# Chapter 5

# Current Urban Gas System Status

# 5. Current Urban Gas System Status

## 5.1 Urban Gas Network and Supply - Existing

### 5.1.1 Gas Supply in West Java

On Java Island, gas fields are located both on-shore and off-shore and are exploited for domestic use by Pertamina and PSCs (Product Sharing Contractors). According to Pertamina's daily production report published in January 1996, the current production plan is as follows :

**Table 5-1-1 Production Plan for West Java (January, 1996)**

| Type | Production (MMSCFD) | Main Gas Fields |
|---|---|---|
| Onshore | 153 | Cicauh, Pasirjadi, Cemara |
| Offshore | 555 | Parigi, ARCO |
| Total | 708 | |

*Source : Pertamina, 1996*

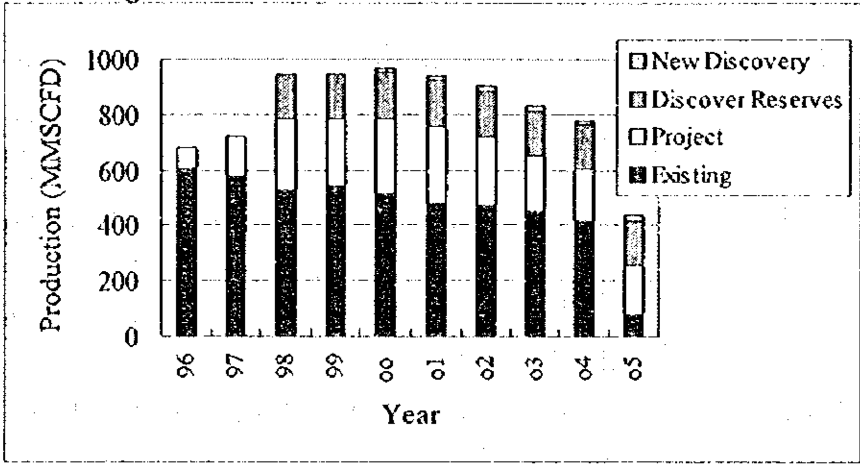
Among offshore production 555 MMSCFD, 260 MMSCFD is utilized for electric power generation by PLN. Compared to offshore gas fields, the scale of onshore gas fields in West Java is small and more than 75% of natural gas is produced at offshore fields.

According to the supply forecast plan released in 1995, 13 projects are planned in West Java. Among these, projects in Kab. Purvakarta (Pasirjadi gas field) and Subang (Subang gas field) are important since they are close to the industrial area where a large of gas demand is expected. Also offshore gas fields exploited by PSCs such as ARCO and Maxus are expected to increase the supply.

The amount of gas production forecast in each year in West Java is shown in Fig. 5-1-1.

As Fig. 5-1-1 shows, the gas production in the West Java area will increase until the year 2000 and after that will begin to decrease. If new gas fields are not found in West Java, it may be necessary to transport gas from other gas fields such as South Sumatra or East Java in order to respond to the rapidly increasing gas demand.

Fig. 5-1-1 Gas Production Forecast in West Java




### 5.1.2 Gas Transmission in West Java

Pertamina's transmission line is the most important for natural gas transmission in West Java.

The West Java transmission system connects gas fields on the east side of Jakarta and in the demand areas in Jakarta and Cilegon as shown in Fig. 5-1-2. The main line of the system is 218 km long, 24 inches in diameter, with 3 compressor stations. The compressor stations are located at Cilamaya, Tegal Gede and Bitung. The Cilamaya compressor station is the starting point of this pipeline and gases produced offshore and east of Cilamaya are channelled to this station. The system was completed in 1976. The capacity of the main line is 250 MMSCFD.

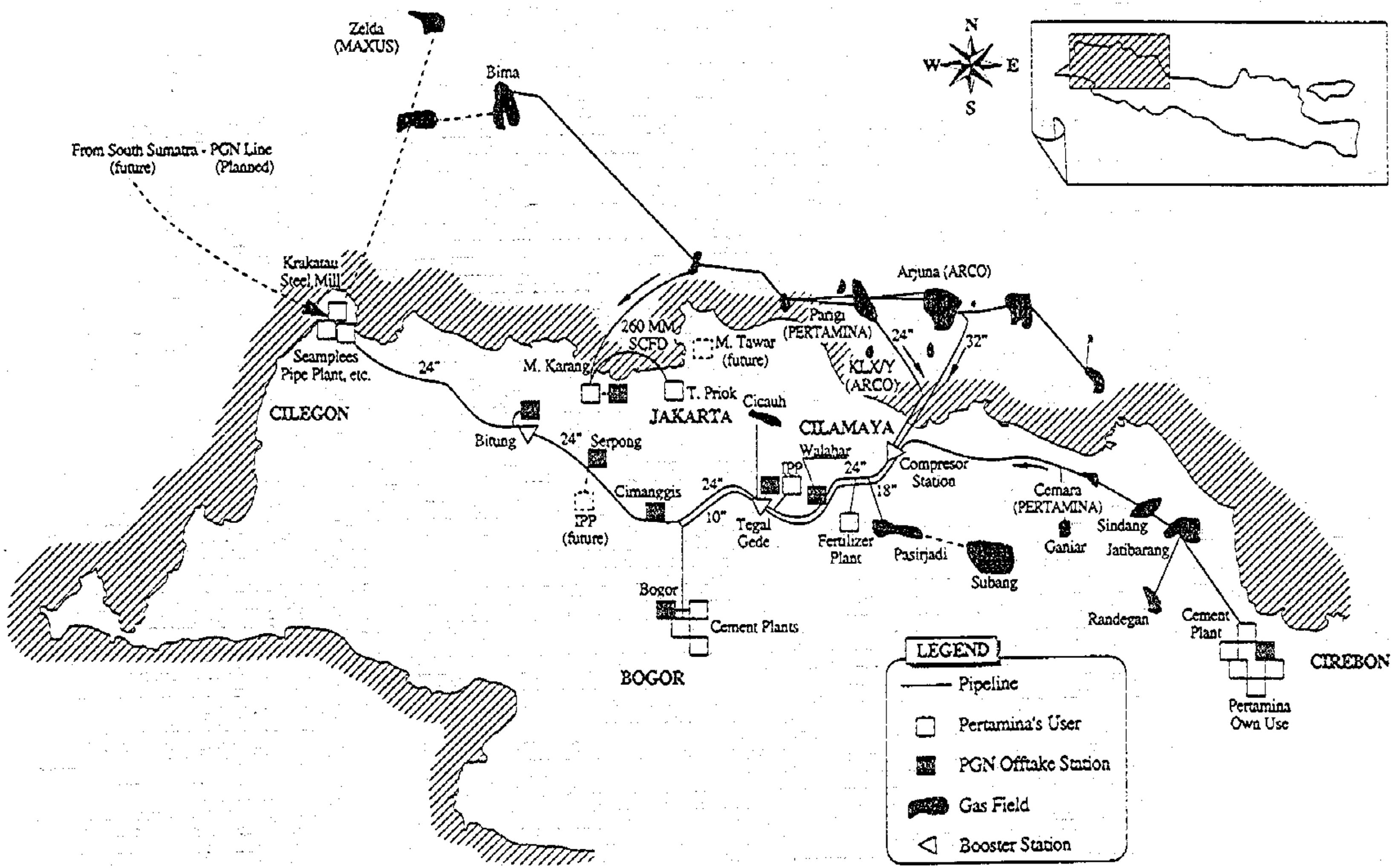
The operating pressure of the system is 10 to 26 bar although the design pressure of the pipeline is 40 bar. The section length and main users of the system are shown in Table 5-1-2.

**Table 5-1-2 Length and Users of West Java Pipeline**

| No | Section | Pipeline | Main Users (MMSCFD) |
|---|---|---|---|
| 1 | Cilamaya - Tegal Gede | 24 inch × 66 km,<br>18 inch × 66 km | Fertilizer Plant (64.3) |
| 2 | Tegal Gede - Bitung | 24 inch × 78 km,<br>10 inch × 27 km | IPP (30.0), PGN Jakarta/Bogor (89.0), Cement Plants (23.2) |
| 3 | Bitung - Cilegon | 24 inch ×78 km | Steel Plants (140.4) |

*Source : Pertamina*

Fig. 5-1-2 West Java Gas Transmission System



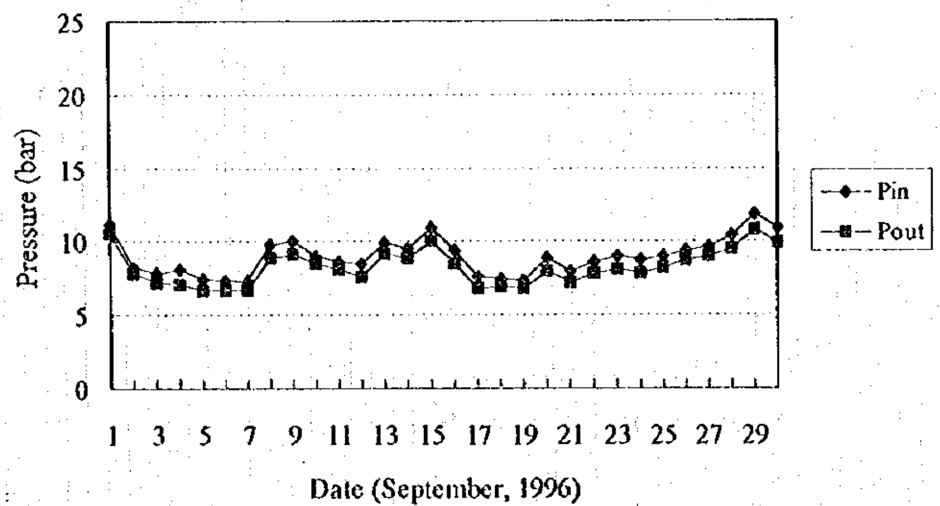

Source : JICA Team

The main users of gas from this line are PGN, an IPP (Cikarang Listrindo) and large factories such as cement plants (Indocement etc.), a fertilizer plant (Pupuk Kujang) and a steel mill (Krakatau Steel). Krakatau Steel is the biggest user which consumes about 140 MMSCFD of gas (55% of the pipeline capacity).

The flow rate of the system seems to reach capacity. As shown in Fig. 5-1-2, an 18 inch pipeline is installed parallel to the main 24 inch pipeline. This line was constructed mainly for transmitting gas to Cikarang Listrindo because the capacity of the main 24 inch line was not sufficient to cope with the demand.

Fig. 5-1-3 shows the inlet and outlet pressure at the PGN Tegal Gede offtake station. As the graph shows, the inlet pressure at Tegal Gede is often lower than 10 bar while 10 bar is the minimum requirement for PGN's system.

**Fig. 5-1-3 Daily Average Pressure at Tegal Gede Station**




*Source : PGN, 1996*

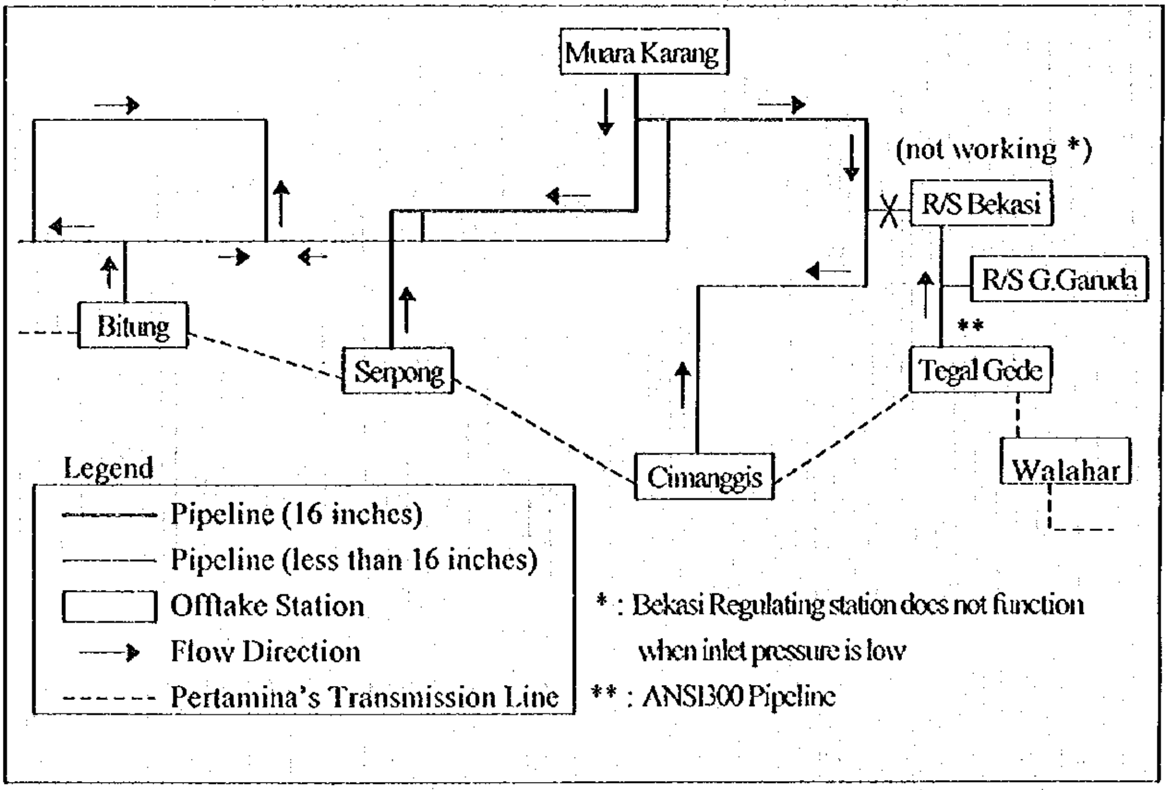
Although the demand in this area is growing, supply and transmission capacity is insufficient. In order to rectify this situation, it will be necessary for onshore gas fields near demand areas such as Subang gas reserve to be developed as soon as possible. Also it is recommended that gas from South Sumatra be utilized efficiently. Currently Cilegon is the terminus of the system and biggest user of the system is located there. However, once gas from South Sumatra is introduced, the West Java area will have two gas sources both from the east and the west and the load of the system will be scattered. This will make it easier to develop gas demand in West Java.

### 5. 1.3 Gas Distribution Status

The distribution system in the PGN Jakarta Branch area consists of 3 networks : (1) a high pressure network (design pressure 16 bar, partially 50 bar), (2) a medium pressure network (design pressure 4 bar), and (3) a low pressure network (design pressure 300 $mmH_2O$). Among these 3 networks, the high pressure network is the most widely developed compared to others. The high pressure network covers from Kab. Tangerang to Kab. Karawang whereas the other two networks are installed over a limited area, mainly downtown Jakarta.

The high pressure network is used for distributing gas to large industrial customers and regulators for the medium and low pressure networks. The network in PGN Jakarta Branch is shown in Fig. 5-1-4.

**Fig. 5-1-4 High Pressure Network in PGN Jakarta Branch**



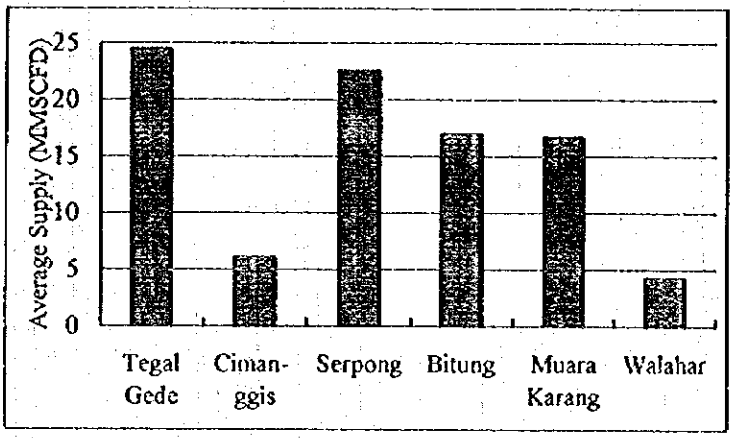

*Source : JICA Team*

The high pressure network receives gas from 6 offtake stations ; Tegal Gede, Cimanggis, Serpong, Bitung, Muara Karang and Walahar. All offtake stations except Muara Karang are located on Pertamina's West-Java transmission line while Tegal Gede and Bitung offtake stations are adjacent to Pertamina's booster stations. The Muara Karang station receives gas directly from PSC ARCO' offshore gas reserves located to the north of Jakarta. The high pressure network connects all of the offtake stations except for Walahar.

