PART III CONCEPTIONAL DESIGN OF THE INTEGRATED GAS DISTRIBUTION SYSTEM

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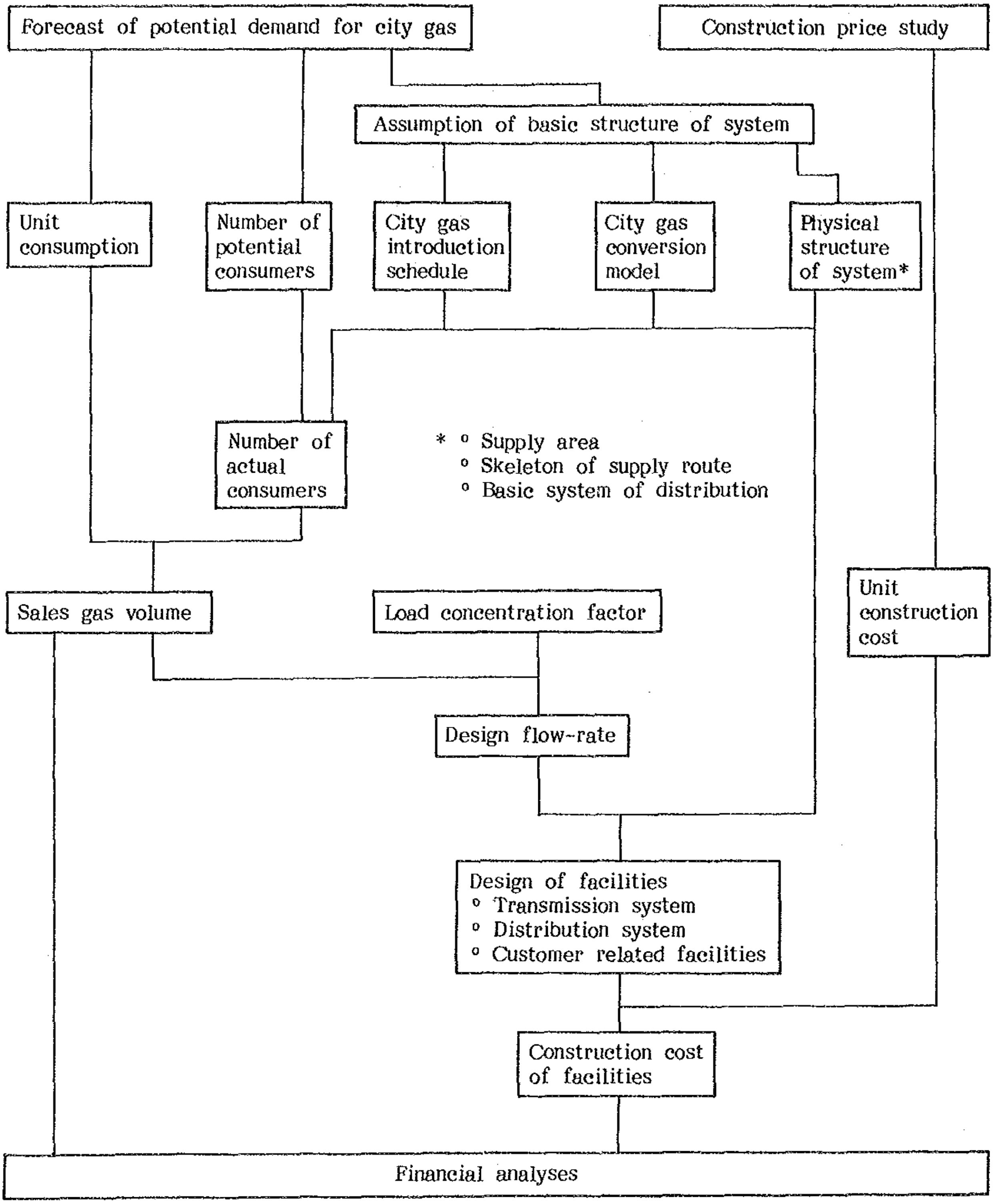
Chapter 1 PROCEDURES OF THE CONCEPTIONAL DESIGN

The conceptional design of the Integrated Gas Distribution System was carried out in accordance with the diagram shown on the next page. The following chapters will explain the details of each step of the design.


Forecast of potential demand for city gas
Construction price study
Assumption of basic structure of system
Unit consumption
Number of potential consumers
City gas introduction schedule
City gas conversion model
Physical structure of system*
Number of actual consumers
* ° Supply area
° Skeleton of supply route
° Basic system of distribution
Sales gas volume
Load concentration factor
Unit construction cost
Design flow-rate
Design of facilities
° Transmission system
° Distribution system
° Customer related facilities
Construction cost of facilities
Financial analyses

Chapter 2 BASIC STRUCTURE OF INTEGRATED GAS DISTRIBUTION SYSTEM

2.1 Conditions for Integrated Gas Distribution System

Be it a city gas system or a reticulation system, any system whereby gas is supplied by pipelines to satisfy demands distributed over geological areas is able to exist only on condition that the cost of transporting gas from the supply source to the points of demand is sufficiently small to justify the entire system economically. The cost of transportation consists of the following two components:

a. Cost of transporting gas from the gas source up to the area wherein the demand exists.

b. Cost of distributing gas to each customer within that area of demand.

