3.2 Factories and Establishments

3.2.1 QUESTIONNAIRE FORM AND INSTRUCTION FOR FILLING QUESTIONNAIRE IN INDONESIA

PETUNJUK PENGISIAN KUESIONER

Umum:

- Penjelasan dalam pengisian kuesioner lebih lanjut, dapat menghubungi salah satu nama sebagai berikut:
  1. Ir. A. Gunawan
  2. Ir. Ilham Malik
  3. Atu Erna, S.Si

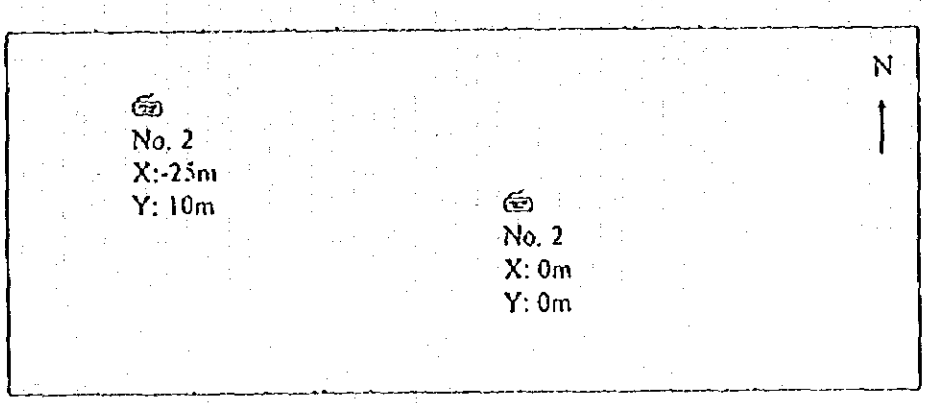
  Direktorat Pengendalian Pencemaran Udara - BAPEDAL
  Telp. 2511540 ext. 218 atau 2512460
  No. fax 2511547

- Gunakan kertas tambahan bila perlu
- Data yang dimasukkan adalah data terakhir
- Jika ada pabrik di lain lokasi, maka gunakan satu kuesioner untuk satu pabrik

Item 4: Gunakan nomor kode industri (Indonesia Industrial Code)

Item 5:
* Penjelasan untuk jumlah dan jenis material awal sampai akhir
* Lampirkan skema sederhana untuk unit prosesnya

Item 8: Skema lokasi untuk Stack yang ada
Jika jumlah stack dua atau lebih, gunakan stack no.1 sebagai acuan seperti dalam contoh di bawah



Item 13:
* Polutan yang dimaksud adalah SO_2, NO_x, dan partikulat.
* Fasilitas:
  Fasilitas penghasil emisi yang terdapat dalam pabrik, misalnya Boiler, Incenerator, crusher, atau yang lain.
  Sebagai contoh:
  Jika boiler yang digunakan, maka diisi Steam (kolom 2), kecepatan evaporasi (kolom 5), kebutuhan bahan bakar (kolom 6), hubungannya dengan kecepatan evaporasi.

Item 13(3): Tipe fasilitas pembangkit emisi, sebagai contoh untuk semen kiln, sistem basah atau kering, tipe kontinu atau batch.

Item 13(5): Kapasitas per jam
Jika operasinya batch, berapa rata-rata operasi dalam jam per batch.

Item 13(11): Jika Stack tidak berbentuk bulat, maka berapa panjang dan lebarnya.

Item 13(26-27): Tulis waktu mulai proses operasi dan berapa jam beroperasi dalam 1 hari

Kuesioner

1. Penanggung jawab pengisian *formulir* kuesioner
   Nama : _____ Jabatan : _____ Telephone : _____
2. Nama Perusahaan : _____
3. Alamat Perusahaan : _____
4. Jenis dari Industri : _____
5. Jenis Produksi : _____
6. Luas Area : _____ Luas lantai : _____ m^3 Jumlah ruangan : _____ buah
7. Jumlah tenaga kerja : _____
8. Sketsa lokasi cerobong : _____

N

9. Rencana pabrik mendatang : _____
10. Keluhan-keluhan tentang polusi udara dari sekitarnya (*)
11. Tindakan-tindakan pengendalian pencemaran udara (saat ini dan yang akan datang) (*)
12. Masalah pencemaran udara (level rasional/regional) (*)

Catatan : (*) Mohon untuk dilampirkan

13. Fasilitas Sumber Emisi

13.1 Fasilitas dan Cerobong

Fasilitas								Cerobong						Catatan
No.	Nama	Tipe	Tujuan	Kapasitas perencanaan		Waktu instalasi		Jml	Tinggi (m)	Diameter dalam bagian atas	Gas Temp. (°C)	Wet Gas Volume (Nm^3 /H	Ukuran sampling Nozzle (mm)	(15)
				Output	Input bahan bakar	tahun	bulan							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	

13.2 Output, Bahan Baku dan Kondisi operasi

No. (16)	Output pertahun (17)	Bahan Bakar				Bahan Baku				Kondisi Operasi					Catatan (31)
		Nama (18)	Sulfur (wt.%) (19)	Specific Gravity (20)	Konsumsi pertahun (21)	Nama (22)	Sulfur (wt.%) (23)	Specific Gravity (24)	Konsumsi pertahun (25)	Harian		Hari dalam 1 bulan	Hari dalam 1 tahun	Jam dalam 1 tahun	
										Mulai pada (26)	Jam (27)	(28)	(29)	(30)	

13.3 Pengendalian Gas Buang

No. (32)	Pengendalian Gas Buang: Nama (33)	Konsentrasi Sebelum Pengendalian: SOx ppm (34)	NOx ppm (35)	DUST mg/Nm^3 (36)	Konsentrasi Setelah Pengendalian: SOx ppm (34)	NOx ppm (35)	DUST mg/Nm^3 (36)	Efisiensi Sistem Pengendalian (%) (40)	Waktu Pengukuran: Tahun (41)	Bulan (42)	Hari (43)	Catatan (44)

KUESIONER

1. Penanggung Jawab pengisian kuesioner
   Nama : _____ Jabatan : _____ Telephone :

2. Nama Hotel / Gedung : _____

3. Alamat Hotel / Gedung : _____

4. Luas Area : _____ Luas lantai : _____ m^2 Jumlah ruangan : _____ buah

5. Jumlah tenaga kerja : _____ orang.

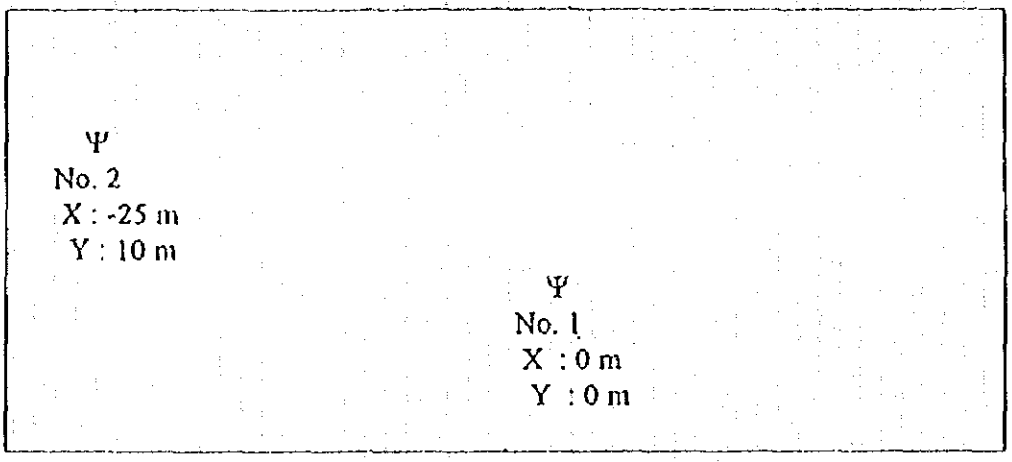
PETUNJUK PENGISIAN KUESIONER

Umum :

* Penjelasan dalam pengisian kuesioner lebih lanjut dapat menghubungi salah satu nama sebagai berikut :
  1. Ir. A Gunawan.
  2. Ir. Ilham Malik
  3. Atu Erna Sunarsih, Ssi.

  Direktorat Pengendalian Pencemaran Udara - BAPEDAL
  Telp. 251 1540 ext. 218 atau 2512460
  No. fax 251 1547

* Gunakan kertas tambahan bila perlu
* Data yang dimasukkan adalah data terakhir
* Skema lokasi untuk stack yang ada
  Jika jumlah stack dua atau lebih, gunakan stack no. 1 sebagai acuan seperti dalam contoh dibawah .



* Untuk tabel II item (g - j) tulis waktu mulai proses operasi dan berapa jam beroperasi dalam 1 hari.
* Untuk tabel III item (f) jika stack tidak berbentuk bulat, maka berapa panjang dan lebarnya.

KARAKTERISTIK PEMBANGKIT TENAGA

(Tabel I)

No. (a)	Nama (*) (b)	Tipe (c)	Tujuan (d)	Kapasitas Design (e)		Tahun (f)
				Output	Input Bahan Bakar Perhari	Waktu Instalasi
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Catatan:
- Kolom (b): misalnya BOILER, DIESEL, INCENERATOR DLL
- Kolom (c): misalnya BOILER Type FIRE TUBE
- Kolom (e): diisi dalam Ton Steam, KW atau yang lain
- Kolom (f): Diisi dalam Kiloliter/hari, atau Ton/tahun dll

Karakteristik Bahan Bakar

(Tabel II)

No.	Nama (*)	Tipe	Bahan Bakar				Kondisi Operasi				Catatan
			Nama	Sulfur (wt/%)	Specific grafity	Konsumsi pertahun	Harian Mulai pada	Jam	Bulan Jam	Tahun Jam	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

Catatan:
1. Kolom (a), (b), dan (c) di isi sama seperti Tabel I Karakteristik Pembangkit Tenaga.
2. Kolom kondisi operasi diisi penggunaannya dalam jam/hari, rata-rata per bulan, dan rata-rata pertahun, jika tidak kontinyu digunakan mohon dijelaskan di kolom catatan.

Fasilitas Sumber Emisi

(Tabel III)

Fasilitas dan Cerobong

Fasilitas			Cerobong					
No	Nama	Tipe	Jml	Tinggi (m)	Diameter dalam bagian atas	Gas Temp. (o.C)	Alat Pengukur Pengendalian udara	Catatan
a	b	c	d	e	f	g	h	i
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Catatan :
1. Kolom (b), (c) diisi sama dengan tabel I.
2. Kolom (h) dapat berupa SCRUBER,ELECTROSTATIC PRECIPITATOR, CYCLON, BLACK FILTERI.

3.2.2 QUESTIONNAIRE FORM AND INSTRUCTION FOR FILLING QUESTIONNAIRE IN ENGLISH

QUESTIONNAIRE

Reference Number:_____ Location Code:_____

Date:

Interviewer Name:

1. PERSON IN CHARGE OF ANSWERING TO THIS QUESTIONNAIRE
   NAME:_____ POSITION:_____ TELEPHONE:_____
2. FACTORY NAME:_____
3. FACTORY ADDRESS:_____
4. TYPE OF INDUSTRY:_____
5. DETAILS ON BUSINESS:_____
6. AREA OF SITE:_____ m² FLOOR SPACE:_____ m² NUMBER OF ROOMS:_____
7. NUMBER OF EMPLOYEES:_____
8. SKETCH DRAWING OF STACK LOCATION

N
↑

9. FACTORY FUTURE PLAN

10. COMPLAINTS ABOUT AIR POLLUTION FROM SURROUNDERS

11. AIR POLLUTION CONTROL MEASURES (PRESENT & FUTURE)

12. REQUESTS ON AIR POLLUTION PROBLEMS TO NATIONAL AND LOCAL GOVERNMENTS

13. POLLUTANT EMISSION SOURCES (FACILITIES)

13.1 FACILITY AND STACK

FACILITY								STACK						REMARKS
No. (1)	NAME (2)	TYPE (3)	PURPOSE (4)	PLANNED CAPACITY per hour		DATE of INSTALLATION		No. (9)	HEIGHT (m) (10)	TOP INSIDE-DIAMETER (m) (11)	GAS TEMP. (°C) (12)	WET GAS VOLUME (Nm^3/h) (13)	SAMPLING NOZZLE SIZE (mm) (14)	(15)
				OUTPUT (5)	FUEL INPUT (6)	year (7)	month (8)							

13.2 OUTPUT, RAW MATERIALS AND OPERATION STATE

No. (16)	OUTPUT per year (17)	FUEL NAME (18)	FUEL SULFUR (wt.%) (19)	FUEL SPE-CIFIC GRAVITY (20)	FUEL CONSUMP-TION per year (21)	RAW MATERIALS NAME (22)	RAW MATERIALS SULFUR (wt.%) (23)	RAW MATERIALS SPE-CIFIC GRAVITY (24)	RAW MATERIALS CONSUMP-TION per year (25)	OPERATION STATE DAILY BEGIN at (26)	OPERATION STATE DAILY hrs (27)	Days in a Month (28)	Days in a Year (29)	Hours in a Year (30)	REMARKS (31)
										:					
										:					
										:					
										:					
										:					
										:					
										:					
										:					
										:					
										:					

13.3 FLUE GAS TREATMENT

No. (32)	FLUE GAS TREATMENT NAME (33)	CONCENTRATION Before TREATMENT			CONCENTRATION After TREATMENT			DESIGNED TREATMENT EFFICIENCY (%) (40)	MEASURING DATE			REMARKS (44)
		SOx ppm (34)	NOx ppm (35)	DUST mg/Nm³ (36)	SOx ppm (37)	NOx ppm (38)	DUST mg/Nm³ (39)		year (41)	month (42)	date (43)	

14. REMARKS FOR LOCATION/ACCESS OF SAMPLING NOZZLE

INSTRUCTION FOR FILLING QUESTIONNAIRES

General: If you have any question concerning the fill-up, please contact BAPADAL attention.

Mr. _____

Telephone No. _____

Fill up the actual results in 1994.

Use extra sheets of paper when necessary.

Use only commonly known abbreviation. Spell out the abbreviation as much as possible.

If you have factories in different locations, use one sheet of questionnaire for one factory.

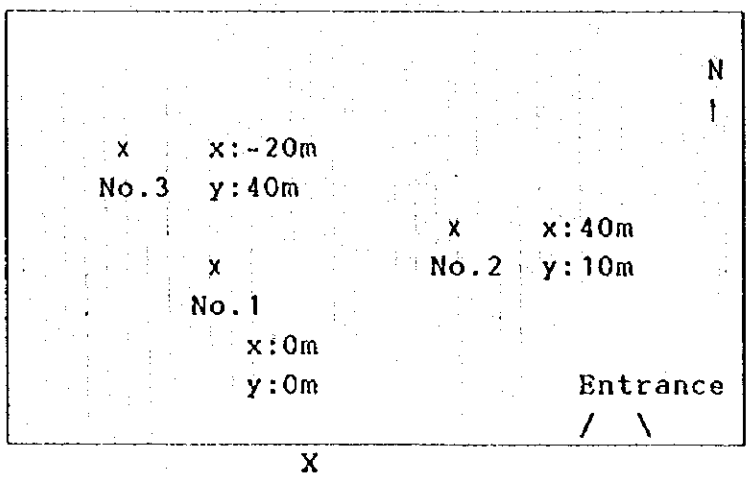
ITEM 4: Use Industrial Code number (attached table 1) or state names of your main merchandises.

ITEM 5: State quantities of your starting materials and end products. Attach or explain briefly simple schemes for each process block. Also attach your company catalogues which show your business nature.

ITEM 6: If the TYPE OF INDUSTRY belongs to manufacturer, fill in AREA OF SITE. Otherwise, write FLOOR SPACE. As to hotels, please fill in NUMBER OF ROOMS.

ITEM 7: Write your permanent annual employees. If you hire temporal support-hands, write their number in average month of a year in parentheses.

ITEM 8: Number all the stacks in sequence in the site. In case there are 2 or more stacks in the site, draw a figure as follows. Plot all the stacks with their number. Then show the distances (x and y in meters) from the stack No.1 as illustrated below.



ITEM 13: Pollutants here are sulfur oxides (SOx), nitrogen oxides (NOx) and dust.

FACILITY: in your factory, you may have several facilities which emit these pollutants, one only or two or three in combination. The facility will be a boiler, an incinerator, a crusher, or else. Write in the table by each facility. For example, if it is a boiler, write steam on 13(2), evaporation rate on 13(5) and fuel input on 13(6) corresponding to the evaporation rate on 13(5).

RAW MATERIALS: Fill in items concerning main raw materials. If you have a stone crusher which emit particulates into atmosphere through opening, write the name on 13(2) and consumption on 13(5) of stone and fill up STACK column as uncontrolled openings.

FLUE GAS TREATMENT: If you have already installed any air pollution control equipment, such as an electrostatic precipitator, a cyclone, a bag filter, a scrubber, and so on, give its names and other details. If you have flue gas measuring data, please attach the measured data.

ITEM 13(1): Number all the air polluting facilities in sequence in the site.

ITEM 13(3): Write type of the facility. For example, for cement kiln, dry or wet type, continuous or batch type.

ITEM 13(5): Fill in planned capacity per hour. In case of batch operations, please write the average operating hours per batch in the column of remarks (13(15)).

ITEM 13(6): Fill in fuel input corresponding to the planned capacity in ITEM 13(5).

ITEM 13(9): Stack Numbers correspond to the numbers in ITEM 8.

ITEM 13(10): In case base of the stack is not located on the ground, write the height of the base of the stack in meter from the ground in the column of remarks (13(15)).

ITEM 13(11): In case stacks are not round, fill in length and breadth like 1.2m x 1.0m.

ITEM 13(14): In case there is a gas sampling nozzle, write the sampling nozzle size in millimeter (mm).

ITEM 13(16): Numbers correspond to the numbers in ITEM 13(1).

ITEM 13(17): Please fill in total annual output in 1994.

ITEM 13(21): Please write total annual fuel consumption in 1994. Units are as follows.

Liquid and solid fuels: ton
Gas fuels: $10^3 Nm^3$
Electricity: 10^3 kWh

ITEM 13(22)~(25): Please fill in these columns, where processed raw materials emit SOx, NOx and/or dust through stacks or any other openings to the atmosphere.

ITEM 13(25): Please fill in total annual consumption in 1994.

ITEM 13(26) & (27):

Write the starting time and operating hours of the facility. In case of batch-wise facility, fill in as following example.

08:00 2 hrs
13:00 5 hrs
18:30 4 hrs

As to special cases in which each sequential work lasts for over 24 hours such as brick baking, fill as following example.

07:00 72 hours

ITEM 13(28): Write average operation days in a month (30days/month) in 1994. In case in which each sequential work lasts for over 24 hours, fill in average operating times in a month.

ITEM 13(29): Write total annual operation days in 1994 (365 days in a year). In case in which each sequential work lasts for over 24 hours, fill in total operating times in 1994.

ITEM 13(30): Calculate and write total annual operating hours from ITEMS 13(27) and (29) (8760 hours/year).

ITEM 13(32): Numbers correspond to the numbers in ITEM 13(1).

ITEM 14 BAPEDAL intends to measure actual emission rates from your stack by our personals jointly with JICA's specialists. Give the information related to your sampling nozzle. ACCESS is a question related safety of measurement. If they have to reach the nozzle through a ladder, write a ladder in ACCESS, and if the nozzle is up-stairs and no safety cage for measurement, write no cage.

Thank you very much in advance for your kind cooperation.

3.2.3 Setting of Emission Factors for Stationary Combustion Facilities

Emission factors were determined from the results of the flue gas measurement (**Section 4.3.2**) and published emission factors in USA and Japan. The results of the fuel analysis (**section 4.2** of the Main Report) were also used. Procedure for setting emission factors from results of emission measurement is shown in **Figure 1**. In this Study, average emission factors were used to estimate pollutant emissions. In case of using existing emission factors by fuel, calorific conversion (consideration of differences in calorific value between original fuel and corresponding fuel in Indonesia) was made. Also in case of applying emission factors from flue gas measurement to different fuels, calory conversion was made.

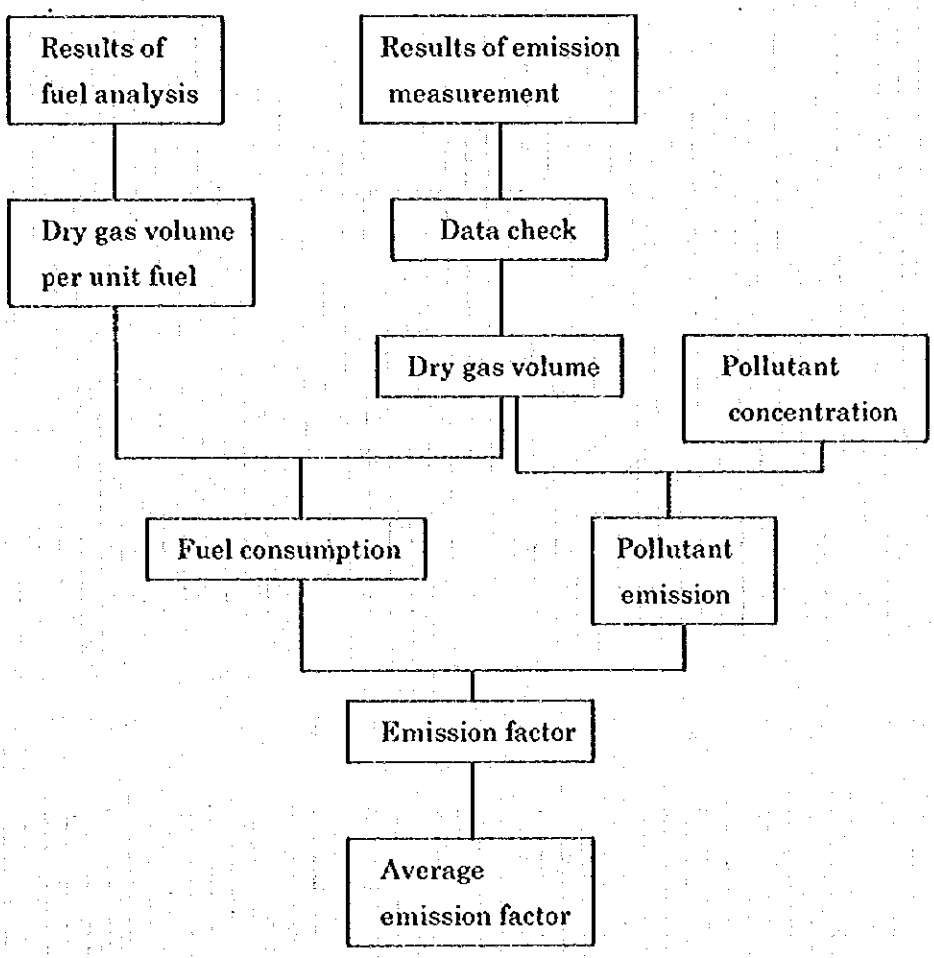


Figure 1 Procedure for Setting Emission Factors for Stationary Sources

(1) Gas volume by Fuel Combustion

There are two kinds of gas volume: dry and wet. Dry gas volume is used in estimating pollutant emission. wet gas volume is used in air dispersion simulation.

