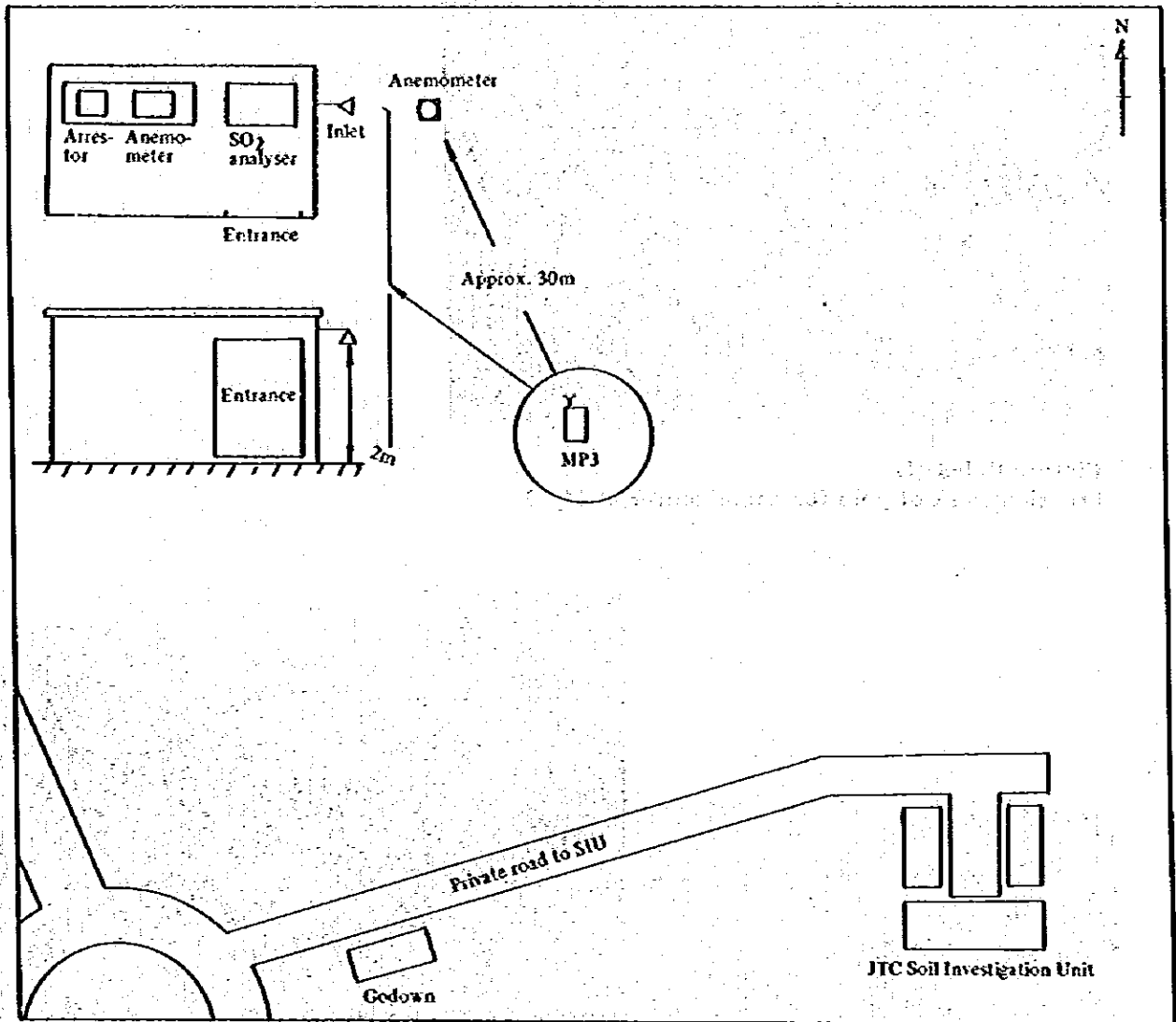


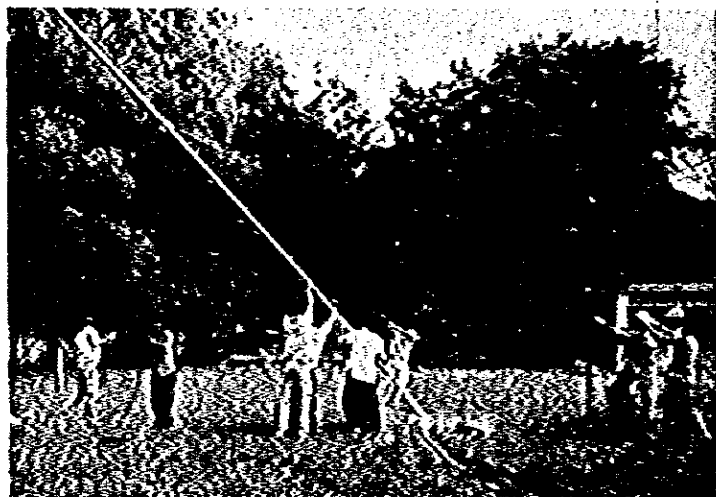
Fig. II-1-4-(1) Surrounding area of monitoring station (MP-3)



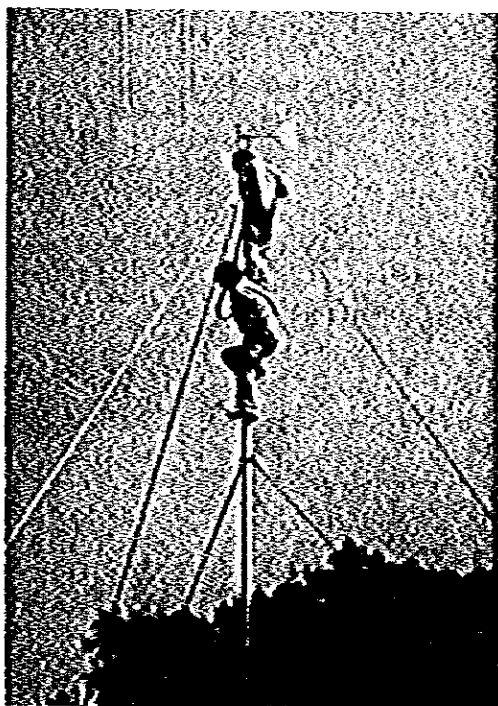
**Fig. II-1-4-(2) Location of monitoring instruments at MP-3**



**Picture II-1-3-(1)**  
**Erection work of pole for anemometer at Mp-3**

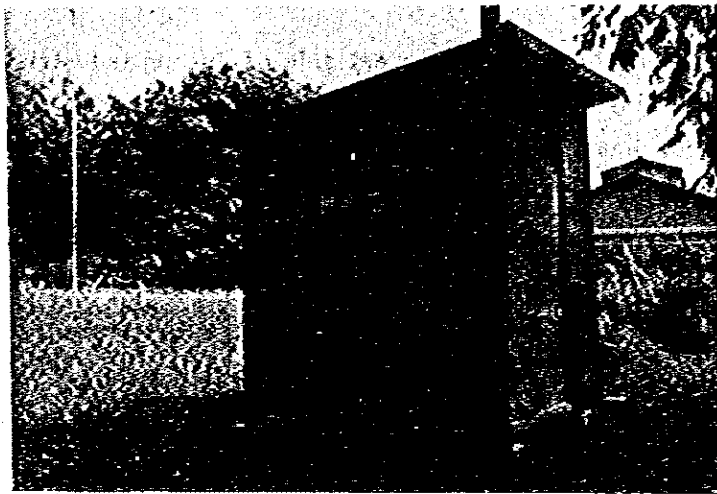


**Picture II-1-3-(2)**  
**Erection of pole for anemometer at MP-3**



**Picture II-1-3-(3)**  
**Installation of sensor of anemometer at MP-3**

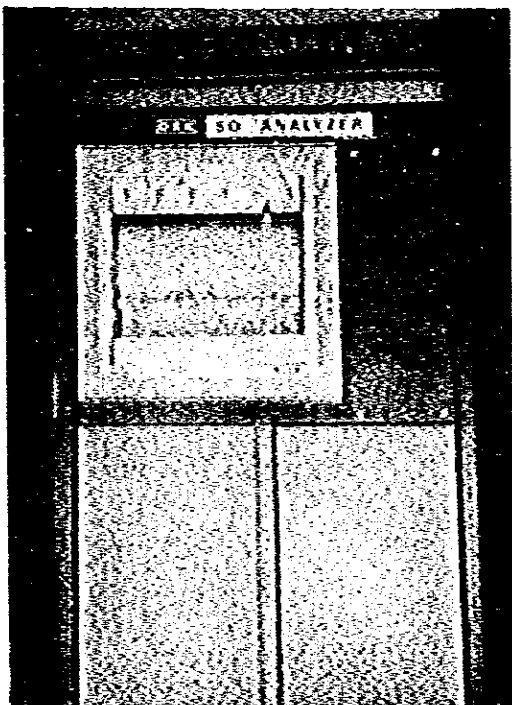




Picture II-1-3-(4) Sensor of anemometer installed at MP-3 and monitoring station



Picture II-1-3-(5) Recorder of anemometer installed at MP-3



Picture II-1-3-(6) SO<sub>2</sub> analyzer installed at MP-3

#### II-1-5-4 MP-4 Boon Lay Apartment

Boon Lay Apartment is located at the west side of Jurong Industrial area and in the center of Jurong residential area. The station has been established on the roof of an apartment building which has the height of about 41 m from the ground.  $SO_2$  analyzer and the recorder of the anemometer have been installed at the landing space connected to the roof. The surrounding area of the apartment buildings are covered by the trees and turfs, and from the roof, Jurong industrial area is looked and spread over before eyes. For setting the sensor of the anemometer, 10 m pole has been erected along side the building and the sensor has been installed on the top of the pole. The cable connected with the recorder, hanging down from the pole. The station and the instruments thereof are shown in Fig. II-1-5 and Picture II-1-4.