In the case of a city gas system, a) above is the cost of the transmission pipeline from the gas source (in the present study, the gas source is the Transpeninsular Pipeline) to the regulator in the demand area from which gas will be distributed. The transmission pipeline route should cut across as many demand concentrating areas as possible. Therefore, in order to determine whether or not a certain area of demand justifies city gas supply in respect to transmission pipeline cost, the demand distribution over all of Klang Valley must be viewed first, and then a realistical transmission pipeline route should be actually selected. In the case of a reticulation system, the position of the area does not matter as long as it is within Klang Valley, but there is a precondition that there must be a certain amount of demand in that area in consideration of transmission and storage efficiency of LPG. The cost of b) above is the cost of the distribution pipelines from the city gas sending-out point or the LPG storage point to individual customers. This cost is mostly regulated by the density distribution of demand within the area. In this regard whether it is city gas or reticulation does not make any difference.

Therefore, as an approach toward establishment of the basic structure for a integrated gas distribution system, it was decided first to determine the overall supply subject area including both city gas and reticulation and then to divide that area into city gas and reticulation zones in consideration of their physical positions in relation to the transmission pipeline route to be established to that supply area.

2.2 Boundary of Total Supply Area

As the demand distribution density which justifies an integrated gas distribution system, the density of an existing typical suburban housing area was assumed. The zones wherein such a density or a density higher than that is expected to exist in the year 2005, the closing year of the study period, will be the supply areas of the integrated gas distribution system. However, it is very difficult to exactly forecast the layout of such zones to be in existence 20 years later in Klang Valley, which is a fast developing region. Under such circumstances, we have decided to take up those areas shown as "built-up area" in the final land use plans of the Klang Valley Perspective Plan and other regional structure plans as the geographical scope wherein such zones are expected to exist. The colored portion in Fig. III.1 indicates the said "built-up area". The demand zones subject to the integrated gas distribution system exist within the boundary of that built-up area. However, it is presumed that the entire area within the boundary is not necessarily a demand area.

2.3 Basic Route of Transmission Pipeline

Investigations and studies were made of possible routes of the transmission pipeline from the Transpeninsular Pipeline to the above-mentioned supply area. Pipelines of 10" to 20" diameter and of a maximum operation pressure of 9.9 kg/cm^2 determined on the basis of the city gas demand estimate was assumed and then the following three conditions were taken into consideration:

a. As many supply areas as possible should be covered.

b. It should have been confirmed by means of a field investigation that the gas pipeline of the above specifications can actually be installed along the route.

c. The pipeline should have the most economical lay-out as a whole.

The results of the investigation are also shown in Figure III.1.