Dry and wet gas volume can be calculated from results of fuel analysis.

Actual dry gas volume per unit fuel (G') = $G_0 + (m-1) A_0$

where A_0 : Theoretical amount of air
G_0 : Theoretical dry gas volume per unit fuel
m : Excess air ratio

Actual wet gas volume per unit fuel (G) = G' + Vw

where Vw : Water vapor

Excess air ratio is usually calculated from emission measurement by the following equation.

$$m = 21/(21 - (O_2))$$

where (O_2) : Concentration of O_2 (%) in the flue gas

Fuel consumption rate can be calculated by dry gas volume per unit fuel and concentration of O_2, while air pollutant emissions can be calculated from dry gas volume and pollutant concentrations.

Finally, emission factors are set from the fuel consumption rate and the pollutant emissions.

Dry and wet gas volume used in this Study is shown in **Table 1.** Concentration of O_2 by facility and fuel type is given in **Table 2.**

Table 2 O_2 Concentration in Flue Gas

Facility kind	Usage	Fuel kind	Oxygen (%)	Source
Boiler	Utility	MFO	5.5	Measurement
		Natural gas	5.2	Measurement
	General	HSD	7.5	Measurement
		IDO	9.5	Measurement
		MFO	7.4	Measurement
		Kerosene	10.1	Measurement
		Coal	12.7	Measurement
		Natural gas	7.0	Measurement
		IDO and MFO	6.1	Measurement
		MFO and black liquor	8.7	Measurement
Genarator		HSD	11.6	Measurement
		IDO	11.6	HSD
Diesel engine		HSD	11.6	Generator HSD
Gas turbine		Natural gas	16.0	Japan
Combined cycle		Natural gas	16.0	Gas turbine
Electric furnace	billet	electricity, IDO, natural gas	18.4	Measurement
Melting furnace	glass	MFO	9.3	Measurement
	zink	Electricity	20.3	Measurement
		IDO	12.0	Japan
	aluminum	HSD, LPG	12.0	zink IDO
	lead	LPG	12.0	zink IDO
Reheating furnace	billet	IDO, natural gas	11.0	Japan
Heat treating furnace	glass	Natural gas	16.0	Japan
	aluminum	HSD	11.0	Japan
Absorption facility	sulfuric acid		6.0	Japan
Burning kiln	cement	Coal, IDO, waste oil, natural gas	11.1	Measurement
	tile	natural gas	18.0	Japan
	ceramics	natural gas	18.0	Japan
Oven	food	HSD, kerosene, natural gas	6.0	Japan
	plastics	natural gas	6.0	Japan
Dryer	paint baking	LPG	16.0	Japan
	detergent	HSD	19.5	Measurement
	clay	natural gas	16.0	Japan

(2) Emission Factor

(a) SOx

Sources of SOx emissions are fuels and raw materials. If a facility such as a glass melting furnace uses raw materials with high sulfur contents, we should take into consideration SOx emission from them. If output of a facility absorbs sulfur in fuels or raw materials, we have to consider it. Cement kiln is one of the latter cases. In such cases flue gas measurements are required.

Emission factors of SOx used in this Study are shown in **Table 3.** They are expressed as SO_2. **Table 4** gives the sulfur content (wt%) and specific gravity of the fuels **(Section 4.2).**

Table 3 SOx Emission Factors
(as SO_2)

Facility	Fuel	Emission factor	Source
General facility	HSD IDO MFO Kerosene Waste oil IDO and MFO MFO and black liquor	20S * D kg/kl fuel	
	Coal	15.5*S kg/ton fuel	(#208)
	Natural gas	20S * D kg/1000m3 fuel	
	LPG	20*S kg/ton fuel	
Cement kiln	Liquid fuel	6S * D kg/kl fuel	flue gas measurement
	Coal	6S kg/ton fuel	
	Natural gas	6S*D kg/1000m3 fuel	
Glass melting furnace	Bottle glass manufacturing	20S * D kg/kl fuel	MFO
	Flat glass manufacturing	29.6S * D kg/kl fuel	flue gas measurement
Absorption facility	Material sulfur	84.2 kg/ton sulfur	(#208)

S: sulfur content in the fuel (wt%)
D: specific gravity

Table 4 Sulfur Content and Specific Gravity of Fuels

Fuel	Sulfur content (wt%)	Specific gravity
HSD	0.28	0.813
IDO	0.54	0.800
MFO	2.23	0.947
Kerosene	0.11	0.867
Waste oil	0.56	0.934
IDO and MFO	1.60	0.900
MFO and black liquor	2.10 (*1)	0.830
Coal A	1.07	
Coal B	0.49	
Natural gas	0.00	
LPG	0.00	

(*1) analysed sulfur content is 0.34%. However, the result of flue gas measurement shows its sulfur content must be about 2.10%.

(b) NOx

NOx emission factors are shown in **Table 5**. They are expressed as NO_2.

(c) Particulate

1) Emission Factors

Emission factors for PM are shown in **Table 6.**

2) Efficiency of Treatment Units

Efficiency of particulate removal of each treatment unit is shown in **Table 7.**

Table 5 NOx Emission Factors

(as NO_2).

Facility	Usage	Fuel	Emission factor	Source
Boiler	Utility	MFO	5.27 kg/kl fuel	Measurement
		Natural gas	2.33 kg/1000m3 fuel	Measurement
	General	HSD	1.68 kg/kl fuel	Measurement
		IDO	1.86 kg/kl fuel	Measurement
		MFO	4.27 kg/kl fuel	Measurement
		Kerosene	1.39 kg/kl fuel	Measurement
		Coal	2.83 kg/t fuel	Measurement
		Natural gas	1.21 kg/1000m3 fuel	Measurement
		Waste heat	0	
		Waste tire	0	No available data
		Waste rubber	0	No available data
		IDO and MFO	2.72 kg/kl fuel	0.75*IDO + 0.25*MFO
		MFO and Black liquor	3.22 kg/kl fuel	Measurement
Generator		HSD	5.08 kg/kl fuel	Measurement
		IDO	5.08 kg/kl fuel	HSD
Diesel engine		HSD	5.08 kg/kl fuel	Generator HSD
Gas turbine		Natural gas	5.54 kg/1000m3 fuel	USA
Combined cycle		Natural gas	5.54 kg/1000m3 fuel	USA
Electric furnace	billet	Electricity	0.1 kg/t metal processed	USA
		Electricity and IDO	0.1 kg/t metal processed	USA
		Electricity and Natural gas	0.1 kg/t metal processed	USA
Melting furnace	glass	Bottle glass (fuel:MFO)	12.77 kg/kl fuel	Measurement
		Flat glass (fuel:MFO)	3.72 kg/kl fuel	Measurement
	zinc	IDO	1.87 kg/kl fuel	Japan
		Electricity	0	Measurement
	aluminum	HSD	1.89 kg/kl fuel	Japan
		LPG	3.23 kg/t fuel	Japan
	lead	LPG	1.38 kg/t fuel	Japan
Reheating furnace	billet	IDO	1.74 kg/kl fuel	Japan
		Natural gas	1.24 kg/1000m3 fuel	Japan
Heat treating furnace	glass	Natural gas	1.24 kg/1000m3 fuel	Japan
	aluminum	HSD	3.70 kg/kl fuel	Japan
Absorption facility	sulfuric acid		1.27 kg/t sulfur	Japan
Burning kiln	cement	Coal	3.34 kg/t fuel	Measurement
		IDO*	3.93 kg/kl fuel	Coal
		Waste oil*	4.13 kg/kl fuel	Coal
		Natural gas*	3.70 kg/1000m3 fuel	Coal
	tile	Natural gas	0.098 kg/1000m3 fuel	USA
	ceramics	Natural gas	0.098 kg/1000m3 fuel	tile
Oven	food	HSD	1.69 kg/kl fuel	Boiler HSD
		Kerosene	1.39 kg/kl fuel	Boiler kerosene
		Natural gas	1.21 kg/1000m3 fuel	Boiler natural gas
	plastics	Natural gas	1.21 kg/1000m3 fuel	Boiler natural gas
Dryer	paint baking	LPG	0.650 kg/t fuel	Japan
	detergent	HSD	4.69 kg/kl fuel	Measurement
	clay	Natural gas	1.63 kg/1000m3 fuel	Japan

Note : For fuels with * mark, calorific conversion was made from coal.

Table 6 Emission Factors for PM

Facility	Usage	Fuel	Emission factor	Source
Boiler	Utility	MFO	1.84 kg/kl fuel	General boiler MFO
		Natural gas	0.013 kg/1000m3 fuel	Measurement
	General	HSD	0.168 kg/kl fuel	Measurement
		IDO	1.25 kg/kl fuel	Measurement
		MFO	1.84 kg/kl fuel	Measurement
		Kerosene	0.011 kg/kl fuel	Measurement
		Coal	6.32 kg/t fuel	Measurement
		Natural gas	0.040 kg/1000m3 fuel	Measurement
		Waste heat	0	
		Waste tire	0	No available data
		Waste rubber	0	No available data
		IDO and MFO	1.40 kg/kl fuel	0.75*IDO + 0.25*MFO
		MFO and Black liquor	2.35 kg/kl fuel	Measurement
Generator		HSD	5.12 kg/kl fuel	Measurement
		IDO	5.12 kg/kl fuel	HSD
Diesel engine		HSD	5.12 kg/kl fuel	generator HSD
Gas turbine		Natural gas	0.186 kg/1000m3 fuel	USA
Combined cycle		Natural gas	0.186 kg/1000m3 fuel	USA
Electric furnace	billet	Electricity	20.4 kg/t metal processed	USA
		Electricity and IDO	20.4 kg/t metal processed	USA
		Electricity and Natural gas	6.5 kg/t metal processed	USA
Melting furnace	glass	Bottle glass (fuel:MFO)	2.19 kg/kl fuel	Measurement
		Flat glass (fuel:MFO)	6.96 kg/kl fuel	Measurement
	zinc	IDO	0.253 kg/kl fuel	Japan
		Electricity	0.011 kg/MWh fuel	Measurement
	aluminum	HSD	0.486 kg/kl fuel	Japan
		LPG	0.685 kg/t fuel	Japan
	lead	LPG	0.016 kg/t fuel	Japan
Reheating furnace	billet	IDO	0.335 kg/kl fuel	Japan
		Natural gas	0.033 kg/1000m3 fuel	Japan
Heat treating furnace	glass	Natural gas	0.030 kg/1000m3 fuel	Japan
	aluminum	HSD	0.338 kg/kl fuel	Japan
Absorption facility	sulfuric acid		0	
Burning kiln	cement	Coal	23.38 kg/t fuel	Measurement
		IDO*	27.54 kg/kl fuel	Coal
		Waste oil*	28.94 kg/kl fuel	Coal
		Natural gas*	25.89 kg/1000m3 fuel	Coal
	tile	Natural gas	0.024 kg/1000m3 fuel	USA
	ceramics	Natural gas	0.024 kg/1000m3 fuel	tile
Oven	food	HSD	0.168 kg/kl fuel	Boiler HSD
		Kerosene	0.011 kg/kl fuel	Boiler kerosene
		Natural gas	0.040 kg/1000m3 fuel	Boiler natural gas
	plastics	Natural gas	0.040 kg/1000m3 fuel	Boiler natural gas
Dryer	paint baking	LPG	2.62 kg/t fuel	Japan
	detergent	HSD	5.49 kg/kl fuel	Measurement
	clay	Natural gas	1.67 kg/1000m3 fuel	Japan

Note : For fuels with * mark, calorific conversion was made from coal.

Table 7 Efficiency of Particulate Removal

Treatment unit	Efficiency of removal (%)
Cyclone	70
Scrubber	90
Baghouse	95
Electric precipitator	95

3.2.4 Basic Data on Stationary Sources Necessary for Air Dispersion Simulation

(1) Factories

1) Stationary Point Sources

In this Study all the facilities in the surveyed factories were treated as stationary point sources.

(a) Pollutant Emission

In this Study, pollutant emissions from facilities were calculated from consumption of fuel and raw materials, and emission factors. Another method is direct calculation from dry gas volume and pollutant concentration from results of emission measurements.

(b) Wet Gas Volume

In this Study, wet gas volumes from facilities were calculated from fuel consumption and wet gas volume per unit fuel, and consumption of raw material and wet gas volume per unit raw material (**Table 1**). Another method is direct use of wet gas volume from emission measurement.

(c) Daily Operation Pattern

The daily operation pattern of each facility written in the questionnaire sheet was used.

(d) Number of Monthly Operation Days

The number of monthly operation days was assigned to each month by taking into consideration the number of Sundays and holidays in each month as shown in **Table 2**.

(e) Gas Temperature

Gas temperature at the top of stack written in the questionnaire sheet was used. In case gas temperature data is missing, average temperature of the corresponding facility in the questionnaire or existing data in USA and Japan (**Table 3**) was used.

Table 1 Calculation Method of Wet Gas Volume

Facility	Usage or input material	Fuel	Calculation method
Boiler	utility		fuel consumption and O2
	general		fuel consumption and O2
Generator	utility		fuel consumption and O2
Diesel engine	fire pump		fuel consumption and O2
Gas turbine	utility		fuel consumption and O2
Combined cycle	utility		fuel consumption and O2
Electric furnace	iron scrap		wet gas volume : 23000m3N/h annual scrap charge : 150000 t/y annual total operation hour : 7350 hrs/y 23000/150000*7350 = 1127 m3N/t scrap dry gas volume : 21200m3N/h
Melting furnace	glass		fuel consumption and O2
	zinc	IDO	fuel consumption and O2
		electricity	measurement wet gas volume : 1300m3N/h electricty : 500kW 1300 / 500 = 2.6 m3N/kWh dry gas volume : 1200m3N/h
	aluminum		fuel consumption and O2
	lead		fuel consumption and O2
Reheating furnace	billet		fuel consumption and O2
Heat treating furnace	glass		fuel consumption and O2
	iron and steel		fuel consumption and O2
	aluminum		fuel consumption and O2
Absorption facility			sulfur consumption and O2
Burning kiln	cement		fuel consumption and O2
	tile		fuel consumption and O2
	ceramics		fuel consumption and O2
Oven	food		fuel consumption and O2
	plastics		fuel consumption and O2
Dryer	paint baking		fuel consumption and O2
	detergent		fuel consumption and O2
	clay		fuel consumption and O2

Table 2 Assignment of Annual Total Operation Days to Each Month

Total days	1	2	3	4	5	6	7	8	9	10	11	12
1	July	Oct.	Jan.	May	Aug.	Nov.	Mar.	Apr.	June	Sep.	Dec.	Feb.
13	July	Oct.	Jan.	May	Aug.	Nov.	Mar.	Apr.	June	Sep.	Dec.	Feb.
.			.			.			.			
.			.			.			.			
325	July	Oct.	Jan.	May	Aug.	Nov.	Mar.	Apr.	June	Sep.	Dec.	Feb.
337	July	Oct.	Jan.	May	Aug.	Nov.	Mar.	Apr.	June	Sep.	Dec.	July
349	Oct.	Jan.	May	Aug.	Nov.	Mar.	Apr.	June	Sep.	Dec.	July	Oct.
361	Jan.	May	Aug.	Mar.	Dec.							

Table 3 Gas temperature at The Top of The Stack

Facility	Usage	Temperature (℃)	Source
Boiler	utility	186	Questionnaire
	general	226	Questionnaire
Generator		318	Questionnaire
Diesel engine		318	Generator
Gas turbine	utility	227	Questionnaire
Combined cycle	utility	150	Questionnaire
Electric furnace	iron scrap	105	Questionnaire
Melting furnace	glass	301	Questionnaire
	zink	365	US EPA
	aluminum	700	Questionnaire
	lead	50	Questionnaire
Reheating furnace	billet	390	Questionnaire
Heat treating furnace	glass	120	Japan
	aluminum	300	Questionnaire
Absorption facility	sulfuric acid	70	Japan
Burning kiln	cement	117	Questionnaire
	tile	262	ceramic ware
	ceramic ware	262	Questionnaire
Oven	food	150	Questionnaire
	plastic materials	150	food
Dryer	paint baking	79	Questionnaire
	detergent	92	Questionnaire
	clay	90	Questionnaire

2) Stationary Area Sources

In this Study, emissions from unsurveyed factories were treated as area sources. Average daily pattern of boiler and generator was used as the daily operation pattern of the unsurveyed factories (Table 4).

Table 4 Hourly Emission Weight for Stationary Area Sources

Time zone	1	2	3	4	5	6	7	8	9	10	11	12
Weight	0.035	0.035	0.035	0.034	0.035	0.035	0.037	0.044	0.048	0.048	0.048	0.048
Time zone	13	14	15	16	17	18	19	20	21	22	23	24
Weight	0.048	0.048	0.048	0.047	0.046	0.044	0.043	0.041	0.040	0.040	0.036	0.036

(2) Households

Daily operation pattern of households was set from the surveyed result shown in **Figure 4.3.9** in the Main Report (Table 5).

Table 5 Hourly Emission Weight for Households

Time zone	1	2	3	4	5	6	7	8	9	10	11	12
Weight					0.02	0.13	0.15	0.11	0.04	0.04	0.06	0.06
Time zone	13	14	15	16	17	18	19	20	21	22	23	24
Weight	0.09	0.04		0.02	0.07	0.11	0.04	0.04	0.02			