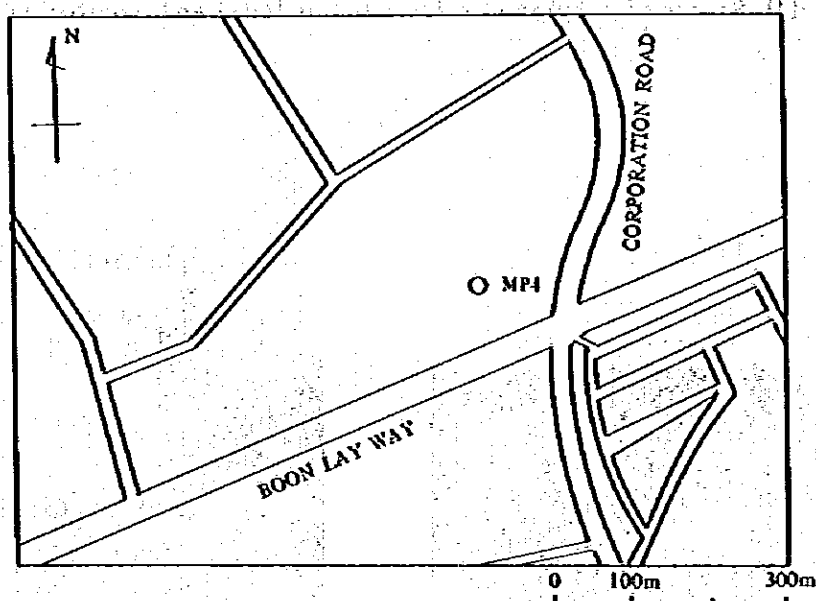


Fig. II-1-5-(1) Surrounding area of monitoring station (MP-4)

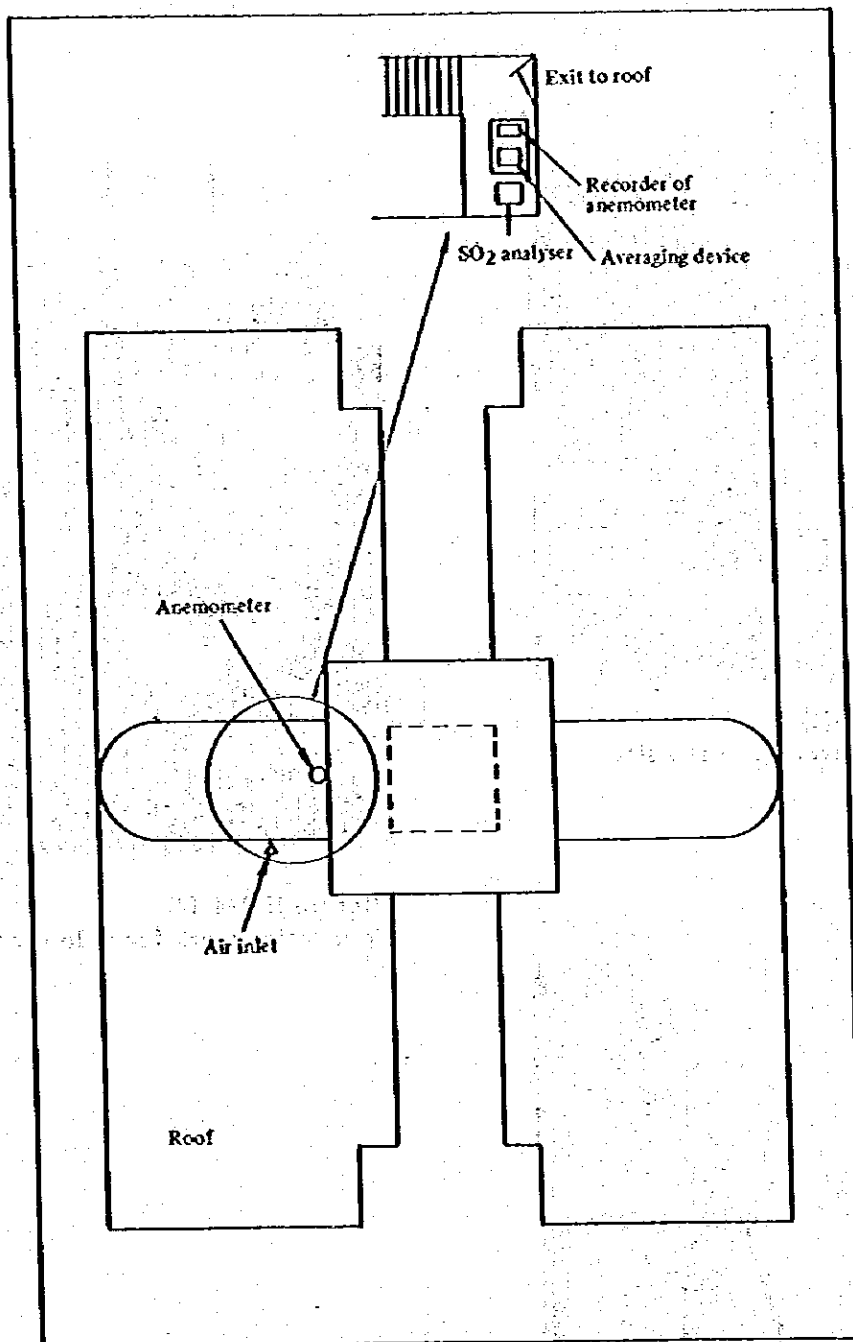


Fig. II-1-5-(2) Location of monitoring instruments at MP-4



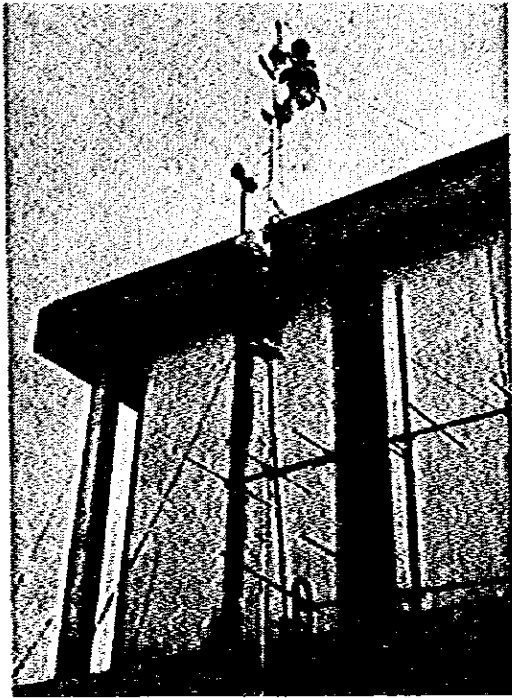
**Picture II-1-4-(1)**  
**Instruments carrying in the site**



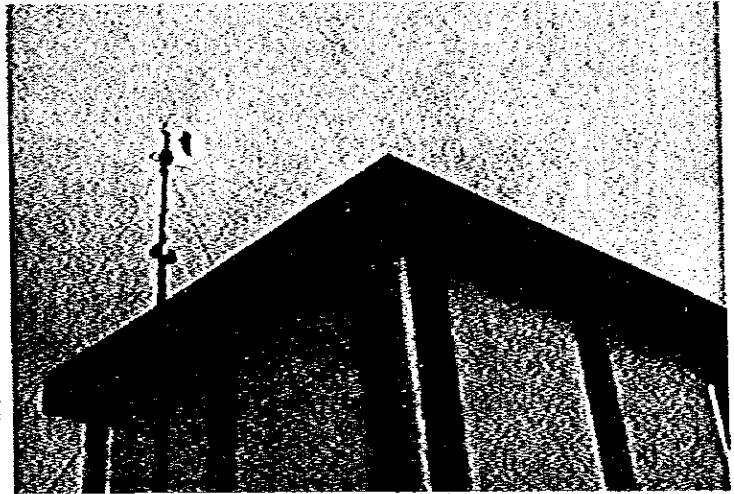
**Picture II-1-4-(2)**  
**Foundation work for pole erection**