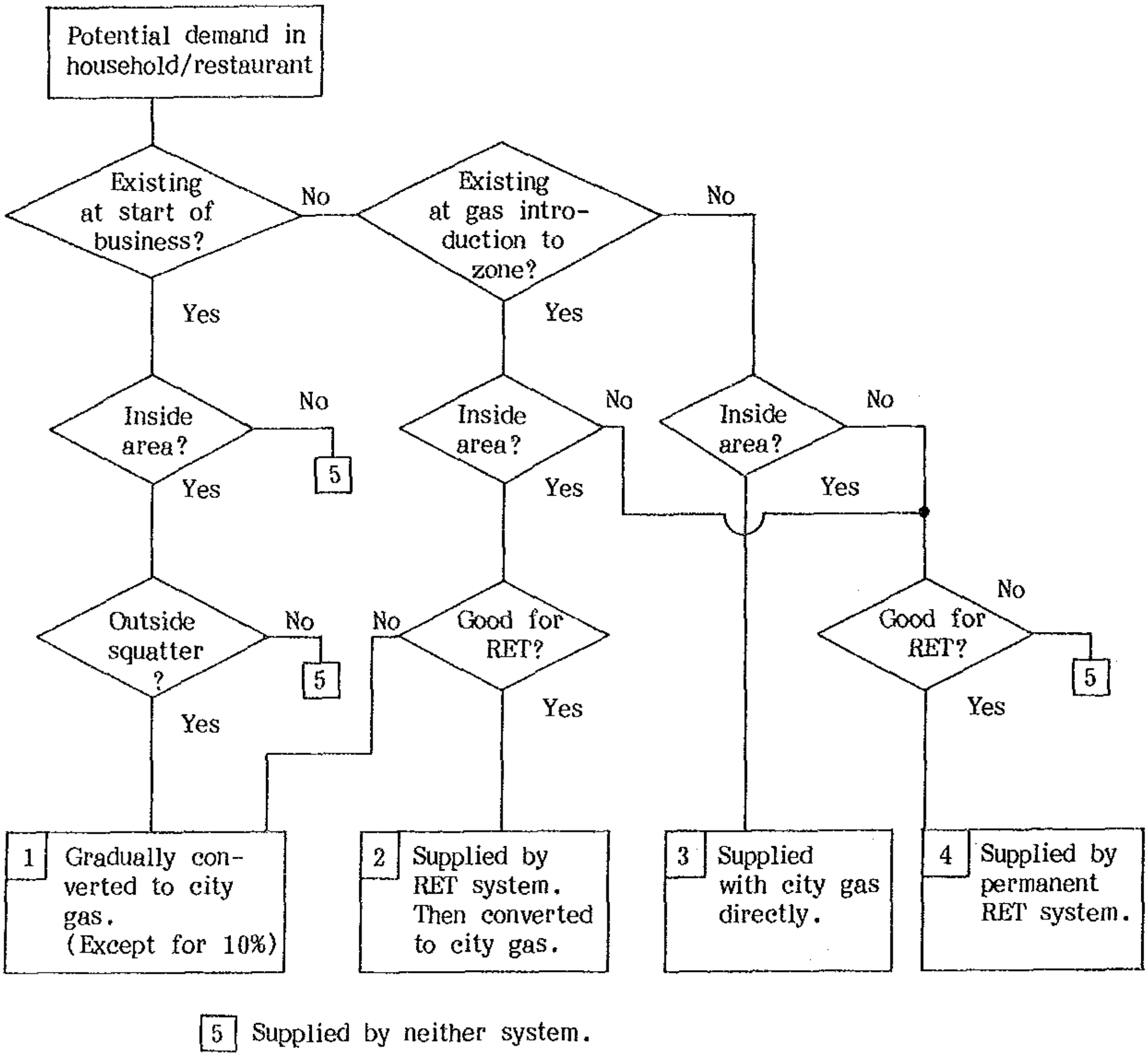
2.4 City Gas Supply Area

As can be seen from Figure III.1, the built-up zones expected to exist in the year of 2005 in Klang Valley are rather concentratedly laid out, therefore it will be possible to select the transmission pipeline route so that almost all of those zones be covered by the basic network only. This basic network may be reinforced with a few additional branch routes which will catch other isolated zones which, having a large demand, are relatively near, and thus the district comprising all those zones will be the city gas supply area in this feasibility study. The major built-up zones to be left out of the above city gas supply area are Zone 52 and Zone 53 (Gombak District), for which a permanent reticulation system will be constructed.

Chapter 3 SUPPLY-SIDE CONVERSION MODEL TO INTEGRATED GAS DISTRIBUTION SYSTEM

3.1 Household and Restaurant Demands

Assumptions were made as shown in the diagram below.



Note: "RET" is for reticulation.

Existing demand

(1) 90% of the households and restaurants which exist at the start of Integrated Gas Distribution System and locate inside the city gas supply area will be converted to city gradually, unless they are located in the remaining squatter areas detailed in (3).

(2) The conversion rate is assumed as follows.

- ° 35% of both households and restaurants are converted in the introduction year.
- ° 35% in the next year.
- ° 10% in the 3rd year.
- ° 10% in the 4th year.

The remaining 10% is assumed not to be converted to city gas.

(3) It was assumed that one-half of the present squatters would remain in 2005, and this number was exempted from the city gas supply subject. To be specific, one-half of the squatter population in 1985 as shown in Table III.15 were deducted from the city gas supply population. The squatter population was distributed to zones in accordance with a squatter location map.

(4) The existing households and restaurants located outside the city gas supply area will be exempted from Integrated Gas Distribution System.

New demand inside city gas area

(5) The households and restaurants which will appear inside the city gas area in the period between the start of Integrated Gas Distribution System and the introduction of city gas to the zone will be supplied by reticulation system temporarily, if the size of demand suffices the condition stated in (7). These demands will then be converted to city gas in the year of introduction of city gas to the zone.

(6) When the demand does not suffice the condition in (7) in the above case, the demand will remain unsupplied until the introduction year of city gas to the zone and then be converted to city gas at the conversion rate mentioned in (2).

(7) It was assumed that the additional population increase of approx. 10,000 (comparative to 2,000 customers) would be subject to application of the LPG reticulation system. Population increases were calculated as to each zone. It was also assumed that the restaurant demand newly appearing in the reticulation system area would be supplied by the said system. No minimum limitation of supply period was assumed for the temporary LPG system which appears within the boundary of the final supply area and is to be converted to city gas in the future.

(8) The households and restaurants which will appear inside the city gas supply area after the introduction of city gas to the zone will be supplied with city gas from the beginning.

New demand outside city gas area

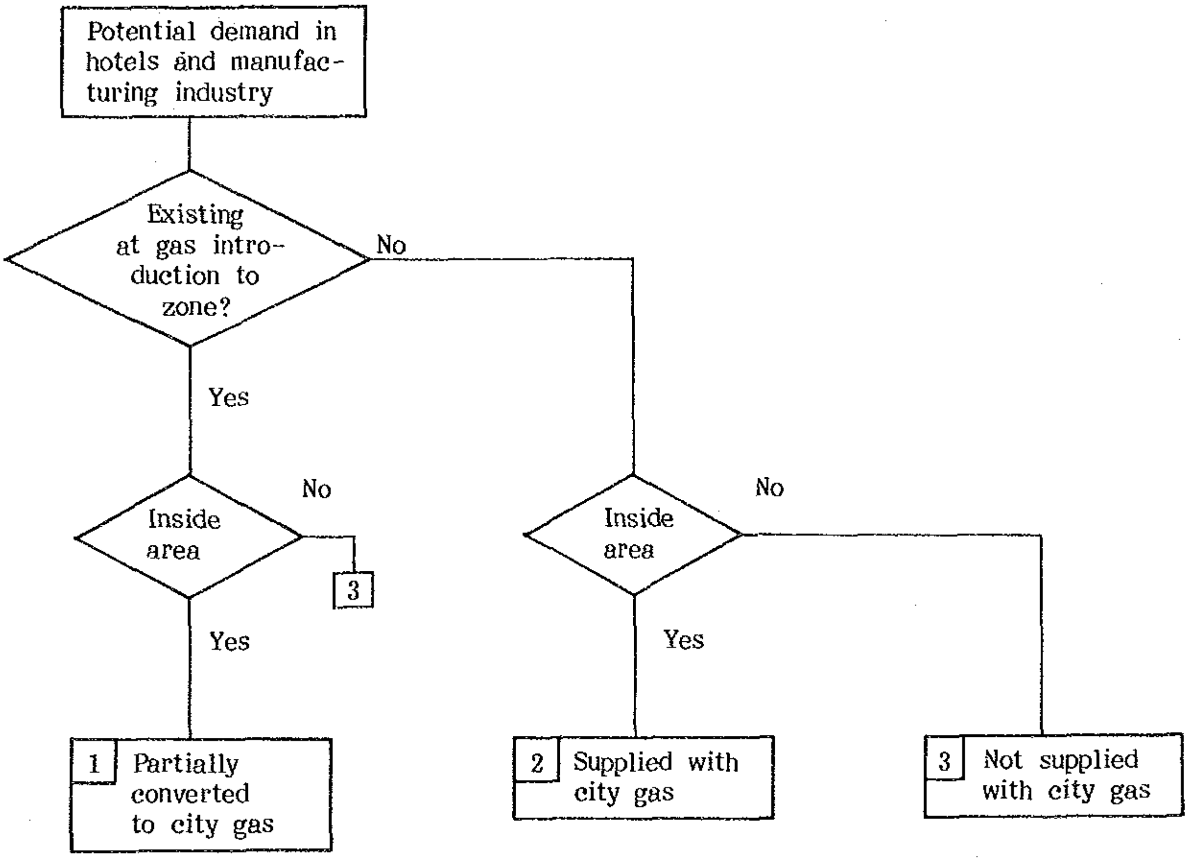
(9) The households and restaurant which will appear at the start of Integrated Gas Distribution System and outside the city gas supply area will be supplied by permanent reticulation system, if the size of demand suffices the condition in (7).