3.3 Automobiles

3.3.1 Traffic Volume

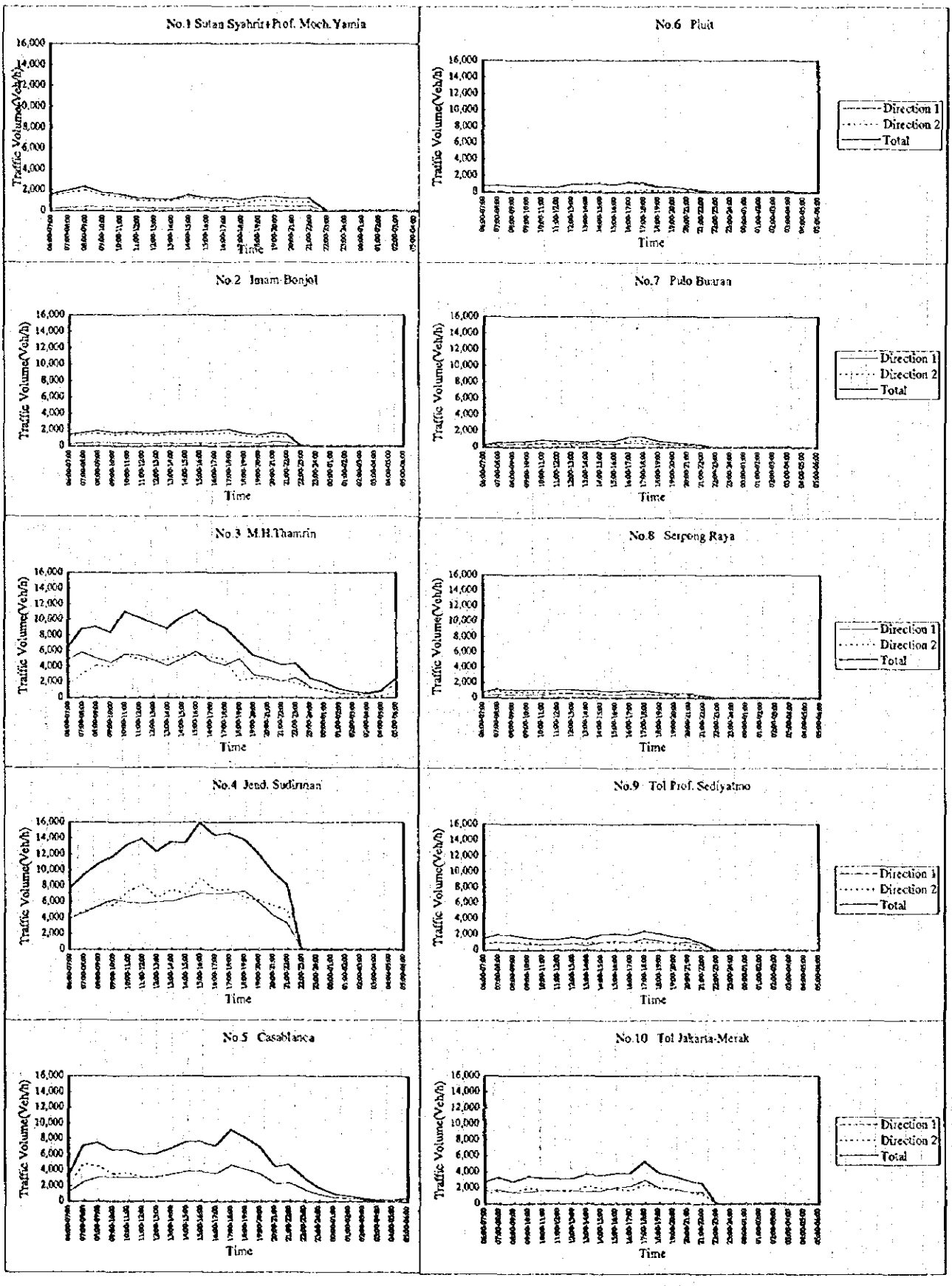


Fig. ***Hourly Fluctuation of Traffic (Point 1 -10)***

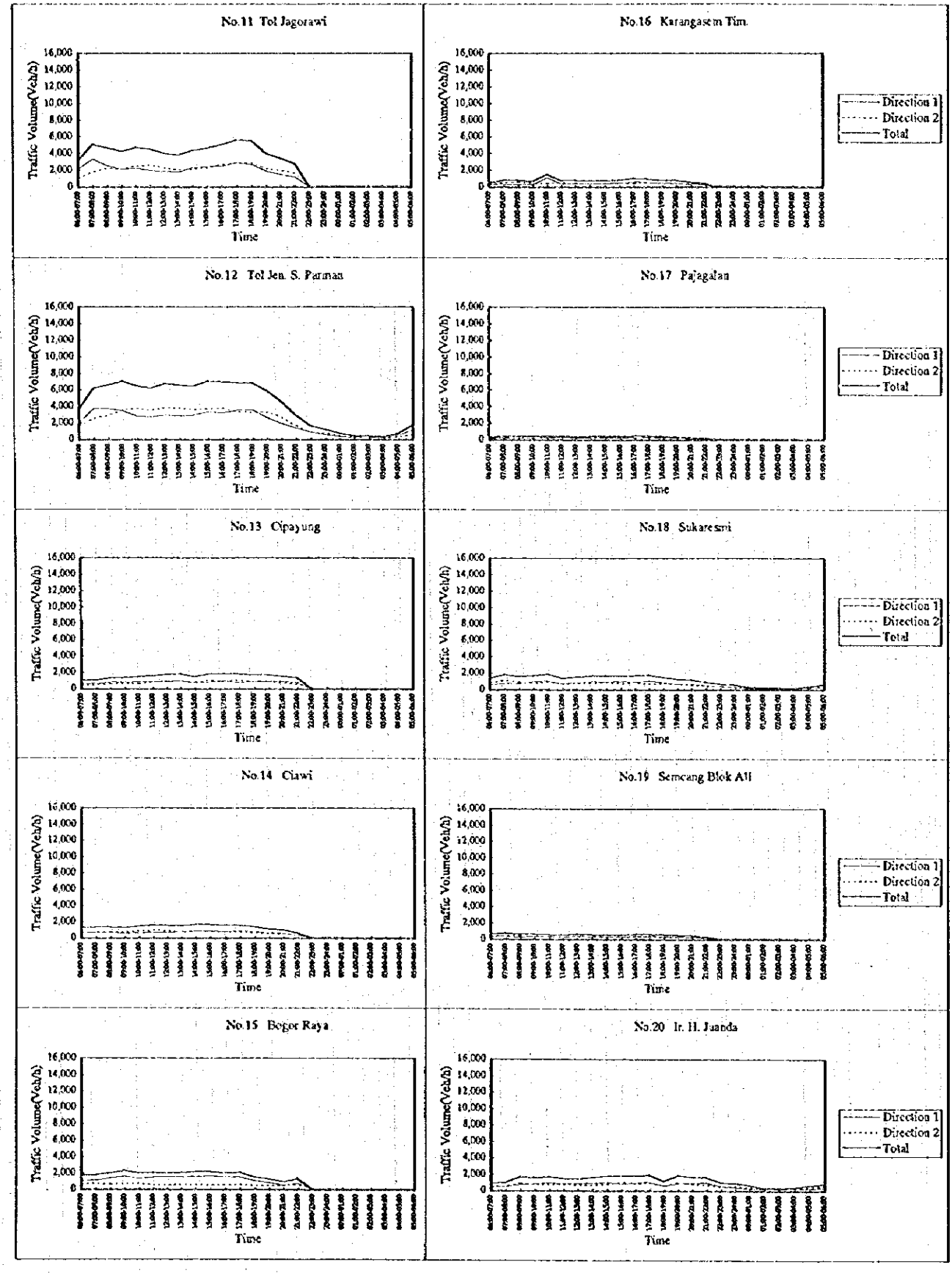


Fig. Hourly Fluctuation of Traffic (Point 11 -20)

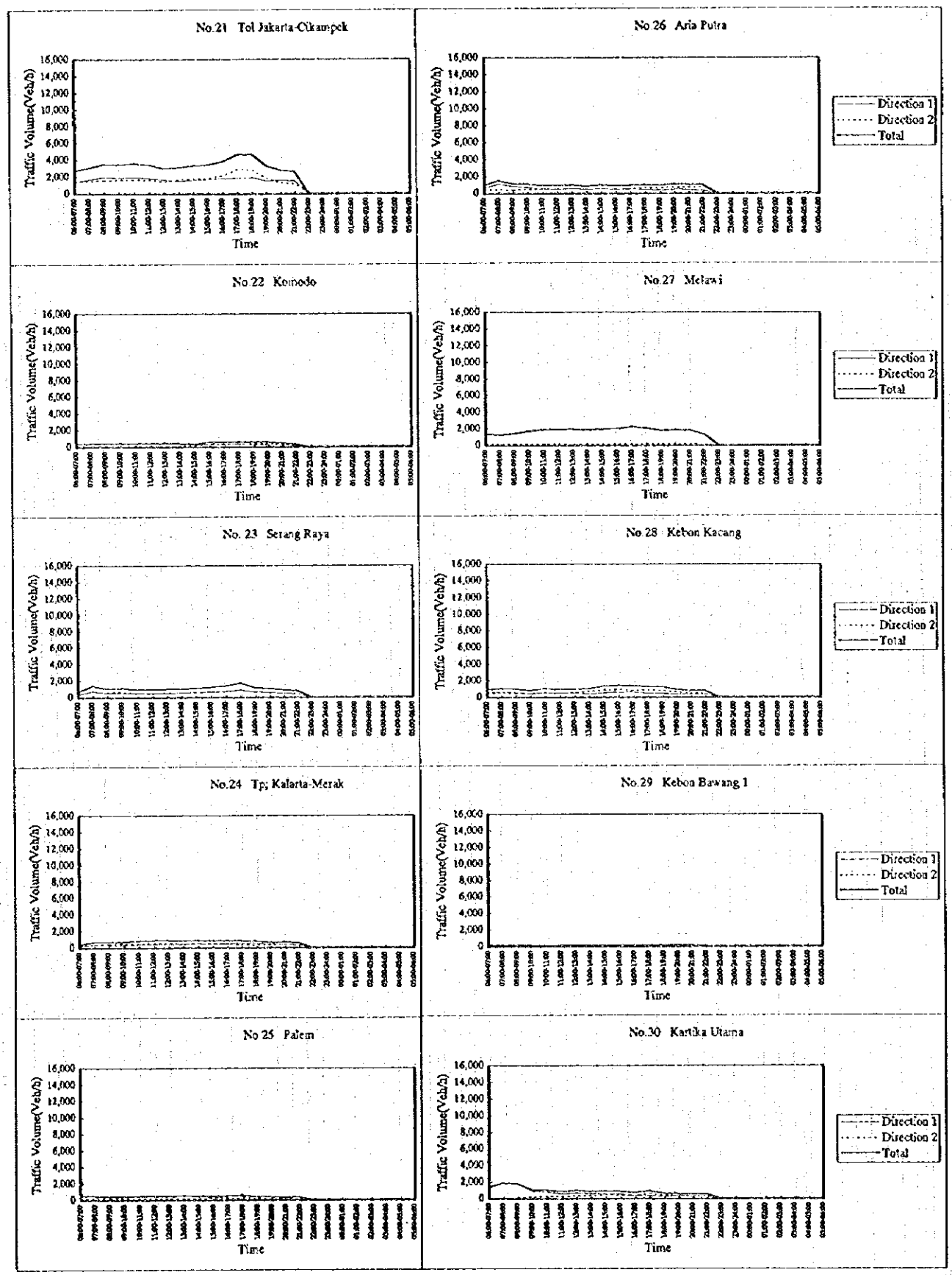


Fig. Hourly Fluctuation of Traffic (Point 21-30)

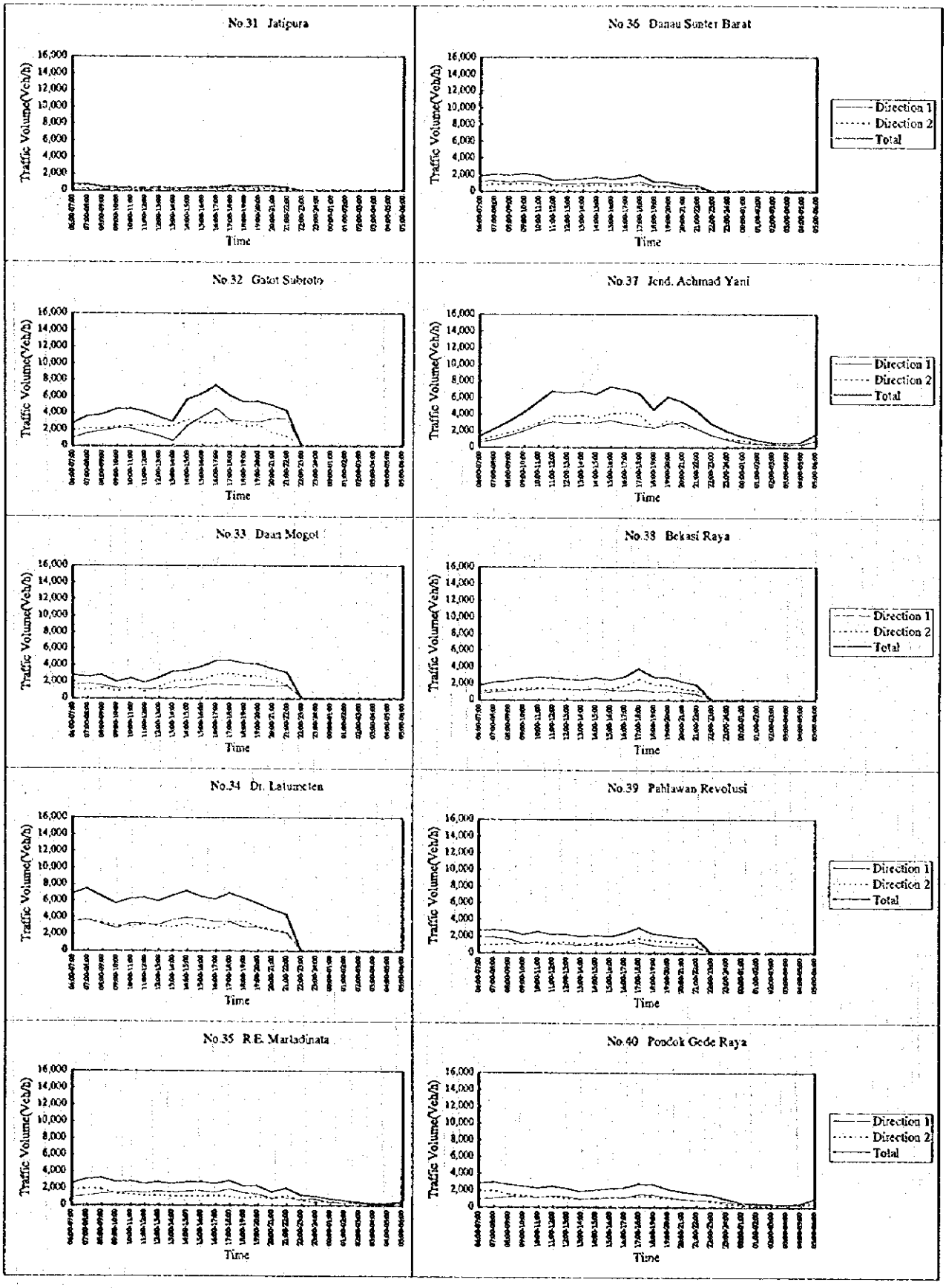


Fig. Hourly Fluctuation of Traffic (Point 31-40)

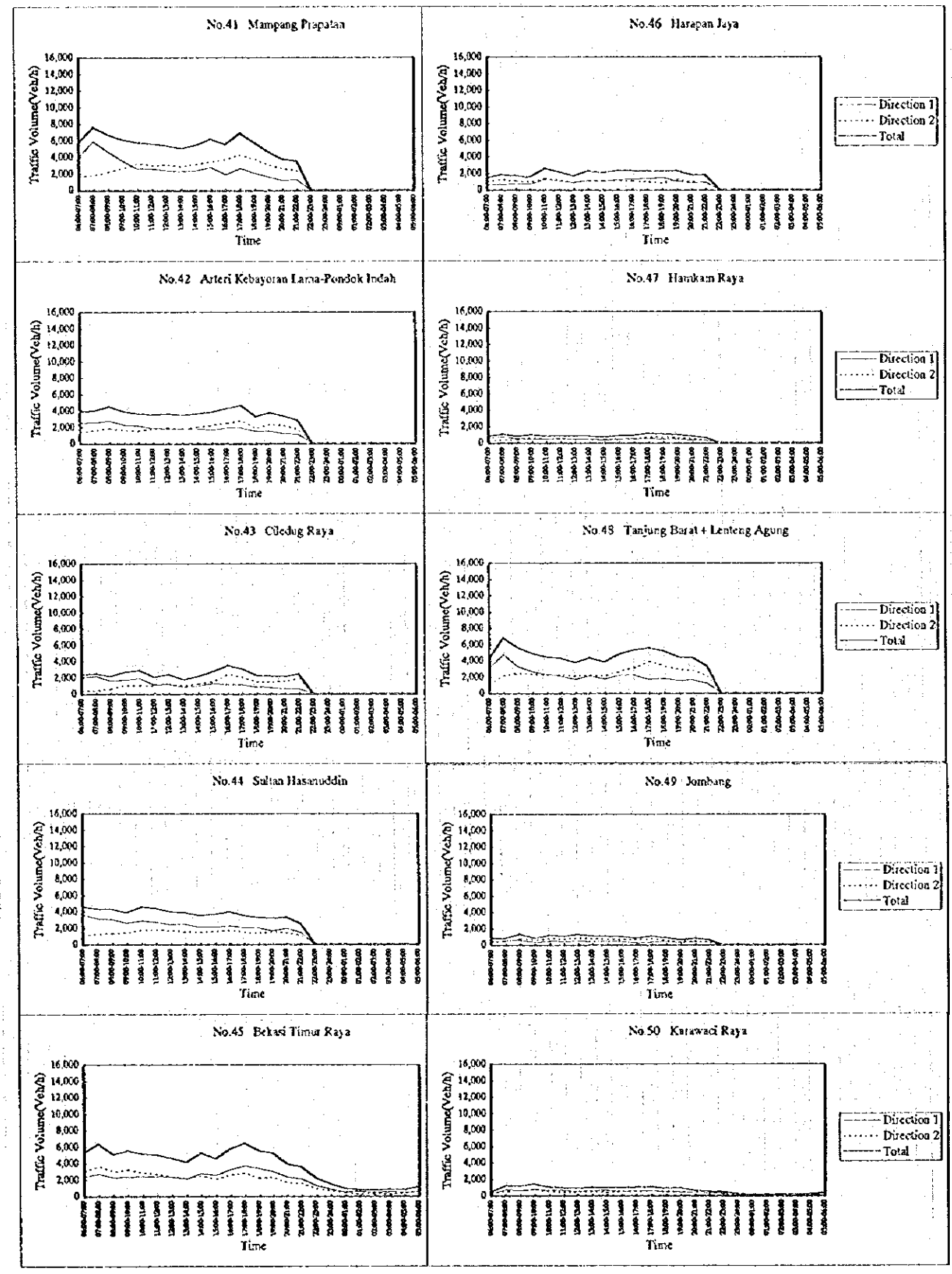


Fig. Hourly Fluctuation of Traffic (Point 41-50)

Table Designation of Direction in Traffic Volume Survey

No.	Road Name	Place Name (Kecamatan/Kabupaten)	Direction (To)	
			1	2
1	Sutan Syahrir+Prof. Moch.Yamin	Menteng/Jakarta Pusat	Hos. Cokroaminoto	M.H. Thamrin
2	Imam-Bonjol	Menteng/Jakarta Pusat	Hos. Cokroaminoto	M.H. Thamrin
3	M.H.Thamrin	Menteng/Jakarta Pusat	Monas	Jend. Sudirman
4	Jend. Sudirman	Tanah Abang/Jakarta Pusat	M.H. Thamrin	Semanggi
5	Casablanca	Setia Budi/Jakarta Selatan	Kp. Melayu	Kuningan
6	Pluit	Penjaringan/Jakarta Utara	Mangga II	Kapuk
7	Pulo Buaran	Cakung/Jakarta Timur	Pulo Gadung	Pulo Buaran
8	Serpong Raya	Serpong/Tangerang	Serpong	Parung
9	Tol Prof. Sedlyatmo	Penjaringan/Jakarta Utara	Jakarta	Soekarno-Hatta
10	Tol Jakarta-Merak	Kembangan/Jakarta Barat	Jakarta	Tangerang
11	Tol Jagorawi	Makasar/Jakarta Timur	Jakarta	Bogor
12	Tol Jen. S. Parman	Palmerah/Jakarta Barat	Grogol	Senayan
13	(Cipayung)	Cisarua/Bogor	Cisarua	Ciawi
14	(Ciawi)	Ciawi/Bogor	Bogor	Sukabumi
15	Bogor Raya	Cibinong/Bogor	Jakarta	Bogor
16	(Karangasem Tim.)	Citeureup/Bogor	Citeureup	Madang
17	Pajagalan	Semplak/Bogor	Bojong Gede	Bogor
18	(Sukaresmi)	Semplak/Bogor	Ciputat	Bogor
19	Sencang Blok AII	Bogor Tengah/Bogor	Cimahpar	Sencang
20	Ir. H. Juanda	Tambun/Bekasi	Cibitung	Bekasi
21	Tol Jakarta-Cikampek	Tambun/Bekasi	Cikampek	Jakarta
22	Komodo	Bekasi Selatan/Bekasi	Nangka	Dahlia Raya
23	Serang Raya	Balaraja/Tangerang	Serang	Merak
24	Tol Jakarta-Merak	Balaraja/Tangerang	Jakarta	Merak
25	Pelem	Jatiuwung/Tangerang	Cibodassari	Bencongan
26	Arla Putra	Ciputat/Tangerang	Ciputat	Kedaung
27	Melawi	Kebayoran Baru/Jakarta Selatan	Sultan Iskandarsyah	Panglima Polim
28	Kebon Kacang	Tanah Abang/Jakarta Pusat	M.H. Thamrin	K.H. Mas Mansyur
29	Kebon Bawang I	Tanjung Priok/Jakrta Utara	Yos Sudarso	Bugis
30	Kartika Utama	Kebayoran Lama/Jakarta Selatan	Pondok Indah Mall	Metro Alam
31	Jatipura	Pondok Gede/Bekasi	Haji Basyar	Pondok Gede
32	Gatot Subroto	Tanah Abang/Jakarta Pusat	Slipi	Semanggi
33	Daan Mogot	Grogol Petamburan/Jakarta Barat	Grogol	Tangerang
34	Dr. Latumeten	Tambora/Jakarta Barat	Sockarno-Hatta	Grogol
35	R. E. Martadinata	Pademangan/Jakarta Utara	Tanjung Priok	Gunung Sahari
36	Danau Sunter Barat	Tanjung Priok/Jakarta Utara	R.E. Martadinata	Sunter
37	Jend. Achmad Yani	Cempaka Putih/Jakarta Pusat	Tanjung Priok	Cililitan
38	Bekasi Raya	Pulo Gadung/Jakarta Timur	Pulo Gadung	Klender
39	Pahlawan Revolusi	Duren Sawit/Jakarta Timur	Klender	Pondok Bambu
40	Pondok Gede Raya	Cipayung/Jakarta Timur	Pondok Gede	Taman Mini
41	Mampang Prapatan	Mampang Prapatang/Jakarta Timur	Kuningan	Warung Buncit
42	Arteri Kebayoran Lama-Pondok Indah	Kebayoran Lama/Jakarta Selatan	Kebayoran Lama	Pondok Indah
43	Cikdug Raya	Cikdug/Tangerang	Jakarta	Cikdug
44	Sultan Hasanuddin	Kebayoran Baru/Jakarta Selatan	Senayan	Blok M
45	Bekasi Timur Raya	Jatinegara/Jakarta Timur	Klender	Jatinegara
46	(Harapan Jaya)	Bekasi Utara/Bekasi	Bekasi	Pulo Gadung
47	Hamkam Raya	Jati Sampurna/Bekasi	Jatiwarna	Jatimurni
48	Tanjung Barat+Lenteng Agung	Jagakarsa/Jakarta Selatan	Pasar Minggu	Depok
49	Jombang	Cikdug/Tangerang	Cikdug	Pondok Aren
50	Karawaci Raya	Tangerang/Tangerang	Tangerang	Tol Jakarta-Merak