Within the high pressure network, the pipeline between Tegal Gede and Bekasi M/S (Metering Station) is of ANSI 300 specification and directly connected to Pertamina's line without a regulator. However, the gas is taken from the upstream of the Tegal Gede booster and the operation pressure is below 15 bar. The design pressure of the remaining high pressure network is 16 bar (ANSI 150) and the current operation pressure is lower than 10 bar. The typical supply from the offtake stations are shown in Fig. 5-1-5.

According to Fig. 5-1-5, the supply from offtake stations located at the suburban areas of Jakarta such as Tegal Gede, Serpong and Bitung is equal to or larger than that from Muara Karang from which gas is supplied to the downtown Jakarta. This means that demand concentrates more at the east and west edge of the system than at the center of the system.

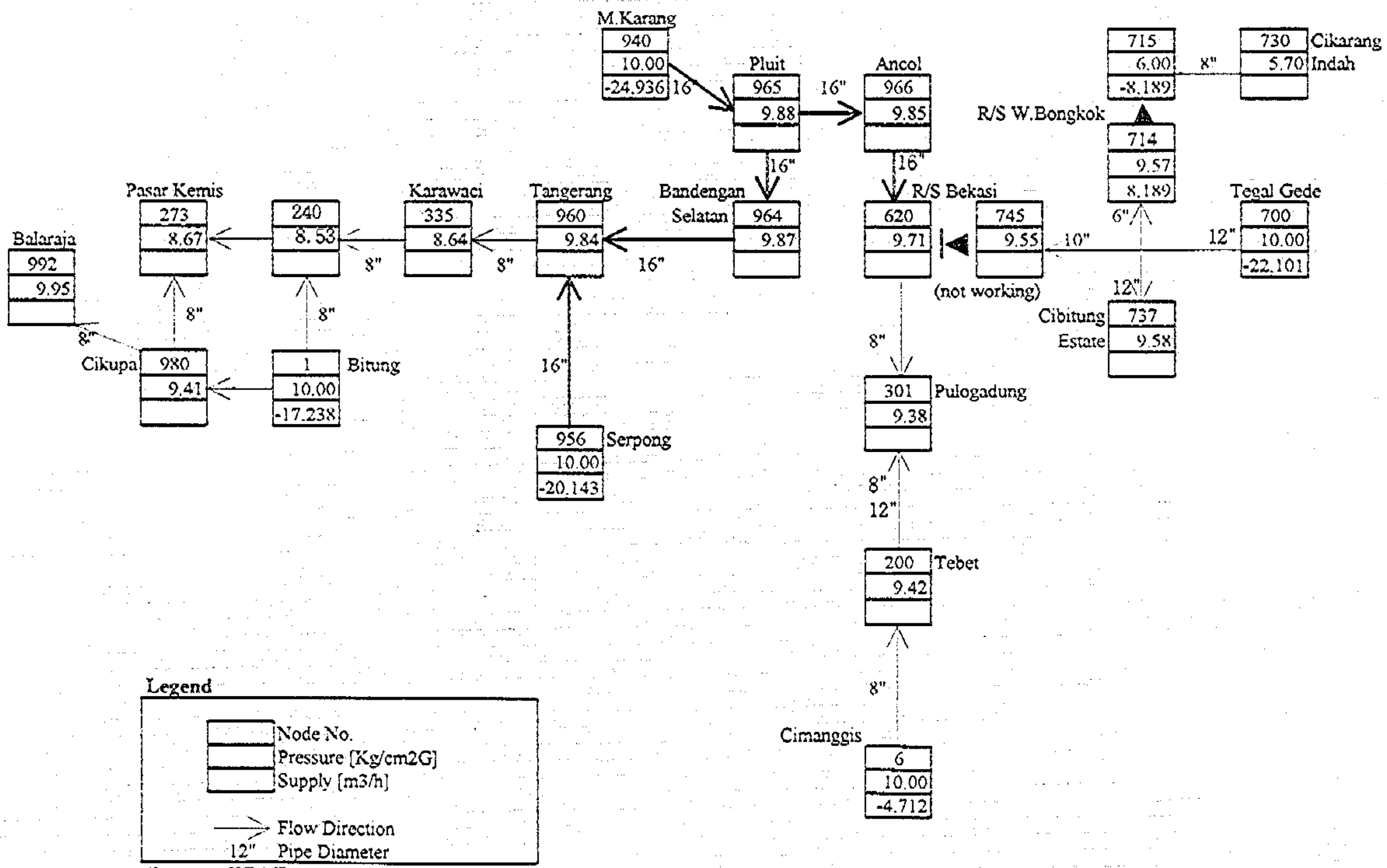
**Fig. 5-1-5 Average Supply from Each Offtake Station**




*Source : PGN, 1996*

According to the results of network analysis, the west part of the high pressure network is weak compared to other parts of the system (Fig. 5-1-6). This is because the pipeline which connects Bitung offtake station and 16 inch main loop pipelines is only 8 inches in diameter and the capacity is limited. Also the size of the pipe from Tegal Gede and Cimanggis stations is less than or equal to 12 inches. A small diameter pipeline directly connected to offtake station often causes a large pressure drop. It may be necessary to increase the capacity of the pipe if demand increases rapidly in the areas that these offtake stations cover.

Fig. 5-1-6 Results of Network Analysis ( 10 bar System )



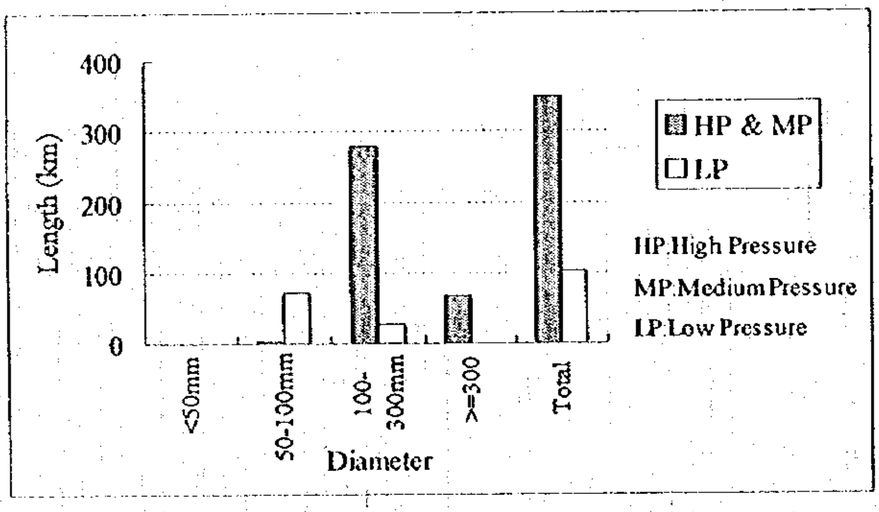

*Source : JICA Team*

The medium and low pressure networks are located in downtown Jakarta and are used for distributing gas to residential and small commercial customers. Since PGN makes an effort mainly to develop industrial demand, the extension of medium or low pressure network is not large compared to the high pressure network. The low pressure network was established about 100 years ago and has problems with gas leakage. The system is currently under repair.

### 5.1.4 Facilities

Fig. 5-1-7 shows the pipeline length of PGN Jakarta Branch.

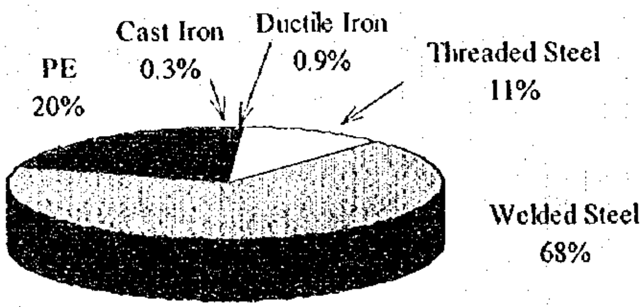
**Fig. 5-1-7 Pipeline Length of PGN Jakarta Branch**




*Source : PGN, 1996*

As Fig. 5-1-7 shows, the length of the high and medium pressure pipelines is more than 3 times longer than that of the low pressure pipeline. The total length of the pipelines is 451 km.

**Fig. 5-1-8 Share of Pipe Materials**




*Source : PGN*

Fig. 5-1-8 shows the materials of the pipelines. 68% of the pipes are made of welded steel and 20% are made of polyethylene. The remaining 12% are made of cast iron, ductile iron and threaded steel which are the target of rehabilitation plans. Currently PGN uses only welded steel and polyethylene pipes for new pipeline construction. After PGN completes the rehabilitation program, the safety level of the distribution system is expected to improve sharply.

Table 5-1-3 shows the number of regulators installed in the PGN Jakarta Branch area. The table verifies that most of PGN's customers are industrial.

**Table 5-1-3 Number of Regulators in PGN Jakarta Branch Area**

| Classification | Operation I Area | Operation II Area | Total |
|---|---|---|---|
| Offtake Station | 3 | 3 | 6 |
| Industrial Use | 128 | 88 | 216 |
| Commercial Use | 6 | 23 | 29 |
| CNG | 4 | 1 | 5 |
| District Regulator | 9 | 21 | 30 |
| Total | 150 | 136 | 286 |

*Source : PGN*

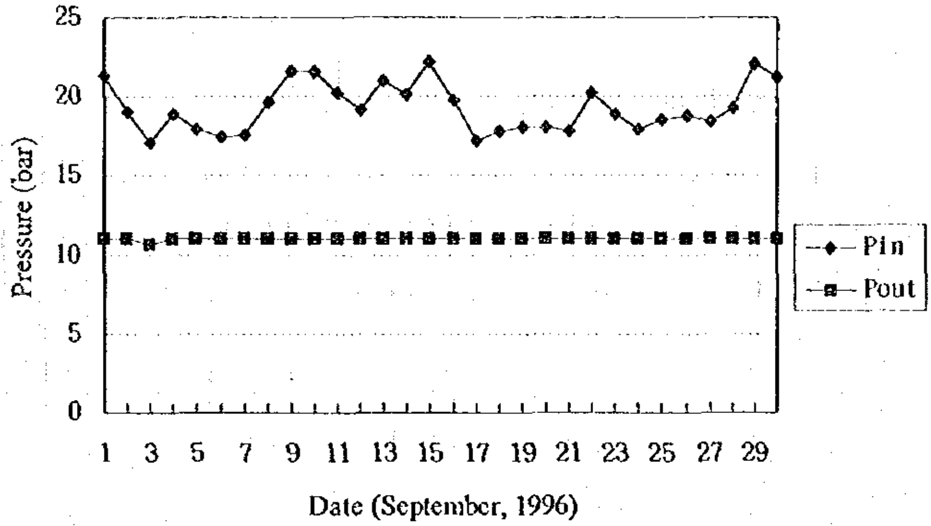
### 5.1.5 Distribution Control and Facility Maintenance

In order to distribute gas safely, steadily and economically to customers, distribution control and facility maintenance are important.

In the case of the PGN Jakarta Branch, gas distribution is controlled by manually changing the outlet pressure at offtake stations in accordance with the fluctuation of demand. In order to maintain stable distribution to customers, it is necessary to keep outlet pressure at offtake stations stable. However, it is sometimes very difficult to keep the stable outlet pressure since the arriving pressure at some offtake stations becomes lower than 10 bar. Fig. 5-1-9 and Fig. 5-1-10 show the inlet pressure (Pin) and the outlet pressure (Pout) from Cimanggis and Serpong offtake stations respectively.

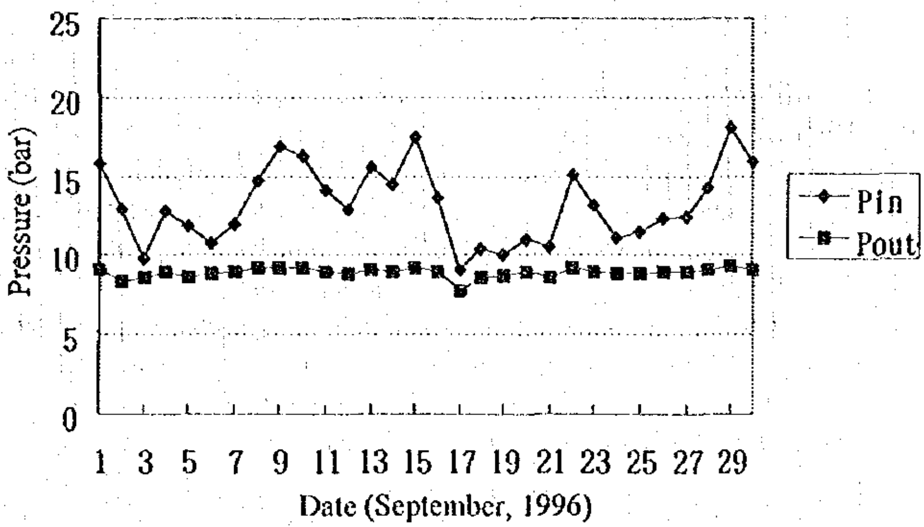
From the graphs, we understand that the outlet pressure from Serpong offtake station becomes lower than usual when the inlet pressure at the station is lower than 10 bar, as on September 3 and 17, although the outlet pressure from Cimanggis was kept stable since the inlet pressures were always higher than 15 bar.

**Fig. 5-1-9 Daily Average Inlet and Outlet Pressures at Cimanggis Station**
(Pin : inlet pressure at station ; Pout : outlet pressure from station)




*Source : PGN, 1996*

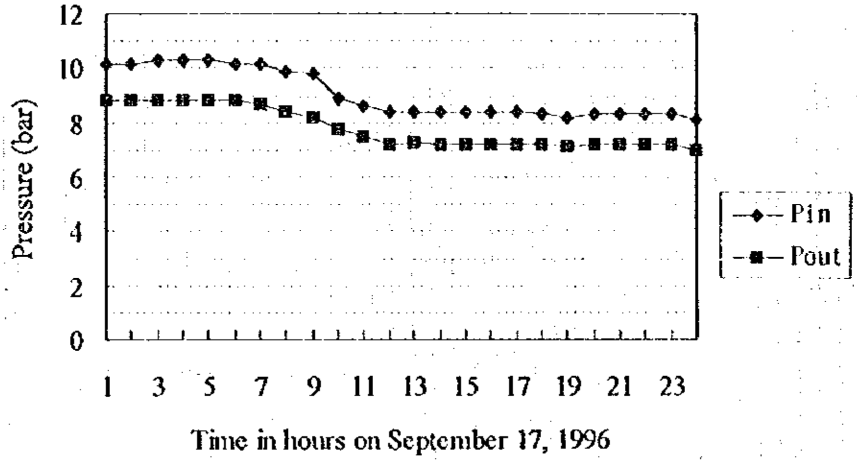
**Fig. 5-1-10 Daily Average Inlet and Outlet Pressures at Serpong Station**
(Pin : inlet pressure at station ; Pout : outlet pressure from station)




*Source : PGN, 1996*

As Fig. 5-1-11 shows, there exists a tendency for the arriving pressure to remain below 10 bar for some hours, once it has dropped to that level. According to the results of a hearing, a manual bypass operation is sometimes executed at Serpong Station. Since the arriving pressure at Serpong station depends on discharge pressure from Pertamina's Tegal Gede booster station, it is recommended that PGN keep a good comunication with Pertamina and let them know the current pressure at Serpong so that Pertamina rise the discharge pressure from the booster station.

**Fig. 5-1-11 Example of Hourly Inlet and Outlet Pressures at Serpong Station**




*Source : PGN, 1996*

At PGN's offtake stations, staff are working 24 hours in order to record distribution data such as flow rate, pressure, and temperature and also to control the outlet pressure. However, it is also necessary to monitor distribution pressures at places other than offtake stations to maintain a sound distribution. In ordinary distribution systems, self-recording pressure gauges are set up at the inlet and outlet of district regulators so that we can review the distribution pressures after withdrawing recording charts. Although PGN does not have pressure recorders installed, it is recommended that this be done.

As for facility maintenance, the following items are important : leak detection surveillance, anti-corrosion control, preventive maintenance of regulators and valves, and the protection of facilities from third party activities. Although PGN administrates these items, the organization which controls third party activities should be strengthened in order to avoid accidents, as a subway system will be constructed in the near future.