(10) When the demand does not suffices the condition in (7) in the above case, it will not be supplied either by city gas system nor reticulation system.

The conversion model in household and restaurant demand is shown in Figure III.2 in a summed up form.

3.2 Hotel and Manufacturing Industry Demands

The city gas conversion model of this type of demand is assumed as follows.



It is different in the following points from that of household and restaurant demand.

a. Application of the LPG reticulation system will not be considered.

b. Existing demand will be converted within a year.
The conversion rates will be 70% for hotels and 50% for the manufacturing industry.

c. Squatter problems do not exist.

These are also shown in a summed up form in Figure III.3.

Chapter 4 CITY GAS INTRODUCTION SCHEDULE

4.1 Start-up of the City Gas Supply System

As described in detail in PART 4 STUDY OF THE CONSTRUCTION SCHEDULE OF THE INTEGRATED GAS DISTRIBUTION SYSTEM, the start-up of the city gas supply system, or the commencement of the city gas supply, is scheduled for the beginning of 1992, allowing the estimated period of project evaluation, construction preparation and construction execution. However, in the cases of Medium and Low economic growth, the start-up of the system will be in the beginning of 1995, 3 years later than the Base Case, for the reasons given in PART 1 THE BACKGROUND AND RELEVANT CONDITION.

Case	Start-up of the system
Base	Beginning of 1992
Medium	Beginning of 1995
Low	Beginning of 1995

4.2 Timing of City Gas Introduction to Districts

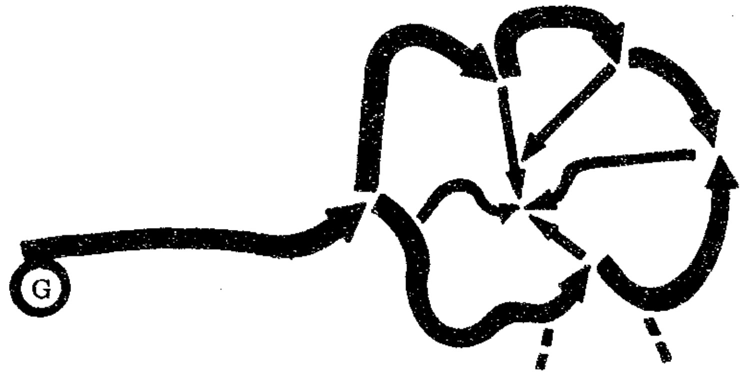
The transmission pipeline construction in the Base Case will be divided into the following five phases. (See PART 4)

Phase	Construction Period	Start-up of the system
I	Mid-1990 - end 1991	Beginning 1992
II	Beginning 1992 - end 1992	Beginning 1993
III	Beginning 1993 - end 1993	Beginning 1994
IV	Beginning 1994 - end 1994	Beginning 1995
V	Beginning 1995 - end 1995	Beginning 1996

In the Medium Case and Low Case, the construction as well as supply commencement will be 3 years later than the above.

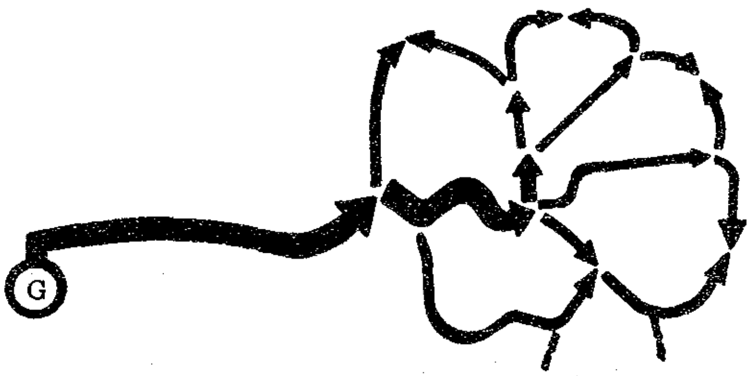
Two construction sequences are conceivable as to forming a loop around Federal Territory.