3.3.2 Travel Speed

Table Travel Speed Survey Results

ROUTE NO.			I (Major Road to/from South)							
ROAD NAME			Pintu Besar Sel. - Hayam Wuruk/Gajah Mada - Maja Pahit - Medan Merdeka Barat - M.H. Thamrin - Jend. Sudirman- Sisingamangaraja - Panglima Polim -Fatmawati							
SECTION			DISTANCE	TRAVEL TIME				TRAVEL SPEED (km/h)			
NO.	CHECKPOINT NAME	CHECKPOINT NAME	(km)	WEEKDAY			HOLIDAY	WEEKDAY			HOLIDAY
				MORNING	DAYTIME	EVENING	DAYTIME	MORNING	DAYTIME	EVENING	DAYTIME
0-1	Medan Merdeka Utara	Imam Bonjol	2.7	08:43	07:47	35:40	05:47	18.6	20.8	4.5	28.0
1-2	Imam Bonjol	Jend. Gatot Subroto	3.1	05:43	11:08	19:27	04:00	32.5	16.7	9.6	46.5
2-3	Jend. Gatot Subroto	Senopati, Pattimura	1.8	04:22	07:05	08:17	02:22	24.7	15.2	13.0	45.6
3-4	Senopati, Pattimura	Kyai Maja, Trunojoyo	1.2	04:37	09:00	05:17	04:02	15.6	8.0	13.6	17.9
4-5	Kyai Maja, Trunojoyo	Cipete Raya	4.2	11:15	20:46	22:21	14:01	22.4	12.1	11.3	18.0
5-6	Cipete Raya	Lingkar Luar (ORR)	1.7	03:28	03:44	03:26	03:37	29.4	27.3	29.7	28.2
Total			14.7	38:08	59:30	1:34:28	33:49	23.1	14.8	9.3	26.1
TOTAL IDLING TIME				06:51	09:25	47:11	05:05				
7-6	Lingkar Luar (ORR)	Cipete Raya	1.7	08:29	04:05	05:32	03:48	12.0	25.0	18.4	26.8
6-5	Cipete Raya	Kyai Maja, Trunojoyo	4.2	26:58	17:45	13:17	17:27	9.3	14.2	19.0	14.4
5-4	Kyai Maja, Trunojoyo	Senopati, Pattimura	1.2	04:39	07:40	03:36	04:20	15.5	9.4	20.0	16.6
4-3	Senopati, Pattimura	Jend. Gatot Subroto	1.8	05:24	03:00	02:29	02:27	20.0	36.0	43.5	44.1
3-2	Jend. Gatot Subroto	Imam Bonjol	3.1	04:57	08:43	03:25	04:58	37.6	21.3	54.4	37.4
2-1	Imam Bonjol	Medan Merdeka Utara	2.7	08:09	10:07	10:39	06:45	19.9	16.0	15.2	24.0
Total			14.7	58:36	51:20	38:58	39:45	15.1	17.2	22.6	22.2
TOTAL IDLING TIME				19:37	10:10	11:27	10:41				

ROUTE NO.			II (Major Road to/from East)							
ROAD NAME			Kramat Bunder - Letjen. Suprapto - Perintis Kemerdekaan - Bekasi Raya - Sultan Hamengku Buwono 9 (Bekasi Raya) - Bekasi Raya - Sultan Agung (Bekasi Raya)							
SECTION			DISTANCE	TRAVEL TIME				TRAVEL SPEED (km/h)			
NO.	CHECKPOINT NAME	CHECKPOINT NAME	(km)	WEEKDAY			HOLIDAY	WEEKDAY			HOLIDAY
				MORNING	DAYTIME	EVENING	DAYTIME	MORNING	DAYTIME	EVENING	DAYTIME
0-1	Senen Raya, Pasar Senen	Jend A.Yani, Laks M.Yos Sudarso	4.4	13:00	12:30	12:50	08:00	20.3	21.1	20.6	33.0
1-2	Jend A.Yani, Laks M.Yos Sudarso	Bekasi Raya	3.9	06:55	15:35	12:50	14:40	33.8	15.0	18.2	16.0
2-3	Bekasi Raya	Lingkar Luar (ORR)	3.6	20:00	09:50	25:15	07:30	10.8	22.0	8.6	28.8
3-4	Lingkar Luar (ORR)	Kranji Flyover	6.9	10:35	11:50	18:20	10:40	39.1	35.0	22.6	38.8
Total			18.8	50:30	49:45	1:09:15	40:50	22.3	22.7	16.3	27.6
TOTAL IDLING TIME				15:50	12:20	20:45	04:00				
4-3	Kranji Flyover	Lingkar Luar (ORR)	6.9	27:55	11:50	13:15	10:15	14.8	35.0	31.2	40.4
3-2	Lingkar Luar (ORR)	Bekasi Raya	3.6	36:10	25:40	19:05	20:10	6.0	8.4	11.3	10.7
2-1	Bekasi Raya	Jend A.Yani, Laks M.Yos Sudarso	3.9	07:40	10:10	10:40	08:20	30.5	23.0	21.9	28.1
1-0	Jend A.Yani, Laks M.Yos Sudarso	Senen Raya, Pasar Senen	4.4	12:00	09:10	10:10	06:55	22.0	28.8	26.0	38.2
Total			18.8	1:23:45	56:50	53:10	45:40	13.5	19.8	21.2	24.7
TOTAL IDLING TIME				38:10	20:50	19:15	11:15				

ROUTE NO.			III (Major Road to/from West)									
ROAD NAME			K.H. Hasyim Asyhai - Kyai Tapa - Daan Mogot									
SECTION			DISTANCE	TRAVEL TIME				TRAVEL SPEED (km/h)				
NO	CHECKPOINT NAME	CHECKPOINT NAME	(km)	WEEKDAY			HOLIDAY	WEEKDAY			HOLIDAY	
				MORNING	DAYTIME	EVENING	DAYTIME	MORNING	DAYTIME	EVENING	DAYTIME	
0-1	Cajah Mada	Railway (Duri-TN. Abang)	2.0	04:50	07:13	07:30	06:54	24.8	16.6	16.0	17.4	
1-2	Railway (Duri-TN. Abang)	Prof.Dr.Latumeten/S. Parman	1.5	03:10	11:20	10:55	06:37	28.4	7.9	8.2	13.6	
2-3	Prof.Dr.Latumeten/S. Parman	Pangeran Tubagus Angke	2.6	08:20	05:42	04:50	05:39	18.7	27.4	32.3	27.6	
3-4	Pangeran Tubagus Angke	Lingkar Luar (ORR)(Future)	4.5	15:35	09:20	12:45	08:41	17.3	28.9	21.2	31.1	
Total			10.6	31:55	33:35	36:00	27:51	19.9	18.9	17.7	22.8	
TOTAL IDLING TIME				08:35	10:22	11:44	07:54					
4-3	Lingkar Luar (ORR)(Future)	Pangeran Tubagus Angke	4.5	14:59	34:28	13:10	07:28	18.0	7.8	20.5	36.2	
3-2	Pangeran Tubagus Angke	Prof.Dr.Latumeten/S. Parman	2.6	19:23	09:35	30:02	14:13	8.0	16.3	5.2	11.0	
2-1	Prof.Dr.Latumeten/S. Parman	Railway (Duri-TN. Abang)	1.5	02:46	02:05	01:38	03:18	32.5	43.2	55.1	27.3	
1-0	Railway (Duri-TN. Abang)	Cajah Mada	2.0	07:50	04:45	06:17	05:45	15.3	25.3	19.1	20.9	
Total			10.6	44:58	50:53	51:07	30:44	14.1	12.5	12.4	20.7	
TOTAL IDLING TIME				13:56	16:51	21:51	08:57					

ROUTE NO.			IV (Toll Road)									
ROAD NAME			Letjen S. Parman - Jend. Gatot Subroto - Letjen. Haryono- Jalan Tol Jakarta-Cikampek									
SECTION			DISTANCE	TRAVEL TIME				TRAVEL SPEED (km/h)				
NO	CHECKPOINT NAME	CHECKPOINT NAME	(km)	WEEKDAY			HOLIDAY	WEEKDAY			HOLIDAY	
				MORNING	DAYTIME	EVENING	DAYTIME	MORNING	DAYTIME	EVENING	DAYTIME	
0-1	Grogol Flyover	Tomang Flyover	1.7	02:25	05:55	02:30	02:15	42.2	17.2	40.8	45.3	
1-2	Tomang Flyover	Slipi Flyover	2.7	02:15	02:20	02:20	02:15	72.0	69.4	69.4	72.0	
2-3	Slipi Flyover	Semanggi Bridge	2.3	02:15	02:00	02:20	01:50	61.3	69.0	59.1	75.3	
3-4	Semanggi Bridge	Kuningan Flyover	2.5	02:25	02:10	02:40	01:55	62.1	69.2	56.3	78.3	
4-5	Kuningan Flyover	Tebet Flyover	1.9	01:50	01:45	03:45	01:45	62.2	65.1	30.4	65.1	
5-6	Tebet Flyover	Cawang Flyover	2.8	02:30	02:15	02:55	02:20	67.2	74.7	57.6	72.0	
6-7	Cawang Flyover	Pondok Cede	5.1	04:20	04:45	11:35	04:25	70.6	64.4	26.4	69.3	
Total			19.0	18:00	21:10	28:05	16:45	63.3	53.9	40.6	68.1	
TOTAL IDLING TIME				00:05	00:20	01:50	00:30					
7-6	Pondok Cede	Cawang Flyover	5.1	09:25	05:40	08:30	05:10	32.5	54.0	36.0	59.2	
6-5	Cawang Flyover	Tebet Flyover	2.8	07:25	02:30	02:35	02:45	22.7	67.2	65.0	61.1	
5-4	Tebet Flyover	Kuningan Flyover	1.9	03:10	01:45	01:45	01:45	36.0	65.1	65.1	65.1	
4-3	Kuningan Flyover	Semanggi Bridge	2.5	02:25	02:20	02:05	02:00	62.1	64.3	72.0	75.0	
3-2	Semanggi Bridge	Slipi Flyover	2.3	01:45	02:00	12:15	01:45	78.9	69.0	11.3	78.9	
2-1	Slipi Flyover	Tomang Flyover	2.7	02:15	03:15	16:30	02:05	72.0	49.8	9.8	77.8	
1-0	Tomang Flyover	Grogol Flyover	1.7	01:20	01:25	01:30	01:25	76.5	72.0	68.0	72.0	
Total			19.0	27:45	18:55	45:10	16:55	41.1	60.3	25.2	67.4	
TOTAL IDLING TIME				01:10	00:20	09:20	00:10					

ROUTE NO.			V (Minor Roads in Pondok Indah Residential Area)									
ROAD NAME			Kartika Utama - Metro Alam 8 - Gedung Hijau 1 - Niaga Hijau Raya - Duta Niaga Raya - Sekolah Duta 5 - Sekolah Duta Raya - Gedung Hijau Raya									
SECTION			DISTANCE	TRAVEL TIME				TRAVEL SPEED (km/h)				
NO	CHECKPOINT NAME	CHECKPOINT NAME	(km)	WEEKDAY			HOLIDAY	WEEKDAY			HOLIDAY	
				MORNING	DAYTIME	EVENING	DAYTIME	MORNING	DAYTIME	EVENING	DAYTIME	
0-1	Metro Pondok Indah	Gedung Hijau Raya	1.7		03:20		03:50		30.6		26.6	
1-2	Gedung Hijau Raya	Metro Pondok Indah(W->E)	1.4		02:35		02:55		32.5		28.8	
2-3	Metro Pondok Indah(W->E)	Metro Pondok Indah(E->W)	1.4		02:55		02:25		28.8		34.8	
3-4	Metro Pondok Indah(E->W)	Ciputat Raya	1.1		02:00		01:45		33.0		37.7	
Total			5.6	00:00	10:50	00:00	10:55	0.0	31.0	0.0	30.8	
TOTAL IDLING TIME				00:00	00:10	00:00	00:05					

3.3.3 Simple Emission Test

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
L.Bus	Mercedes Benz	2	-	Diesel	-	-1	-1	78	79	72	76.3
L.Bus	Mercedes Benz	5	-	Diesel	-	-1	-1	52	56	52	53.3
L.Bus	Mitsubishi	2	48759	Diesel	7545	-1	-1	31	31	32	31.3
L.Bus	Mitsubishi FUSO	2	37391	Diesel	7545	-1	-1	42	44	46	44
L.Bus	Mercedes Benz	11	-	Diesel	-	-1	-1	64	63	65	64
L.Bus		4	588654	Diesel	6723	-1	-1	43	44	45	44
L.Bus		-	-	Diesel	-	-1	-1	25	30	21	26.3
L.Bus	Mercedes Benz	8	-	Diesel	-	-1	-1	61	62	57	60
L.Bus	Hino	6	80871	Diesel	6728	-1	-1	45	46	44	45.3
L.Bus		1	41837	Diesel	6728	-1	-1	17	10	14	13.7
L.Bus	Mercedes Benz O306	8	-	Diesel	5675	-1	-1	42	40	46	42.7
L.Bus	Mercedes Benz	10	-	Diesel	5675	-1	-1	33	35	36	34.7
L.Bus	Mercedes Benz	-	213906	Diesel	-	-1	-1	50	54	54	52.7
L.Bus	Mercedes Benz	0	125	Diesel	-	-1	-1	18	12	18	16
L.Bus	HINO	-	124086	Diesel	-	-1	-1	8	16	22	15.3
L.Bus	Mercedes Benz	3	358750	Diesel	-	-1	-1	5	8	10	7.7
L.Bus	Mercedes Benz	2	419251	Diesel	-	-1	-1	25	21	23	23
L.Bus	Mercedes Benz O305	8	84106	Diesel	5675	-1	-1	54	50	52	52
L.Bus	Hino	8	140807	Diesel	6728	-1	-1	34	20	18	24
L.Bus	Mercedes Benz	4	-	Diesel	5958	-1	-1	50	36	8	31.3
L.Bus	Hino	-	378270	Diesel	-	-1	-1	26	26	28	26.7
L.Bus	Hino	10	28449	Diesel	-	-1	-1	0	14	0	4.7
L.Bus	Mercedes Benz	1	10899	Diesel	-	-1	-1	20	23	18	20.3
L.Bus	Mercedes Benz	3	8771	Diesel	-	-1	-1	17	21	22	20
L.Bus		2	9881	Diesel	-	-1	-1	35	24	43	34
L.Bus	Mercedes Benz	-	8450	Diesel	-	-1	-1	36	37	46	39.7
L.Bus	Mercedes Benz	16	-	Diesel	5675	-1	-1	70	58	54	60.7
27										27	7

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
S.Bus	Toyota KIJANG	5	864166	Gasoline	1300	3.1	3000	-3	0	0	-1
S.Bus	Toyota KIJANG	5	734781	Gasoline	1400	0.07	1582	-3	0	0	-1
S.Bus	Toyota KIJANG	5	864340	Gasoline	1400	4.81	1222	-3	0	0	-1
S.Bus		1	28564	Diesel	3298	-1	-1	12	10	12	11.3
S.Bus	Isuzu Mini	3	482	Diesel	2238	-1	-1	58	52	48	52.7
S.Bus	Isuzu Metro Mini	17	-	Diesel	2369	-1	-1	51	49	42	47.3
S.Bus		12	-	Diesel	2188	-1	-1	62	50	57	56.3
S.Bus	Isuzu Metro Mini	15	-	Diesel	-	-1	-1	48	50	51	49.7
S.Bus		7	-	Diesel	3298	-1	-1	72	69	65	68.7
S.Bus	Isuzu TL	1	59792	Diesel	2300	-1	-1	60	60	58	59.3
S.Bus		-	-	Diesel	-	-1	-1	51	43	50	48
S.Bus	Isuzu	2	-	Diesel	2230	-1	-1	72	62	66	66.7
S.Bus	Isuzu Metro Mini	18	-	Diesel	2775	-1	-1	42	40	46	42.7
S.Bus		-	30138	Diesel	3290	-1	-1	32	28	30	30
S.Bus		4	-	Diesel	3268	-1	-1	60	50	58	56
S.Bus	Isuzu Metro Mini	4	-	Diesel	3268	-1	-1	40	33	36	36.3
S.Bus	Isuzu Metro Mini	0	63	Diesel	3635	-1	-1	25	20	25	23.3
S.Bus	Mitsubishi	-	426702	Diesel	3000	-1	-1	46	42	36	41.3
S.Bus	Isuzu Metro Mini	4	6867	Diesel	3268	-1	-1	36	36	45	39
S.Bus	Isuzu Metro Mini	14	-	Diesel	2775	-1	-1	56	60	51	55.7
S.Bus	Toyota HIACE	18	47228	Gasoline	1600	0.11	1370	-3	0	0	-1
S.Bus	Daihatsu	15	223706	Diesel	2540	-1	-1	34	30	12	25.3
S.Bus	Toyota KIJANG	6	52991	Gasoline	1486	0.41	974	-3	0	0	-1
S.Bus	Toyota KIJANG	5	64327	Gasoline	1486	3.64	1240	-3	0	0	-1
S.Bus	Toyota KIJANG	5	-	Gasoline	1486	8.62	768	-3	0	0	-1
S.Bus		1	61277	Gasoline	1589	0.47	598	-3	0	0	-1
S.Bus	Toyota Kijang	7	22238	Gasoline	1486	7.2	1660	-3	0	0	-1
S.Bus	Isuzu Metro Mini	1	8158	Diesel	2238	-1	-1	36	40	30	35.3
S.Bus	Mitsubishi T120 SS	1	8698	Gasoline	1343	3.1	438	-3	0	0	-1
S.Bus	Toyota KIJANG	4	90143	Gasoline	1486	3.74	1100	-3	0	0	-1
S.Bus	Toyota Kijang	6	22355	Gasoline	1486	2.06	720	-3	0	0	-1
S.Bus	Mitsubishi COLT	3	-	Diesel	3298	-1	-1	44	32	32	36
S.Bus	Isuzu Kopamilet	1	40403	Diesel	3268	-1	-1	58	66	56	60
S.Bus	Toyota	12	79647	Gasoline	2188	-1	-1	70	67	66	67.7
S.Bus	Isuzu (Kopaja)	11	-	Diesel	3268	-1	-1	28	25	28	27
S.Bus	Isuzu (Kopaja)	10	-	Diesel	3268	-1	-1	36	29	33	32.7
S.Bus	Mitsubishi COLT	9	-	Diesel	-	-1	-1	30	30	32	30.7
S.Bus	Mitsubishi COLT	7	-	Diesel	3298	-1	-1	83	72	66	73.7
S.Bus	Isuzu Metro Mini	5	-	Diesel	3268	-1	-1	45	40	41	42
S.Bus	Toyota KIJANG	5	10735	Gasoline	1466	1.43	3400	-3	0	0	-1
S.Bus	Mitsubishi COLT	1	87767	Diesel	-	-1	-1	42	43	41	42
S.Bus	Isuzu Metro Mini	1	414343	Diesel	3298	-1	-1	61	54	37	50.7
S.Bus	Isuzu Metro Mini	7	-	Diesel	2775	-1	-1	60	56	60	58.7
S.Bus	Toyota KIJANG	1	74496	Gasoline	1600	8.1	1934	-3	0	0	-1
S.Bus	Toyota KIJANG	2	72858	Gasoline	1486	6.7	636	-3	0	0	-1
S.Bus	Toyota KIJANG	2	98773	Gasoline	1486	0.06	3010	-3	0	0	-1
S.Bus	Toyota KIJANG	4	78551	Gasoline	1486	2.16	1220	-3	0	0	-1
S.Bus	Toyota KIJANG	2	58664	Gasoline	1486	0.49	2520	-3	0	0	-1
S.Bus	Toyota KIJANG	5	13075	Gasoline	1486	0.13	2330	-3	0	0	-1
S.Bus	Toyota KIJANG	3	36493	Gasoline	1486	5.1	1400	-3	0	0	-1
S.Bus	Toyota KIJANG	5	-	Gasoline	1486	5.94	1360	-3	0	0	-1
S.Bus	Toyota KIJANG	4	-	Gasoline	1486	0.03	4010	-3	0	0	-1
S.Bus	Daihatsu	7	-	Gasoline	993	5.71	1046	-3	0	0	-1
S.Bus	Isuzu Metro Mini	15	-	Diesel	2775	-1	-1	54	52	54	53.3

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
S.Bus	Isuzu Metro Mini	8	371204	Diesel	3298	-1	-1	40	34	36	36.7
S.Bus	Toyota KIJANG	1	22460	Gasoline	1456	6.99	948	-3	0	0	-1
S.Bus	Isuzu Metro Mini	10	-	Diesel	3268	-1	-1	24	32	34	30
S.Bus	Isuzu Metro Mini	9	-	Diesel	3268	-1	-1	57	33	47	45.7
S.Bus	Isuzu Metro Mini	10	-	Diesel	3268	-1	-1	52	59	70	60.3
S.Bus	Isuzu Metro Mini	15	-	Diesel	2977	-1	-1	18	2	6	8.7
S.Bus	Mitsubishi COLT	1	12239	Diesel	3298	-1	-1	26	27	38	30.3
S.Bus	Mitsubishi COLT	0	2767	Diesel	3298	-1	-1	34	25	30	29.7
S.Bus	Toyota KIJANG	4	-	Gasoline	1486	0.13	1338	-3	0	0	-1
S.Bus	Isuzu Metro Mini	5	-	Diesel	2530	-1	-1	56	44	44	48
S.Bus	Isuzu Metro Mini	-	-	Diesel	2530	-1	-1	31	30	33	31.3
S.Bus	Isuzu Metro Mini	-	-	Diesel	2530	-1	-1	31	32	37	33.3
S.Bus	Isuzu Metro Mini	15	-	Diesel	2775	-1	-1	36	32	36	34.7
S.Bus	Isuzu Metro Mini	-	-	Diesel	2530	-1	-1	51	44	52	49
S.Bus	Isuzu Metro Mini	4	-	Diesel	3268	-1	-1	54	49	52	51.7
S.Bus	Isuzu Metro Mini	14	-	Diesel	2775	-1	-1	58	47	46	50.3
S.Bus	Isuzu Metro Mini	5	-	Diesel	3268	-1	-1	37	41	37	38.3
71					25	9	16	25		46	16