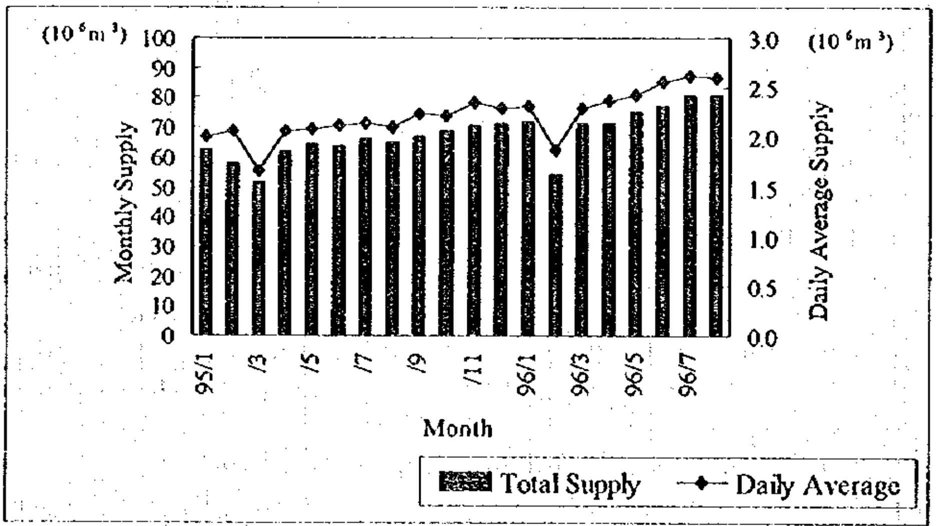
## 5.2 Gas Load Fluctuations

### 5.2.1 Gas Flow Fluctuations

Survey on gas flow fluctuation is important for network design because pipelines are designed using the scale of cubic meter per *hour* while the gas demand is usually estimated by the scale of cubic meter per *year* or *month*. If fluctuation is very large, it is necessary to introduce a conversion factor when we calculate the hourly pipeline load from the estimated demand instead of merely dividing the demand estimated by hours.

In order to investigate seasonal fluctuation, monthly gas supplies from January 1995 to August 1996 were studied. The result is shown in Fig. 5-2-1.

**Fig. 5-2-1 Monthly Supply to PGN Jakarta Branch**

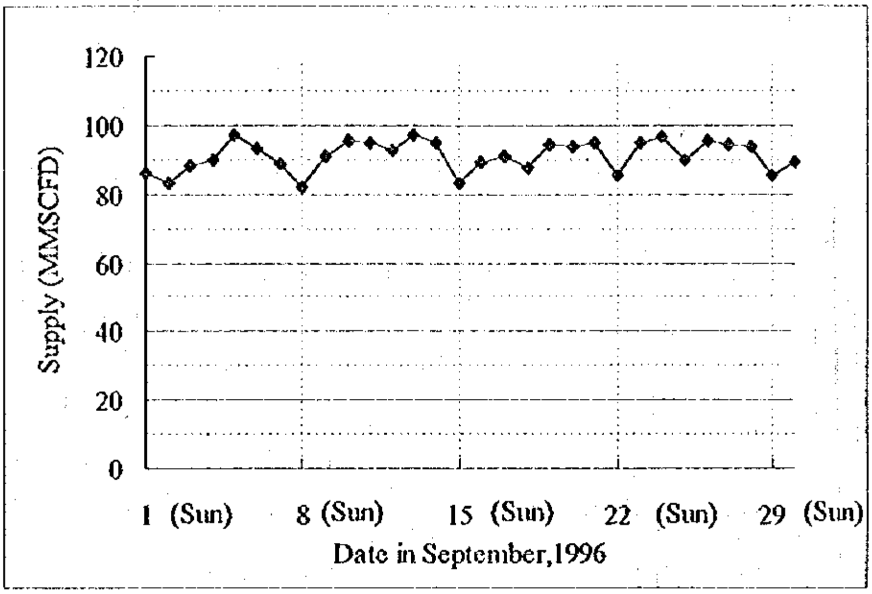



*Source : PGN, 1996*

As the above graph shows, supply increases gradually month by month. This is the result of sales activities. Compared with other months, supply in February and March is rather small. This is mainly because of Ramadan. From the graph, we can conclude that the seasonal fluctuation is not large except in the period of Ramadan.

In order to investigate the daily and hourly fluctuations, log data at offtake stations is reviewed. The supply from 6 offtake stations, Tegal Gede, Cimanggis, Serpong, Muara Karang, Bitung and Walahar, is added and the daily fluctuation of supply is investigated as shown in Fig. 5-2-2.

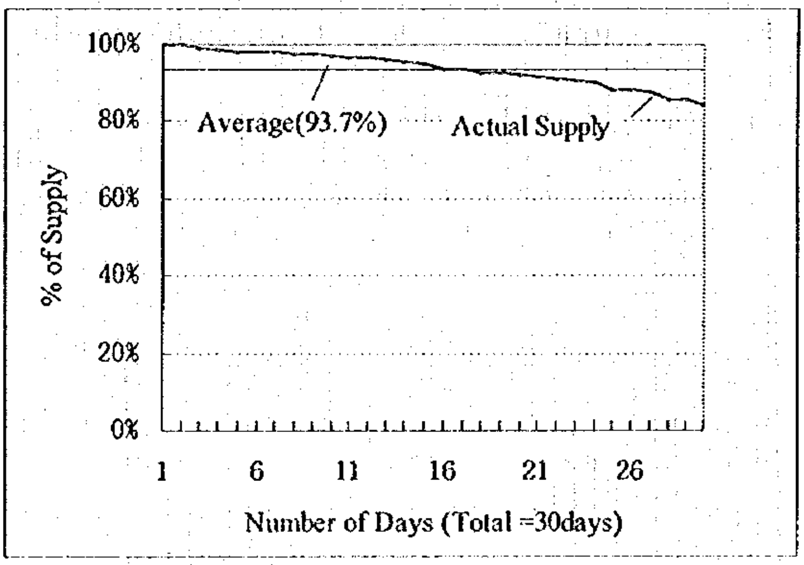
Fig. 5-2-2 Daily Supply to PGN Jakarta Branch




*Source : PGN, 1996*

Although the supply on Sundays is apt to be smaller than on other days as the figure shows, daily supply on the whole does not fluctuate greatly. In order to evaluate the magnitude of fluctuation, we rearranged the order from the biggest to the smallest and constructed a duration curve. (Fig. 5-2-3)

Fig. 5-2-3 Duration Curve Drawn from Supply in September 1996

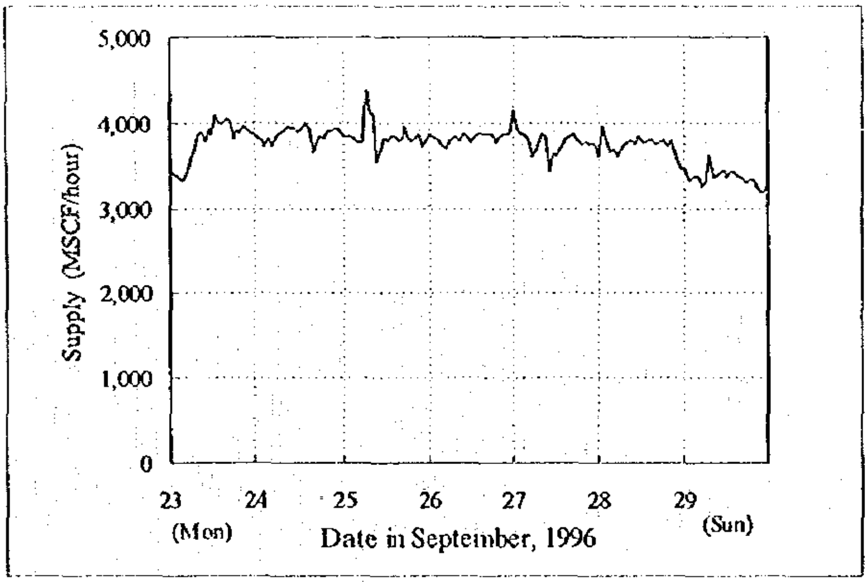



*Source : JICA Team*

From Fig. 5-2-3, we understand that the average daily supply is 93.7% of that on the maximum day and even on the minimum day, supply is more than 80% of the maximum supply. This means that the usage ratio of facilities is very high.

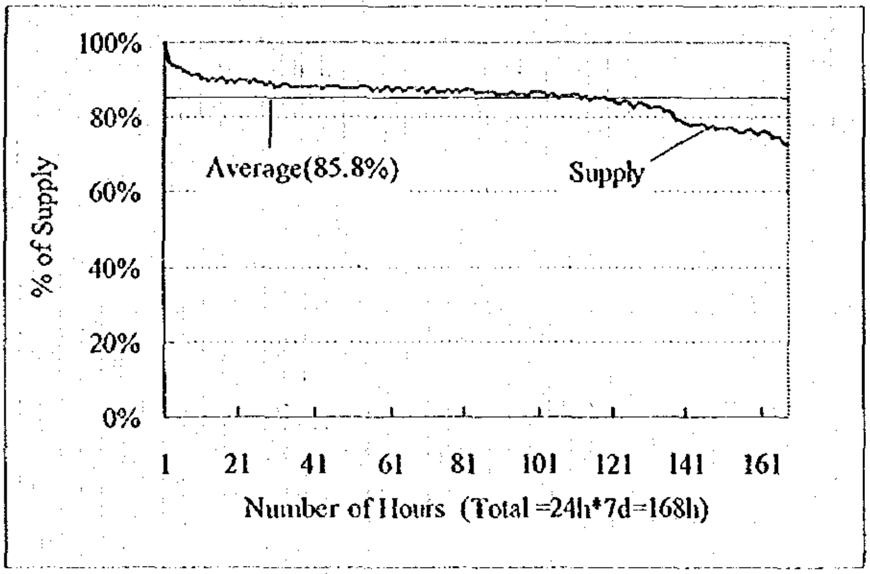
In order to review hourly fluctuation, hourly supply to PGN Jakarta Branch from September 23 (Monday) to 29 (Sunday) was also surveyed and the results are shown in Fig. 5-2-4 and Fig. 5-2-5. (In this survey, supply from Walahar is not included since hourly data is not available at Walahar.)

**Fig. 5-2-4 Hourly Supply to PGN Jakarta Branch**




*Source : PGN, 1996*

**Fig. 5-2-5 Duration Curve Drawn from Hourly Supply Data**




*Source : JICA Team*

From Fig. 5-2-4 and Fig. 5-2-5, we understand that the hourly supply does not fluctuate much either. This is because the most of the customers in PGN Jakarta Branch are industrial and most of them use gas 24 hours constantly.

### 5.2.2 Demand Fluctuations in the Residential Sector

The hourly load fluctuation should not be neglected after the number of customers in residential sector increases because customers in the residential sector use gas intermittently and the consumption of gas concentrates at certain times. In order to clarify the actual gas usage in the residential sector of PGN quantitatively, load surveys were conducted during the second field work with the great cooperation of PGN staff.

The load survey for residential customers was conducted in the following manner:

(1) By Changing a customer's gas meter to a "load survey gas meter" which dispatches
pulses in response to the amount of gas used. Also set a data logger which receives and stores the pulse data from the load survey meter.
(2) Recording the usage data for certain weeks.
(3) Withdrawing the recorded data and change the gas meter to the original one.

We made a load survey program targeting residential customers and the actual gas usage of 7 customers were surveyed. Table 5-2-1 lists the load survey customers and their characteristics.

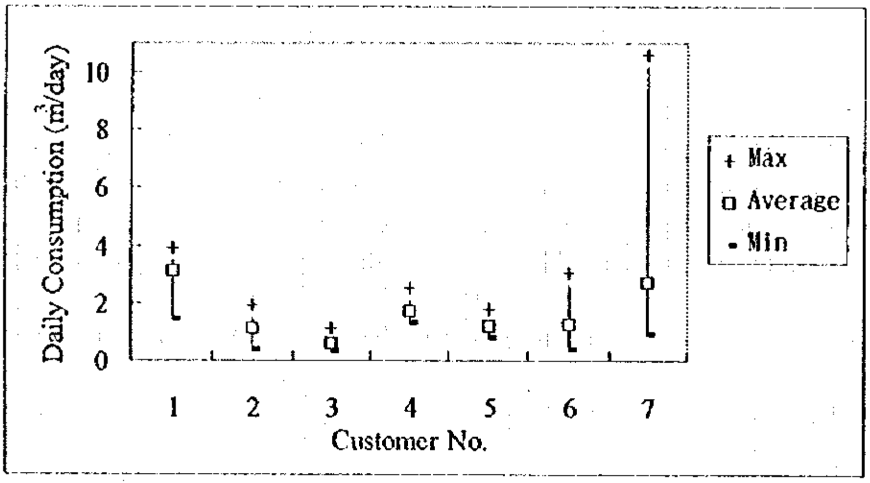
**Table 5-2-1 Load Survey Customers**

| No | Duration of Survey (1996) | | Gas Consumption ($m^3$) | Purpose of Gas Usage |
|---|---|---|---|---|
| | Starting Date | Ending Date | | |
| 1 | October 2 | October 23 | 58.8 (2.80) | Cooking |
| 2 | October 2 | October 23 | 24.5 (1.17) | Cooking |
| 3 | October 1 | October 24 | 13.1 (0.57) | Cooking |
| 4 | October 1 | October 24 | 39.3 (1.71) | Cooking |
| 5 | October 23 | November 12 | 24.2 (1.21) | Cooking & Shower |
| 6 | October 23 | November 12 | 24.5 (1.22) | Cooking |
| 7 | October 24 | November 11 | 47.8 (2.65) | Cooking |

*( ) shows average daily consumption.
*Source : JICA Team*

The maximum, average and minimum of the daily gas consumption of these customers are shown in Fig. 5-2-6.

**Fig. 5-2-6 Daily Gas Consumption of Each Customer**

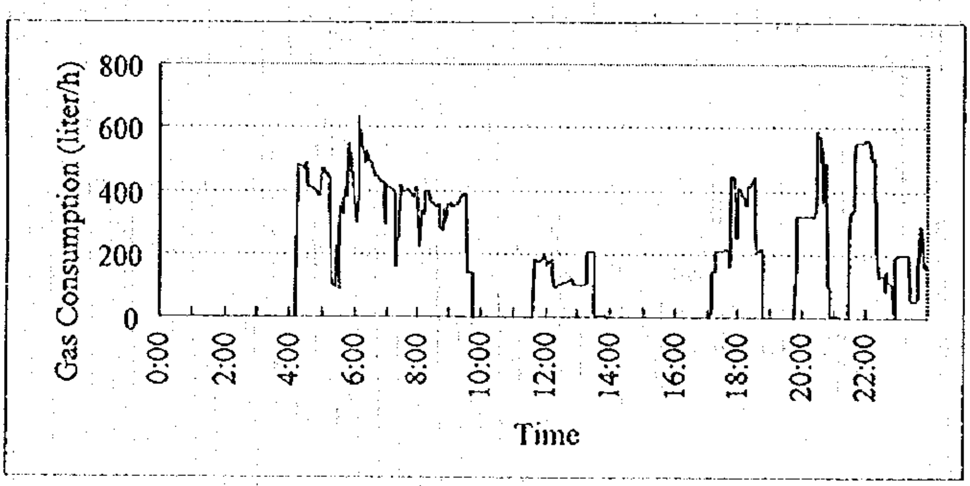



*Source : JICA Team*

From the figure, we understand that average consumption is less than 4 $m^3$/day and the maximum is also less than 4 $m^3$/day except for customer No. 7. According to the hearings conducted during the load survey, No. 1 and No. 7 customers sometimes cooked foods not only for their own use but also for selling. This makes the gas consumption of these customers rather high compared to other customers.

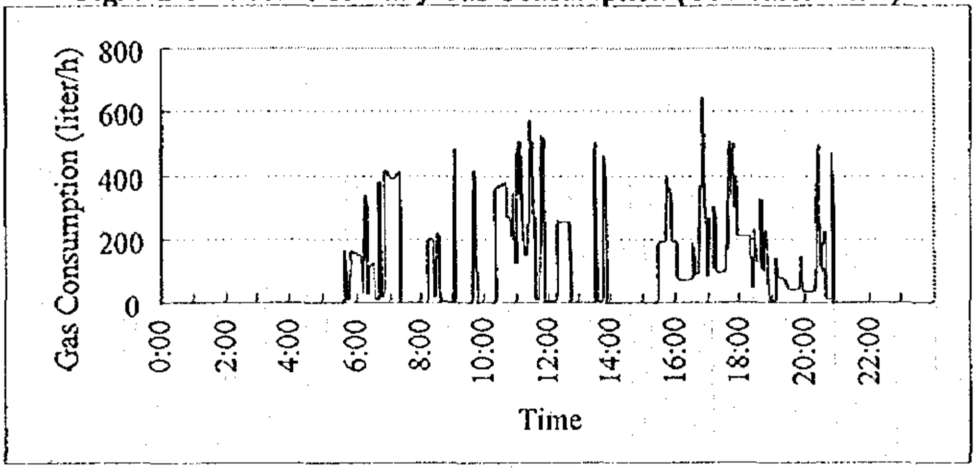
Fig. 5-2-7 to Fig. 5-2-13 show the profiles of each customer's consumption on the day when each daily gas consumption was the maximum.