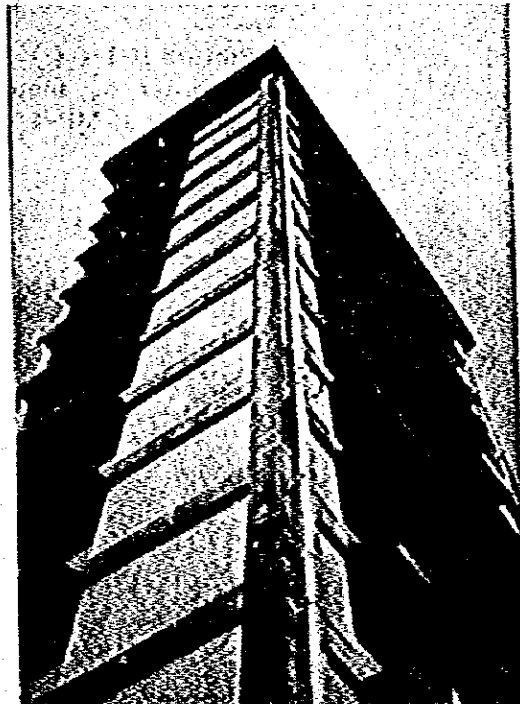
**Picture II-1-4-(3)**  
**Erection of pole for anemometer**



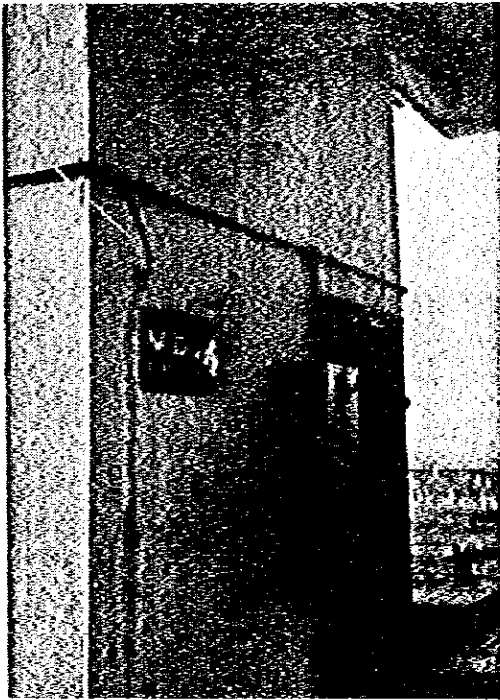
**Picture II-1-4-(4)**  
**Installation of sensor of anemometer**  
**at MP-4**



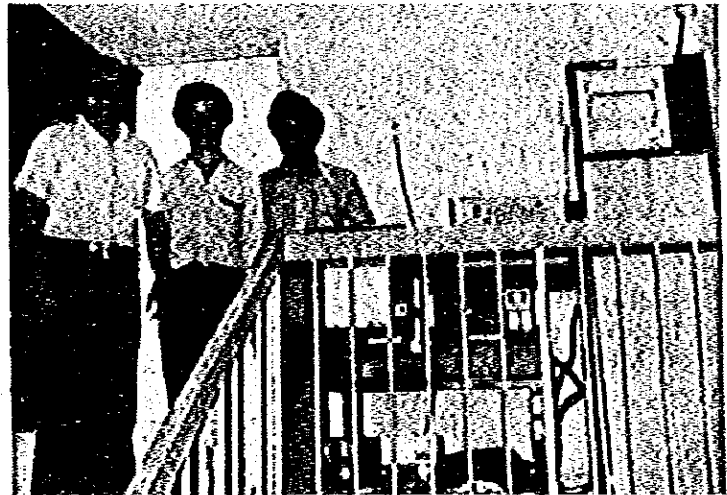
**Picture II-1-4-(5)**  
**Sensor of anemometer installed at MP-4**



**Picture II-1-4-(6) View of Boon Lay Apartment (MP-4)**



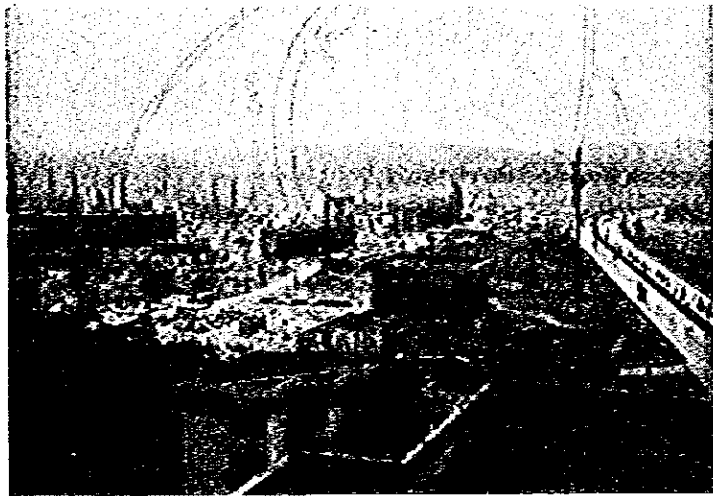
Picture II-1-4-(7)  
MP-4 monitoring station  
(roof of Boon Lay Apartment)



Picture II-1-4-(8)  
Recorder of anemometer and SO<sub>2</sub> analyzer  
installed at MP-4



Picture II-1-4-(9) Surrounding area of MP-4 (Boon Lay Apartment)

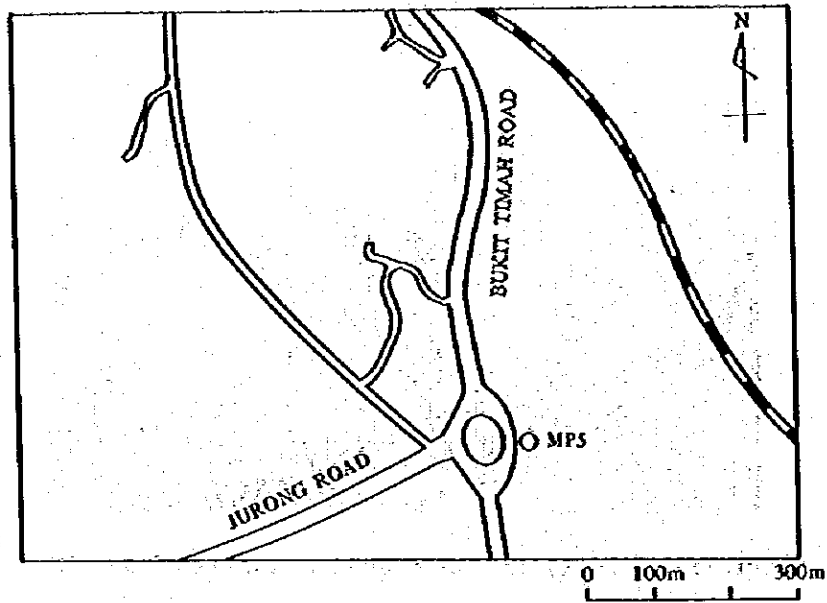


Picture II-1-4-(10) Industrial area overviewed from MP-4

#### II-1-5-5 MP-5 Bukit Timah Fire Station

Bukit Timah Fire Station is located about 4 km N/NE of Jurong industrial area, and faced with the heavy traffic road running to Woodlands. The east side of the station is connected with the hill. The station has been established in a corner of parking building of Fire Station, where  $\text{SO}_2$  analyzer and the recorder of anemometer have been installed, with the consideration to avoid the impact of the fire engines' idling combustion.

The Fire Station is surrounded by comparatively high trees and for the location of the sensor, consideration has been given to avoid the impact of these trees and the pole of 10 m length has been erected for installing the sensor. The cable was buried in the ground for the portion of running outdoor. The station and the instruments thereof are shown in Fig. II-1-6 and Picture II-1-5.