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>2400	1	2	3	>50
MC	Bajaj	-	-		-	4.84	6000	-3	0	0	-1
MC	Suzuki SEPEDA MOTOR	5	57305		110	4.08	14833	-3	0	0	-1
MC	Bemo	-	557961		150	5.79	11200	-3	0	0	-1
MC	Bajaj	19	-		150	5.04	11530	-3	0	0	-1
MC	Bajaj	18	-		150	5.89	19760	-3	0	0	-1
MC	Bajaj	18	-		150	4.65	12530	-3	0	0	-1
MC	Bajaj	19	-		150	2.77	5640	-3	0	0	-1
MC	Bajaj	19	-		150	5.77	15070	-3	0	0	-1
MC	Bajaj	14	-		150	4.1	6700	-3	0	0	-1
MC	Bajaj	20	-		150	4.84	8240	-3	0	0	-1
MC	Bajaj	18	-		150	5.01	19270	-3	0	0	-1
MC	Honda, Astra	27	-	Gasoline	90	8.16	11500	-3	0	0	-1
MC	Honda	11	-	Gasoline	100	8.7	2450	-3	0	0	-1
MC	Suzuki	0	-	Gas+	50	5	6130	-3	0	0	-1
MC	Honda, Astra	1	-	Gasoline	50	0.4	580	-3	0	0	-1
MC	Honda	0	-	Gasoline	50	0.7	204	-3	0	0	-1
MC	Honda	16	-	Gasoline	100	2.96	372	-3	0	0	-1
MC	Honda	3	-	Gasoline	50	0.99	238	-3	0	0	-1
MC	Vespa	14	-	Gas+	150	2.57	5750	-3	0	0	-1
MC	Vespa	1	-	Gas+	150	4.11	11600	-3	0	0	-1
MC	Honda	14	-	Gasoline	50	4.14	7660	-3	0	0	-1
MC	Suzuki	0	-	Gas+	50	0.11	6030	-3	0	0	-1
22					22	11	18	22			

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
Pass	Daihatsu HIJNE	2	65300	Diesel		-1	-1	34	38	50	40.7
Pass	Toyota KIJANG	4	-	Gasoline	1500	9.3	1016	-3	0	0	-1
Pass	Daihatsu HIJNE	3	38852	Diesel	2765	-1	-1	46	50	52	49.3
Pass	Toyota KIJANG	-	46445	Gasoline	1500	8.87	1522	-3	0	0	-1
Pass	Suzuki FUTRA	3	97584	Gasoline	1300	8.37	1940	-3	0	0	-1
Pass	Toyota KIJANG	1	44698	Gasoline	1500	10.11	808	-3	0	0	-1
Pass	Toyota CORONA	6	59941	Gasoline	2000	0.75	594	-3	0	0	-1
Pass	Toyota KIJANG	1	58787	Gasoline	2500	11.5	796	-3	0	0	-1
Pass	Toyota	3	53006	Gasoline	1000	1.25	318	-3	0	0	-1
Pass	Toyota KIJANG	5	21466	Gasoline	2500	8.5	1388	-3	0	0	-1
Pass	Toyota CORONA	7	21941	Gasoline	1800	0.14	590	-3	0	0	-1
Pass	Holden GEMINI	8	48816	Diesel	1600	-1	-1	36	40	14	30
Pass	Peugeot 405SR	1	38908	Gasoline	1905	2.65	312	-3	0	0	-1
Pass	Isuzu PANTHER	2	52224	Diesel	2250	-1	-1	26	28	32	28.7
Pass	Toyota KIJANG	2	96555	Gasoline	1600	6.49	1100	-3	0	0	-1
Pass	Isuzu PANTHER	1	24523	Diesel	2250	-1	-1	12	21	24	19
Pass		-	-	Gasoline	-	9.7	1338	-3	0	0	-1
Pass	Nissan SUNNY	5	321700	Gasoline	1300	6.57	522	-3	0	0	-1
Pass	Toyota KIJANG	2	191463	Gasoline	1456	6.37	770	-3	0	0	-1
Pass	Toyota KIJANG	15	718408	Gasoline	1300	1.84	606	-3	0	0	-1
Pass	Mazda HARTGE	9	148550	Gasoline	1500	4.79	1168	-3	0	0	-1
Pass	Ford Laser	0	4800	Gasoline	1300	4.07	434	-3	0	0	-1
Pass	Ford Laser	7	71623	Gasoline	1300	7.44	606	-3	0	0	-1
Pass	Ford Laser	7	74456	Gasoline	1300	10.37	1520	-3	0	0	-1
Pass	Ford Laser	7	75094	Gasoline	1300	4.01	374	-3	0	0	-1
Pass	Ford Laser	7	72525	Gasoline	1300	5.02	936	-3	0	0	-1
Pass	Ford Laser	7	57431	Gasoline	1300	1.95	454	-3	0	0	-1
Pass	Ford Laser	7	63777	Gasoline	1300	6.94	1078	-3	0	0	-1
Pass	Holden Gemini	4	60294	Diesel	1471	-1	-1	73	74	67	71.3
Pass	Ford Laser	7	69949	Gasoline	1300	11.85	2320	-3	0	0	-1
Pass	Ford Laser	7	5142	Gasoline	1300	0.22	318	-3	0	0	-1
Pass	Ford Laser	7	68845	Gasoline	1300	8.98	960	-3	0	0	-1
Pass	Ford Laser	7	72206	Gasoline	1300	8.11	1192	-3	0	0	-1
Pass	Ford Laser	7	76924	Gasoline	1300	6.3	406	-3	0	0	-1
Pass	Holden Gemni	6	601976	Diesel	1600	-1	-1	64	65	47	58.7
Pass	Ford Laser	7	81724	Gasoline	1300	4.03	556	-3	0	0	-1
Pass	Frod Laser	7	783596	Gasoline	1300	0.07	952	-3	0	0	-1
Pass	Ford Laser	7	71460	Gasoline	1300	0.33	368	-3	0	0	-1
Pass	Ford Laser	7	729131	Gasoline	1300	8.72	610	-3	0	0	-1

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
Pass	Ford Laser	7	75359	Gasoline	1300	6.71	658	-3	0	0	-1
Pass	Ford Laser	7	79649	Gasoline	1300	7.06	940	-3	0	0	-1
Pass	Ford Laser	7	67607	Gasoline	1300	0.35	317	-3	0	0	-1
Pass	Ford Laser	7	64493	Gasoline	1300	1.81	374	-3	0	0	-1
Pass	Ford Laser	7	74310	Gasoline	1300	4.1	664	-3	0	0	-1
Pass	Toyota KIANG	2	43729	Gasoline	1500	1.02	772	-3	0	0	-1
Pass	Ford Laser	7	74402	Gasoline	1300	7.12	1294	-3	0	0	-1
Pass	Ford Laser	2	26909	Gasoline	1300	6.58	450	-3	0	0	-1
Pass	Ford Laser	2	27217	Gasoline	1300	9.05	390	-3	0	0	-1
Pass	Ford Laser	2	29198	Gasoline	1300	2.69	422	-3	0	0	-1
Pass	Ford Laser	2	27962	Gasoline	1300	4.19	312	-3	0	0	-1
Pass	Ford Laser	2	27095	Gasoline	1300	5.09	558	-3	0	0	-1
Pass	Ford Laser	2	27517	Gasoline	1300	5	378	-3	0	0	-1
Pass	Ford Laser	2	26329	Gasoline	1300	0.1	454	-3	0	0	-1
Pass	Ford Laser	3	28220	Gasoline	1300	4.37	480	-3	0	0	-1
Pass	Ford Laser	2	27500	Gasoline	1300	7.75	696	-3	0	0	-1
Pass	Ford Laser	2	28504	Gasoline	1300	10.77	872	-3	0	0	-1
Pass	Ford Laser	2	27284	Gasoline	1300	2.59	538	-3	0	0	-1
Pass	Ford Laser	2	28887	Gasoline	1300	4.53	526	-3	0	0	-1
Pass	Ford Laser	2	27873	Gasoline	1300	1.9	582	-3	0	0	-1
Pass	Ford Laser	2	27538	Gasoline	1300	11.2	1210	-3	0	0	-1
Pass	Ford Laser	2	28116	Gasoline	1300	3.16	546	-3	0	0	-1
Pass	Ford Laser	2	28151	Gasoline	1300	5.59	894	-3	0	0	-1
Pass	Ford Laser	2	54135	Gasoline	1300	0.04	304	-3	0	0	-1
Pass	Ford Laser	2	29735	Gasoline	1300	2.9	528	-3	0	0	-1
Pass	Ford Laser	2	28885	Gasoline	1300	7.19	468	-3	0	0	-1
Pass	Ford Laser	2	27483	Gasoline	1300	11.11	1054	-3	0	0	-1
Pass	Ford Laser	2	22293	Gasoline	1300	2.41	428	-3	0	0	-1
Pass	Ford Laser	2	26800	Gasoline	1300	11.02	994	-3	0	0	-1
Pass	Ford Laser	2	27142	Gasoline	1300	5.81	740	-3	0	0	-1
Pass	Ford Laser	2	28964	Gasoline	1300	3.93	506	-3	0	0	-1
Pass	Ford Laser	2	27974	Gasoline	1300	4.83	560	-3	0	0	-1
Pass	Ford Laser	2	27904	Gasoline	1300	0.12	304	-3	0	0	-1
Pass	Ford Laser	2	27667	Gasoline	1300	6.11	626	-3	0	0	-1
Pass	Ford Laser	5	46325	Gasoline	1300	9.79	1308	-3	0	0	-1
Pass	Ford Laser	2	27149	Gasoline	1300	5.6	546	-3	0	0	-1
Pass	Ford Laser	5	46608	Gasoline	1300	5.44	596	-3	0	0	-1
Pass	Ford Laser	2	26530	Gasoline	1300	0.88	526	-3	0	0	-1
Pass	Opel KADET	6	46808	Gasoline	1300	0.09	1424	-3	0	0	-1
78					71	40	10	71		7	2

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
L.Truck	Nissan CKA	1	259795	Diesel	5660	-1	-1	4	2	8	4.7
L.Truck	Merci 917	6	303812	Diesel	5958	-1	-1	6	34	26	22
L.Truck	Isuzu CX2	1	780988	Diesel	10000	-1	-1	28	30	28	28.7
L.Truck	Hino FF	1	266763	Diesel	5000	-1	-1	37	28	25	30
L.Truck	Nissan CKA	2	701306	Diesel	5600	-1	-1	16	18	24	19.3
L.Truck	Mitsubishi Fuso	14	345435	Diesel	6557	-1	-1	18	28	37	27.7
L.Truck	Hino FF	3	167989	Diesel	7000	-1	-1	45	22	28	31.7
L.Truck	Merci 917	8	56453	Diesel	5675	-1	-1	60	86	56	67.3
L.Truck	Merci 917	20	160955	Diesel	5675	-1	-1	44	30	29	34.3
L.Truck	Nissan CKA	1	92874	Diesel	7000	-1	-1	50	54	46	50
L.Truck	Hino FF	1	77962	Diesel	5675	-1	-1	46	46	52	48
L.Truck	Mercedez Benz 917	17	9856	Diesel	5613	-1	-1	50	54	53	52.3
L.Truck	Mitsubishi FUSO	16	85670	Diesel	6557	-1	-1	27	42	44	37.7
L.Truck	Hino FF	1	43043	Diesel	7412	-1	-1	12	13	11	12
L.Truck	Hino FF	1	43095	Diesel	7412	-1	-1	16	17	6	13
L.Truck	Nissan CKA	1	97326	Diesel	7000	-1	-1	19	18	20	19
L.Truck	SCANIA	0	4767	Diesel	10000	-1	-1	38	38	38	38
L.Truck	Nissan CKA	2	60271	Diesel	7412	-1	-1	28	25	25	26
L.Truck	Mitsubishi FUSO	3	87119	Diesel	5500	-1	-1	60	50	36	48.7
19										19	2

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
S.Truck	Isuzu TL	4	88072	Diesel	1950	-1	-1	4	14	4	7.3
S.Truck	Isuzu Panther	2	119657	Diesel	1900	-1	-1	8	14	14	12
S.Truck	Mitsubishi FE	0	67291	Diesel	2300	-1	-1	42	0	8	16.7
S.Truck	Mitsubishi FE	2	84625	Diesel	2300	-1	-1	22	54	32	36
S.Truck	Isuzu TL	1	4331	Diesel	2300	-1	-1	66	32	24	40.7
S.Truck	Delta	1	206916	Diesel	2765	-1	-1	44	36	60	46.7
S.Truck	Mitsubishi	1	59634	Diesel	1500	-1	-1	88	60	34	60.7
S.Truck	Mitsubishi	3	64936	Diesel	2477	-1	-1	82	22	56	53.3
S.Truck	Mitsubishi FE T120	2	38804	Diesel	3907	-1	-1	26	10	2	12.7
S.Truck	Toyota Dyna	4	55123	Diesel	3660	-1	-1	2	0	0	0.7
S.Truck	Mitsubishi Fuso	6	142155	Diesel	3500	-1	-1	0	10	12	7.3
S.Truck	Mitsubishi FE	13	35905	Diesel	2500	-1	-1	20	33	12	21.7
S.Truck	Mitsubishi	0	22354	Diesel	2477	-1	-1	12	10	10	10.7
S.Truck	Toyota Kijang	3	22048	Gasoline	1486	3.26	690	-3	0	0	-1
S.Truck	Isuzu Panther	0	13673	Diesel	2477	-1	-1	14	18	12	14.7
S.Truck	Toyota Kijang	2	8444	Gasoline	1486	3.78	520	-3	0	0	-1
S.Truck	Mitsubishi	1	25929	Diesel	2477	-1	-1	3	9	17	9.7
S.Truck	Toyota Kijang	5	45598	Gasoline	1486	0.26	360	-3	0	0	-1
S.Truck	Isuzu TL	4	53911	Diesel	2300	-1	-1	19	12	28	19.7
S.Truck	Mitsubishi	2	50166	Diesel	2500	-1	-1	14	0	4	6

Type	Model Name	Age	Km	Fuel	Capacity	CO	HC	Smoke			
						>4.5	>1200	1	2	3	>50
S.Truck	Mitsubishi FE	3	58526	Diesel	3298	-1	-1	10	23	5	12.3
S.Truck	Toyota Dyna	10	273452	Diesel	3431	-1	-1	4	8	2	4.7
S.Truck	Toyota Kijang	6	74515	Gasoline	1500	3.08	780	-3	0	0	-1
S.Truck	Isuzu Panther	0	17637	Diesel	2477	-1	-1	11	26	24	20.3
S.Truck	Mitsubishi FE	2	11605	Diesel	3907	-1	-1	4	0	2	2
S.Truck	Toyota Kijang	5	10358	Gasoline	1486	2.68	7420	-3	0	0	-1
S.Truck	Isuzu Panther	0	637	Diesel	2238	-1	-1	16	12	14	14
S.Truck	Mitsubishi	1	20297	Diesel	2477	-1	-1	3	3	8	4.7
S.Truck	Mitsubishi	5	94657	Diesel	2477	-1	-1	14	18	12	14.7
S.Truck	Toyota Kijang	1	12726	Gasoline	1456	5.45	618	-3	0	0	-1
S.Truck	Toyota Kijang	7	80245	Gasoline	1486	5.3	5690	-3	0	0	-1
S.Truck	Toyota Kijang	0	5392	Gasoline	1486	9	844	-3	0	0	-1
S.Truck	Toyota Kijang	5	83769	Gasoline	1486	0.79	1008	-3	0	0	-1
S.Truck	Suzuki Cary	0	3997	Diesel	1300	6.2	502	-3	0	0	-1
S.Truck	Suzuki Cary	11	95291	Gasoline	1000	8.98	1270	-3	0	0	-1
S.Truck	Daihatsu Zebra	0	6704	Gasoline	1300	8.66	1000	-3	0	0	-1
S.Truck	Toyota Kijang	5	9931	Gasoline	1486	2	666	-3	0	0	-1
S.Truck	Daihatsu Zebra	2	9537	Gasoline	1300	0.23	590	-3	0	0	-1
S.Truck	Daihatsu Zebra	5	5625	Gasoline	1300	3.14	386	-3	0	0	-1
S.Truck	Daihatsu Zebra	5	2802	Gasoline	1300	13.9	1420	-3	0	0	-1
S.Truck	Toyota Kijang	11	42369	Gasoline	1500	0.25	316	-3	0	0	-1
S.Truck	Mitsubishi T120SS	4	84503	Gasoline	1200	0.91	468	-3	0	0	-1
S.Truck	Toyota Kijang	13	47999	Gasoline	1166	8.39	810	-3	0	0	-1
S.Truck	Daihatsu Zebra	0	71	Gasoline	1300	0.7	650	-3	0	0	-1
S.Truck	Toyota Thiac	13	819633	Diesel	2158	-1	-1	46	64	56	55.3
S.Truck	Mitsubishi T120 SS	1	24669	Gasoline	1200	15.66	1080	-3	0	0	-1
S.Truck	Mitsubishi FE	14	274396	Diesel	3298	-1	-1	28	44	46	39.3
S.Truck	Mitsubishi	10	38121	Gasoline	1597	10.72	1760	-3	0	0	-1
S.Truck	Mitsubishi FE	1	13508	Diesel	3500	-1	-1	26	32	30	29.3
S.Truck	ZEBRA	7	44545	Gasoline	1000	3.35	1200	-3	0	0	-1
S.Truck	ZEBRA	1	3923	Gasoline	1300	5.91	1184	-3	0	0	-1
S.Truck	Mitsubishi FE	6	262672	Diesel	3298	-1	-1	62	62	60	61.3
S.Truck	Mitsubishi FE	2	36407	Diesel	3298	-1	-1	32	38	42	37.3
S.Truck	DELTA	1	12656	Diesel	2765	-1	-1	24	33	29	28.7
S.Truck	Toyota DYNA	4	4494	Diesel	3660	-1	-1	40	28	34	34
S.Truck	Mitsubishi FE	8	87396	Diesel	3298	-1	-1	54	50	44	49.3
S.Truck	DELTA	1	46642	Diesel	2765	-1	-1	29	27	27	27.7
S.Truck	Mitsubishi L300	1	35243	Diesel	2477	-1	-1	33	19	34	28.7
S.Truck	Mitsubishi L300	0	1530	Diesel	3298	-1	-1	30	28	30	29.3
S.Truck	DELTA	11	60827	Diesel	2765	-1	-1	24	19	18	20.3
60					24	11	5	24		36	4

3.3.4 Details of Estimate of pollutants from Major Road Traffic

Air pollutant load from automobiles was in estimated in detail for major roads.

(1) Major Road Network

Major road network was determined from the maps listed below. The maps are more accurate in the DKI Jakarta area.

- Falk Plan JAKARTA Street Atlas, 10th Edition '1993/94, 1/15,000
- JABOTABEK, C.V. INDO BUWANA, 1995, 1/70,000
- KABUPATEN DATI II BOGOR, PT FITRATAMA SEMPANA, 1/100,000
- KABUPATEN BEKASI, C.V. PRADIKA, 1/72,500
- KABUPATEN DATI II TANGERANG, C.V. PRADIKA, 1/60,000

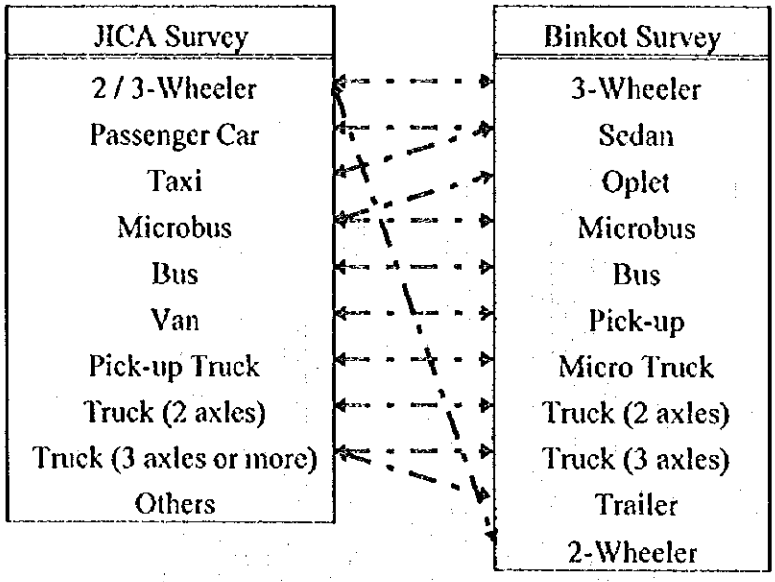
(2) Traffic Volume

The traffic count data of this Study, namely 50 points on weekdays and 10 points on holidays, and Binkot data at 110 points on weekdays were used. Comparison of contents of each survey is shown in Table 1 and Table 2.

Table 1 Comparison between JICA Survey and Binkot Survey

Contents	JICA Survey		Binkot Survey
Points	10 points in holidays (Major Road)	50 points on weekdays (Major & Minor Road)	110 points on Weekdays (Major Road)
Time	24 Hours	16 hours: 40 points 24 hours: 10 points	24 hours
Year	1995	1995	1993
Vehicle types	10 types	10 types	11 types

Table 2 Comparison of Vehicle Types in JICA Survey and Binkot Survey



Based on the analysis of JICA and Binkot data, traffic volume data for each hour and 10 vehicle types on a weekday and on a holiday in 1995 were estimated for 50 JICA survey points and 110 Binkot survey points. Traffic volume data during the nighttime (from 22:00 to 6:00) were estimated for 16 hours survey points of JICA study to obtain 24-hour traffic data on weekdays. Then, 24-hour traffic data on holidays were estimated according to holiday/weekday ratio. 24-hour traffic data of Binkot survey were converted to 10 vehicle types of JICA study in the year 1995. Then, 24-hour traffic data on holidays were estimated according to holiday/weekday ratio.

1) Correction by Year

The Binkot traffic data of year 1993 were converted to the ones of year 1995 using a factor of 1.268, which is the increasing factor from 1993 to 1995 based on the DKI Jakarta related traffic data of Jasa Marga.

2) Taxi Fraction

The conversion from 11 vehicle types of Binkot to 10 vehicle types of JICA is based on Table 2. The "Sedan" type of Binkot is divided into "Passenger car" and "Taxi" of JICA with the taxi fraction derived from the analysis of 16-hour data of JICA survey at 40 points. The taxi fraction, Taxi/(Taxi + Passenger Car), is 0.161.

3) Hourly Traffic Volume during the Nighttime

Hourly fraction by areas and road types during the nighttime is obtained from the analysis of 24-hour survey points, 10 points of JICA survey and 110 points of Binkot as shown in Table 3. Road types are major road, toll road, and minor road. Areas are considered for major roads.