**Fig. 5-2-7 Profile of Daily Gas Consumption (Customer No. 1)**



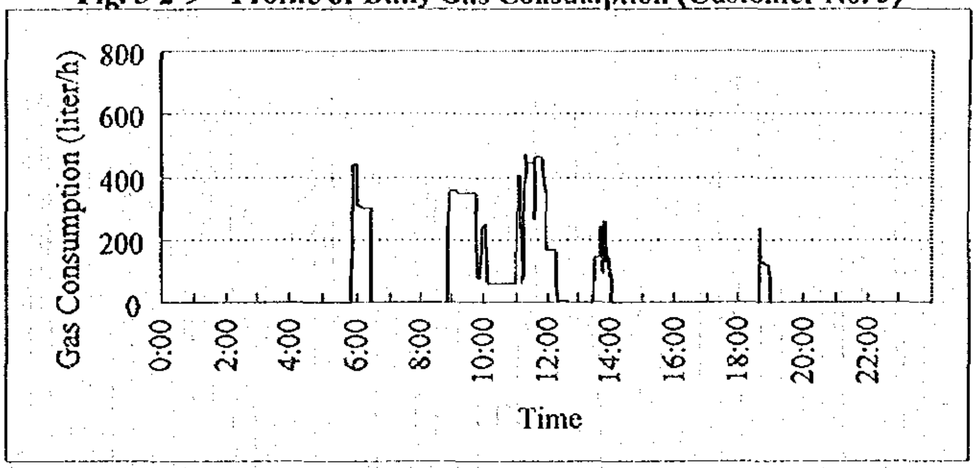

*Source : JICA Team*

**Fig. 5-2-8 Profile of Daily Gas Consumption (Customer No. 2)**



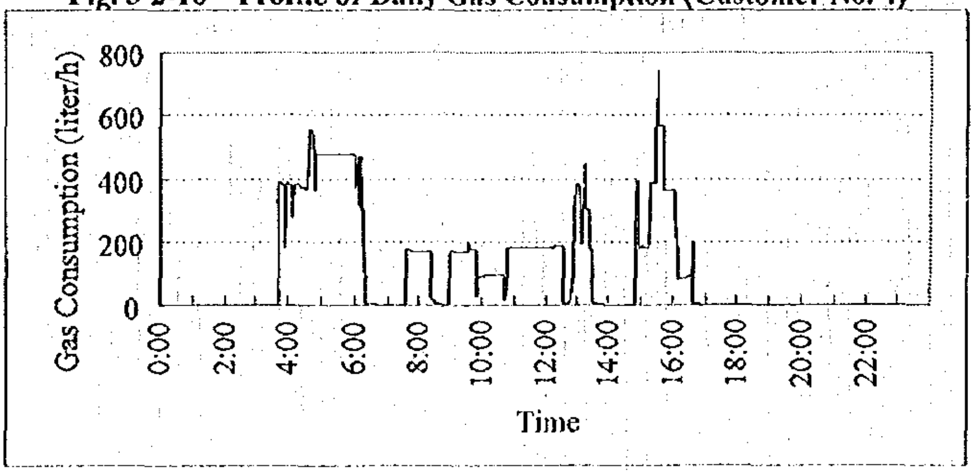

*Source : JICA Team*

**Fig. 5-2-9 Profile of Daily Gas Consumption (Customer No. 3)**



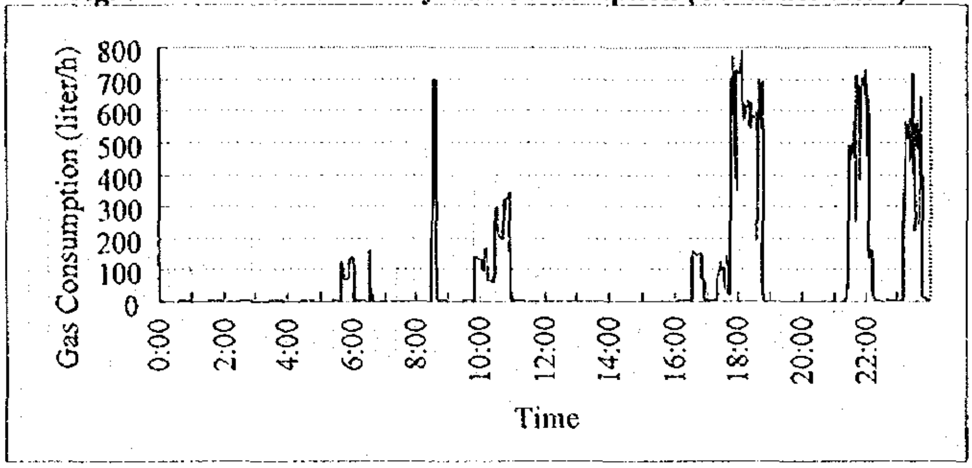

*Source : JICA Team*

**Fig. 5-2-10 Profile of Daily Gas Consumption (Customer No. 4)**



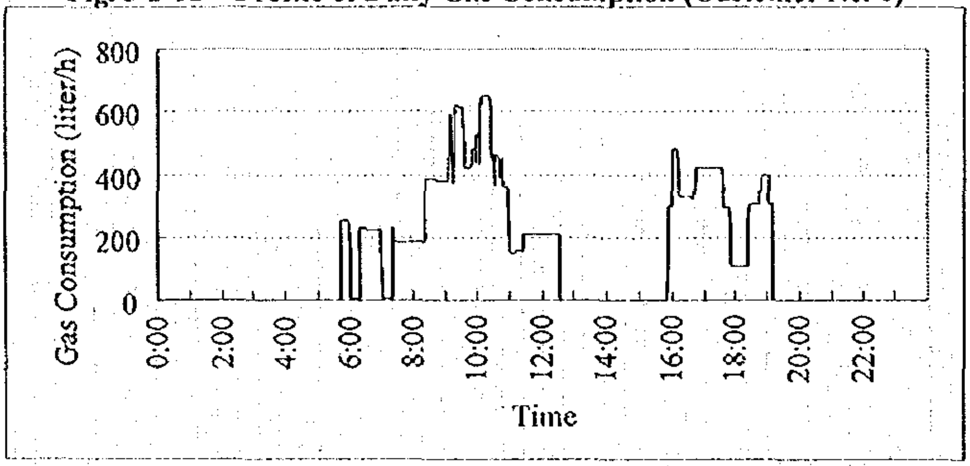

*Source : JICA Team*

Fig. 5-2-11 Profile of Daily Gas Consumption (Customer No. 5)



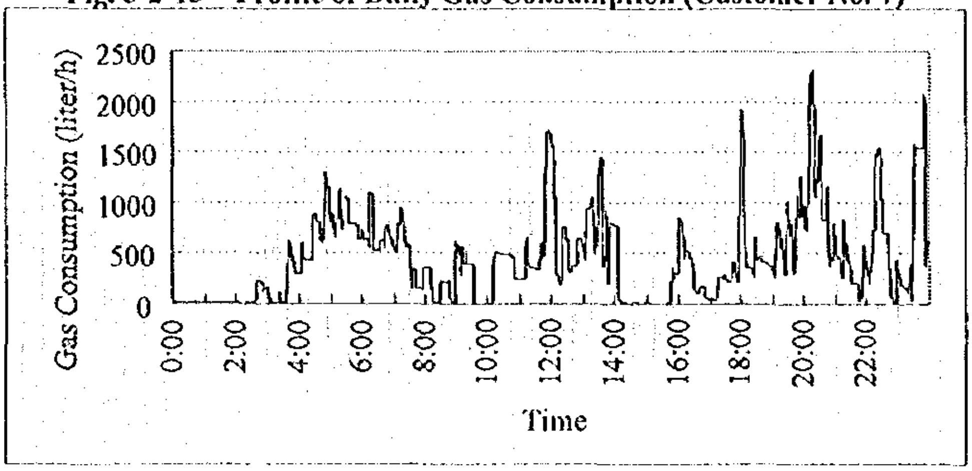

*Source : JICA Team*

Fig. 5-2-12 Profile of Daily Gas Consumption (Customer No. 6)




*Source : JICA Team*

Fig. 5-2-13 Profile of Daily Gas Consumption (Customer No. 7)




*Source : JICA Team*

From these graphs, we see the following characteristics :

(1) Gas consumption patterns widely differ from customer to customer.
(2) Except for customer No. 7, the maximum gas consumption is less than 0.75 $m^3/h$.
(As mentioned before, customer No. 7 uses gas not only for own use, but also for preparing food for selling. No. 7 customer can be regarded as a small commercial customer.)

In order to study the actual gas consumption status quantitatively, we arranged the load survey data and made a database which consists of every 15 minute gas consumption data. The structure of the database is shown in Table 5-2-2 and Table 5-2-3.

**Table 5-2-2. Structure of 15 Minute Gas Consumption Data Base**

| No. | Data No. | 1 | … | 18 | … | 131 | … | 137 |
|---|---|---|---|---|---|---|---|---|
| | Time | Customer No. 1 | | | … | Customer No. 7 | | |
| | | Day 1 | … | Day $n_1$ | … | Day 1 | … | Day $n_7$ |
| 1 | 0:00-0:15 | | | | | | | |
| 2 | 0:15-0:30 | | | | | | | |
| | | | | | | | | |
| 96 | 23:45-24:00 | | | | | | | |

*Source : JICA Team*

**Table 5-2-3 Data Number Corresponding to Each Customer**

| Customer | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| No. of Days | 18 | 20 | 22 | 22 | 19 | 19 | 17 |
| Data No. | 1-18 | 19-38 | 39-60 | 61-82 | 83-101 | 102-120 | 121-137 |

*Source : JICA Team*

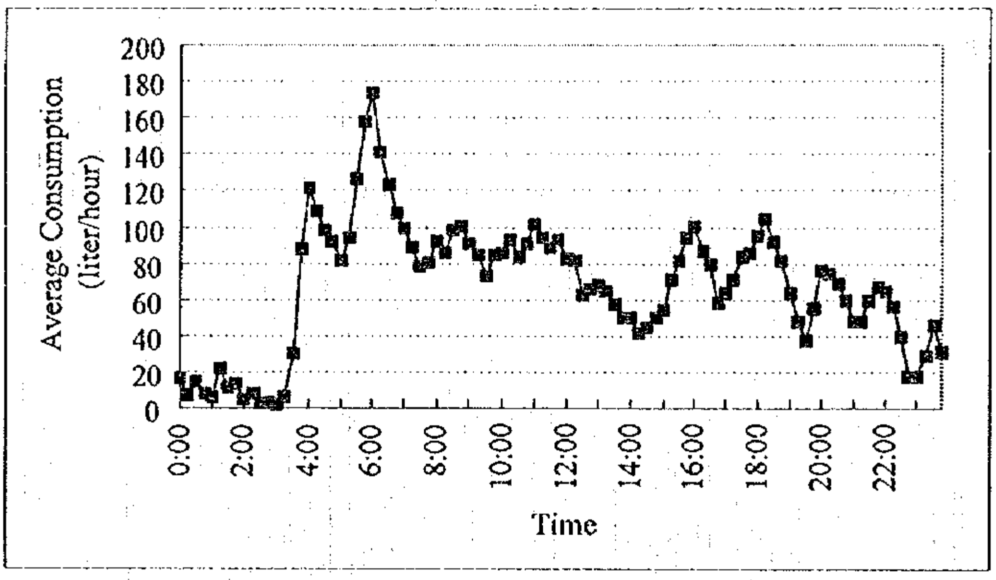
As shown in Table 5-2-2, the database contains $96(=4\times24)\times137=13{,}152$ data entries in total and every cell in the database represents gas consumption in the corresponding day's 15 minute by *liter/hour* units.

Using the database, we first estimated the time of peak use by residential customers by calculating the average gas consumption of the 137 15-minute entries. The result is shown in Fig. 5-2-14.

From Fig. 5-2-14, we find the following characteristics :

(1) The peak time of gas in the residential sector is early in the morning ( 5:45 - 6:45).
(2) Gas is continuously used except in the middle of the night although the amount of gas consumption in the day time is about half of that in the peak time.

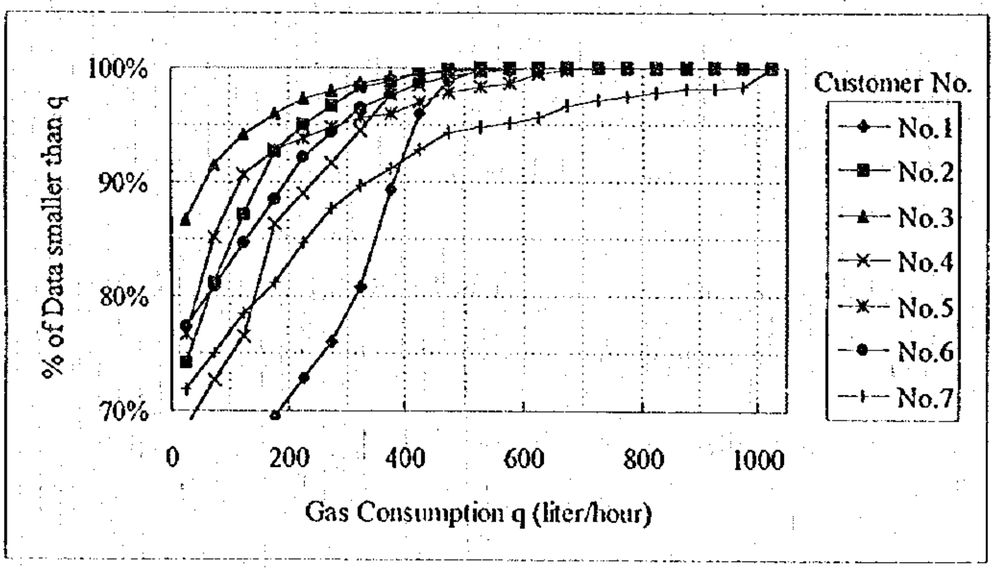
**Fig. 5-2-14 Average Gas Consumption Every 15 Minutes**




*Source : JICA Team*

Secondly we reviewed the maximum gas consumption flow rate of each customer. The results are shown in Fig. 5-2-15.

**Fig. 5-2-15 Distribution of Gas Consumption in Each Customer**




*Source : JICA Team*

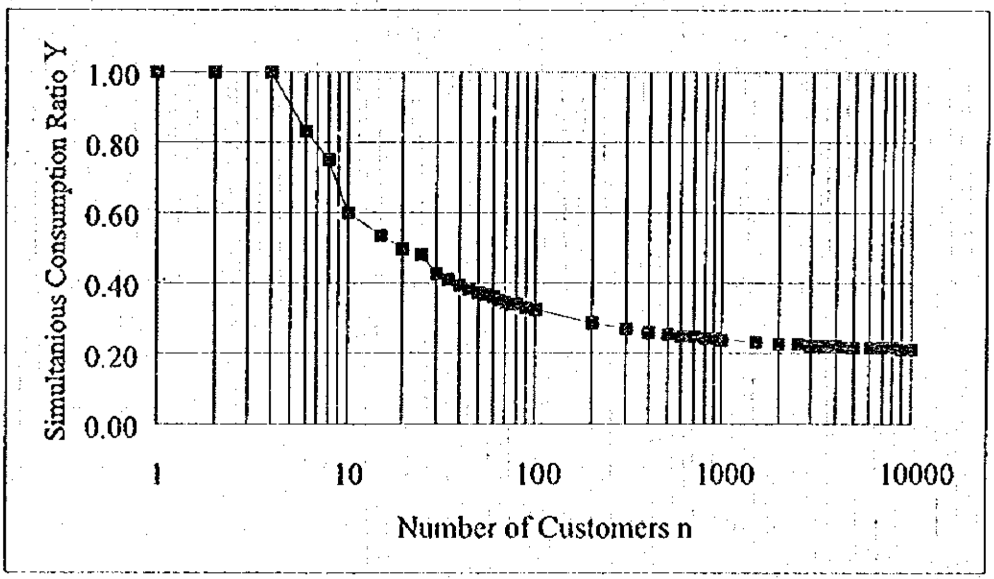
From Fig. 5-2-15, we understand that the gas consumption rate of a residential customer seldom exceeds 0.60 $m^3$/h except for customers No. 5 and No. 7. Here, customer No. 5 uses gas not only for cooking but also for showers. Also the customer No. 7 has more gas appliances than ordinary customers. Therefore, if we target standard residential customers who have only one table top cooker, 0.60 $m^3$/h is suitable as the design load of one customer.