**Fig. II-1-6-(1) Surrounding area of monitoring station (MP-5)**



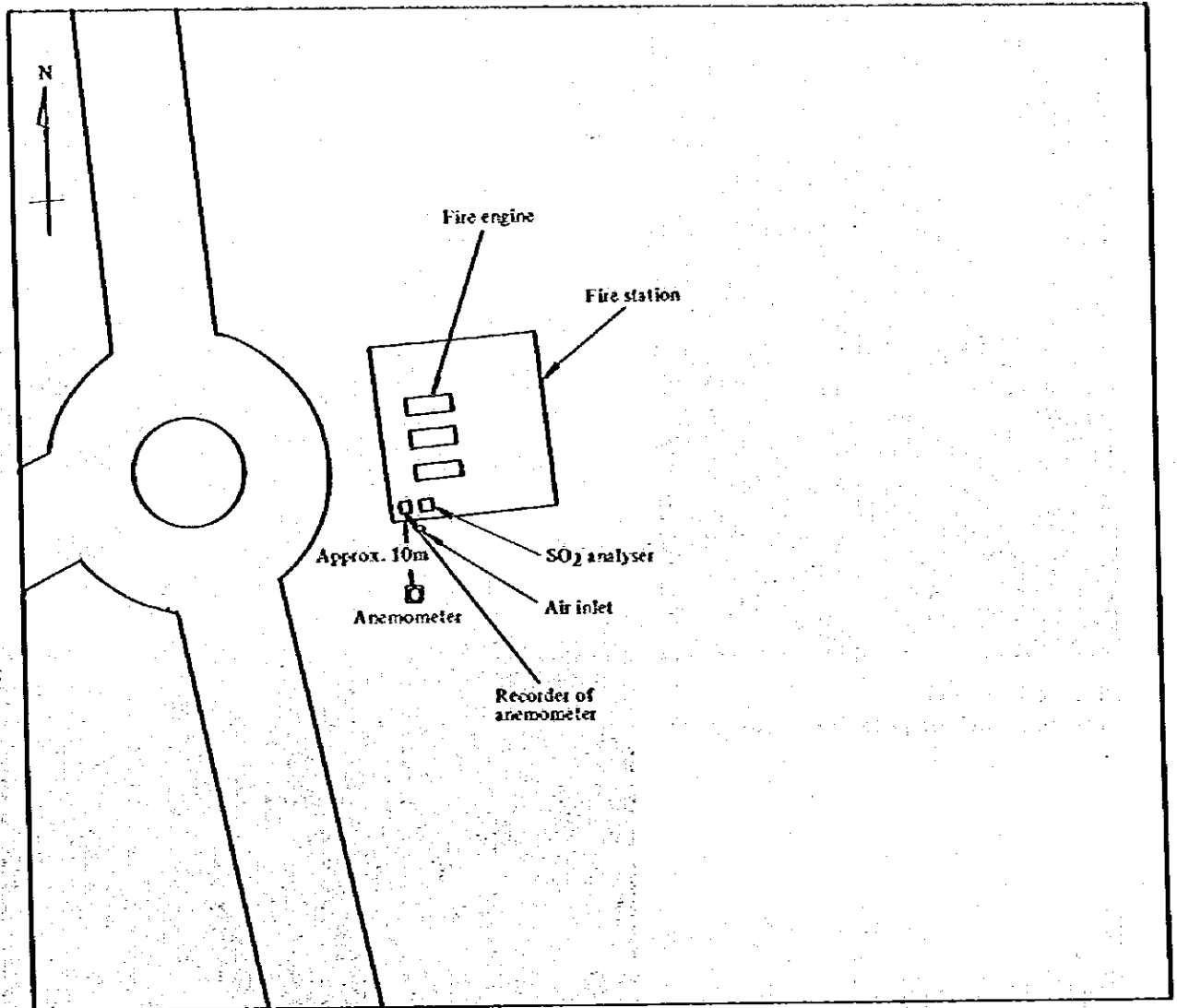
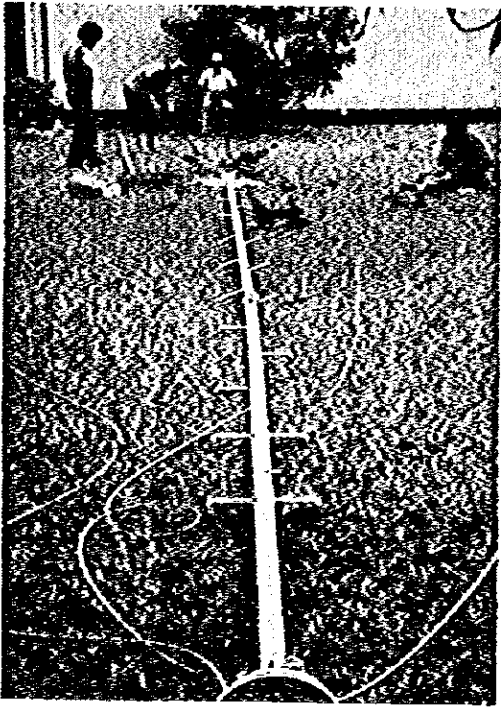
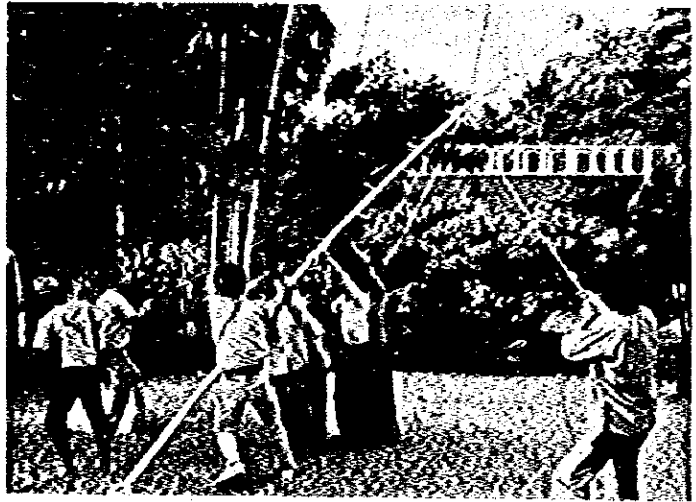


Fig. II-1-6-(2) Location of monitoring instruments at MP-5



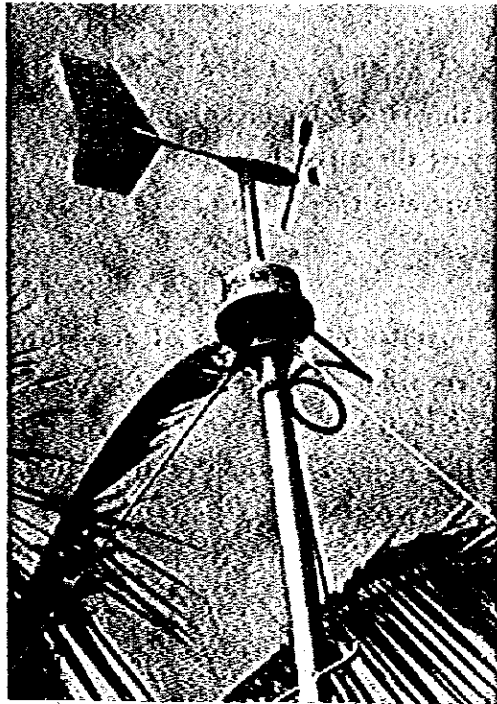
**Picture II-1-5-(1)**  
**Erection work of pole for anemometer**



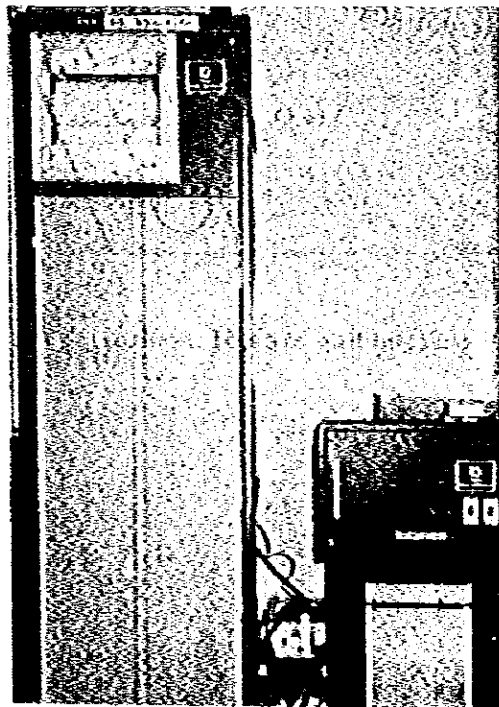
**Picture II-1-5-(2)**  
**Erection of pole for anemometer at MP-5**



**Picture II-1-5-(3)**  
**Installation of sensor of anemometer at MP-5**



Picture II-1-5-(4) Sensor of anemometer installed at MP-5



Picture II-1-5-(5) SO<sub>2</sub> analyzer and recorder of anemometer installed at MP-5

## II-1-5-6 MP-6 Changi Airport

Changi International Airport is located at the east side of main island, facing the Straits of Singapore, and about 5 km north/east of Pulau Tekong. The station has been established at meteorological observatory of the airport, utilizing one preparatory room. The surrounding area is fully covered by turf and there is no trees planted. The distance to the runway is about 1 km from the station.

The sensor of anemometer has been installed on the roof of observatory (3 m high), erecting 3 m pole.  $\text{SO}_2$  analyzer and the recorder of anemometer have been installed in the preparatory room. The installation of instruments have been conducted under the presence of the responsible officer of the observatory. The station and instruments thereof are shown in Fig. II-1-7 and Picture II-1-6.