Table 3 Hourly Fraction during Nighttime

Road Type & Area	Hourly Fraction during Nighttime (Daily Total=1)							
	23:00	24:00	1:00	2:00	3:00	4:00	5:00	6:00
Major Road								
Jakarta Selatan	0.028	0.020	0.010	0.007	0.005	0.005	0.007	0.018
Jakarta Timur	0.024	0.016	0.012	0.007	0.007	0.007	0.010	0.020
Jakarta Pusat	0.027	0.022	0.017	0.010	0.007	0.005	0.004	0.014
Jakarta Barat	0.025	0.018	0.010	0.007	0.006	0.006	0.010	0.020
Jakarta Utara	0.021	0.016	0.010	0.007	0.006	0.005	0.008	0.017
Bogor	0.023	0.020	0.010	0.008	0.007	0.007	0.011	0.023
Tangerang	0.026	0.012	0.007	0.006	0.007	0.008	0.009	0.019
Bekasi	0.033	0.026	0.017	0.010	0.009	0.010	0.015	0.024
Minor Road	0.027	0.017	0.009	0.006	0.004	0.004	0.008	0.021
Toll Road	0.016	0.012	0.007	0.004	0.004	0.003	0.006	0.016

4) Holiday/Weekday Ratio

The holiday/weekday ratios by road types and areas for the daytime and the nighttime were set based on the analysis of the holiday and weekday data at 10 points of JICA study (Table 4).

Table 4 Holiday/Weekday Ratio

Road Types & Areas	Holiday/Weekday Ratio		
	Day	Night	All Day
Toll Road	0.75	1.24	0.78
Jakarta	0.68	0.86	0.69
Botabek	0.89	0.88	0.89

5) Estimate of Traffic Volume to Each Link

The traffic volumes of the JICA and Binkot survey points were to the links including or continuing to the corresponding survey points. The "Traffic Assignmnet Method" was adopted to estimate the traffic volume of links without counting data in the DKI Jakarta area (Appendix 3.3.5), and the traffic volumes in Botabek area were estimated considering the road types and areas.

(3) Emission Factor

Targeted pollutants are CO (Carbon Monooxide), HC (Hydrocarbon), NOx (Nitrogen Oxide), SOx (Sulfur Oxide), and PM(Particulate Matter). Fuel economy of gasoline and diesel vehicles was also analyzed.

The emission factors were set based on the following:

Material 1: "Automobile Emission Factors under Actual Driving Condition", Japan Environment Agency, January 1994 (for CO, HC, NOx excluding Motor-cycle) (Ref. 238)

Material 2: "Report on Emission Condition Study from Uncontrolled Vehicles", Japan Environment Agency, October 1995 (CO, HC, NOx of Motor-cycles) (Ref.239)

Material 3: "Total Emission Control Manual for Nitrogen Oxides (revised)", Japan Environment Agency, August 1993 (for SOx and Fuel Economy) (Ref.217)

Material 4: "Compilation of Air Pollutant Emission Factors, Volume II, Mobile Sources", U.S. Environmental Protection Agency, September 1985 (Ref.240)

1) Emission Factor for CO, HC, and NOx

CO, HC, and NOx emission factors (except for motor cycles) were based on the above material 1. The emission factors in the said material are categorized by engine types and gross vehicle weight. Therefore, it is necessary to set engine type fractions by traffic vehicle type and gross vehicle weight information for the Jabotabek area.

Gasoline/diesel fractions by each traffic vehicle type were based on the country report

presented by S.M. Lubis of Bapedal (Ref. 241) and the sales data from GAIKINDO (Table 4.4.7, Main Volume).

Emission factors and fuel economy of heavy duty vehicles are proportional to gross vehicle weight. The gross vehicle weight by traffic vehicle type was set based on the material 1 and "Japanese Motor Vehicle Guidebook" (Ref.242) (Table 44.8, Main Volume).

Then, the vehicle types of JICA study were linked with the engine types in the mateiral 1 (Table 5), and emission factors by traffic vehicle type were determined considering the gross vehicle weight and the composition of engine types. Six classes of travelling speed were defined as in the material 1. The classes are 5 to 10 km/h, 10 to 15 km/h, 15 to 25 km/h, 25 to 40 km/h, 40 to 60 km/h, and 60 to 80 km/h.

Table 5 Vehicle Types for Traffic and Emission Factor

Traffic Vehicle Type	Gasoline Engine	Diesel Engine
Motor-cycle	-----	-----
Passenger Car	Passenger Car (4 stroke)	Passenger Car (Small/Medium)
Taxi	Passenger Car (4 stroke)	Passenger Car (Small/Medium)
Microbus	Heavy Duty Truck (Over 2.5t)	Heavy Duty Truck (DI*/Below 5.0t)
Bus	Heavy Duty Truck (Over 2.5t)	Heavy Duty Truck (DI*/Over 5.0t)
Van	Light Duty Truck	Medium Duty Truck
Pick-up Truck	Light Duty Truck	Medium Duty Truck
Truck 2 axles	-----	Heavy Duty Truck (DI*/Over 5.0t)
Truck 3 axles	-----	Heavy Duty Truck (DI*/Over 5.0t)

* DI: Direct Injection

Emission factor equations by vehicle speed in each of material 2 were used for motor- cycles (Table 6), and the emission factors were determined for the above mentioned six speed classes. The composition by 2/4 stroke engines and exhaust gas categories were based on the sales data of PASMI (Table 4.4.9, Main Volume).

Table 6 Emission Factor Equation for Motor-cycles

Pollutants	Category	Coefficients			
		A	B	C	D
CO	1	2.51E-03	-2.01E-01	1.21E+01	3.36E+02
	2	3.88E-03	-3.26E-01	1.77E+01	6.99E+01
	3	1.12E-03	-9.05E-02	1.24E+01	1.38E+02
	4	-2.05E-02	1.54E+00	-1.94E+01	2.71E+02
	5	4.89E-03	-3.79E-01	1.76E+01	2.18E+01
	6	0.00E+00	-2.41E-01	1.57E+01	-3.20E+00
	7	0.00E+00	-2.27E-01	1.22E+01	-5.61E+00
HC	1	-6.41E-05	-1.63E-02	1.87E+00	2.58E+01
	2	1.28E-03	-1.80E-01	1.15E+01	1.61E+02
	3	-5.55E-06	-2.40E-02	2.18E+00	1.26E+01
	4	-4.17E-03	3.07E-01	-3.74E+00	1.21E+02
	5	1.20E-03	-1.00E-01	2.95E+00	-1.01E+01
	6	0.00E+00	-8.94E-02	5.29E+00	3.50E+01
	7	0.00E+00	-5.54E-02	2.23E+00	-6.67E+00
NOx	1	-1.15E-05	1.97E-03	1.22E-01	9.29E-01
	2	-5.92E-06	7.48E-04	6.98E-03	1.64E-02
	3	1.33E-04	-1.18E-02	5.21E-01	-2.06E+00
	4	-5.11E-05	4.03E-03	-6.39E-02	4.65E-01
	5	-4.97E-04	3.69E-02	-6.25E-01	4.45E+00
	6	0.00E+00	-4.69E-04	3.47E-02	-1.87E-01
	7	0.00E+00	-1.59E-04	1.19E-01	-4.52E-01

Note: Emission Factor (g/km)=$A*V^2+B*V+C+D/V$, V: Vehicle Speed (km/h)

2) Fuel Economy and SOx Emission Factor

SOx emission factors are derived from fuel economy with sulfur content of the fuels. Sulfur content and specific gravity in Indonesia are given in Table 4.4.10 of the Main Volume. Regression equations by vehicle type for fuel economy in the mateiral 3 were used (Table 7). Vehicle types for traffic and fuel economy are given in Table 8. Engine type composition and gross vehicle weight are the same as in table 4.4.7 and table 4.4.8 of the Main Volume.

Table 7 Fuel Economy Equations by Vehicle Type

Vehicle Types	A	B	C
Light Passenge r Car (4 Stroke)	1.285E-01	-3.768E-03	3.554E-05
Passenger Car (Gasoline)	2.564E-01	-7.639E-03	7.250E-05
Passenger Car (Diesel)	1.264E-01	-2.852E-03	2.661E-05
Passenger Car (LPG)	1.938E-01	-3.833E-03	3.166E-05
Light Duty Truck (4 Stroke)	1.706E-01	-4.325E-03	4.100E-05
Truck & Bus (Diesel/DI)	4.224E-02	-8.094E-04	7.173E-06
Truck & Bus (Diesel/IDI)	1.008E-01	-2.895E-03	2.703E-05
Truck & Bus (Gasoline/Light)	1.713E-01	-4.983E-03	4.618E-05
Truck & Bus (Gasoline/Medium)	1.378E-01	-3.943E-03	3.651E-05
Truck & Bus (Gasoline/Heavy)	2.084E-01	-6.950E-03	6.944E-05

Note: Fuel Economy (liter/km)=$A+B*V+C*V^2$, V: Vehicle Speed (km/h)
DI: Direct Injection, IDI: Indirect Injection

Table 8 Vehcile Types for Traffic and Fuel Economy Equations

Traffic Vehicle Types	Gasoline	Diesel
Motor-cycle	Light Passenger Car(4 stroke)	-----
Passenger Car	Passenger Car	Passenger Car
Taxi	Passenger Car	Passenger Car
Microbus	Heavy Duty Truck & Bus	Truck & Bus (DI)
Bus	Heavy Duty Truck & Bus	Truck & Bus (DI)
Van	Light Duty Truck & Small Bus	Truck & Bus (DI)
Pick-up Truck	Light Duty Truck & Small Bus	Truck & Bus (DI)
Truck 2 axles	-----	Truck & Bus (DI)
Truck 3 axles	-----	Truck & Bus (DI)

3) PM Emision Factor

PM emission factors for particles under 10 micrometer diameter were based on the material 4. The PM emission factors of the material 4 are composed of lead salt, organic/sulfate (Gasoline vehicle), diesel particle (Diesel vehicle), and brake/tire wear. The lead salt portion was obtained from fuel economy and lead content in the fuels, and the lead content of gasoline fuel was set at 0.106 grams/liter. Furthermore, a conversion factor of 0.7474 from lead content in the fuel to emission was used

considering under 10 micrometer fraction, emitted fraction, and conversion ratio from lead to lead salt. Vehicle types for traffic and PM emission factor are given in Table 9.

Table 9 Vehicle Types for Traffic and PM Emission Factors

Traffic Vehicle Types	Gasoline	Diesel
Motor-cycle	Motor Cycle	-----
Passenger Car	Light Duty Gasoline	Light Duty Diesel
Taxi	Light Duty Gasoline	Light Duty Diesel
Microbus	Light Duty Gasoline	Light Duty Diesel
Bus	Heavy Duty Gasoline	Heavy Duty Diesel
Van	Light Duty Gasoline	Light Duty Diesel
Pick-up Truck	Light Duty Gasoline	Light Duty Diesel
Truck 2 axles	-----	Heavy Duty Diesel
Truck 3 axles	-----	Heavy Duty Diesel

4) Compilation of Emision Factors

CO, HC, NOx, SOx, and PM emission factors are compiled in Table 10.

Table 10 Compilation of Emission Factors

CO	5-10	10-15	15-25	25-40	40-60	60-80
MOTOR-CYCLE	19.59	15.59	13.18	11.06	.00	.00
PASSENGER CAR	41.68	26.98	18.71	13.42	10.45	8.87
TAXI	29.11	18.85	13.07	9.38	7.31	6.20
MICROBUS	55.75	40.52	30.31	21.52	14.54	14.36
BUS	33.22	24.46	18.65	13.70	9.79	9.26
VAN	34.91	25.36	19.98	16.53	14.61	13.58
PICK-UP TRUCK	31.41	22.82	17.98	14.87	13.15	12.23
TRUCK 2 AXLES	5.04	3.92	3.22	2.66	2.24	1.89
TRUCK 3 AXLES	10.80	8.40	6.90	5.70	4.80	4.05

HC	5-10	10-15	15-25	25-40	40-60	60-80
MOTOR-CYCLE	8.48	6.07	4.57	3.30	.00	.00
PASSENGER CAR	5.06	3.38	2.44	1.84	1.50	1.32
TAXI	3.58	2.39	1.73	1.31	1.07	.94
MICROBUS	6.50	4.48	3.70	2.70	1.87	1.34
BUS	7.38	5.21	4.08	3.09	2.27	1.84
VAN	7.35	4.21	2.44	1.88	1.56	1.40
PICK-UP TRUCK	6.64	3.81	2.22	1.71	1.42	1.28
TRUCK 2 AXLES	3.50	2.52	1.89	1.47	1.12	.98
TRUCK 3 AXLES	7.50	5.40	4.05	3.15	2.40	2.10

NOx	5-10	10-15	15-25	25-40	40-60	60-80
MOTOR-CYCLE	.09	.08	.09	.10	.00	.00
PASSENGER CAR	2.78	2.77	2.24	2.25	2.22	3.39
TAXI	2.67	2.39	2.00	1.98	1.94	2.72
MICROBUS	4.78	6.69	6.21	5.97	8.06	7.45
BUS	16.79	14.25	11.73	10.00	10.77	10.30
VAN	3.45	3.10	2.95	3.10	3.38	4.40
PICK-UP TRUCK	3.40	3.01	2.83	2.93	3.17	4.09
TRUCK 2 AXLES	11.97	9.10	7.21	5.88	5.67	5.53
TRUCK 3 AXLES	25.65	19.50	15.45	12.60	12.15	11.85

SOx	5-10	10-15	15-25	25-40	40-60	60-80
MOTOR-CYCLE	.02	.01	.01	.01	.00	.01
PASSENGER CAR	.18	.16	.13	.10	.08	.09
TAXI	.28	.25	.21	.16	.13	.15
MICROBUS	.76	.66	.56	.46	.38	.40
BUS	2.75	2.42	2.09	1.76	1.43	1.54
VAN	.13	.12	.10	.07	.06	.07
PICK-UP TRUCK	.31	.27	.23	.19	.16	.17
TRUCK 2 AXLES	2.00	1.76	1.52	1.28	1.04	1.12
TRUCK 3 AXLES	4.50	3.96	3.42	2.88	2.34	2.52

PM	5-10	10-15	15-25	25-40	40-60	60-80
MOTOR-CYCLE	.01	.01	.01	.01	.01	.01
PASSENGER CAR	.17	.17	.17	.16	.16	.16
TAXI	.22	.22	.22	.22	.21	.22
MICRO BUS	.87	.84	.80	.76	.74	.77
BUS	1.40	1.40	1.40	1.40	1.40	1.40
VAN	.17	.17	.17	.16	.16	.16
PICK-UP TRUCK	.27	.27	.27	.27	.27	.27
TRUCK 2 AXLES	1.40	1.40	1.40	1.40	1.40	1.40
TRUCK 3 AXLES	1.40	1.40	1.40	1.40	1.40	1.40

5) Traveling Speed

Because emission factors are function of traveling speed as stated above, traveling speed at each link is necessary for estimating emission factors. Traveling speed was set for each link based on the results of this Study and another JICA study conducted in the past.

This Study investigated five routes while the earlier study had investigated ten routes. The traveling speed on each route investigated was based on the individual result, and the traveling speed at other links was set as given in Table 4.4.12 of the Main Volume.

(4) Estimate of Air Pollutant Emission

Air pollutant emission, fuel consumption, and running kilometers were estimated as given in Table 4.4.13 of the Main Volume.

3.3.5 Traffic Assignment

(1) Outline

Future traffic demands were forecast through the assignment of origin-destination (OD) tables on the road network of each target year. Outline of traffic assignment is shown in **Figure I.1.**

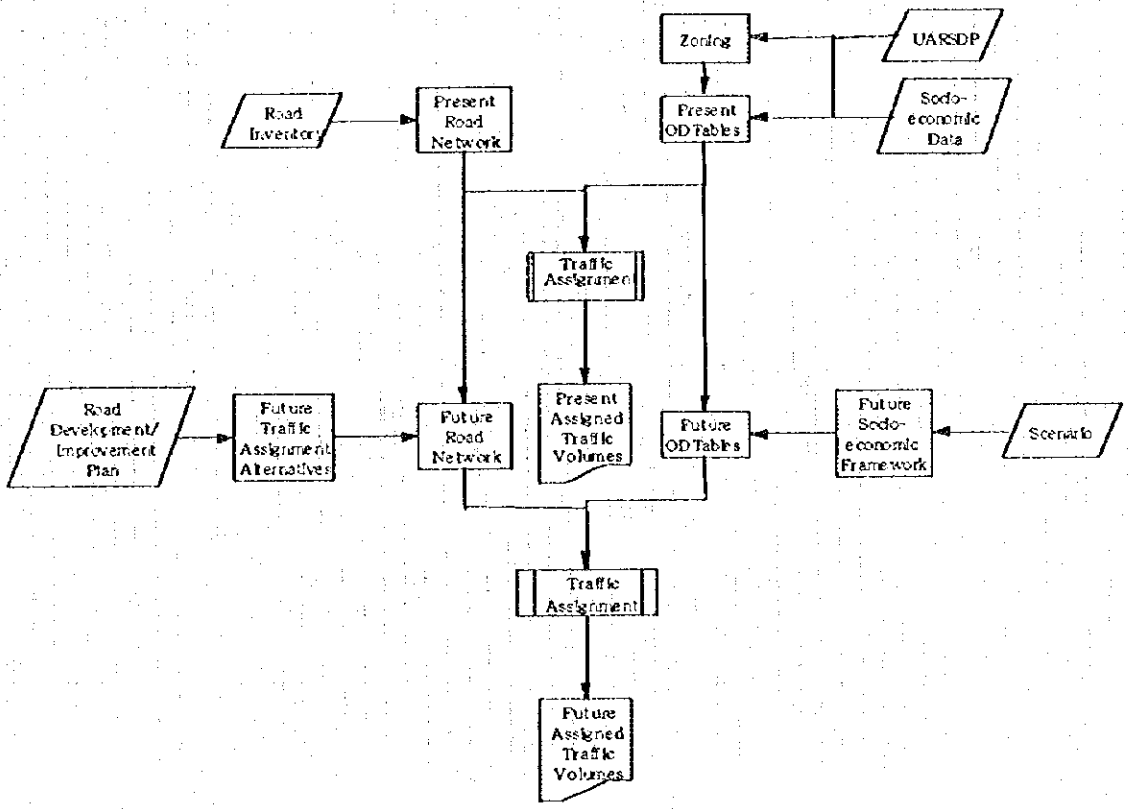


Figure I.1 Outline of Traffic Assignment

(2) Target Year

Base Year : 1995

Target Year : 2000 and 2010

(3) Assignment Procedure

Figure I.2 shows the procedural technique which is based on the capacity restrained assignment as the most straightforward method for a large number of zones in the trip matrices.

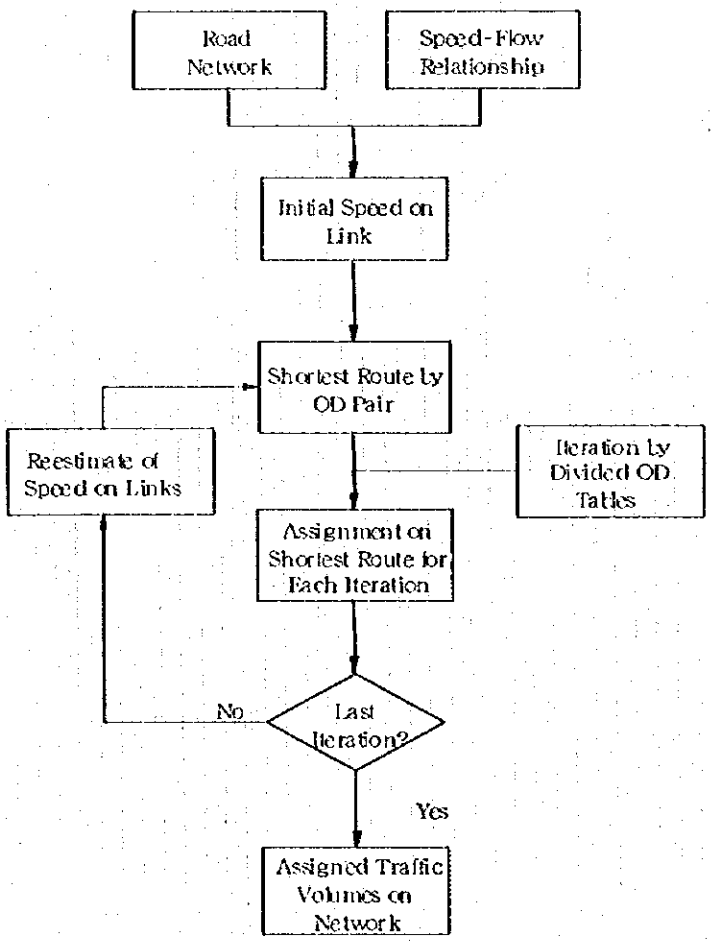


Figure I.2 Traffic Assignment Procedure

(4) Zoning

The Study Area was subdivided into traffic analysis zones. Zoning system was based on "The Feasibility Study on Urban Arterial Road System Development Project in Jakarta Metropolitan Area (UARSDP)". Within DKI, subdivisions were typically based on Kelurahan boundaries, and within Botabek, Kecamatan (Subregency) boundaries. The 131-zone system in UARSDP was grouped into 110 zones considering the number of generation and attraction trips (less than 50,000 pcu/day) and the density of road network. Final zoning system in the Study is shown in **Figure I.3.**

Number of Zones	UARSDP	Study
DKI Jakarta	90 Zones	76 Zones
Botabek	36 Zones	29 Zones
Outside of Jobotabek	5 Zones	5 Zones
Total	131 Zones	110 Zones

(5) Present OD Tables

OD tables in 1995 were developed from the vehicle OD matrices in UARSDP and the expansion factor between 1993 and 1995. Vehicle OD matrices in UARSDP was developed from person trip OD matrices. Expansion factor of 1995/1993 is calculated as the growth rate of the annual traffic volumes on toll roads to/from DKI. Motorized vehicle trips for OD tables were divided into three categories: passenger cars (including motorcycles), trucks, and buses. Since vehicle trips usually represent in pcu (passenger car unit), a passenger car is equivalent to 1.00 pcu, a truck to 2.22 pcu, and a bus to 1.50 pcu. Total generated and attracted trips are presented in **Table I.1.**