### 5.2.3 Simultaneous Consumption Ratio for Residential Customers

When we design a distribution system for a group of residential customers, it is necessary to estimate the pipeline load as a whole. Suppose there exists a group of $n$ housing units which use the same type of gas appliances with the input of $q$ [$m^3$/h]. Then, the total load of the group is usually smaller than $n \times q$ since all customers do not necessarily use gas at the same time. Using the simultaneous consumption ratio Y, we can express the total load of n customers as $q \times n \times Y$ and the load per customer as $q \times Y$.

Using the statistic theory discussed in the Appendix, the simultaneous consumption ratio Y can be induced from binomial distribution and normal distribution functions. The values of Y obtained from the load survey data are shown in Fig. 5-2-16. These values are used for estimating residential customer loads in the Master Plan and the Feasibility Study.

**Fig. 5-2-16 Simultaneous Consumption Ratio for Residential Customers**




*Source : JICA Team*

## 5.3 Gas Network Expansion Plan

PGN has the network expansion plan of both the transmission system and the distribution system. As for the transmission line, PGN is currently preparing 2 projects, Central Sumatra Project and South Sumatra Project.

The main line of the Central Sumatra Project transmits gas from Gerisk to Duri and a branch line extends from Jambi to Batam Island. Currently this project is in the stage of contractor bid and selection and is expected to be completed at the end of September 1998. As for the section between Gerisk and Duri, PGN only transmits gas for Caltex and receives a toll fee. After the completion, the line is expected to contribute to the development of small and medium size gas reserves along the line. As for the branch line, PGN buys gas at Jambi from Pertamina and sells to PGN's customers in Batam Island where large industrial estates exist. This project is supported by ADB, JEXIM and other investors.

The South Sumatra Project aims at responding to the rapid gas demand increase in West Java. Originally this project consisted of 3 parts ; (1) gas reserve development, (2) a 370 km transmission pipeline, and (3) the high pressure distribution system. But the first part was eliminated from the project and currently the project consists of the transmission line and the distribution system. Construction work on the transmission line will start from December 1998 and will be completed in September 2000. Operation is expected to begin in November 2000. The South Sumatra Project is financially supported by The World Bank.

As for the distribution pipeline, PGN has been studying several options for developing industrial gas demand in West Java. Among these options, Table 5-3-1 shows the amount of gas demand to be developed and the pipe length to be installed in a case of 500 MMSCFD demand and ANSI 150 system.

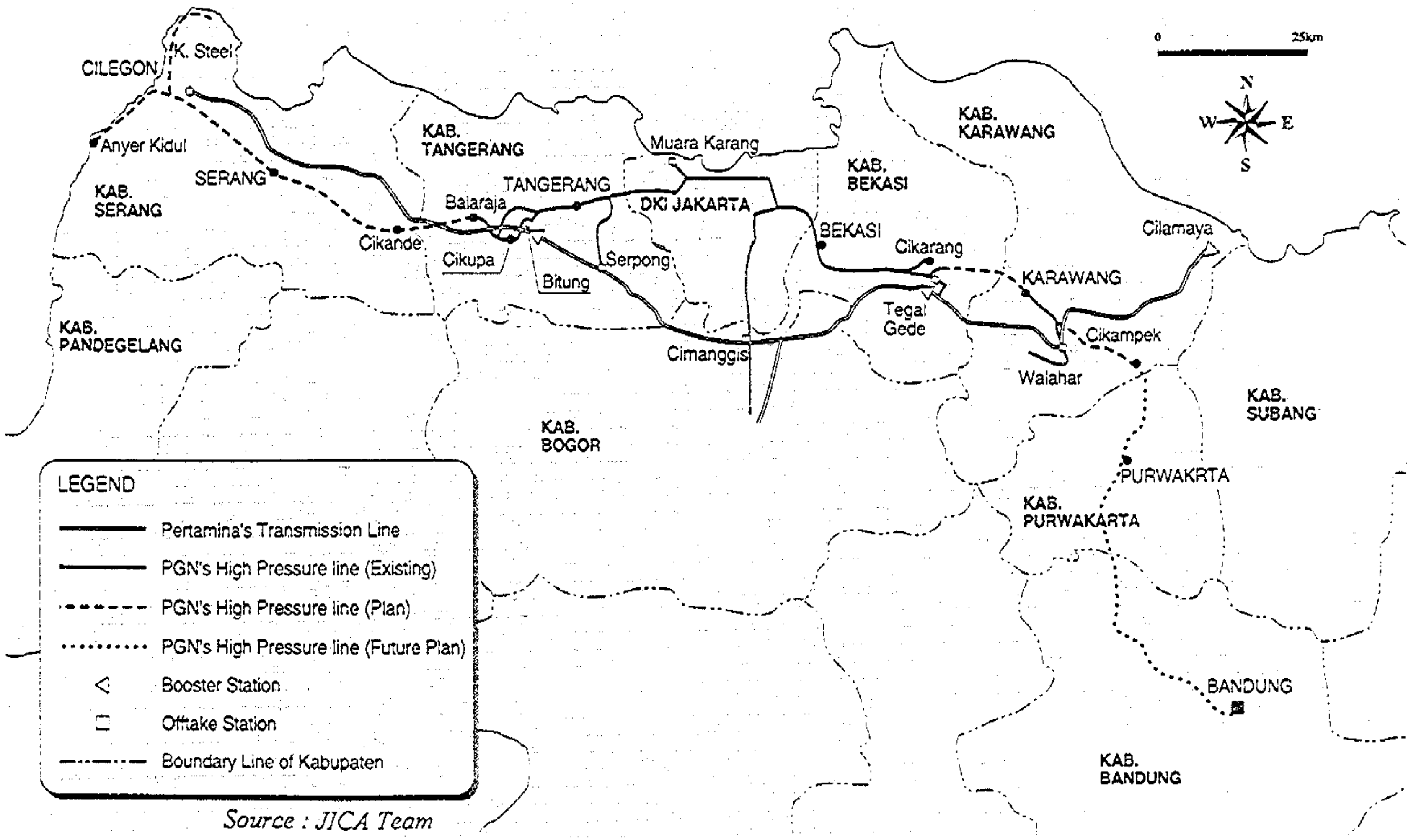
**Table 5-3-1 PGN's West Java Pipeline Expansion Plan**
**(500 MMSCFD and ANSI 150 Case)**

| .No | Area | Demand (MMSCFD) | Number of Customers: Factories | Number of Customers: Industrial Estate | Length (km) | Cost ($1,000) |
|---|---|---|---|---|---|---|
| 1 | Central | 189 | 325 | 5 | 16.250 | 13,287 |
| 2 | West | 94 | 60 | 16 | 111.050 | 30,893 |
| 3 | East | 215 | 56 | 25 | 128.250 | 30,409 |
| | Total | 498 | 441 | 46 | 256.550 | 74,589 |

*Source : PGN*

This master plan is synchronized with the construction of the transmission line from South Sumatra and gas demand development activities have already started. Fig. 5-3-1 shows the outline of the distribution pipeline expansion plan.

# Fig. 5-3-1 PGN's Pipeline Expansion Plan



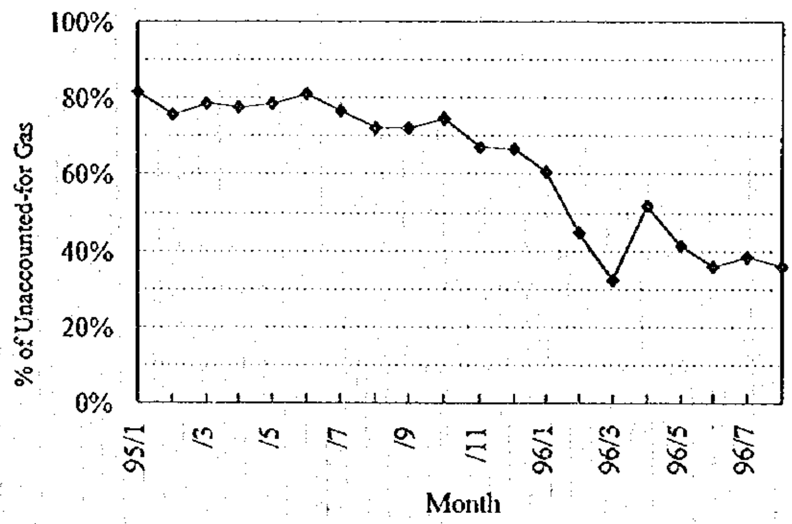

*Source : JICA Team*

## 5.4 Rehabilitation Status and Issues

In downtown Jakarta, PGN has old pipelines which have caused gas leakage. PGN began low pressure system rehabilitation in 1990 in order to reduce unaccounted-for gas and to maintain safety. In the rehabilitation program, isolated sectors are established by cutting off old pipelines from existing 'live' pipelines. According to the rehabilitation plan, more than 30 sectors have been prepared. Among these sectors, 29 sectors are already finished or are being worked on now.(Fig. 5-4-2) In 1996, 45 km of pipeline will be reconstructed. Next year 4 sectors are planned for rehabilitation.

Fig. 5-4-1 shows the change of unaccounted-for gas from January 1995. It seems that unaccounted-for gas is decreasing as the rehabilitation plan progresses.

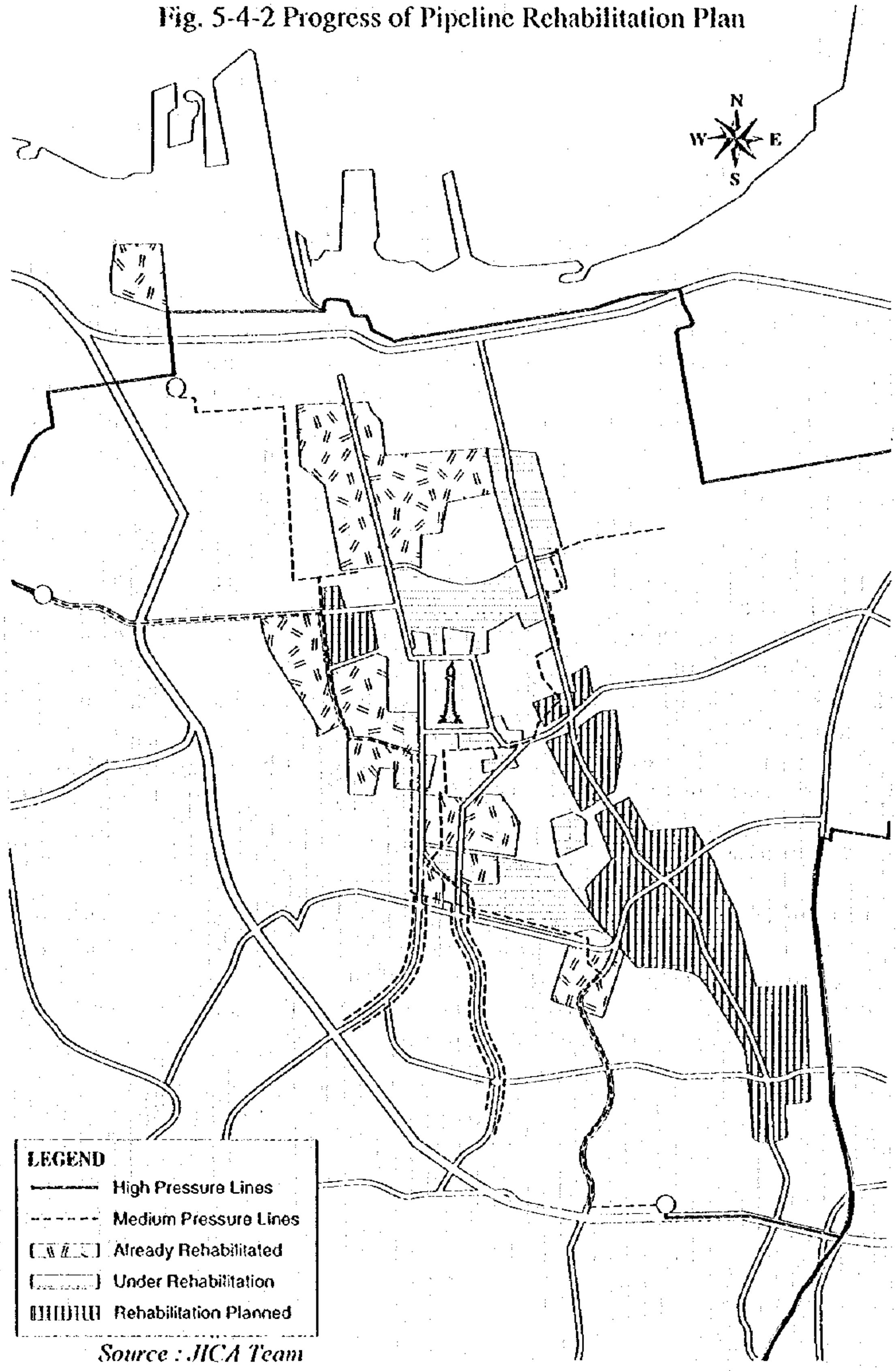
**Fig. 5-4-1 Decrease of Unaccounted-for Gas**




*Source : PGN, 1996*

An issue of rehabilitation is that the number of customers who use gas from the rehabilitated new pipeline is small. For example, two sectors in Operation I of Jakarta branch will be planned for rehabilitation next year. However, the pipeline length per customer is more than 80m. It is recommended to make an effort for the sales promotion to residential customers who do not use natural gas at the time of rehabilitation.

Fig. 5-4-2 Progress of Pipeline Rehabilitation Plan




*Source : JICA Team*

## 5.5 Pipeline Costs

The unit price for construction work to be used for estimating the gas pipeline construction cost in the current development and investigation was calculated on the basis of the amount which was given by PGN.

Amongst the items of construction material, import items are few and limited to gas pressure regulators, gas meters, polyethylene pipes, electro-fusion fittings, etc. PGN has recently imported polyethylene lining steel pipes from the Republic of Korea and adopted for high-pressure trunk pipelines. Since polyethylene lining pipes are not manufactured in Indonesia, it is inevitable to rely upon importation if their application is intended. However, their application for the present purpose is not due to the results of pursuing specifically the quality from the viewpoint of corrosion protection, but to the price of polyethylene lining pipes which is lower than that of asphalt lining pipes made in Indonesia. Under the circumstances, it seems unlikely that polyethylene lining pipes will continue to be imported.

### 5.5.1 Construction Cost of the Distribution Network

Two departments of PGN manage the construction cost of pipelines. One is the Material Department and the other is the Construction Department. The JICA Team has obtained information on the cost of materials from PGN as in Table 5-5-1 and Appendix. Since the costs in different years were included in that data, it was corrected to the year of 1996 by the Team. Furthermore, the Team added certain business profits of the construction companies. Costs of construction work for special pipelines such as bridge pipes are estimated separately.

### 5.5.2 Construction Cost of Indoor Pipes

Branches of PGN have the data of the construction cost of indoor pipes. Standard construction cost of indoor pipes was calculated from the quotation submitted to customers by the Jakarta Branch. Table 5-5-2 shows the unit price for the construction of indoor pipes. As the costs estimated by contractors vary depending upon contractor and site, average values are used for calculations.