A. From outskirts to center (Route 1)



The main pipe branches off in two circular directions to form a circumference first and then smaller diameter pipes will extend from the circumference toward the center.

B. From center to outskirts (Route 2)



Centering on the main pipe, smaller diameter pipes will extend slowly toward and around the circumference.

These two construction sequences are to comparatively studied as they may differ in construction cost and consumer acquisition speed.

Refer to Figure III.4 and III.5 for the supply commencement time by district and the transmission pipeline construction period by section for Route 1 and Route 2.

Chapter 5 LOAD CONCENTRATION FACTOR

5.1 Household Load Pattern

Load variation patterns in household LPG use were measured, using load survey gas-meters (See Fig. III.6).
Thirteen (13) measurements (consisting of 9 Malay, 2 Chinese and 2 Indian) were made with the results as shown in Fig. III.7.

On the average, there were two peaks corresponding to lunch and dinner preparation hours of which the lunch time peak showed a slightly higher load concentration.

Load concentration factors, which are given by the following equation, for these peaks are between 9 and 10%.

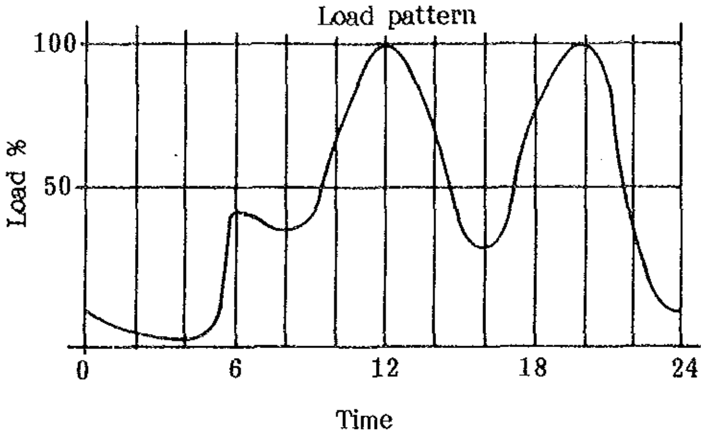
$$\text{Load concentration factor} = \frac{\text{Gas consumption volume in peak hours}}{\text{Gas consumption volume per day}} \times 100 \ (\%)$$

Hours	11:00 - 12:00	18:00 - 19:00
Load concentration factor (%)	9.97	8.50

Applying 20% of safety factor on this observed factor, a load concentration factor of 12% was assumed for this feasibility study.
This figure corresponding the empirically used one in Tokyo. The peak period is assumed to be one hour around lunch time.

5.2 Restaurant Load Pattern

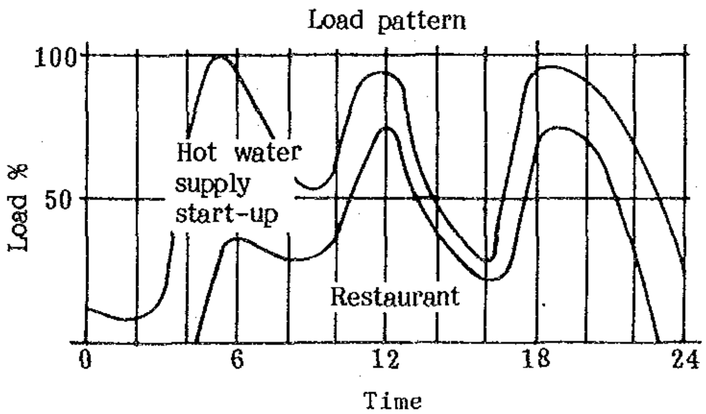
According to our experience there are two peaks daily, showing that a large amount of energy is used at lunch and dinner hours, as shown in the following figure.



A load concentration factor of 24%, which is twice the household load concentration factor, was assumed during the same concentration hour as households.

5.3 Hotel Load Pattern

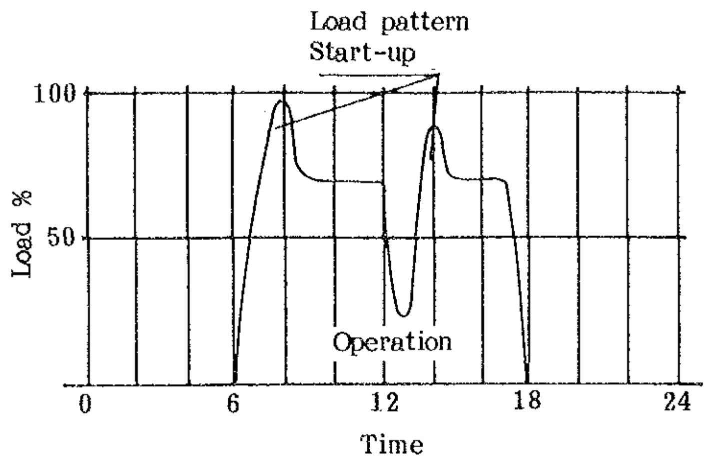
Normally, consumption hours and volumes are long and large in general, showing three peaks daily in the morning, at noon and in the evening, respectively.



To be on the safe side, the same concentration hour and factor as restaurants was assumed.