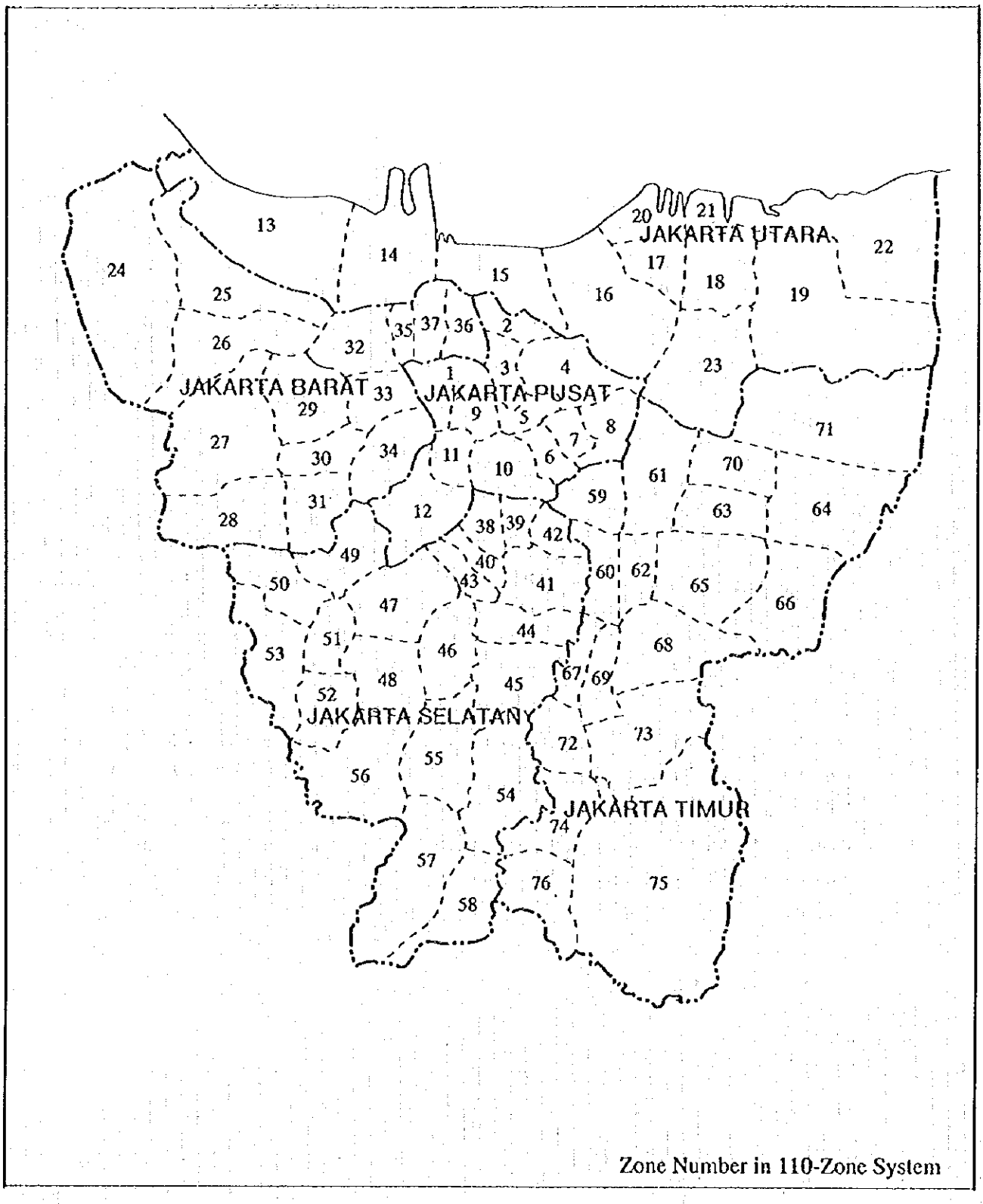


Figure I.3.1 Zoning System (DKI)

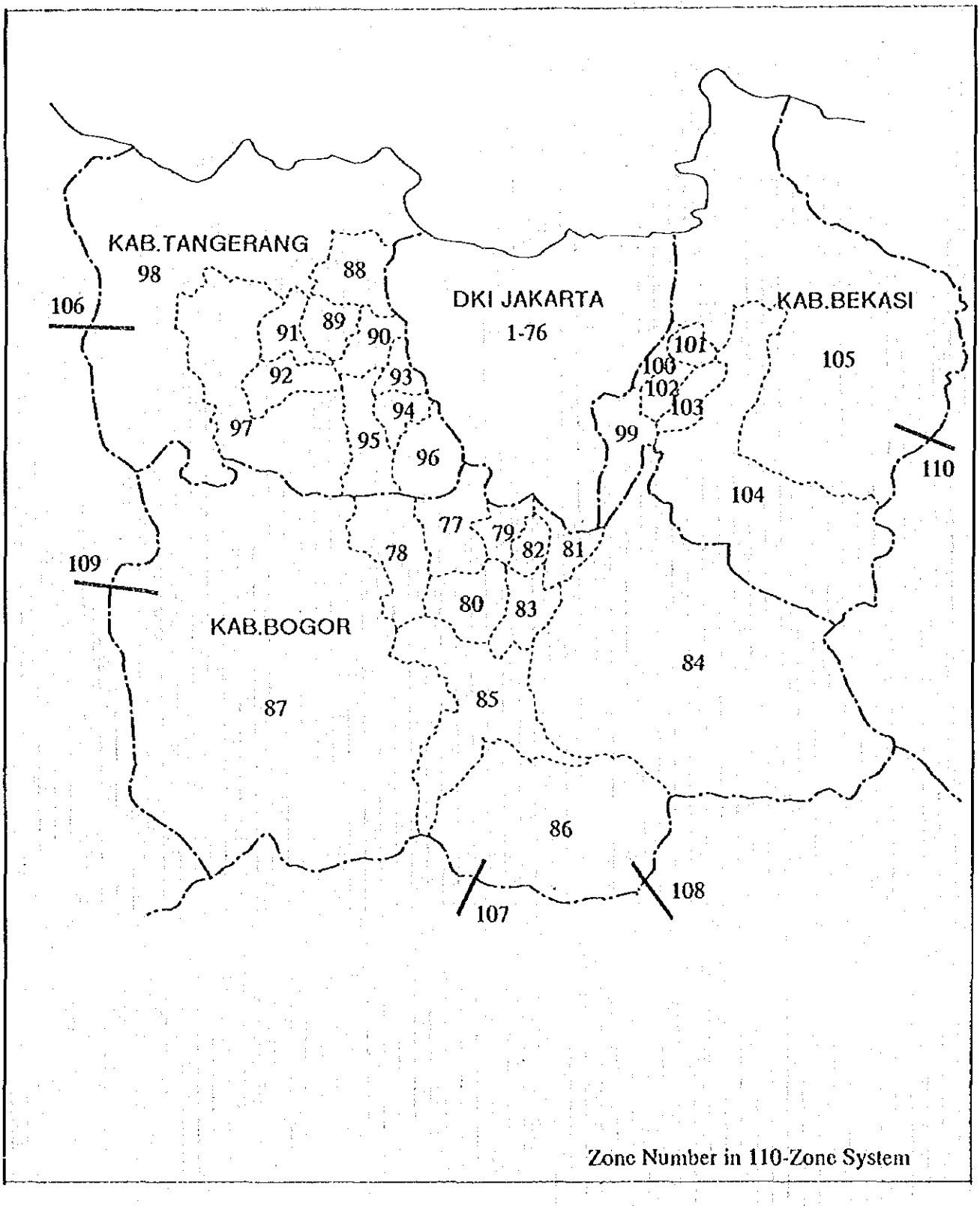


Figure 1.3.2 Zoning System (Botabek)

Table I.1 Trip Generation (1/2)

(Unit:pcu)

Zone No.	Area	Trip Generation				Trip Attraction			
		P/C(incl.M/C)	Truck	Bus	Total	P/C(incl.M/C)	Truck	Bus	Total
1	Jakarta Pusat	64,176	2,085	9,952	76,213	76,643	2,096	11,373	90,112
2		28,960	1,914	4,578	35,452	34,447	1,924	5,255	41,627
3		49,144	1,821	7,612	58,577	57,292	1,828	9,016	68,135
4		84,298	2,442	13,223	99,963	81,042	2,446	12,798	96,286
5		30,340	1,335	4,543	36,218	41,528	1,349	6,217	49,093
6		51,515	1,369	8,355	61,239	52,734	1,353	9,272	63,359
7		52,724	1,240	8,565	62,528	51,553	1,248	8,456	61,257
8		33,939	1,478	5,959	41,377	32,743	1,487	6,431	40,662
9		52,558	1,751	7,842	62,151	64,489	1,735	8,819	75,043
10		78,411	2,657	12,305	93,373	88,430	2,697	13,529	104,657
11		45,282	2,282	7,236	54,800	48,116	2,320	7,217	57,654
12		58,195	2,005	9,026	69,226	67,202	1,990	10,116	79,308
13	Jakarta Utara	19,150	1,828	2,628	23,605	23,962	1,817	3,259	29,039
14		111,542	6,750	20,913	139,205	115,232	6,761	20,430	142,424
15		66,154	4,646	10,550	81,350	73,332	4,642	10,988	88,962
16		68,133	3,212	11,416	82,761	70,128	3,226	11,181	84,535
17		52,088	1,380	8,439	61,907	49,371	1,386	7,968	58,725
18		73,147	2,257	11,391	86,794	71,124	2,291	11,017	84,432
19		58,104	3,029	9,529	70,661	61,225	3,319	9,441	73,985
20		23,195	7,267	3,545	34,007	27,746	7,276	3,898	38,919
21		30,538	5,020	4,555	40,114	34,853	5,019	4,949	44,821
22		33,226	5,022	5,394	43,641	36,519	5,018	5,668	47,204
23		55,223	2,173	9,931	67,328	58,302	2,174	9,930	70,406
24	Jakarta Barat	66,068	5,724	12,968	84,760	63,392	5,645	12,097	81,134
25		105,195	4,318	19,545	129,059	99,404	4,340	18,266	122,010
26		56,128	2,962	11,093	70,183	53,698	2,887	10,165	66,750
27		30,016	2,525	5,420	37,961	29,798	2,532	5,154	37,484
28		31,563	1,422	5,781	38,767	30,380	1,419	5,507	37,305
29		66,558	1,958	11,132	79,648	67,936	1,948	11,420	81,304
30		19,548	2,090	3,438	25,076	19,663	2,107	3,377	25,147
31		34,460	3,325	5,900	43,685	33,627	3,306	5,577	42,509
32		58,975	2,347	10,061	71,383	58,089	2,363	9,804	70,256
33		49,660	2,010	8,776	60,446	48,221	1,977	9,355	59,553
34		90,508	2,243	15,236	107,987	91,887	2,224	15,660	109,771
35		33,832	1,521	5,795	41,148	32,851	1,538	5,319	39,708
36		98,184	2,123	14,959	115,266	115,860	2,116	17,335	135,311
37		77,222	2,675	12,261	92,158	82,499	2,677	12,429	97,606
38	Jakarta Selatan	42,832	2,899	6,632	52,363	51,131	2,883	8,270	62,285
39		28,879	1,532	4,484	34,895	28,020	1,561	4,543	34,124
40		25,377	2,753	3,959	32,089	30,154	2,760	4,437	37,351
41		55,104	1,883	9,285	66,272	53,101	1,793	9,187	64,082
42		35,532	1,721	5,903	43,156	34,323	1,761	5,960	42,045
43		21,223	2,065	3,406	26,694	24,257	2,009	3,655	29,921
44		44,750	3,569	7,997	56,316	46,420	3,547	7,831	57,798
45		63,172	3,901	10,864	77,937	62,683	3,889	10,672	77,244
46		27,569	1,162	4,712	33,443	25,832	1,163	4,321	31,316
47		68,073	2,828	10,798	81,699	81,771	2,811	13,172	97,754
48		45,132	2,461	7,873	55,468	42,709	2,396	7,517	52,622
49		36,768	828	6,477	44,073	35,028	851	6,198	42,076
50		39,743	1,120	7,122	47,986	36,784	1,120	6,739	44,643
51		32,687	1,360	5,878	39,925	31,159	1,350	5,757	38,266
52		28,458	3,520	5,051	37,029	29,613	3,495	5,051	38,158
53		31,859	1,844	5,685	39,388	29,718	1,849	5,381	36,948
54		44,624	1,753	8,307	54,684	44,215	1,717	8,666	54,599
55		38,021	1,212	6,855	46,088	35,476	1,222	6,662	43,360
56		43,026	1,466	7,729	52,221	41,479	1,440	7,751	50,670
57		27,161	1,003	5,353	33,518	24,244	1,007	5,221	30,472
58		13,915	734	2,729	17,379	12,830	712	2,846	16,388

Table I.1 Trip Generation (2/2)

(Unit:pcu)

Zone No.	Area	Trip Generation				Trip Attraction			
		P/C(incl.M/C)	Truck	Bus	Total	P/C(incl.M/C)	Truck	Bus	Total
59	Jakarta Timur	60,217	1,481	10,386	72,084	59,144	1,528	10,756	71,427
60		63,783	1,979	10,159	75,921	70,355	1,963	11,295	83,614
61		125,124	6,091	20,392	151,607	127,065	6,073	22,149	155,287
62		47,398	2,289	7,833	57,520	44,181	2,275	7,738	54,193
63		33,171	1,556	5,810	40,537	35,317	1,595	5,631	42,544
64		49,183	1,288	8,929	59,400	47,024	1,261	8,412	56,698
65		48,740	1,509	8,936	59,185	46,860	1,544	9,215	57,620
66		59,451	1,092	10,472	71,016	52,379	1,114	9,752	63,245
67		36,529	1,469	6,313	44,312	36,516	1,400	6,605	44,521
68		28,552	1,146	4,672	34,370	26,132	1,180	4,799	32,111
69		37,327	1,175	7,040	45,541	33,799	1,147	6,533	41,478
70		18,538	2,301	3,099	23,938	23,099	2,309	3,316	28,724
71		49,238	4,380	8,872	62,490	51,542	4,340	8,449	64,331
72		34,186	1,231	6,017	41,434	32,772	1,240	5,923	39,935
73		32,300	2,851	6,198	41,349	33,811	2,823	6,544	43,179
74		65,415	1,228	11,807	78,450	59,535	1,212	11,027	71,774
75		43,801	2,438	8,675	54,915	40,245	2,451	7,812	50,508
76		17,779	2,064	3,496	23,339	17,765	2,050	3,251	23,066
77	Bogor	74,963	451	13,466	88,880	75,148	451	14,172	89,771
78		74,018	481	13,425	87,925	79,827	480	15,390	95,697
79		90,228	748	16,271	107,248	91,951	759	16,786	109,496
80		63,831	555	12,043	76,430	59,906	571	11,763	72,240
81		111,023	1,123	20,611	132,757	113,960	1,097	20,758	135,815
82		91,280	951	17,214	109,445	96,158	972	18,068	115,198
83		62,079	652	11,636	74,366	71,874	665	13,763	86,303
84		307,265	5,128	57,988	370,381	301,464	5,141	54,964	361,569
85		474,586	1,610	89,687	565,884	420,576	1,619	76,768	498,963
86		232,444	1,255	43,685	277,385	207,454	1,233	39,634	248,322
87		408,570	1,328	76,214	486,113	383,541	1,327	76,752	461,621
88	Tangerang	98,438	583	17,968	116,989	105,548	584	18,501	124,634
89		136,159	5,419	25,118	166,696	150,048	5,418	24,501	179,967
90		75,917	3,620	14,380	93,916	79,982	3,621	14,766	98,369
91		113,519	2,022	21,452	136,992	125,482	2,017	21,756	149,256
92		53,335	975	9,822	64,132	51,892	979	9,732	62,603
93		99,104	859	18,194	118,157	98,675	881	18,423	117,979
94		55,846	513	10,392	66,751	56,831	493	10,977	68,301
95	Bekasi	72,208	3,754	13,160	89,122	67,916	3,776	12,912	84,604
96		167,589	1,920	31,311	200,820	167,806	1,928	30,587	200,321
97		166,672	3,127	30,757	200,556	169,130	3,151	33,029	205,309
98		423,591	2,163	78,990	504,744	376,711	2,140	74,766	453,617
99		144,544	2,089	26,119	172,752	141,354	2,088	27,885	171,327
100		79,985	1,695	14,528	96,208	83,583	1,687	14,818	100,087
101		51,645	1,091	9,644	62,380	50,847	1,096	9,345	61,288
102		75,620	1,831	13,782	91,233	81,084	1,815	14,620	97,519
103		104,325	2,173	19,249	125,748	109,366	2,189	18,847	130,402
104		205,614	3,860	37,365	246,838	201,602	3,871	37,887	243,360
105		371,142	5,461	69,557	446,160	364,613	5,458	70,176	440,248
106	Outside of	0	6,910	0	6,910	0	6,914	0	6,914
107	Jabotabek	0	1,478	0	1,478	0	1,473	0	1,473
108		0	2,865	0	2,865	0	2,846	0	2,846
109		0	0	0	0	0	0	0	0
110		0	8,482	0	8,482	0	8,503	0	8,503
		8,168,131	258,567	1,460,083	9,886,915	8,168,131	258,567	1,460,083	9,886,915

(6) Present Road Network

The major road network was basically applied in the traffic assignment for estimating of air pollution. Information of link data on the base-year road network was derived from the road inventory prepared by Binkot and additionally from the Jakarta Road Atlas (Falk map). Information items of link data are as follows :

- Origin node,
- Destination node,
- Link distance,
- Road classification,
- Area classification,
- Number of lanes, and
- Toll road type

The link distance was calculated from X and Y co-ordinates of each node. Roads were divided into five categories: toll road, arterial road, main street, other road, and frontage road. The area was divided into DKI and Botabek. Toll road types were divided into closed system and flat tariff system. Speed-flow relationship, which depicts the relation between travel speed and link capacity, differs in road classification, area classification, number of lanes, and toll road type, as shown in **Table 1.2.**

Free flow speed (Vmax) is defined as the safe speed at which a vehicle travels on a link in the absence of other traffic. As the traffic increases, travel speed decreases. Link capacity (Q0) was adopted from Standard Traffic Volume (STV) as defined by "Spesifikasi Standar Untuk Perencanaan Geometrik Jalan Luar Kota" (Bina Marga, 1990). The total number of links in the present road network is 1,260 including toll road links (131) and access links (44).

Table I.2 Speed-Flow Relationship

Formula No	Road Type	Area	No.of Lanes	Fare	Vmax	Vmin	Q0	Qmax
1	Toll Road	All	8-lane	Closed System	100km/h	25km/h	48,000pcu/day	115,200pcu/day
2				Flat Tariff System				
3			6-lane	Closed System			36,000pcu/day	86,400pcu/day
4				Flat Tariff System				
5			4-lane	Closed System			24,000pcu/day	57,600pcu/day
6				Flat Tariff System				
7	Arterial Road	DKI	10-lane		50km/h	15km/h	40,000pcu/day	96,000pcu/day
8			8-lane				32,000pcu/day	76,800pcu/day
9			6-lane				24,000pcu/day	57,600pcu/day
10			4-lane				16,000pcu/day	38,400pcu/day
11			2-lane				4,000pcu/day	9,600pcu/day
12		Botabek	6-lane		60km/h	15km/h	24,000pcu/day	57,600pcu/day
13			4-lane				16,000pcu/day	38,400pcu/day
14			2-lane				4,000pcu/day	9,600pcu/day
15	Main Street	DKI	6-lane		45km/h	15km/h	24,000pcu/day	57,600pcu/day
16			4-lane				16,000pcu/day	38,400pcu/day
17			2-lane				4,000pcu/day	9,600pcu/day
18		Botabek	4-lane		50km/h	15km/h	16,000pcu/day	38,400pcu/day
19			2-lane				4,000pcu/day	9,600pcu/day
20	Other Road,	All	8-lane		40km/h	10km/h	32,000pcu/day	76,800pcu/day
21	Frontage Road		6-lane				24,000pcu/day	57,600pcu/day
22			4-lane				16,000pcu/day	38,400pcu/day
23			2-lane				4,000pcu/day	9,600pcu/day
24	Ramp	All	2-lane	Closed System	20km/h	10km/h	5,000pcu/day	12,000pcu/day
25	(Toll Road Acess)			Flat Tariff System				

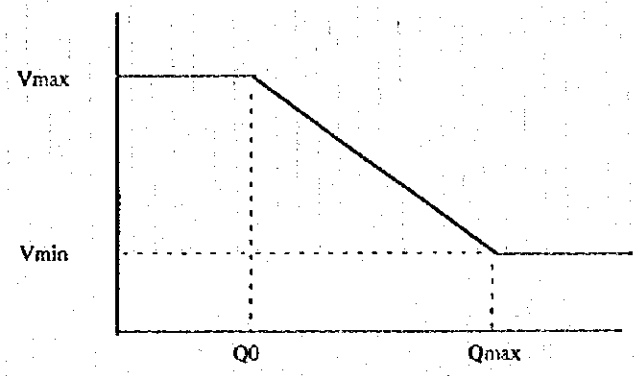


Table I.3 Toll Rate

Toll Road	Section	Length	Toll Fee for Sedan	Toll Rate per km	Remarks
Jagorawi Tollway	Taman Mini - Caiwi	42km	4,000Rp.	95Rp./km	Closed System
Jakarta - Merak Tollway	Kebon Jeruk - Ciujung	57km	6,500Rp.	114Rp./km	Closed System
Jakarta - Cikampek Tollway	Pondok Gede Timur - Cikampek	65km	6,500Rp.	100Rp./km	Closed System
Jakarta Intra Urban Tollway		31km	2,500Rp.		Flat Tariff System
Cengkareng Airport Access		13km	4,000Rp.		Flat Tariff System

3.3.6 Details of Estimate of Pollutant from Ships

(1) Basic Concept of Air Pollution Source Study

The port area and cruising routes are target area related to ships' emission. Data on locations of cruising routes and mooring sites are necessary for the estimate of pollution emission from ships.