**Table 5-5-1 Pipeline Network Construction Costs**

| Materials | Size | Note | Total Cost unit | Pipeline/Facility Cost(Rp/m) Material | Construction | Supervising |
|---|---|---|---|---|---|---|
| Steel Pipe | 16 inch | more than 10bar | 426,000 | 185,000 | 170,000 | 71,000 |
| | 12 inch | | 317,000 | 115,000 | 149,000 | 53,000 |
| | 10 inch | | 268,000 | 92,000 | 131,000 | 45,000 |
| | 8 inch | | 221,000 | 66,000 | 118,000 | 37,000 |
| Steel Pipe | 16 inch | 4-10 bar | 355,000 | 148,000 | 136,000 | 71,000 |
| | 12 inch | | 264,200 | 92,000 | 119,200 | 53,000 |
| | 10 inch | | 223,400 | 73,600 | 104,800 | 45,000 |
| | 8 inch | | 184,200 | 52,800 | 94,400 | 37,000 |
| Polyethylene Pipe | 180 mm | -4 bar | 191,000 | 48,000 | 93,000 | 50,000 |
| | 125 mm | | 136,000 | 24,000 | 79,000 | 33,000 |
| | 90 mm | | 101,000 | 14,000 | 64,000 | 23,000 |
| | 63 mm | | 84,000 | 8,000 | 58,000 | 18,000 |
| | 32 mm | | 24,000 | 4,000 | 15,000 | 5,000 |
| Gas Meter | 1000M3/h | G250 4" | 13,862,000 | 13,862,000 | | |
| (Medium Pressure) | 500M3/h | G100 3" | 11,327,000 | 11,327,000 | | |
| Gas Meter | G6.0 | 10m3/h | 815,000 | 815,000 | | |
| (Low Pressure) | G4.0 | 6m3/h | 276,000 | 276,000 | | |
| | G2.5 | 4m3/h | 255,000 | 255,000 | | |
| | G1.6 | 2.5m3/h | 76,000 | 76,000 | | |

*Source: PGN, Analyses by JICA Team*

**Table 5-5-2 Indoor Pipe Construction Costs**

| Materials | Size | Note | Construction Cost (Rp/m) |
|---|---|---|---|
| Steel Pipe | 150mm | 200mm H2o | 50,000 |
| | 100mm | | 40,000 |
| | 50mm | | 26,000 |
| | 25mm | | 24,000 |
| | 32mm | | 20,000 |
| | 13mm | | 20,000 |

*Source : PGN, Analyses by JICA Team*

### 5.5.3. Scope of Burden of Gas Pipeline Cost on Customers

In principle, customers must bear the initial cost of pipelines within the site according to the PGN Standard. However, PGN is supposed to bear the pipeline cost from the battery limit to the gas meter within a 3 meter limit. Even if the pipeline were to be laid outside the border, the cost of the portion of service pipe exceeding 12 meters should be borne by customers. While the construction cost of gas pipelines laid underground parallel to the road is to be borne by PGN, the land development company bears the cost and PGN cares for maintenance of pipelines after installation by request from the developer.

## 5.6 Other Issues

Apart from the recommendations already mentioned in the above sections, several items which might be changed were noticed during the field survey :

(1) Drawing administration

In order to maintain a large number of distribution facilities such as pipelines, regulators, valves and so on, the pipeline drawing administration is very important. It is quite difficult to administer the distribution system only by built drawings of pipeline construction since they represent only a part of the system. Without integrated pipeline drawings, it takes a lot of time to find the pipe location, size or connection, and misreading a drawing may cause an accident to occur. The integrated pipeline drawing is the map which shows overall pipeline connection, pressure, size and location and can be utilized for maintenance, planning and construction of pipeline.

Currently PGN doesn't have an integrated pipeline map. Construction of the subway will start in the near future and in order to avoid third party's damage, it is necessary to implement a pipeline drawing system. It is recommended that a computer mapping system, or any other kind of pipeline drawing administrative system be introduced.

(2) Usage of polyethylene-coated steel pipe

PGN still uses tar-coated steel pipes. But tar-coated steel pipes are inferior to polyethylene-coated steel pipe from the view point of corrosion protection especially where underground water exists. Although the polyethylene-coated steel pipe may be more expensive than the tar-coated pipe, it is recommended to use the polyethylene - coated steel pipe in order not to leave regret in the selection of pipe material in the future.

(3) Utilization of SCADA system

Although PGN has already introduced a remote data acquisition system, the system is out of order now and it seems that the system has not been utilized for long time. Distribution log data such as the pressure and flow rate from offtake stations is gathered manually and there exist some misread data and some abnormal data which may be because of manual data acquisition. It is recommended that the data acquisition system be utilized more efficiently for the preparation of PGN's future transmission business.

(4) Odorization

PGN gas is odorized with tetra-hydrothiophene (THT) injected at the rate of 16 mg/m3 at offtake stations. PGN checks the olfactory level, or the strength of smell, at the outlet of the offtake stations, not necessarily quantitatively. During the field survey, however, a Team member heard that certain customers have never smelled gas. Therefore there may be a need to study the appropriateness of the current odorization practice, i.e., the kind of odorant and/or the level of concentration and control.

Gas leaks are usually best detected by smelling the odor of gas. It is more important when gas is distributed to mass customers as in the residential and commercial markets. THT was used as an excellent odorant in the era of manufactured gas. When the natural gas era started, however, its appropriateness as the odorant became controversial because of its "masking effect" that is said to damage the olfactory strength in methane gas. It is still used, but mostly with other materials.

The olfactory level should be checked in several parts of the distribution network. Gas must be still smelled at the end of the network. The odor, however, should not be so strong to cause customers to complain about harmless levels of leakage at the time of gas stove ignition. The concentration of the odorant in gas can be checked by gas-chromatography and can be correlated with olfactory levels when measured. There are olfactory level meters. Such correlationship can be used for day-to-day control.

Just for reference, the Japanese Gas Enterprise Law regulates the gas olfactory level at 1,000 times. This means that a volume of gas diluted into 1,000 times of volume of air should still be smelled by ordinary people. Osaka Gas, for example, controls its gas to be smelled at 3,000 to 4,000 times dilution for extra safety assurance after many years of testing and experience, by injecting 14 mg of a mixture of two odorant formulas:

**Table 5-6-1 50/50 Mix of TBM and DMS as Odorant for Natural Gas:**

| | TBM | DMS |
|---|---|---|
| Name/ molecular | Tertiary Buthyl Mercaptane<br>$C(CH_3)_3SH$<br>MW=90<br>TS=35.5 wt% | Dimethyl Sulfide<br>$(CH_3)_2S$<br>MW=62<br>TS=51.6 wt% |
| Olfactory threshold | 0.09 ppb | 2.5 ppb |
| Water solubility, 20 degC | 0.96 g/l | 0 g/l |

*Source : Osaka Gas Co., Ltd.*

(5) Connection of South Sumatra Line to Pertamina's Transmission Line

As mentioned in the previous section, gas supply situation is not perfect for future gas market development, although we assume in our Study that it will be separately resolved.

The supply issues are in two areas, upstream and mid-stream; both involves relationships with Pertamina, which are basically good. In the upstream, PGN is vigorously developing trunklines for the domestic gas market especially in Sumatra for the initial phases in cooperation with Pertamina. In the mid-stream though, we find it more necessary to maintain serious dialogues between PGN and Pertamina in the areas of current distribution network organizations and future interconnection of Sumatra lines into West Java pipelines. We have seen many bottlenecks in the pipeline network and consider that they will be resolved only through joint work and analyses since pipelines are interconnected to one system. Higher-level's attention is especially recommended in this regard.

# Chapter 6

# Urban Development

# 6. Urban Development

(Note. Tables and Figures concerning this chapter are shown in the Appendix B.)

## 6.1 Administrative Hierarchy

The Republic of Indonesia has 6 levels of administrative hierarchy as follows:

1. D.I. Aceh, DKI Jakarta, D.I. Yogyakarta (Special Districts) and Propinsi (Province)
2. Wilayah/Kotamadya (Municipality) and Kabupaten (Regency)
3. Kecamatan (Subregency)
4. Kelurahan
5. Rukun Warga
6. Rukun Tengga

The country is divided into 3 Special Districts (D.I. Aceh, DKI Jakarta and D.I. Yogyakarta) and 24 provinces. The Java Island is composed of 2 Special Districts and (DKI Jakarta and D.I. Yogyakarta) and 3 provinces (East Java, Central Java and West Java).

The West Java Province that includes the part of the study area is composed of 20 Kabupaten and 5 Kotamadya.

The ongoing urban development of DKI Jakarta is expanding over its administrative boundary into neighboring regions. In order to overcome the administrative discrepancies between DKI Jakarta and West Java Province and to create a comprehensive development plan for the area that consists of DKI Jakarta, Kabupaten and Kotamadya Bogor, Kabupaten and Kotamadya Tangerang and Kabupaten Bekasi, the area being collectively called Jabotabek, the Jabotabek Development Coordination Board (BKSP Jabotabek) was established by Presidential Decree No. 13 in 1976.

Kotip is an intermediate administrative level between Kabupaten and Kecamatan and headed by a mayor. Similar to the DKI mayoralties a Kotip does not have a Peoples Representative Council (DPRD). Bekasi City in the study area has this status.

## 6.2 Present Urban Development Status

Very little data is available on present urban development such as land uses and infrastructure. In addition, many new estates have been developed in the study area in recent years. Accordingly, estate development should be researched further.

### 6.2.1 DKI Jakarta

DKI Jakarta is divided into 5 Wilayahs (Municipalities) and further subdivided into 43 Kecamatans (Sub-Districts) including the Thousand Islands in the Java Sea.

The present urban development of DKI Jakarta has expanded over its administrative boundaries into neighboring regions, while new estate developments and redevelopment has occurred in DKI Jakarta.

Major residential estates are in the west and east part of DKI Jakarta as shown in Appendix B-1. Real estate developments in the south part of DKI Jakarta, including residential/industrial development, are regulated for the protection of its water resources, thus urbanization is expanding to the east and west. Development of areas near toll roads is very high. The other side of the Jakarta inner ring road is almost completed and development/redevelopment inside/by inner toll roads is taking place. Commercial areas are concentrated in the central areas of Kecamatan Senen/ Menteng/ Sawabesar/ Tanahabang. Industrial areas are found mainly in the eastern area of Jakarta, Kecamatan Cakung and by Daan Mogot street.

PGN gas pipe lines are concentrated in the central and northern areas of DKI Jakarta and pass through the industrial areas. The existing land use and road/gas networks in DKI Jakarta are shown in Appendix B-2.

### 6.2.2 Kotamadya Tangerang

Kotamadya Tangerang is divided into 6 Kecamatans.

Kotamadya Tangerang was upgraded administratively from Kotip Tangerang in 1993, and the government offices are separated from Kabupaten Tangerang.

Kotamadya Tangerang, where the Sukarno Hatta International Airport is located, is growing into an important area for transportation and for supporting DKI Jakarta. Major residential estates are located between the toll road and provincial road as shown in Appendix B-1 and Appendix B-3. The commercial area is in Kecamatan Jatiuwung.

A provincial road and Jakarta-Merak toll road run through Kotamadya Tangerang and the PGN gas pipe line is parallel to the Provincial Road (Serang street). The road/PGN gas networks in Kotamadya Tangerang are shown in Appendix B-3.

### 6.2.3 Kabupaten Tangerang

Kabupaten Tangerang is divided into 19 Kecamatan(s).

The Kabupaten Tangerang government separated from Kotamadya Tangerang in 1993, but many government offices still remain in Kotamadya Tangerang.

Kabupaten Tangerang is growing as a supporting region of DKI Jakarta. New estates are appearing after a toll road passing through the region was completed. Major residential estates are by toll road and in the south area of Tangerang. There are new towns already in Kecamatan Ciputat and Serpong as shown in Appendix B-1 and Appendix B-3. Industrial areas are near the provincial road.

A provincial road and Jakarta-Merak toll road run west-east in the middle of Kabupaten Tangerang. PGN gas pipe lines are located in Kecamatan Cikupa and Serpong. The road/ PGN gas networks in Kabupaten Tangerang are shown in Appendix B-3.

### 6.2.4 Kabupaten Bekasi

Kabupaten Bekasi is divided into 18 Kecamatan(s) and 1 Kotip Bekasi. Kotip Bekasi is divided into 4 Kecamatan(s).

Kabupaten Bekasi includes Kotip Bekasi (urban area) and is growing as a supporting region of DKI Jakarta. The high growth of Bekasi is affected by DKI Jakarta. New industrial and residential estates are appearing after a toll road was constructed through the region. On the south side of the provincial road, there are many major residential estates as shown in Appendix B-1 and Appendix B-4. Most of the industrial parks are located in Kecamatan Cibitung.

A provincial road and Jakarta-Cikampek toll road run west-east through the middle of Kabupaten Bekasi. PGN gas pipe line is located in the middle of the provincial road and toll road. The road/PGN gas networks in Kabupaten Bekasi are shown in Appendix B-4.

### 6.2.5 Kabupaten Karawang

Kabupaten Karawang is divided into 17 Kecamatan(s).

Most of the residential/industrial areas are located near the provincial and Jakarta-Cikampek toll road. The new industrial and residential estates are growing, after a toll road was passed through the region. Some large scale residential/industrial areas are located in Kecamatan Telukjambe and Pangkalan.

A provincial road and Jakarta-Cikampek toll road run west-east through the middle of Kabupaten Karawang. PGN gas pipe line is parallel to a part of the provincial road. The road/PGN gas networks in Kabupaten Karawang are shown in Appendix B-5.

## 6.3 Urban and Industrial Estate Development Plans

### 6.3.1 West Java

West Java Provincial Structure Plan

The Provincial Structure Plans (RSTRP) for all the 27 provinces in Indonesia were made by the Ministry of Public Works and Ministry of Home Affairs. The plans further elaborate upon the planning stages of strategic areas, urban/rural areas and development sectors. The West Java Provincial Structure Plan is one of those plans.

In the provincial plan, a strategic area with selected priority industrial sectors and a city ordering system within the province have been designated. The strategic development area is the regional consumption/trading center. West Java Province is divided into 6 Satuan Wilayah Pengembangan (Regional Development Units), SWP. The Study area is included in Banten, Botabek, Purwasuka which are defined in the plan as the regional development unit.

The priority industrial sectors selected by development strategy and the hierarchy of strategic development area and city in West Java Province are shown in Appendix B-6 and Appendix B-7.

### 6.3.2 Jabotabek

Jabotabek Metropolitan Development Plan Review (JMDPR)

JMDPR, a review report on the original Jabotabek Metropolitan Development Plan (JMDP) was published in 1993.

JMDP was finalized in 1981 and dictated a principal mechanism for the coordination of strategic investment in Jabotabek. The Central government agencies and the provinces of DKI Jakarta and West Java, with principal assistance from the World Bank, Asian Development Bank, Government of Japan (OECF and JICA) and the Government of the Netherlands have implemented the 1981 Jabotabek Metropolitan plan program.

The main strategies of the plan are :

a) an integrated growth and investment strategy for the metropolitan region;

b) an east-west alignment for future development, in order to avoid further pollution of the important aquifer charge area to the south of Jakarta, and high development costs in the environmentally sensitive wetlands and poor soil in northern coastal areas; and

c) a major emphasis on water supply, sanitation, kampung (village) improvement and flood protection together with guided land development for residential and industrial areas focused on primary infrastructure deficiencies (including roads).

However, since the publication of the JMPD, urban growth has accelerated and influenced adjustment regions further to the east and west. This dramatic explosion of growth has necessitated reviewing the original plan. JMPDR targets the year 2010.

JMDPR assessed three urban development paradigms (self sustaining towns, finger city and liniar city : refer to Appendix B-8). As a result of that study, JMDPR recommends the East - West liner City for urban development.

The structural element of East - West liniar city are:

a) urban growth centers, including both new towns and expansion of existing centers;

b) the transportation system, including toll road, arterial road, suburban rail and mass rapid transit options; and

c) green space/wedges, reserves and low density semi-open areas.

In addition, JMDPR recommends the following:

a) Promotion of a polycentric urban structure
The geographical extent of existing urban areas is such that an active policy to promote a hierarchy of urban sub-centers is essential, particularly as investment in transport (especially mass transit) continues to lag behind urban growth.

b) Promotion of mass rapid transit system
The slow but steady construction of a mass transit system must be accelerated for relief of the over-stressed transportation system in the key commuter corridor.

c) Nominating and defending green wedge
A liniar, polycenter city implies the need for substantial green zones and recreational sports area. To promote 'high value-added' green zones that can be defended against urban development pressure.

d) Adoption of well balanced mix use balance
The strategy argues that a large scale, but single use development is undesirable for problems such as excessive loads on the environment.

e) Urban management
To introduce finance and management for an effective strategy.

### 6.3.3 DKI Jakarta

DKI Jakarta Structure Plan 2005

The DKI Jakarta Structure plan 2005 was published in 1984 and revised in 1990. The plan is based on the 1965-1985 DKI Jakarta Master Plan.

As a result of interview and discussions at DKI Jakarta, DKI Jakarta is processing the revision of the present structure plan and will publish in 1996. The revised plan follows the present plan, but it has 2 additional big projects ( refer to Appendix B-9) as follows:

-The Jakarta Waterfront Project
To reclaim the Coastal area in Jakarta. The new Waterfront CBD will be located in the area.