5.4 Industry Load Pattern

Industrial load patterns vary greatly from a type of industry to another. In the case of a whole day operation, a constant loading level continues all day. For daytime operation type of industry the following pattern is common.



The highest peak appears at the morning start-up, including the highest loading for heating of boilers, furnaces, etc.
During the work operation, a 70% to 85% consumption level continues constantly in the daytime.

Assumedly, this daytime operation type dominates in Klang Valley.
Since the household load concentration hour fall on the constant operation hours of day type industrial consumers, a load concentration factor equal to 1/2,000 of the annual gas sales volume was adopted. It was calculated as follows.

Annual working days: $365 \times \frac{5.5}{7} = 286.8$

Assumed equivalent hours at peak load operation (Daily) : 7.0

$286.8 \times 7.0 = 2,007.4 \fallingdotseq 2,000$ (hours/year)

Chapter 6 DESIGN OF TRANSMISSION SYSTEM

6.1 Design Flow-rate

The transmission pipeline system was so designed as to ensure a transmission capacity sufficient to meet the city gas demand estimated for 2005. The design flow-rate of city gas was sought by the following formula from the annual sales amounts given by consumption purpose:

$$\text{Design flow-rate factor} = \frac{1}{365} \times \frac{\text{Load concentration factor}}{100} \times k$$

or,

$$\text{Design flow-rate factor} = \frac{1}{\text{Equipment peak load operation hour}} \times k$$

where k, which is the temperature correction factor, was assumed to be 1.1. (The average atmospheric temperature was assumed to be 27°C.)

The design flow-rate factors used in the calculations are shown below.

Use	Load concentration factor	Equipment peak load operation hour	Design flow-rate factor
Household	12 %	-	3.62×10^{-4}
Restaurant	24	-	7.24
Hotel	24	-	7.24
Industrial	-	2,000 h/year	5.50
Cooling	-	1,500	7.33
CNG	-	2,400	4.58

6.2 Components of Transmission System

A transmission system composed of the followings was assumed:

(1) Regulator station

The regulator station will be installed on the Transpeninsular Pipeline, which will reduce the gas pressure of maximum 70 kg/cm^2 to 9.9 kg/cm^2 or less and feed the main transmission pipeline.

(2) Main transmission pipeline

The main transmission pipeline of the maximum operation pressure of 9.9 kg/cm^2 will be installed along the basic route selected as described in 2.3 (See Figure III.1). The pipe materials will be of the following standards or equivalent in other international standards:

API 5L Grade-B
JIS G 3452/3457

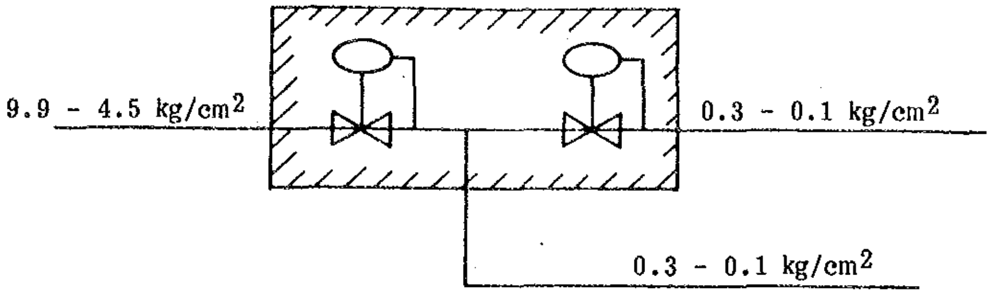
Valves will be installed in downstream of branch points of the pipeline unless otherwise required.

(3) Auxiliary transmission pipeline

The auxiliary transmission pipeline will send the gas of maximum 3.0 kg/cm^2 from the MPA district regulator installed on the main transmission pipeline to the MPB district regulator installed at a position distant from the main transmission pipeline.

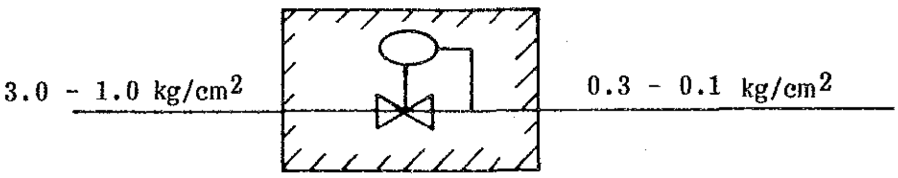
Note: MPA is for Medium Pressure A (higher range) and MPB for Medium Pressure B (lower range)

(4) *MPA district regulator The MPA district regulator will be installed on the* main transmission pipeline to feed the auxiliary transmission pipeline and the distribution pipelines.



(5) MPB district regulator

The MPB district regulator will be installed on the auxiliary transmission pipeline to feed the distribution pipelines.



6.3 Dimensions and Quantities of Transmission System Components

(1) Regulator station

A regulator station having a facility layout as shown in Figure III.8 and occupying a land area of approximately 40 m x 40 m will be installed at three locations, namely at Shah Alam, Connaught Bridge and Kajan.

(2) Main transmission pipeline

The diameter designs were carried out, using the optimum pipeline network design system of Tokyo Gas, for each case of Base, Medium and Low economical growth as well as the modified Base Case which include the additional demands for cooling (2 levels), industry (2 levels) and CNG. The results are shown in Figure III.9 and Table III.1 and III.2. The linear pipeline length was 236.2 km in all cases. The average diameter was approx. 10 inches in the Base Case. In the hypotheical case referred as Maximum case, where Base Case is added by all additional demands, the diameter was approx. 15 inches.