Ships were divided into "general ships" and "in-port ships". The general ships are cargo ship, tanker, and ferry which cruise from a port to a port. In-port ships are tug boat, cruising boat, and patrol boat which cruise in a port.

(2) Collection of Basic Information

a. General Ships

(a) Ship Specifications

Information like name of ships, ship types, purpose of arrival, mooring time, etc. was recorded in "Ship and Cargo Investigation Sheet". Information like type, number, and power of engines on ships was recorded in "Ship Detail Report".
The rated power of diesel engines and rated fuel consumption of boilers are shown in **Table 1** and **Table 2**.

Table 1 Rated Power of Main and Sub Diesel Engines

Ship Types	Rated Power (PS) of Main Diesel Engines	Rated Power (kW) & Number of Sub Diesel Engines
Passenger Ship	$7.9X^{0.83}$	$1.5X^{0.63}*3$
Ferry	$4.1X^{0.95}$	$1.4X^{0.70}*3$
Full Container	$1.9X^{0.97}$	$2.2X^{0.60}*2$
Tanker (Oil)	$12X^{0.70}$	$10X^{0.37}*2$
Cargo Ship	$19X^{0.65}$	$7.7X^{0.40}*2$
Fish Boat	$73X^{0.50}$	$13X^{0.43}*3$
Others	$33X^{0.61}$	$0.089X*2$

Note: 1. X means gross tonnage.

2. For sub diesel engines include rated power per engine and number of engines.
3. Cargo ships include special ships for minerals, wood, automobiles, and grain.
4. Conversion factor from kW to PS: 1.88

Table 2 Rated Fuel Consumption of Main and Sub Boilers

Ship Types	Rated Consumption of Main Boiler (liter/hr)	Rated Consumption of Sub Boiler (liter/hr)
Tanker (more than 100,000GRT)	$6.7X^{0.58}$	-----
Tanker (less than 100,000GRT)	-----	$0.29X^{0.88}$
Other than Tanker	-----	$0.27X^{0.67}$

Note: 1. X means gross tonnage.

2. Tanker of more than 100,000 gross tonnage is turbine ship with main boiler, and tanker of less than 100,000 gross tonnage is diesel ship with sub boiler.
3. Rated fuel consumption is the total of all main and sub boilers.

(b) Operational Patterns of Engines

Operational pattern of engines are basically investigated by hearing or visit questionnairre. Generally, ships except large tanker conduct cruising and loading/unloading during the daytime, and don't conduct them on holidays. On the other hand, large tanker conduct cruising and loading/unloading not related with weekday or holiday, daytime or nighttime.
Loading patterns of engines in port area are shown in **Table 3.**

Table 3 Loading Patterns of Engines in Port Area

Ships Types	Non-loading/Inner Movement		Loading		Time Ratio
	Load of Sub Diesel	Load of Sub Boiler	Load of Sub Diesel	Load of Sub Boiler	Loading/ Mooring
Passenger, Ferry, Fish	0.42 (1)	0.48 (all)	---	---	0
Full Container	0.42 (1)	0.48 (all)	---	---	0
Tanker	0.37 (1)	0.19(all)	0.45 (1)	0.76 (all)	Ocean: 0.23 Inner : 1
Cargo	0.42(1)	0.48(all)	0.46(2)	0.56(all)	Ocean: 0.23 Inner: 1
Others	0.42(1)	0.48(all)	0.46(2)	0.56(all)	

Note: 1. In parentheses: Number of operating engines
2. Cargo ships include special ships for minerals, grains, wood, and automobiles

(c) Fuels

Fuel contents were basically investigated by verbal enquiring and questionnaire survey. Examples of fuel contents are shown in **Table 4.**

a) For Sub Diesel Engine

Fuel Consumption:

$$W = 0.17 * P^{0.98} * (A_1^{0.98} * T_1 * d_1 + A_2^{0.98} * T_2 * d_2)$$

NO_x Emission Load:

$$N = 1.49 * P^{1.14} * (A_1^{1.14} * T_1 d_1 + A_2^{1.14} * T_2 * d_2) * 10^{-3}$$

SO_x Emission Load:

$$S = W * s * 1/100 * 22.4/32$$

Where,

A_1 : Load Factor at Loading/Unloading

A_2: Load Factor at Non-Loading/Unloading

T_1: Loading/Unloading Hours

T_2: Non-Loading/Unloading Hours

d_1: Number of Operating Engines at Loading/Unloading

d_2: Number of Operating Engines at Non-Loading/Unloading

Load factor are those of a sub diesel engine int Loading/Unloading and Non-Loading/Unloading conditions. Loading/Unloading hours are counted for one arrival of one vessel.

b) For Sub or Main Boiler

Fuel Consumption:

$$W = F * (A_1 * T_1 + A_2 * T_2)$$

NO_x Emission Load:

$$N = W * n * 22.4 / 46$$

SO_x Emission Load:

$$S = W * s * 1/100 * 22.4 / 32$$

F: Rated Fuel Consumption (kg / hour / vessel)

A_1 : Load Factor at Loading/Unloading

A_2: Load Factor at Non-Loading/Unloading

T_1: Loading/Unloading Hours

T_2: Non-Loading/Unloading Hours

Load factor are those of a sub or main boiler in Loading/Unloading and Non-

Table 4 Fuel Contents

Ships Types	Main Diesel Engine		Sub Diesel Engine		Sub Boiler	
	S contents (%)	Specific Gravity	S contents (%)	Specific Gravity	S contents (%)	Specific Gravity
Passenger	1.906	0.916	2.031	0.898	2.277	0.921
Ferry	2.054	0.922	1.796	0.910	2.359	0.937
Full Container	1.423	0.902	1.326	0.908	2.466	0.956
Tanker	0.989	0.866	0.804	0.856	2.214	0.919
Cargo	1.103	0.878	1.010	0.874	2.430	0.937

Note: Cargo ships include special ships for minerals, grains, wood, and automobiles

b. In-port Ships

Information on in-port ships was collected by verbal enquiring to in-port businesses and included monthly or annual fuel consumption by ship type, fuel type, fuel contents, operating patterns, etc. Generally, in-port ships operat during the daytime on weekdays.

(3) Estimate of Pollution Emission

a. General Ships

The following symbols are used in the equations in this section.

W: Fuel Consumption (kg/vessel)
P: Rated Power (PS/engine)
N: NO_x Emission Load (Nm^3/vessel)
n: NO_x Emission Factor (kg/kg)
S: SO_x Emission Load (Nm^3/vessel)
s: Sulfur Contents in Fuel (Weight %)

(a) Mooring

Main diesel ships use sub diesel engine(s) and sub boiler(s) at mooring,and main turbine ships use only main boiler(s) at mooring.

Loading/Unloading conditions. Loading/Unloading hours are counted for one arrival of one vessel.

The following are examples of the parameters used above.

Load Factor of Main Boiler at Loading/Unloading:	0.8
Load Factor of Main Boiler at Non-Loading/Unloading:	0.086
NO_x Emission Factor	0.0059 kg/kg

(b) Arrival and Departure

Pollution emission from ships on the way from mooring sites to main cruising routes was estimated. Main diesel ships use main and sub diesel engine(s), and sub boiler(s) during arrival and departure. Main turbine ships usually use only main boiler(s) during arrival and departure.

a) For Main Diesel Engine(s)

Fuel Consumption:

$$W = 0.21 \cdot \sum \left\{ (P \cdot A_i)^{0.95} \cdot T_i \right\}$$

NO_x Emission Load:

$$N = 1.49 \cdot \sum \left\{ (P \cdot A_i)^{1.14} \cdot T_i \cdot 10^{-3} \right\}$$

SO_x Emission Load:

$$S = W \cdot s \cdot \frac{1}{100} \cdot \frac{22.4}{32}$$

A_i: Load Factors of Each Operation Mode

T_i: Operation Hours of Each Operation Mode

Load factors of main diesel engine at each mode are shown in **Table 5**.

Table 5 Load Factors of Main Diesel Engine at Each Mode

Operation Mode	Load Factors
F (Full)	0.80
S.F. (Stand by Full)	0.52
H (Half)	0.32
S (Slow)	0.17
D.S. (Dead Slow)	0.09

Basically, operation patterns and operational load factors are investigated by questionnaire survey. If such an investigation is difficult, average cruising time from mooring sites to main cruising routes is used.

b) For Sub Diesel Engine(s)

Fuel Consumption:

$$W = 0.17 * (P * A)^{0.98} * T * d$$

NO_x Emission Load:

$$N = 1.49 * (P * A)^{1.14} * T * d * 10^{-3}$$

SO_x Emission Load:

$$S = W * s * 1/100 * 22.4/32$$

A: Load Factor

T: Cruising Hours

d: Number of Operating Engines

Load factors are average load factors of a sub diesel engine during arrival and departure of the ship. Cruising hours are ones from the mooring site to the main cruising route.

c) Sub or Main Boiler

Fuel Consumption:

$$W = F * A * T$$

NO_x Emission Load:

$$N = W * n * 22.4/46$$

SO_x Emission Load:

$$S = W * s * 1/100 * 22.4/32$$

F: Rated Fuel Consumption (Kg/hour)

A: Load Factor

T: Cruising Hours

Load factors are average load factors of a sub or main boiler during arrival and departure of the ship. Cruising hours are ones from the mooring site to the main cruising route.

NO_x emission factor of 0.0059 (kg/kg) was also used as an example in the above equation.

(c) Cruising Outside the Port

Pollutant emission from ocean cruising ships outside the port area would be estimated in some cases, and the estimate method is similar to the ones for arrival and departure.

b. In-port Ships

Engines of in-port ships were assumed as diesel engines, and annual pollution emission was estimated as follows.

NO_x Emission Load:

$$N_i = W_i * n_i * 22.4/46$$

SO_x Emission Load:

$$S_i = W_i * s_i * 1/100 * 22.4/32$$

W_i: Annual Fuel Consumption of Ship Type i (kg)
N_i: NO_x Emission Load from Ship Type i (Nm^3)
n_i: NO_x Emission Factor of Ship Type i (kg/kg)
S_i: SO_x Emission Load from Ship Type i (Nm^3)
s_i: Sulfur Contents of Fuel (Weight %)

Annual fuel consumption is basically investigated by verbal enquiring. An example of NO_x emission factor is 0.033 kg/kg.

3.3.7 Frequencies of Flights

Soekarno-Hatta Airport

Domestic

Seq	Aircraft Types	Flights
1	Boeing 737 all series	43,599
2	Fokker 100	21,253
3	Fokker 28 Fellowship	13,475
4	Boeing 737 400	5,338
5	Boeing 737 300	3,458
6	Fokker 27 Friendship	5,455
7	Boeing 747 all series	2,105
8	Fokker 70	2,041
9	Airbus A300 B4	1,408
10	Airbus A300 600	3,522
11	Advanced Turbo HS 72	2,343
12	Douglas DC 10 30 40	2,179
13	Vickers Viscount 828	1,249
14	Hawker Siddeley 748	987
15	Douglas DC9 30	841
16	Douglas MD11	779
17	Boeing 747 400	692
18	British Aerospace	597
19	Boeing 747 200 B/C	442
20	Boeing 757 all series	197
21	Gulfstream IIB/III	35
22	Lockheed L188 Electera	31
23	Lockheed C130 Hercules	26
24	Gates Lear Jet 35/36	17
25	Boeing 747 Freighter	16
26	SA 330J Heli Puma	14
27	Falcon Mystere 20	12
28	Piper Aztec	8
29	Beech King Air	7
30	Others	354
31	Total	112,480

International

Seq	Aircraft Types	Flights
1	Boeing 737 all series	6,516
2	Boeing 747 400	5,633
3	Airbus A-310	5,318
4	Airbus A300 600	4,051
5	Douglas DC8 63	2616
6	Boeing 767 all series	2,091
7	Douglas MD 11	2,001
8	Boeing 747 200 B/C	1,681
9	Boeing 737 300	1,487
10	Airbus B300 B4	1,368
11	Fokker 28 Fellowship	526
12	Boeing 737 400	525
13	Boeing 757 all series	524
14	Boeing 747 300 Sud	390
15	Airbus 330-00	343
16	Fokker 100	305
17	Lockheed 1011 500 Trister	283
18	Boeing 747 Sud	274
19	Boeing 737 200 Cargo	228
20	Lockheed 1011 Trister	197
21	Airbus Industrie A300	170
22	Boeing 747 all series	110
23	Ilyushin IL-62	99
24	Gulfstream IIB/III	97
25	Airbus A-340	76
26	Challenger CL 600	18
27	Boeing 747 Freighter	13
28	Airbus A-340	9
29	Others	319
30	Total	37,268

Source: Statistik Angkutan Udara, Tahun 1995

Halim-Perdanakusuma Airport

Domestic Flights

1	CN253	10,776
2	B412	1,904
3	B206	1,882
4	F28	1,706
5	B105	514
6	F100	501
7	DASH7	465
8	G159	377
9	DA20	171
10	B212	166
11	GIII	163
12	B200	112
13	B125	105
14	C160	97
15	BL11	92
16	GIV	81
17	C550	68
18	RJ85	60
19	L382	56
20	PA31	51
21	HS125	48
22	GII	45
23	C650	42
24	B300	35
25	CHC	25
26	B146	24
27	CTA	24
28	BK117	23
29	B300	8
30	Others	18,079
31	Total	37,700

Source: Statistik Angkutan Udara, Tahun 1995

3.3.8 Details of Pollutant Estimation from Aircrafts

(1) Basic Concept of of Air Pollution Source Study

Number of arrivals and departures by runways, aircraft types and pollution emission per aircraft are investigated, and total pollution emission from aircrafts are estimated.
The necessary informations on pollution emission of aircrafts are compiled in Table 1.

Table 1 Basic Informations on Pollution Emission from Aircrafts

Items	Basic Information	Remarks
Number of Arrivals and Departure	Number of arrivals & departures by runways, aircraft types, months, weekdays, time zones	Flight schedule etc.
Flying Routes	Flying routes of approaches and departures by runways, destinations, wind directions	Flight schedule, information from airport authorities
Durations of each Mode	Durations of each modes by aircraft types	Information of JEA, USEPA etc.
Emission Factors of each Mode	Emission factors by engine types, modes	Ditto

(2) Setting of Flying Routes

Flight schedule, flight chart , and some statistical informations like flight number by months, weekdays, and time zones are compiled to set representative flying routes.
For aircrafts, climbing altitude is also necessary , and pollution emission from aircrafts are considered to the altitude of around 1000 meters.

(3) Number of Arrivals and Departures

Number of arrivals and departures of aircrafts is usually determined with flight schedule.

(4) Pollution Emission by Aircraft Types and Modes

a. Modes

Modes of aircrafts are divided into the followings.

- Idling:
  Idling modes include warming up of engines, taxing-idling to certain place in airport, and load factor is around 5 %.
- Take off:
  Engine shows maximum load during taking off, and it continues below 2 minutes.
- Climbing:
  Climbing angles of aircrafts are around 3 and 5 degrees, and load factors are around 85 %.
- Approaching:
  Load factors are around 30 % in case of approach.

b. Number of Engines of Aircrafts

Examples of engine numbers of aircrafts are shown in Table 2.

c. Durations of Each Mode by Aircraft Types

Examples of durations of each mode by aircrafts types are shown in Table 3.

d. Emission Factors by Modes and Aircraft Types

Emission factors by modes and aircraft types are shown in Table 4.

Table 2 Types and Number of Engines of Aircrafts

Aircraft	Engine	Type	Number
Commercial Carrier			
Boeing 727-200	P&W JT8D-17A	TF	3
Boeing 737-200	P&W JT8D-17A	TF	2
Boeing 747-100,200	P&W JT9D-7 etc	TF	4
Boeing 747-300	P&W JT9D-7R4G2, GE CF6-50E2	TF	4
Boeing 747-400	GE CF6-80C2B1F	TF	4
Boeing 767-200	P&W JT9D-7R4D, GE CF6-80A	TF	2
Boeing 767-300	P&W JT9D-7R4D, GE CF6-80C2B1	TF	2
Lockheed L1011-385-1	RR RB211-22B	TF	3
McDonnell-Douglas DC-9-41	P&W JT8D-15	TF	2
McDonnell-Douglas DC-9-81/MD-81	P&W JT8D-209/217A	TF	2
McDonnell-Douglas MD-87	P&W JT8D-217A/C	TF	2
McDonnell-Douglas DC-10-30	GE CF6-50C2	TF	3
McDonnell-Douglas DC-10-40	P&W JT9D-59A	TF	3
Airbus Industrie A300B2	GE CF6-50C2R	TF	2
Airbus Industrie A300B4-622R	P&W PW4156/4158	TF	2
Airbus Industrie A320-200	CFM CFM56-5-A1	TF	2
YS-11	RR DART MK542-10	TP	2
DeHavilland DHC-6-300	P&WC PT64A-27	TP	2

Note: Manufacturers, P&W: Pratt & Whitney, GE: General Electric,
CFM: CFM International
TF: Turbofan, TP: Turboprop

Table 3 Duration of Modes

Aircraft	Durations in Modes (minutes)					
	Taxiidle	Take Off	Climbout	Approach	Taxiidle	Total
Commercial Carrier						
Jumbo, Long & Medium Range Jet	19.0	0.7	2.2	4.0	7.0	32.9
Turboprop	19.0	0.5	2.5	4.5	7.0	33.5
Transport-Piston	6.5	0.6	5.0	4.6	6.5	23.2
General Aviation						
Business Jet	6.5	0.4	0.5	1.6	6.5	15.5
Turboprop	19.0	0.5	2.5	4.5	7.0	33.5
Piston	12.0	0.3	5.0	6.0	4.0	27.3
Helicopter	3.5	---	6.5	6.5	3.5	20.0
Average at Haneda Airport	15.0	1.0	2.0	4.5	4.5	27.0

Table 4 Fuel Economy and Emission Factors by Modes

Engine	Mode	Fuel Economy (Kg/hr)	NO_x Emission Factor (Kg/hr)	SO_x Emission Factor (Kg/hr)
Civil Aircraft				
P&W JT8D-17 (TF)	Idle	521.6	1.77	0.52
	Takeoff	4527.0	91.90	4.53
	Climb-out	3588.0	55.97	3.59
	Approach	1275.0	8.80	1.28
P&W JT9D-7 (TF)	Idle	838.7	2.60	0.84
	Takeoff	7322.0	215.30	7.32
	Climb-out	5984.0	128.00	5.98
	Approach	2108.0	16.44	2.11
GE CF6-50C (TF)	Idle	547.0	1.37	0.55
	Takeoff	8573.0	304.30	8.57
	Climb-out	7104.0	290.60	7.10
	Approach	2395.0	23.95	2.40
RR RB211-524 (TF)	Idle	802.4	2.15	0.80
	Takeoff	8096.0	299.60	8.10
	Climb-out	6662.0	213.20	6.67
	Approach	2472.0	28.53	2.47
P&W PT6A-27 (TP)	Idle	52.2	0.13	0.05
	Takeoff	192.8	1.51	0.19
	Climb-out	181.4	1.27	0.18
	Approach	97.5	0.82	0.10

Note: Manufacturers, RR: Rolls Royce

(5) Estimation of Pollution Emission

Total pollution emission is derived from the pollution emission load per one aircraft by aircraft types in (4) and flight number of aircrafts by aircraft types. The total emission load can be distributed in runways, seasons, time zones, aircraft types.

3.4 Existing Estimates of Air Pollutant Emission in Jabotabek

3.4 Existing Estimates of Air Pollutant Emission in Jabotabek

There are two different estimates for metropolitan Jakarta and DKI Jakarta and one for Jabotabek. **Table 3.4.1** gives estimates for metropolitan Jakarta in 1988, and **Table 3.4.2** for DKI Jakarta in 1991. NOx emissions in these tables differ by a factor of about 10.

Table 3.4.1 Estimated Emission in Metropolitan Jakarta in 1988

(ton/year)

	Industry	Household	Solod waste	Transport	Total	Traffic	EIESI
CO	300	300	3,300	321,700	325,600	584,000	340,000
HC	200	300	1,100	13,000	14,600		72,100
NOx	3,300	2,000	200	15,000	20,500	16,100	251,000
PM	1,000	2,300	600	3,100	7,100	3,100	7,400
SOx	15,500	2,600	100	6,500	24,700	800	16,400

Source: Winarto, W: Contributions to emissions of gases and particulates by the combustion of fuels by industry, motor vehicles, household and waste incineration in Jakarta, Institute Teknologi Bandung, Bandung 1989 and etc. ;Jakarta an excerpt from NILU and Inst. for Environmental Studies: URBAIR-Urban Air Quality Management in Jakarta: Draft of AQM Guidelines (Part A), 1993 (Ref. 7)

Table 3.4.2 Estimated Emission in DKI Jakarta

(ton/year)

	Industry	Household	Solid waste	Transport	Total
CO	400	400	3,800	373,600	378,200
HC	200	300	1,200	13,700	15,400
NOx	33,300	20,100	2,300	153,900	209,700
PM	1,100	2,400	600	3,300	7,400
SOx	17,700	2,700	300	7,500	28,200

Source: BAPEDAL; an excerpt from NILU and Inst. for Environmental Studies : URBAIR - Urban Air Quality Management in Jakarta : Draft of AQM Guidelines (Part A), 1993 (Ref. 7)

Table 3.4.3 gives estimated emissions in Jabotabek in 1995 as reported in Third Jabotabek Urban Development Project (JUDP III).

Table 3.4.3 Air Pollutant from Fuel Burning in Jabotabek, 1995

(ton/year)

	CO		HC		NOx		PM	
	EU	US	EU	US	EU	US	EU	US
Petrol	817,830	739,630	31,450	110,940	22,340	59,170	4,340	6,100
Diesel	170,090	25,790	10,170	6,560	43,010	23,210	7,820	10,550
Kerosene		460		730		4,190		5,460
Total	987,920	765,880	41,620	118,230	65,350	86,570	12,160	22,110

Source: Third Jabotabek Urban Development Project (JUDP III) Environmental Component 2 (Part B), Phase I Report, October 1993 (Ref. 2)