-MRT (Mass Rapid Transit) system
The system adopted the Subway system that will link Block M and Kota area.
As reported in the newspaper, the system will include 17 MRT stations, namely Panglima Polim, Block M, Sisingamangarja, Senayan, Pintu I, Bendungan Hilir, Setiabudi, Dukuh Atas, Hotel Indonesia, Sarinah, National Mounment (Monas), Harmoni, Sawah Besar, Mangga Besar, Glodok, Jakarta Kota and Kali Besar.

The summary of the Present DKI Jakarta Structure Plan 2005 is described below.

The plan's target year is 2005. The projection of DKI Jakarta's population is 11,988,000 in 2005.

1) Development planning zone

The boundaries of development regions are based on the existing administrative boundaries of Kecamatan and Kelurahan.
DKI Jakarta is divided into 9 Development planning zones (refer to Appendix B-10) :

1. Northwest Development Zone (WP-BL),
2. North Development Zone (WP-U),
3. Tanjung Priok Development Zone (WP-TP),
4. Northeast Development Zone (WP-TL),
5. West Development Zone (WP-B),
6. Central Development Zone (WP-P),

7. East Development Zone (WP-T),
8. South Development Zone (WP-S), and
9. Thousand Islands Development Zone (WP-PS).

Those centers whose development has been prioritized have been chosen to maximize east-west expansion of urbanization. Many commercial/industrial/residential areas are already located in WP-U, thus another primary center in WP-U would have limited development for avoiding the over-stress of the development.

2) Immediate or priority actions

The immediate or priority actions in the plan are as follows:

a) To regulate to a reasonable level the growth of large and medium scale industries within the city.

b) To limit the growth of job opportunities in the north of Jakarta as much as possible through the control of the issue of permits.

c) To implement the Guided Land Development Plan in East and West Jakarta by controlling and reviewing land ownership, planning regulations and building permit procedures to encourage maximum participation of low-income groups.

d) To carry out the Environmental Improvement Program in North Jakarta within the framework of the Kampung Improvement Program, e.g. the improvement of primary socio-economic infrastructure and certain land adjustment.

e) To limit the construction of new roads in the northeast, northwest and south of the city and determine the conditions for further development , in order to reduce the speed of urbanization and growth in these areas.

f) To limit the number of private water connections and increase the number of public faucets (particularly in North Jakarta) for equal sharing of available water resources.

g) To accelerate the flushing out of canals and drains for smooth flow of water.

h) To accelerate the development of new water sources to meet present and future requirements.

I) To adopt a policy restraining the use of private cars, while striving to increase public transportation services.

j) To implement a comprehensive plan to preserve the urban environment.

3) District Plans

DKI Jakarta has a district plan with a land use map for every Kecamatan based on DKI Jakarta Structure plan 2005. A more detailed plan with such planning data as population density, floor area ratio, and right of way for planned constructions has been prepared by Pemerintah Wilayah (the authority of Municipal Government).

The structure and road network plan in DKI Jakarta is shown in Appendix B-11.

### 6.3.4 Kotamadya Tangerang

Kotamadya Tangerang Urban Structure Plan
The plan's target year is 2010.

The urban center is in Kecamatan Tangerang. Industrial areas are located in the west part of Kotamadya Tangerang and by provincial road in Kecamatan Batuciper/Tangerang. Residential areas are located in the south part of Kotamadya Tangerang.

The plan is based on the following:

1. The forecasted population in 2010 will be about 3 million in Kotamadya Tangerang.

2. The grid road network system will be applied to the new road network.

3. The development of the Province and Kotamadya Tangerang will not include farming activities. Kotamadya Tangerang will promote the development of industrial/commercial/residential area.

The land use and road network plan in Kotamadya Tangerang is shown in Appendix B-12.

### 6.3.5 Kabupaten Tangerang

Kabupaten Tangerang Urban Structure Plan
The plan's target year is 2005. Kabupaten Tangerang's population is projected at 5,793,000 in 2005.

The plan locates new towns in the south part of Kabupaten Tangerang and coastal area. The core area of new towns in the south area is already formed and development is expanding toward the surrounding dry land area. Industrial area expand along the toll road.

The hierarchy of cities in Kabupaten Tangerang is as follows:

| | |
|---|---|
| Order I | : Serpong, Balaraja, Teluknaga |
| Order II | : Ciputat, Pamulang, Tigaraksa |
| Order III | : Curug, Mauk, Cikupa, Pasarkemis, Sepatan, |
| Order IV | : Pondok Aren, Legok, Cisoka, Kresek, Kronjo, Rajeg, Kosambi, Pakuhaji, Cisauk, Pagedangan, Jayanti, Jambe, Panongan, Kemiri, Sukadiri |

Some of the main strategies of the plan are:

1. To motivate the development of three central business districts and three regents (Serpong, Balaraja and Teluknaga) by expanding and developing infrastructure such as roads, electricity, water and gas supply.

2. To expand road networks that connect three regents/central business districts with the commercial area and service areas.

3. To expand primary road networks that connect the three regents/central business districts and also those between the three regents/central business districts and outer Tangerang .

4. The development of new commercial areas in housing estates should be controlled by the local government in order to avoid confusion among the district system.

The land use and road network plan in Kabupaten. Tangeran is shown in Appendix B-13.

### 6.3.6 Kabupaten Bekasi

Kabupaten Bekasi Urban Structure Plan

The plan's target year is 2005. Bekasi's population is projected at 4,590,000 in 2005.

Residential/Industrial area are located in the south of Kabupaten Bekasi. The Jakarta-Cikampek toll road runs east-west through the middle of the area . Residential areas have grown in Kecamatan Pondokgede/Jatiasih, adjacent to DKI Jakarta.

The hierarchy of development centers (cities) in Kabupaten Bekasi is as follows:

| | |
|---|---|
| Primary growth centers | : Bekasi, Cikarang |
| Intermediate growth centers | : Cibitung, Pondokgede |
| Growth centers II | : Tambun, Bantargebang, Serang, Sukatani |
| Growth centers III | : Muaragembong, Setu, Babelan, Lemahabang, Jatisampurna, Cibarusah |

| | |
|---|---|
| Growth centers IV | : Pebayuran, Kedungwaringin, Karangsatu, Sumberreja, Cabangbungin,Tamberang, Tarumajaya, Sriamur, Wanasari, Jatiasih, Hengarmanah, Bojongmanggu |

Kabupaten Bekasi has a road development plan known as the Bekasi By-pass, and a toll road from Cikaran to Tanjung Priok.

The land use and road network plan in Kabupaten Bekasi is shown in Appendix B-14.

### 6.3.7 Kabupaten Karawang

Kabupaten Karawang Urban Structure Plan

The plan's target year is 2000. Karawang's population is projected at 1,538,000 in 2000.

Residential areas are located between a provincial road and the Jakarta-Cikampek toll road. Industrial areas are located south of the toll road. A provincial road that is the only arterial road in Kabupaten Karawang and Jakarta-Cikampek toll road continue to support transportation in Karawang.

The hierarchy of cities in Kabupaten Karawang is as follows:

| | |
|---|---|
| Order I | : Cikampek, Karawang |
| Order II | : Rengasdengklok, Cilamaya |
| Order III | : Batujaya, Pakis, Cibuaya, Sungaibuntu, Telagasari, Klari, Pangkalan, Cikalong, Tempuran, Lemahabang, Rawamerta, Jatisari, Tirtamulya |

Some main points of the plan are:

1. The industrial area are located south of the provincial road and the Jakarta-Cikampek toll road. Infrastructures (such as roads, water and gas supply, electricity and telephone line) will be provided for the industrial area.
2. New area surrounding the primary roads and the Jakarta-Cikampek toll road will be developed intensively as urbanized land use areas.
3. To maintain existing farms and its irrigation system in the north of the provincial road.
4. To maintain the water resource, especially Citarum and Cilamaya rivers.
5. To conserve the forest in northern Kabupaten Karawang and in the southern Jatiluhur area.
6. To motivate and develop infrastructure including transportation facilities.

The land use and road network plan in Kabupaten Karawang is shown in Appendix B-15.

# PART II

# MASTER PLAN

# Chapter 7

# Principles of the Master Plan

# PART II MASTER PLAN

## 7. Principles of the Master Plan

### 7.1 Scope of the Master Plan

#### 7.1.1 Master Plan Area

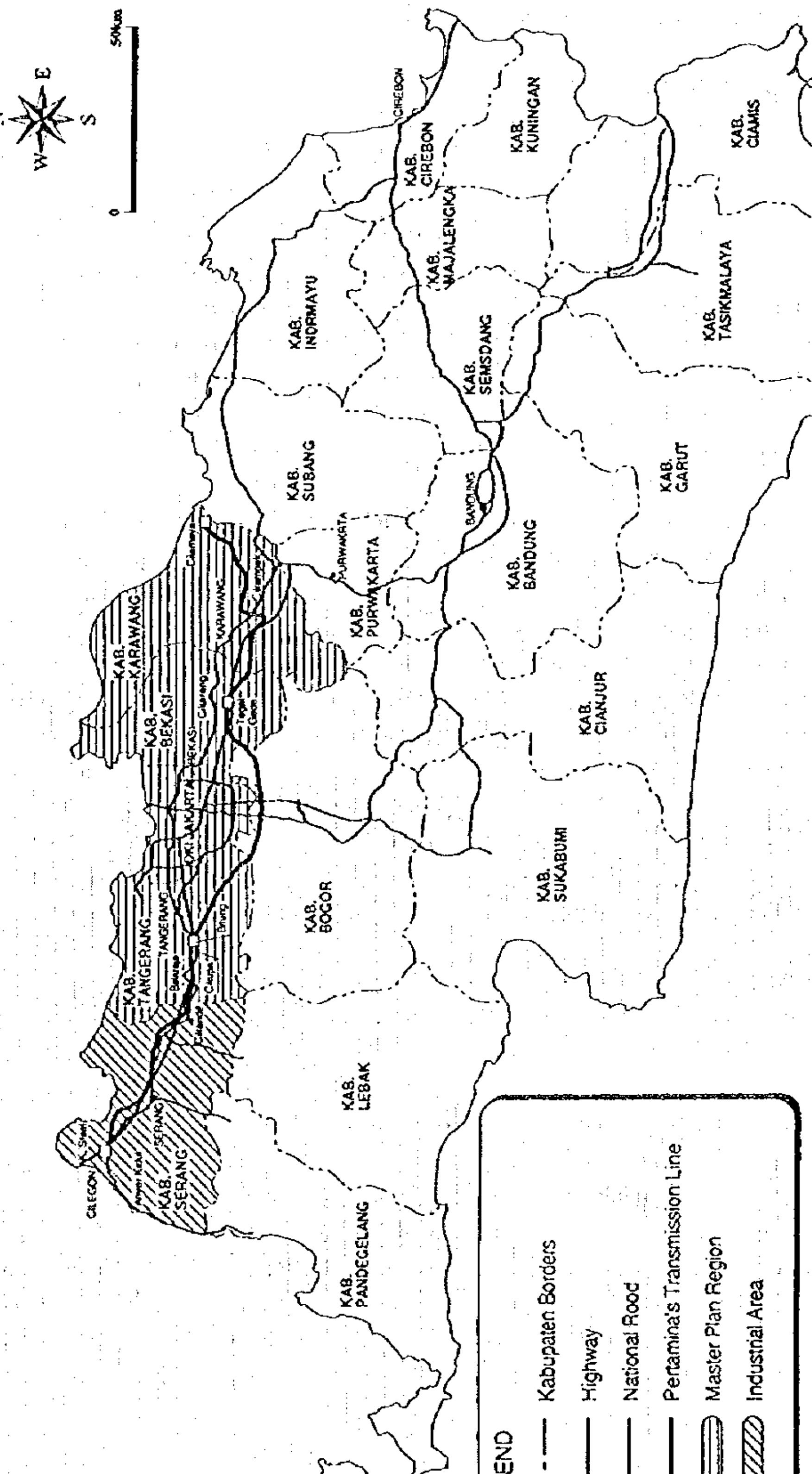
The Team has defined the coverage area of the Master Plan as the area comprising Jatabek (Metropolitan area comprising Jakarta, Tangerang and Bekasi) and Kab. Karawang, as shown in Fig. 7-1-1, and covers the houses, commercial facilities and industrial customers located within 5 to 10km radius from the existing main pipelines. The Master Plan area almost covers the area where PGN has already installed major pipelines or where PGN intends to install pipelines in the near future. This area is within the Study Area defined initially.

The pipeline expansion plan that PGN prepared in response to the support from the World Bank covers a broad area from Cilegon, Kab. Serang, up to Bandung, Kab. Bandung, but this Master Plan has omitted Kab. Serang, Kab. Purwakarta and Kab.Bandung which are already included in existing plans, due to the reasons described below. Firstly, this Study covers mainly gas pipelines for distribution to the residential and commercial markets and, therefore, economical development in these markets is subject to integration of customers. When comparing these areas with the Jatabek area, integration of customers is not seen in Kab. Serang or Kab. Purwakarta. Secondly, the distance from existing pipelines must also be taken into consideration for a realistic Master Plan. For example, Bandung and Purwakarta display characteristics that make them seem feasible for gas development for residential and commercial markets, but these cities are too remote from the existing pipelines.

Urban infrastructure such as roads, express ways, etc., in the area covered by the Master Plan are better than in other areas. The main Pertamina gas line between Cilamaya and Cilegon is the main gas source in this area and PGN's high pressure gas distribution network receives gas from this main line.

Regarding the gas demand for the residential and the commercial markets, the Team considers the Jatabek area as its main priority. Potential residential gas users, who currently uses kerosene and LPG and are wanting to use natural gas, already exist in this area. In addition, a number of facilities such as shopping centers, hotels, office buildings, etc., considered as typical objectives of commercial gas demand development also exist in this area.

**Fig 7-1-1 Master Plan Region**




*Source : JICA Team*

The rough estimate of the potential demand in Kab.Serang area, though it is excluded from the Study area, however, will be considered in discussing gas supply and transmission capacities of the Sumatra-Java pipeline.

### 7.1.2 Major Contents of the Master Plan

The Master Plan includes potential gas demand projections under gas network constraints (we define it as the possible gas demand), distribution network plans, business improvement plans, economic and financial analyses, environmental and social assessment and recommendations.

Among these, the procedures to make potential gas demand estimates are presented in extra detail. This is because it is desired that PGN may apply the procedures to other potential areas in Indonesia.

### 7.1.3 Starting Year and Demands

The strategy for sale of urban gas given in this Study may be fruitful as the result of actual sale, at the earliest, from 1998. Therefore, this Master Plan assumes that the relevant marketing activity and pipeline expansion work will be carried out in 1997 and the results be reflected in the annual gas sales in the next year.

PGN's 1996 actual gas sales amount and 1997 expected gas sales amount, in rounded figures, will be employed as the base before adding the demand estimates of this Master Plan beginning in 1998.

**Table 7-1-1 Actual and Expected Gas Sales Amount by PGN**

| | | 1994 | 1995 | 1996 | 1997 (Expected) |
|---|---|---|---|---|---|
| Gas sales in volume unit ($Km^3$) | Residential | 2,478 | 2,490 | 2,274 | 2,766 |
| | Commercial | 6,838 | 7,469 | 10,234 | 13,212 |
| | Industrial | 613,305 | 750,734 | 877,599 | 960,411 |
| | Total | 622,621 | 760,693 | 890,107 | 976,389 |
| Number of customers | Residential | 8,874 | 9,057 | 9,670 | 11,135 |
| | Commercial | 266 | 186 | 168 | 162 |
| | Industrial | 159 | 186 | 211 | 215 |
| | Total | 9,299 | 9,429 | 10,049 | 11,512 |

*Source : PGN*

### 7.2 Demand Estimation Principles

#### 7.2.1 Outline and Definition

This section (7.2) briefly describes the principles of demand projections and the fundamental and common items relative to market analysis as an introduction. The analytical procedures actually used for each market sector is described in the next section and thereafter.

While several technical terms are used in relation to demand projections, we use those terms as respectively defined as follows:

*Demand survey: to survey various factors which mainly relate to demand, by means of literature or field survey.

*Demand forecast: to estimate future gas demand considering economical and other external factors by using econometric models.

*Demand projection: to define future prospective gas demand which is set up as a planned value from the demand forecast, considering technical and administrative restrictions to real implementation of projects.