(3) Auxiliary transmission pipeline

It is assumed that the auxiliary transmission pipelines of average 6' diameter, in the total linear length of 50 km, will be distributed all over the supply areas.

(4) District regulator

One district regulator is considered to cover 8,000 to 10,000 consumers. Therefore, assumedly, 100 MPA and MPB district regulators will be distributed all over the supply areas.

6.4 Outline of Transmission Pipeline Design

(1) Pipeline should be installed under the unpaved section in the road shoulder or the planted section except in the case of city streets.

Figure III.10 through III.13 show the general installation method of transmission pipelines.

(2) Highway and railway crossing should be designed based on the standard methods shown in Figure III.14 and III.15.

(3) The method of river crossing should be selected from the standards shown in Figure III.16 through III.18 in compliance with river width, space on the bank and other conditions of the locations.

Chapter 7 DESIGN OF DISTRIBUTION NETWORK

7.1 Selection of Basic Supply Systems

(1) Distribution system for general demand

There are the following supply methods for city gas distribution to households and small commercial customers.

1) Low pressure distribution system (Max. 0.03 kg/cm^2)

2) Intermediate pressure distribution system (Max. 0.3 kg/cm^2)

3) Medium pressure distribution system (Max. 3 kg/cm^2)

With a view to selecting a supply method for this purpose, Subang Jaya was studied as a basic model with the following results:

Method / Item	Low pressure system	Intermediate pressure system	Medium pressure system
Average diameter	3.2 in.	2.9 in.	2.4 in.
Required auxiliary facility	District regulator	House regulator	House regulator
Total construction cost comparison with low pressure supply being 100	100	98	96

Since the gas consumption amount of each consumer was relatively small, there was little difference between average diameters, and as the result their construction costs were very much the same.
Finally, however, the supply method withintermediate pressure (0.3 kg/cm^2 - 0.1 kg/cm^2), which allows maximum cost saving, gas supply flexibility and easy maintenance and operation, was selected.

As the main piping materials, medium density polyethylene pipe was selected from the standpoint of the supply method selected, corrosion prevention, material cost and construction work easiness.

The use of this polyethylene pipe is limited to 4" in diameter for economical reason. For larger diameters, steel pipes with arc weld should be used.

(2) Large volume distribution system

For industrial demands, hotels and buildings, the supply pressure of max. 3.0 kg/cm^2 to min. 1.0 kg/cm^2 were selected, considering the requirements of such consumers.

7.2 Selection of Sample Areas

Normally, in making a city gas supply plan, the total construction cost is estimated after surveys have been made throughout the subject supply area concerning the total number of households, commercial establishment and industrial factories and the number, out of them, of those who may actually require service connections as well as surveys on the amount of potential energy consumption and the conditions of roads and streets in that area.

In this feasibility study, which is under restriction of time, several sample areas having a typical structure of consumption were selected and the design and estimation of distribution network were performed. Then the resulted construction costs in those areas were analogically applied to other areas in order to arrive at the total investment amount of the entire distribution network.

The following areas were selected as sample areas representingthe typical categories of areas in Klang Valley.

Features of these areas are shown in Table III.3.

Category	Sample area
1. Residential area	
A. High class residential area	(1) Damansara Heights
B. Middle class residential area	(2) Subang Jaya
C. Middle-low class residential area	(3) Ampang Ulu Klang
D. Suburban residential area	(4) Kajang
2. Commercial area	
A. Common shop and store area	(5) Petaling Street area
B. Concentrated building area	(6) Golden Triangle
3. Concentrated industrial area	(7) Petaling Jaya (#83 Zone)

7.3 Field Survey

Field surveys of the sample areas were conducted as a part of actual design work of distribution network as follows.

(1) A distinct supply area was established for each sample area by selecting such a block surrounded by rivers and canals, trunk roads, railways, etc. that a whole self-sustaining distribution is required.