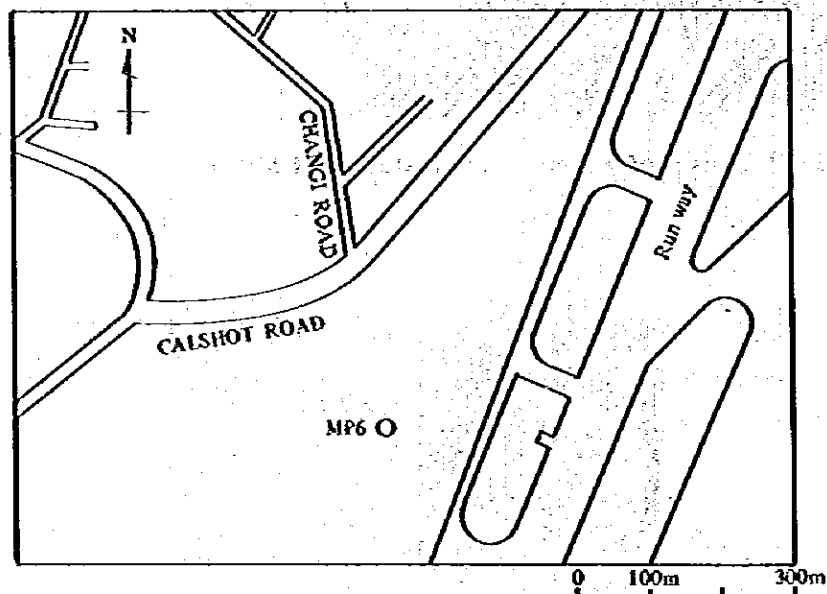


Fig. II-1-7-(1) Surrounding area of monitoring station (MP-6)

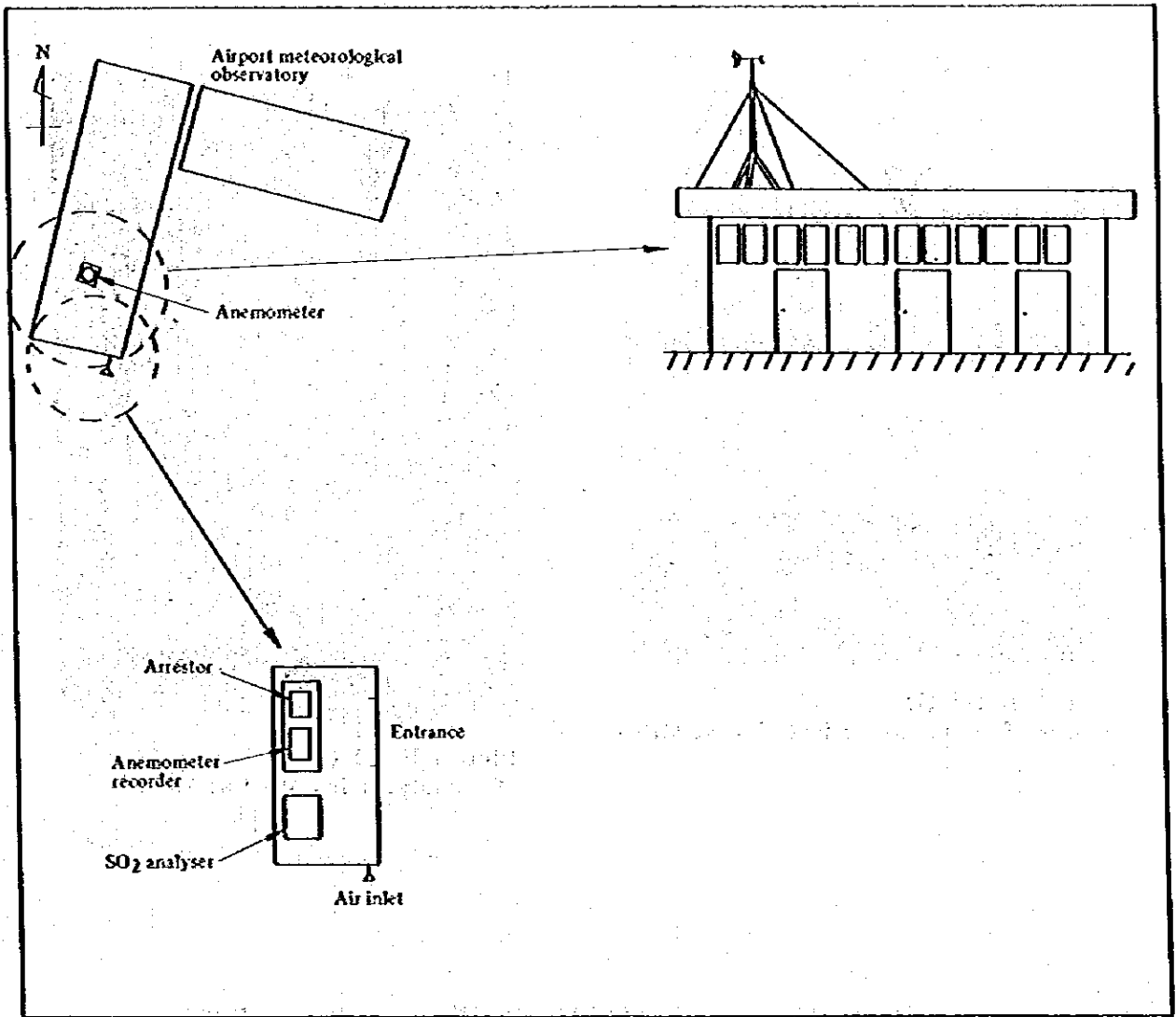
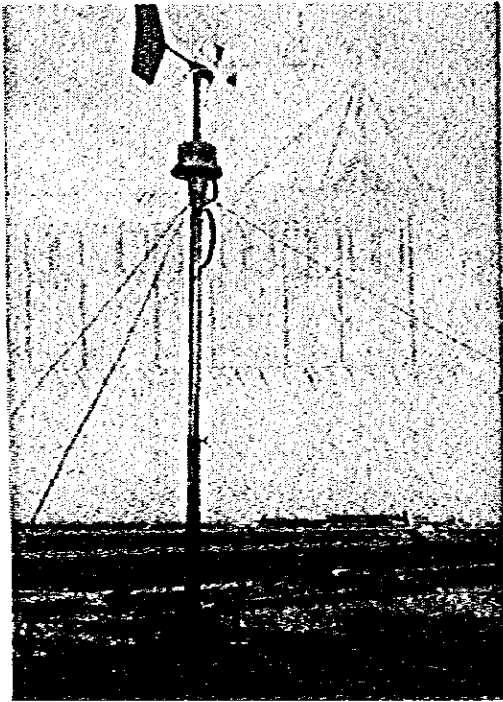
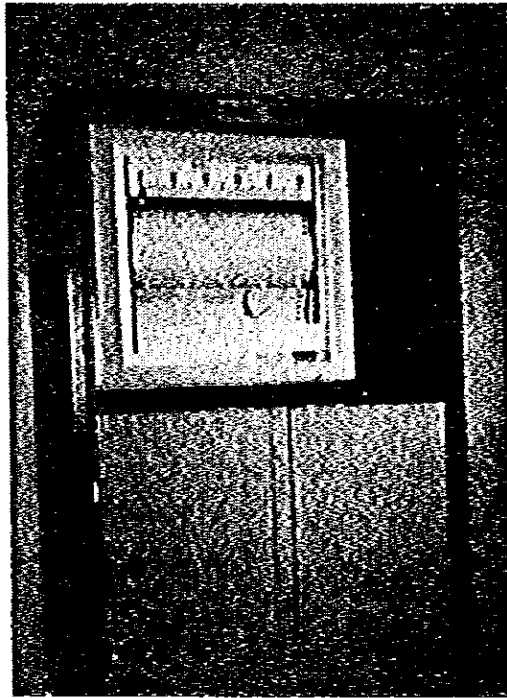


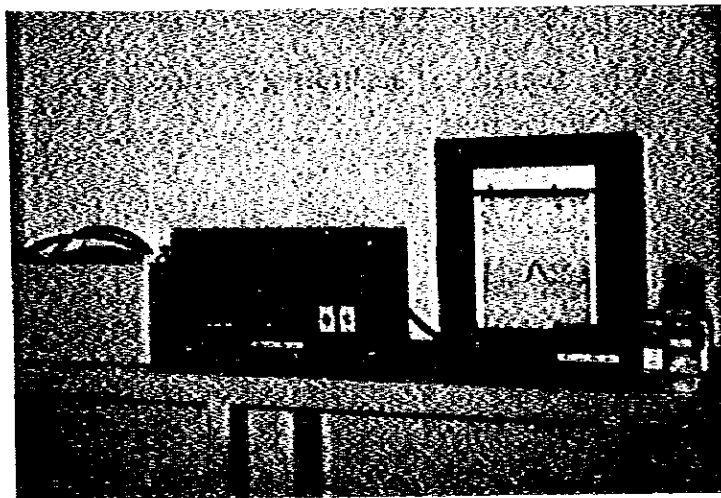
Fig. II-1-7-(2) Location of monitoring instruments at (MP-6)