A determinate difference between the demand for gas from other several energy commodities is that gas demand can not be actualized unless tremendous advance investment for pipeline networks are carried out. Potential gas demand which is estimated econometrically sometimes does not indicate actual demand. To distinguish such discrepancies, we thus define the following terms in this Study:

*Potential demand: potential gas demand which is estimated from inter-fuel competition or demand trends, etc., ignoring actual conditions of pipelines.

*Possible demand or marketable potential demand: potential demand based on the possibility of the construction of pipelines or in an area where we assumed pipeline construction feasible.

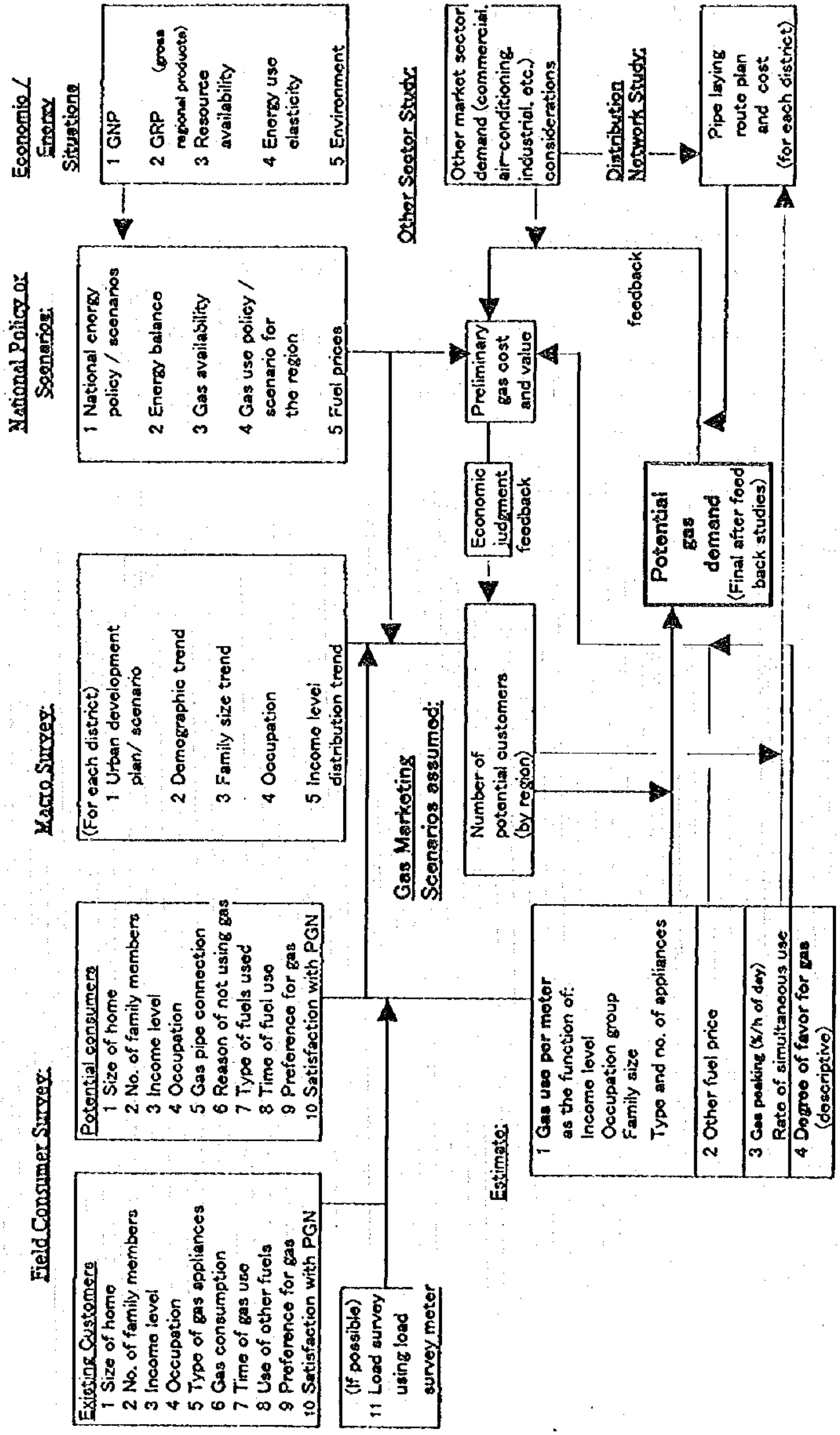
*Projected demand: demand values set up as a projected value considering feasibility from technical, economical and administrative sides.

### 7.2.2 General Work Flow of Gas Demand Projection

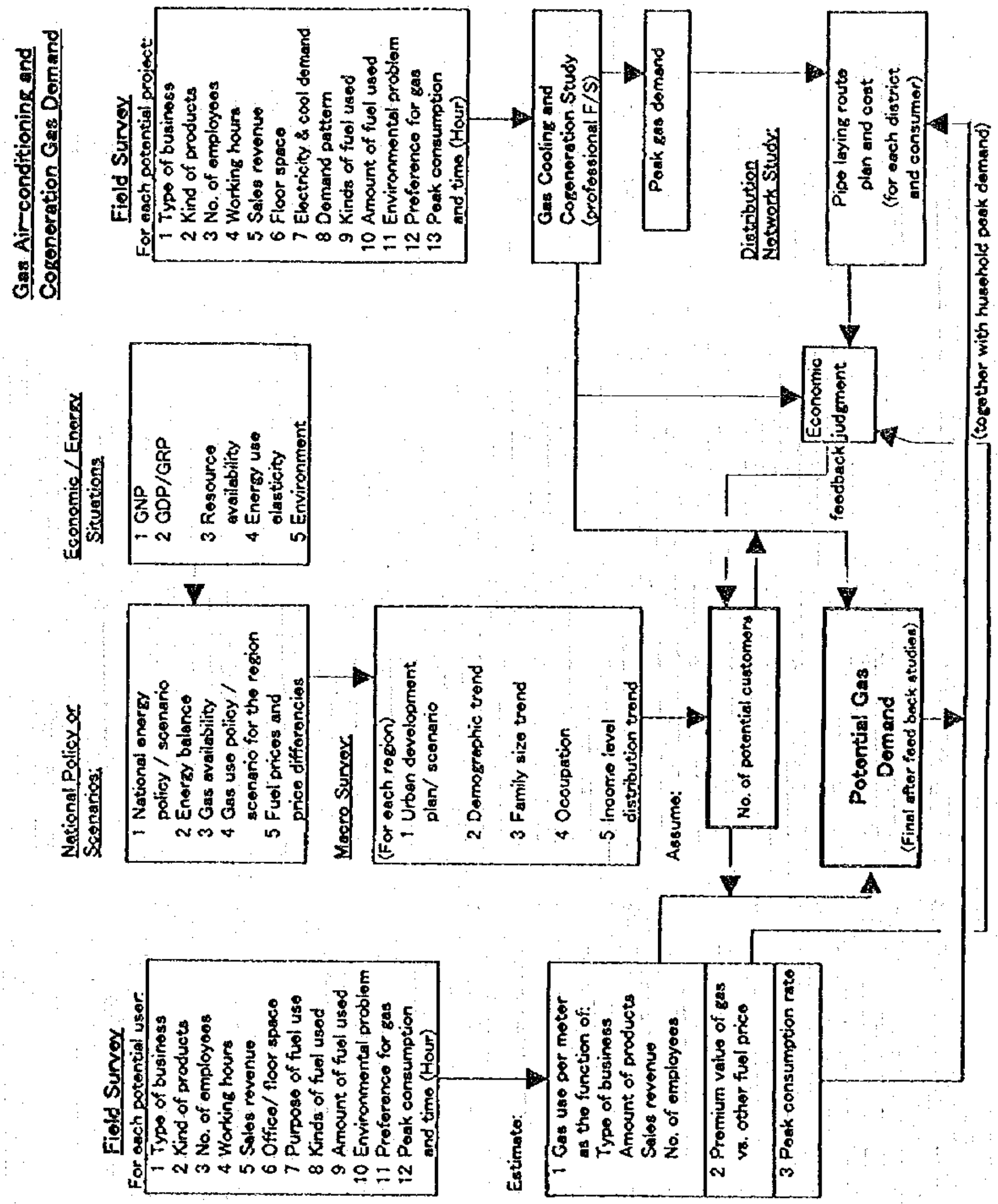
In general the demand for any type of energy is greatly influenced by the price. If costs of gas including transportation and distribution costs are much higher than the prices of other energies, sales may fall and the demand will naturally change. Therefore, in Japan for example, it is usual to examine the cost of gas transportation and distribution to an applicable area for the development of new customers and to consider whether demand can be expected or not. Figs. 7-2-1 and 7-2-2 show the logic flow, in which a cycle of repetitive calculation is inserted.

In actuality, however, especially when the demand in a broad area such as in this Master Plan is to be determined, it is not easy to apply these calculations to all customers. Therefore, in many cases the number of customers, scale and rough costs of pipelines in a predetermined area are tentatively calculated, and the feasibility of gas sale is checked and demand value in the area may be established from the data obtained by calculation.

Fig. 7-2-1 Demand Survey for Residential Gas



## Fig. 7-2-2 Demand Survey for Commercial and Industrial Gas



### 7.2.3 "Macro Method" and "Micro Method"

The "Macro Method" and the "Micro Method" are available as demand estimation methods.

*a) The "Macro Method":*

The "Macro Method" uses econometric and statistical methods to estimate or forecast the demand and is often called the Top-down Method or the Econometric Model.

The energy demand (E) in the econometric model is generally supposed to be a function of the income level (I) and energy prices (P), i.e., the own energy price and/or the competing fuel prices. If the demand is to be determined per family, the family size (F) is also a variable. Defining $P_1$ as the own price and $P_2$ as a competing fuel price, the relation is formulated as:

$$E = f \times I^a \times P_1^b \times P_2^c \times F^d$$

This is rewritten in a logarithmic form as:

$$\ln(E) = a\ln(I) + b\ln(P_1) + c\ln(P_2) + d\ln(F) + f$$

where $a$ is the income elasticity (of energy); $b$ and $c$ are the own price elasticity and the cross price elasticity respectively; $d$ is the family size elasticity and $f$ is a constant.

When the demand is to be adjusted chronologically, the following formula can be used assuming $E_{-1}$ as the demand in a previous period:

$$\ln(E) = a\ln(I) + b\ln(P_1) + c\ln(P_2) + d\ln(F) + e\ln(E_{-1}) + f$$

This econometric model can be used by obtaining the value of elasticity separately for each variable and the value of energy intensity (energy consumption per certain variable unit) from statistics on economic activities and energy. When there is no reliable historical data on the effect of prices, we may have to drop the price related terms of the formula.

*b) The "Micro Method":*

The Micro Method is either called the bottom-up method, the end-use model or the engineering process approach.

The engineering process approach introduces the concept of "effective energy" into a stock type demand function which is formulated as:

$$E = \sum_i S_i \cdot Q_i \cdot R_i$$

where, $S_i$ is the number of an energy appliance in the stock (market); $Q_i$ is the effective energy consumption capacity of an appliance; $R_i$ is the operation load of an appliance. The number of an appliance to be added in the market in a period is a function of the price of the appliance, the income level, the energy price and the stock level of the appliance in the previous period.

*c) Advantage/ Disadvantage:*

The econometric model and the engineering process approach have advantages and disadvantages each; the former requires long term chronological data, but not too many kinds of them, while the latter requires many data but not necessarily the chronological ones. Therefore, when sufficient number of data and chronological data are unavailable for the "Macro Method" approaches, the "Micro Method" is often used in which the energy demand is estimated by bottoming-up from the number of customers and gas supply plans, etc. When the shares of a few large energy customers in the market are significantly large, we often have to rely on the Micro Method for at least the near future forecast based on the planning.

### 7.2.4 Market Features

The table below summarizes the features of each market sector:

| Sector | Number of Target Customers | Correlation of Demand to Urban Gas Network |
|---|---|---|
| Residential | Several hundred thousand | Urban gas is mostly used in a zone where the gas network is readily available compared to other energy sources.<br>Expansion of pipelines strongly determines gas sale. |
| Commercial | Several thousand | *Demand characteristics for kitchen equipment are identical to those of residences.<br>*Other gas facilities such as gas boilers, gas air conditioners, etc., are new appliances in the market. Therefore, competitiveness has to be examined and the percentage of their advance into the market must be measured.<br>*Orderly planning for investment in pipelines is important and individual investment plan for each pipeline by each project is required. |
| Industrial | Several hundred | *Urban gas is excellently economical as a heating source; the sales of urban gas for this application by PGN has already shared most of its total sales.<br>*Potential and promising customer list is already established by PGN. |

### 7.2.5 Residential Demand Forecast

The residential fuel consumption is usually influenced by various factors such as the income level of a family, number of family members in a family, fuel and electricity prices. Numbers per family are important because the energy for the residential sector is usually delivered to families rather than to individuals.

We have forecast the residential gas demand on five income level points in this Study. We first determined the demand numbers of the period from 1995 to 2004 based on the Micro Method and then used them for forecasting the demand of the whole forecasting period from 1998 through 2020. The procedures are described in the following:

I. Bottom-up Model for 1995 to 2004:

① We first determine the gas demand from the potential number of customers separately estimated and gas consumption per customer for the period from 1995 to 2004.

② The resultant demand estimates are then used as the known input numbers for the econometric model described in the next paragraph.

II. The Econometric Model for the Period from 1995 to 2020:

① First determine the electricity demand as the function of GRDP per capita, family size and number of households.

② Then determine the total fuel demand as the function of GRDP per capita, family size and number of households.

③ Take the sum of the electricity and the fuel demands to determine the total residential energy consumption estimates and compare them with the estimates made separately as the function of GRDP per capita, family size and number of households.

④ Considering the inter-fuel competition, apply the "share function" to each fuel of LPG, kerosene and other fuels to determine the shares in the total residential energy consumption.

⑤ Finally, under the constraint by the amount of demand of "other fuel" consumption, determine the gas demand in a year as a function of the GRDP and the demand in the previous year.

### 7.2.6 Commercial Demand Forecast

In the large customer market as in the commercial and industrial sectors, statistical or econometric methods involving elasticity are not often used because of the smaller number of customers and larger gas use. For a bottom-up model, new parameters will be found to link to the gas demand estimates.

New equipment such as boilers, gas air conditioners, co-generators, etc., will be the main gas firing equipment in the commercial sector. Therefore, the percentage of fuel conversion to gas must be calculated by fully considering the result of comparative evaluation of this equipment against current competing equipment with respect to the economic merit. In addition, the gas demand value must be calculated by multiplying the conversion percentage by energy consumption per specific unit (total floor area) and forecast total floor area of applicable buildings which were both obtained through questionnaire and visit surveys.

Once installed, it is extremely difficult to convert the fuel of boilers, air conditioners and power generators to gas. Therefore, the target of gas demand must be limited to new buildings except over the very long term.

For short term demand projections, facilities at close proximity to the existing gas pipelines in the Jatabek area will be examined and the data for regionally developed individual commercial facilities obtained in Chapter 6 will be used. Regarding long-period demand projection, the gross demand will be forecast by adding the demand projection based on the forecast total floor area of new buildings, considering GRDP in DKI as a parameter, and the projection based on the continuity of regional development in the suburban areas (Bekasi, Tangerang).

### 7.2.7 Industrial Gas Demand Forecast

PGN has already listed up the promising industrial gas customers for the near future. Therefore, we first estimate the short- and mid-term (1995-2004) industrial demand by bottoming them up, and then apply the resultant demand amounts to the econometric model for forecasting over the long term period (1998-2020).

I. Bottom-up Forecast for the Period 1995-2004:

① Determine the industrial gas demand amount by using the potential number of customers and the gas consumption per customer by sub-sector.

② Use the resultant data of the period from 1995 to 2004 as the known data for the econometric model procedures.

II. Economic Model for the Period of 1998-2020:

① Determine the industrial electricity demand for each year as a function of the total added values in the regional industrial sector and the electricity demand in the previous year.

② Determine the total industrial fuel demand for each year as a function of the total added values in the regional industrial sector and the total industrial fuel demand in the previous year.

③ Sum up the above two results to determine the total industrial energy demand.

④ Determine the demand of each fuel of LPG, bunker C oil and other fuels by assuming the shares of each considering the inter-fuel competition.

⑤ Finally determine the industrial gas demand under the constraint of the amount of "other fuels" and as the function of the regional industrial added values and the gas demand in the previous year.