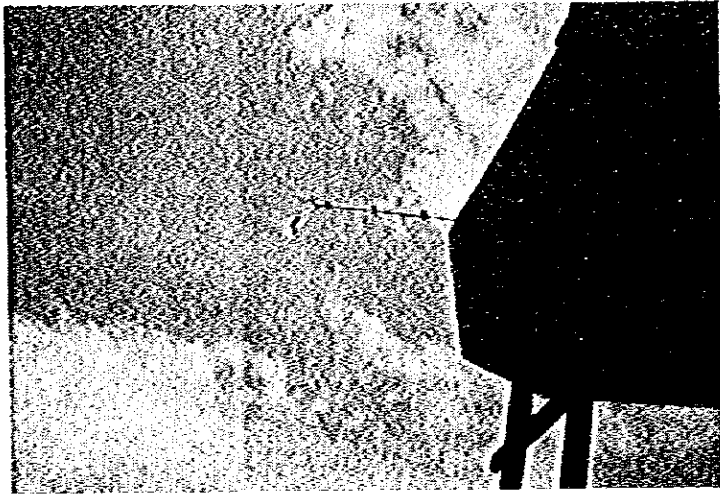
**Picture II-1-6-(1)**  
Sensor of anemometer installed at MP-6



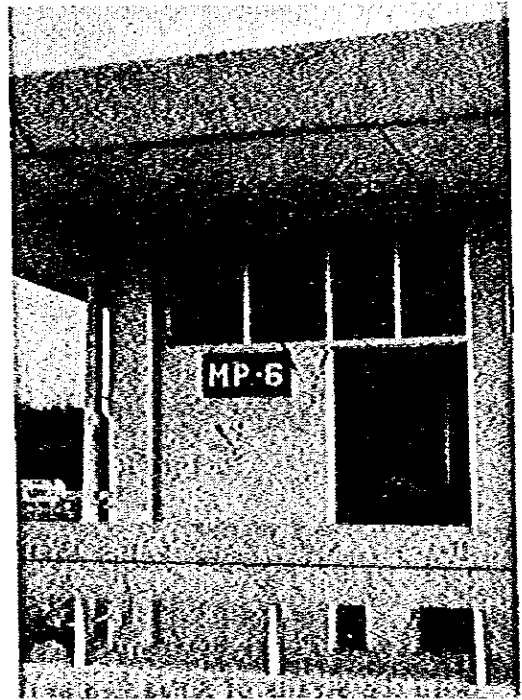
**Picture II-1-6-(2)**  
SO<sub>2</sub> analyzer installed at MP-6



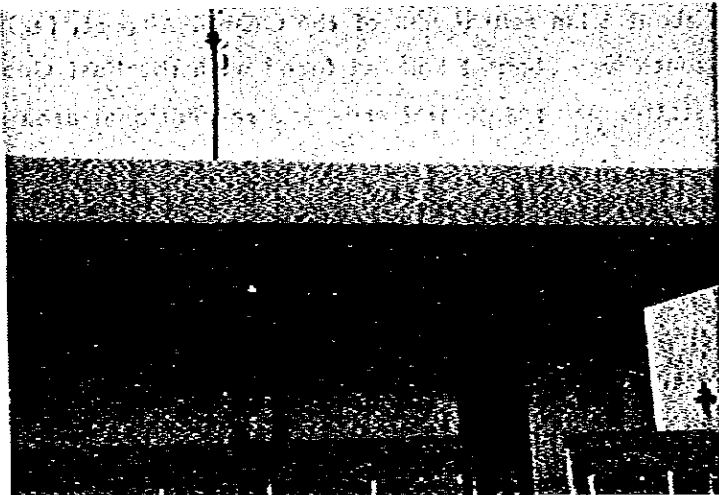
**Picture II-1-6-(3)** Recorder of anemometer installed at MP-6



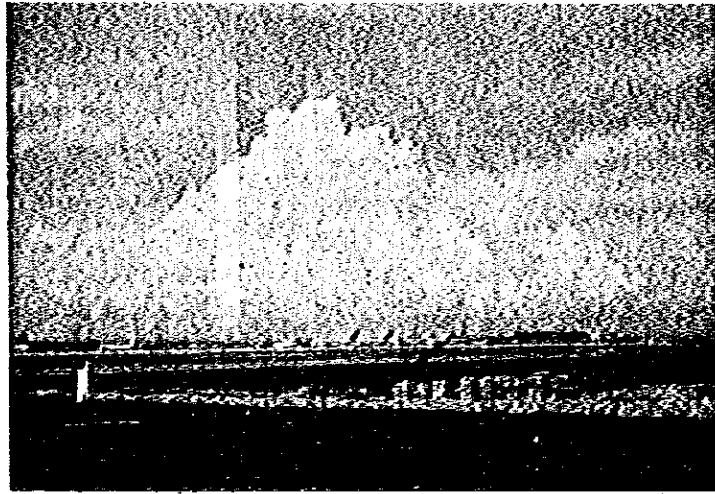
**Picture II-1-6-(4)**  
**Air inlet installed at MP-6**



**Picture II-1-6-(5)**  
**MP-6 monitoring station**  
**(Airport observatory)**



**Picture II-1-6-(6)**  
**View of MP-6**



Picture II-1-6-(7) Changi Airport overviewed from MP-6

#### II-1-5-7 MP-7 Bedok Police Station

Bedok Police Station is located about 5 km south/west of the Changi Airport, facing with the Straits of Singapore in the south way about 1 km and faced with the East Coast road. The surrounding areas of the station are residential area and recreational area of the East Coast of the main island.

A prefabricated hut has been erected about 5 m away from the police station, in which  $\text{SO}_2$  analyzer and the recorder of anemometer have been installed. In order to avoid the impact of the police station building which has the height of about 15 m, and also the growing trees, 10 m pole has been erected on the roof of small concrete house next to the station, which has the height of 2 m.

The station and instruments thereof are shown in Fig. II-1-8 and Picture II-1-7.



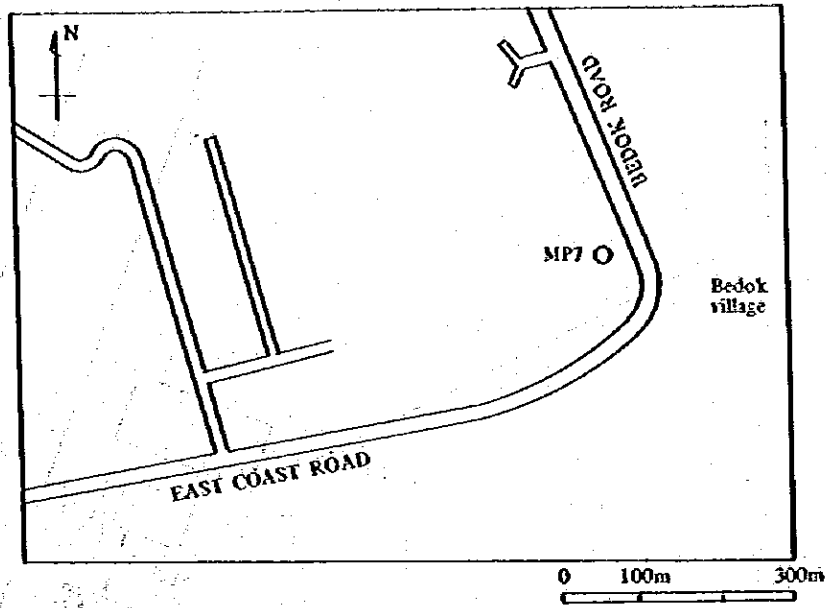


Fig. II-1-8-(1) Surrounding area of monitoring station (MP-7)

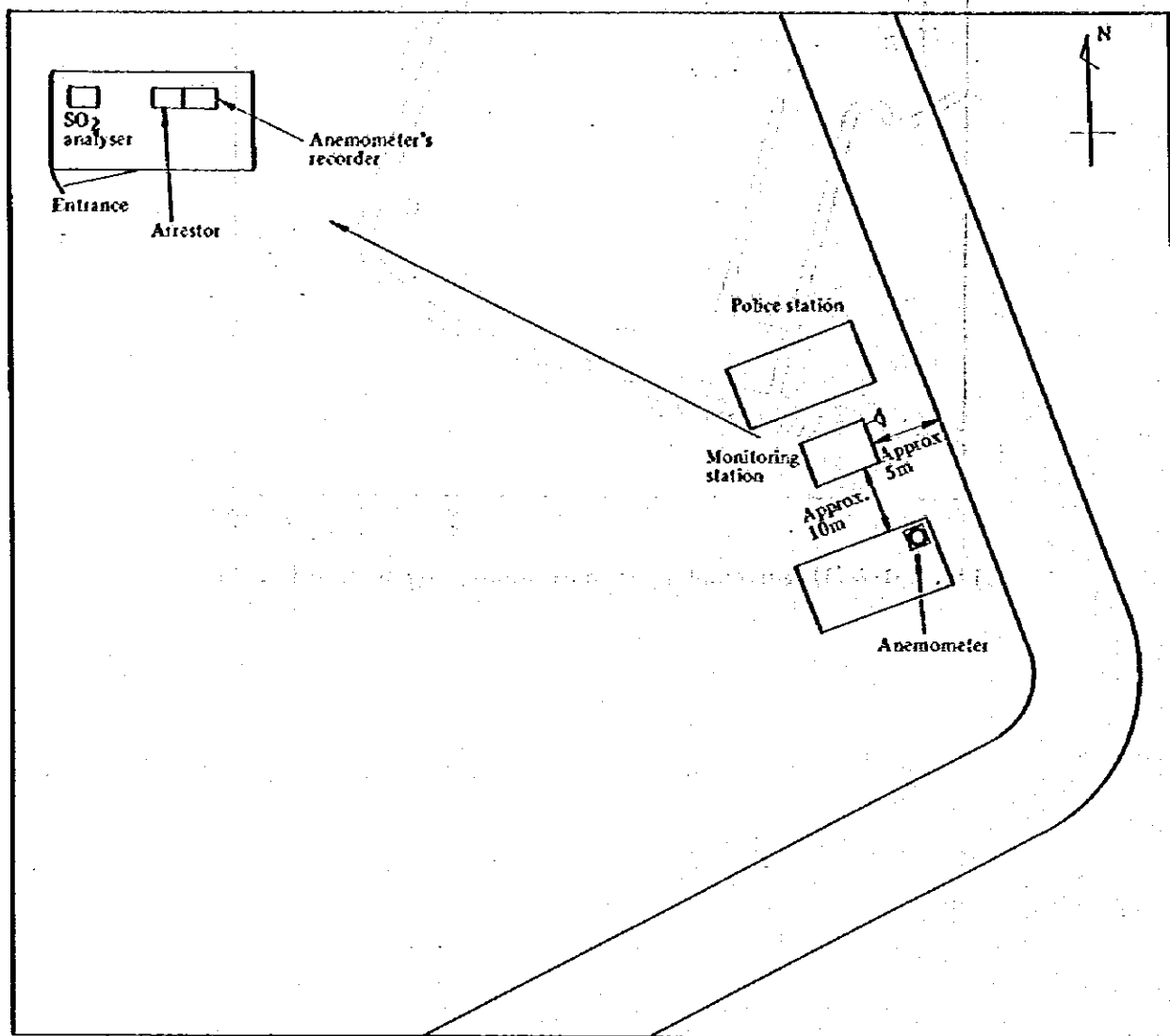
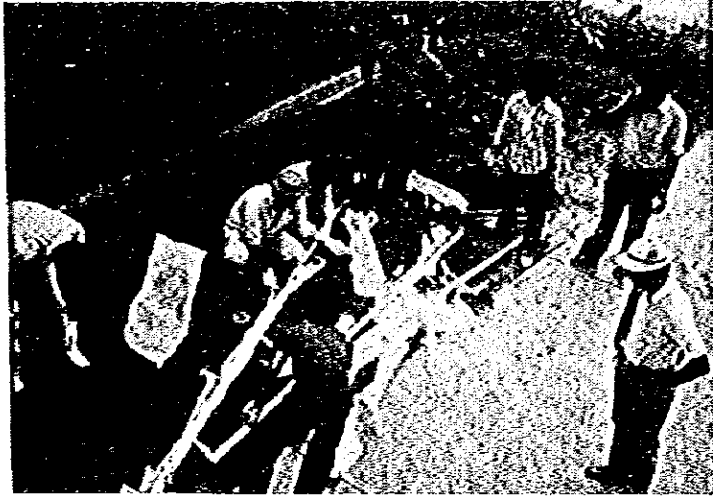
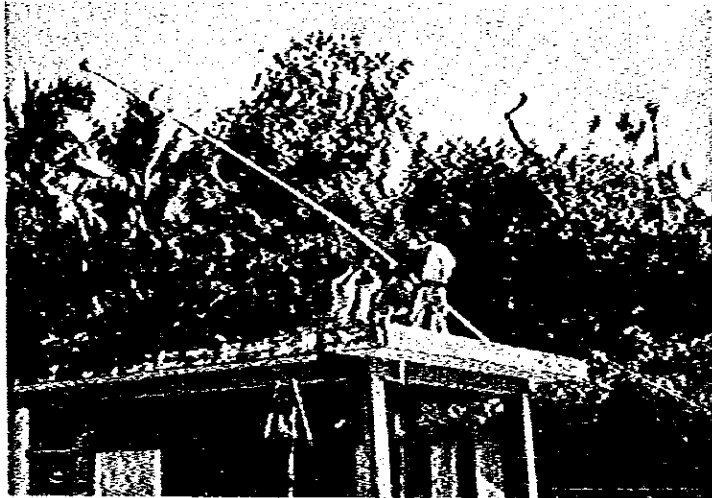


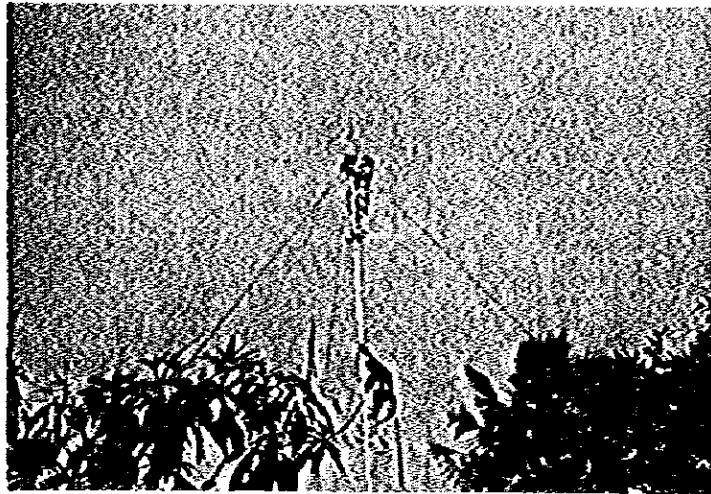
Fig. II-1-8-(2) Location of monitoring instruments at MP-7



Picture II-1-7-(1) Erection work of pole for anemometer at MP-7



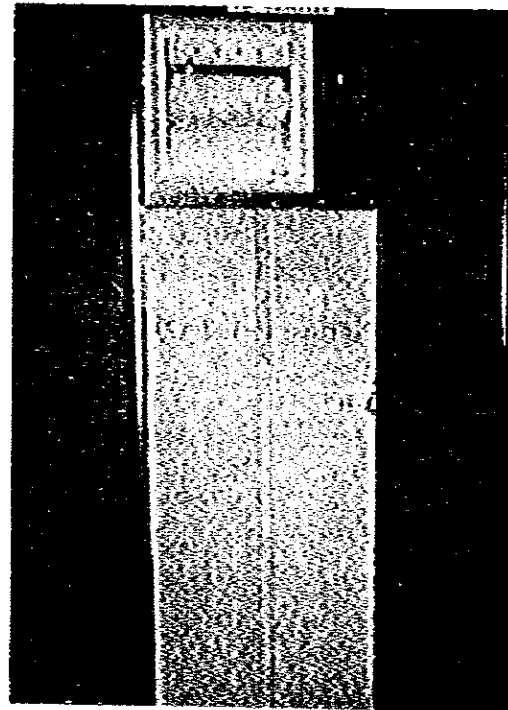
Picture II-1-7-(2) Erection of pole for anemometer at MP-7



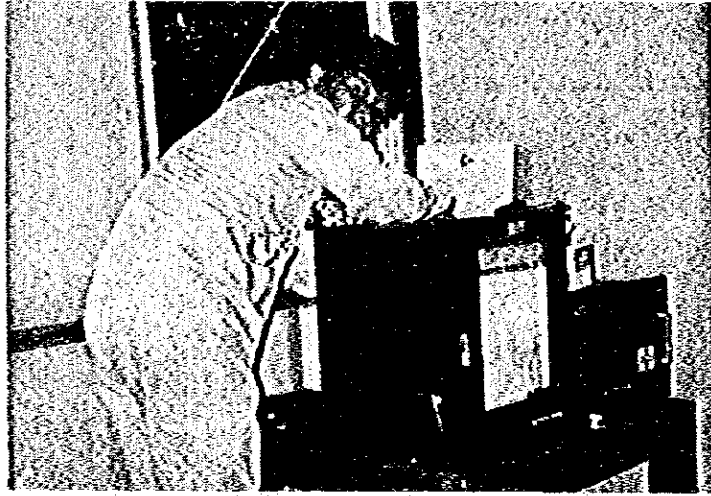
**Picture II-1-7-(3) Installation of sensor of anemometer at MP-7**



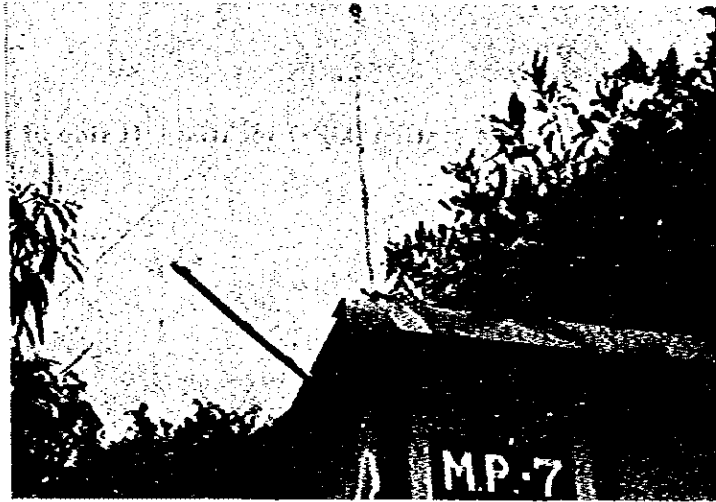
**Picture II-1-7-(4)  
Sensor of anemometer installed at MP-7**



**Picture II-1-7-(5)  
SO<sub>2</sub> analyzer installed at MP-7**



**Picture II-1-7-(6) Recorder of anemometer installed at MP-7**



**Picture II-1-7-(7) MP-7 monitoring station**



**Picture II-1-7-(8) Bedok police station (MP-7 located left side of police station)**

## CHAPTER 2 TRAINING ON MAINTENANCE OF MEASURING INSTRUMENTS

In the field survey of the environmental study, the measurements of SO<sub>2</sub> ambient concentration and meteorological conditions have been carried out for one year by automatic and continuous instruments. And it has been agreed between two parties, JTC and Japanese team, that the maintenance and daily check of the instruments would have been conducted by JTC and the calibration of instruments by Japanese team once every three months.

Under the circumstances, the necessary training has been provided to JTC officers on the maintenance of the instruments prior to the commencement of monitoring.

The training on the maintenance of instruments provided will be outlined as follows, and for the detailed information it will be described in the following chapters.

### II-2-1 Names of Instruments and Measuring Items

On the 22nd of June 1981, each one instrument has been gathered in the conference room of JTC and the necessary explanation has been given by Japanese team. JTC has recorded the meeting by VTR. The names of JTC officers presented are as follows.

Mr. Tan Suan Yong, Mr. Hee Ah Mui, Mr. Tan Hoon Swee, Mr. Wong Kuwe Choi and Mr. Lim Sey Peng.

Picture II-2-1 shows the above meeting.

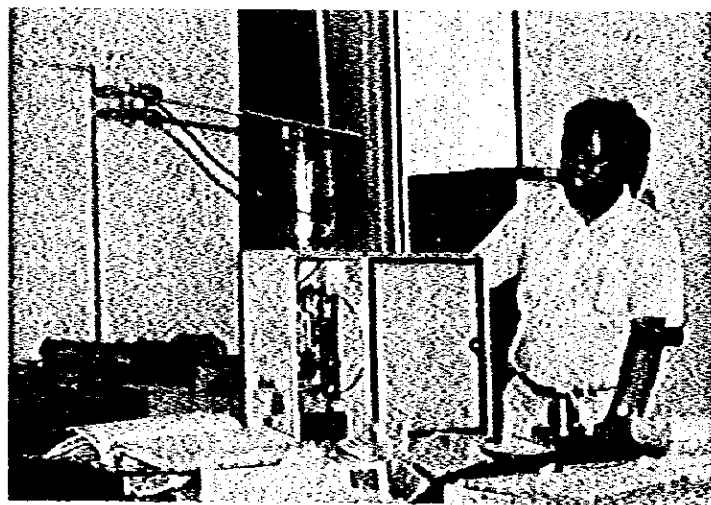
calibration is carried out by JTC (1/3/81) and  
(4/3/81) and (7/3/81) respectively.



**Picture II-2-1-(1)**  
**Training on handling of monitoring instruments (SO<sub>2</sub> analyzer)**



**Picture II-2-1-(2)**  
**Training on handling of monitoring instruments (anemometer)**



**Picture II-2-1-(3)** **Training on handling of monitoring instruments (net radiation meter)**



## II-2-2 Training on Maintenance of Instruments

Soon after the monitoring stations were established, the necessary training on handling and maintenance of instruments have been provided to JTC officers at the actual stations in which the instruments had already been installed and operated. The date and officers presented at the training are as follows:

July 6th 1981 (at MP-1), during 09:00 to 12:00

Mr. Hee Ah Mui, Mr. Tan Hoon Swee and Mr. Tan Suan Juan

July 6th 1981 (at MP-2), during 14:00 to 17:00

Mr. Tan Hoon Swee, Mr. Tan Tio Hai, Mr. Ho Swee Hoe, and Mr. Salleh Ahmad

July 7th 1981 (at MP-3), during 09:00 to 12:00

Mr. Tan Hoon Swee, Mr. Wong Kuwe Choi, Mr. Lim Sey Peng and Mr. Wong Keng Luong

July 7th 1981 (at MP-4), during 14:00 to 17:00

Mr. Hee Ah Mui, Mr. Tan Hoon Swee, Mr. Lim Hua Khai and Mr. Lim Sey Peng

July 8th 1981 (at MP-5), during 09:00 to 12:00

Mr. Tan Hoon Swee, Mr. Wong Kok Cheong, and Mr. Tan Suan Juan

July 9th 1981 (at MP-6), during 09:00 to 12:00

Mr. Hee Ah Mui, Mr. Ng Hwee Choon, Mr. Lim Sey Peng and Mr. Ho Swee Ling

July 9th 1981 (at MP-7), during 14:00 to 17:00

Mr. Hee Ah Mui, Mr. Ng Hwee Choon, Mr. Kwan Hin Chong and Mr. Kwek Keng Chin



**Picture II-2-2-(1)**  
Training on handling of monitoring instruments at MP-1



**Picture II-2-2-(2)**  
Training on handling of monitoring instruments at MP-2



**Picture II-2-2-(3)**  
Training on handling of monitoring instruments at MP-4



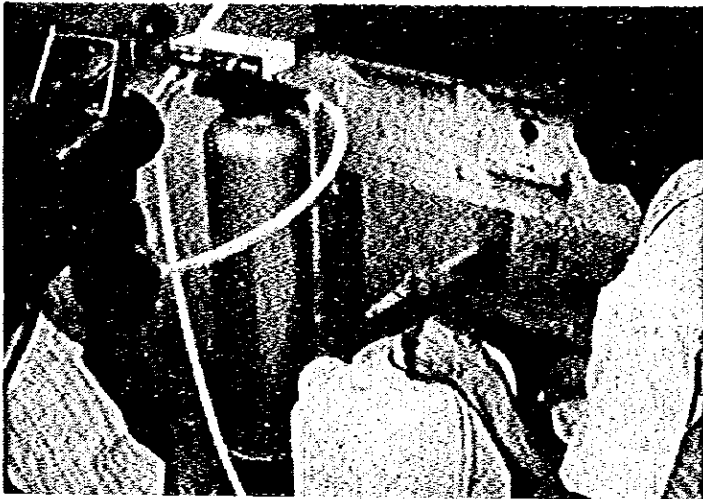
Picture II-2-2-(4) Training on handling of monitoring instruments at MP-5

### II-2-3 Training on Preparation of Absorbing Solution and Equivalent Solution for Calibration and Handling of Distiller

During 14:00 to 17:00 of July 8th 1981, the training on the preparation methods of absorbing solution and equivalent solution for calibration has been provided to 3 JTC officers together with the handling method of distiller. The training has been recorded by JTC in VTR.

The absorbing solution (20 litre) for  $\text{SO}_2$  analyzer is scheduled to be replaced every two weeks and the solution itself is required to be very accurate in preparation process. So the necessary training has been given with careful attention. And for preparation of absorbing solution, the pure water of under  $1\mu\Omega/\text{cm}^2$  in terms of conductivity is absolutely required and the distiller of ion exchanger has been brought from Japan.

As mentioned in the above, the calibration of the instruments is agreed to be conducted by Japanese team, but the related training for preparation of equivalent solution has also been provided. Picture II-2-3 shows the training conducted at SIU (Soil Investigation Unit) of JTC.



**Picture II-2-3-(1)** Production of distilled water



**Picture II-2-3-(2)** Preparation of absorbing solution



**Picture II-2-3-(3)**  
**Preparation of equivalent solution**



**Picture II-2-3-(4)**  
**Calibration of SO<sub>2</sub> analyzer by equivalent solution (recording calibration processes by VTR)**