(2) Demand survey

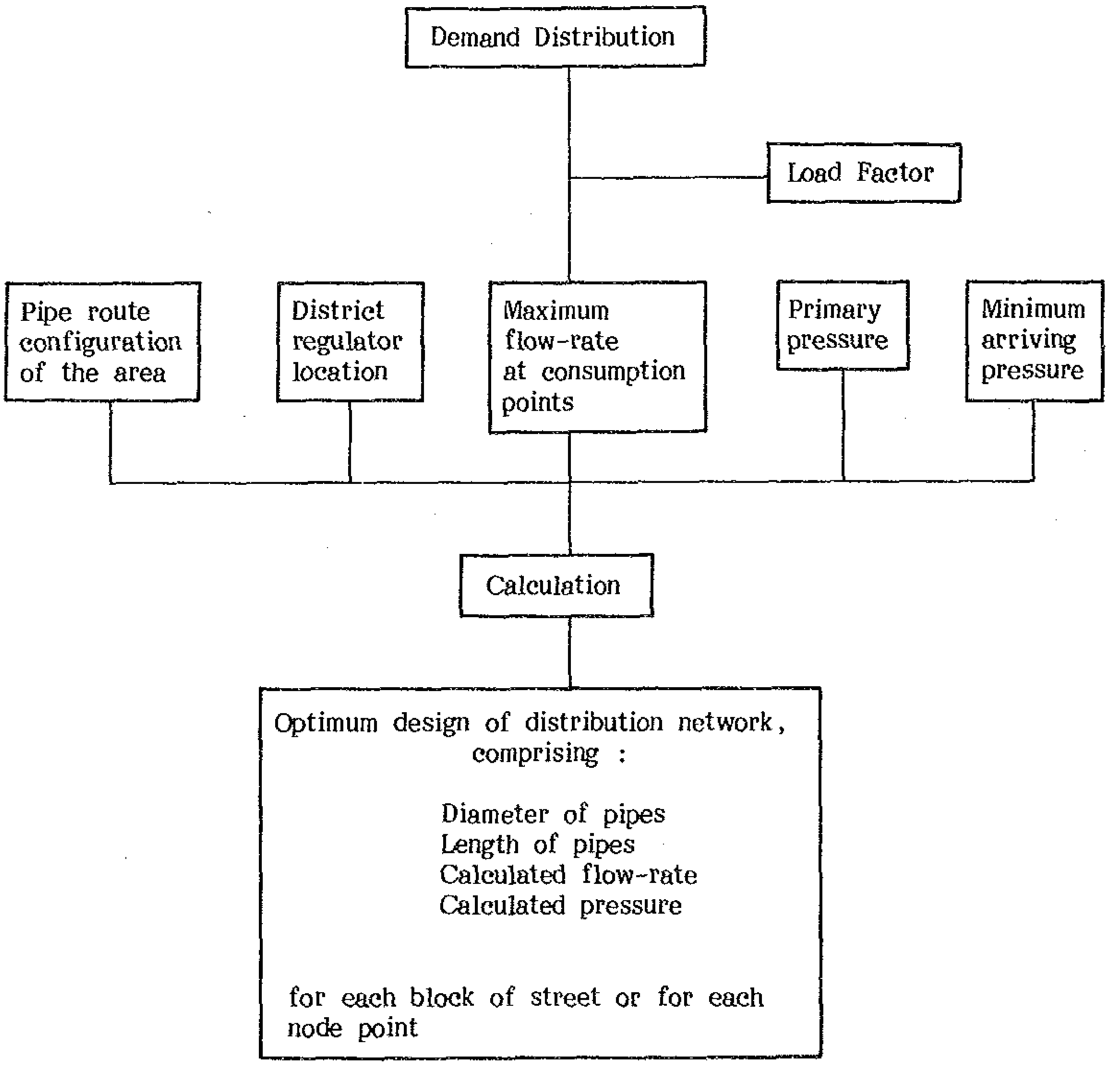
Investigations were made on the populations and the numbers of houses, stores, buildings and factories.
Type and energy utilization conditions of the factories were also investigated for the industrial sample area.

(3) Observation of road conditions

Investigations were made on road width and structures, underground objects, pavement conditions as well as plantations along the road for finalizing gas pipe installation locations. In addition, the soil resistivities were measured for designing cathodic protection.

7.4 Procedures of Network Design

Actual and detailed designing of the distribution networks for each of the sample areas was performed based on the results of the field survey and the city gas demand assigned to the area. Outline of the designing procedures is shown in the diagram below.



7.5 Design Flow-rate

The philosophy concerning the design flow-rate is basically the same as what was entertained in 6.1. Based on the same assumptions, the flow-rate per housing unit was established as follows:

City gas consumption per person per year (year 2005)	36.3	(Nm^3)
Number of persons per household (2005, from KVPP)	4.55	
Number of households per housing unit (From KVPP)	1.18	

City gas consumption per housing unit per year (2005)

$= 36.3 \times 4.55 \times 1.18 = 195\ (Nm^3)$

Design flow-rate per housing unit (2005)

$$= 195 \times 1.1 \times \frac{1}{365} \times \frac{12}{100} = 0.070\ (m^3/h)$$

Assuming that on the average a population of 1,000 contains an employment of 400, the above household consumption will be added by a restaurant consumption of 75 Nm^3/year.

(See Part 2. 3 Demand by Restaurant)

The design flow-rate to answer this demand will be:

$$75 \times 1.1 \times \frac{1}{365} \times \frac{24}{100} = 0.055\ (m^3/h)$$

Therefore, the total design flow-rate per housing unit will be:

$0.070 + 0.055 = 0.125\ (m^3/h)$

7.6 Results of Design Work

(1) The design data and results are summarized in Table III.4.

(2) The configuration of designed networks are shown in Figure III.19 through III.24.

Chapter 8 DESIGN OF OTHER FACILITIES

8.1 Cathodic Protection

8.1.1 Design Conditions

The soil resistivities were measured in the Klang Valley area, which resulted in the following classification of the area.

Category	A	B
Feature	Areas with relatively low soil resistivity and medium corrosiveness	Areas with relatively high soil resistivity and low corrosiveness
Average soil resistance (cm・Ω)	6,627	19,452
Name of area	Ampang Ulu Klang area/ K.L. central area (including Golden triangle) and Port Klang City area	Other areas

Other conditions assumed for the design are as follows.

(1) Magnesium anode installation at 200 m interval is to be adopted.

(2) The electric potential difference between the pipe and the anode shall be -1,000 mV.

(3) The coating resistance of the polyethylene pipe in a stationary state is 5,000 Ωm^2.

(4) The expected life span of the magnesium anode shall be more than 40 years.

(5) Average diameter of pipe to be protected is supposed 300 mm.

8.1.2 Design Results

Magnesium anodes to be installed along the transmission pipelines at 200 m interval are determined as follows.

Soil category	A	B
Main line	Type 25S x 2	Type 25S x 1
Auxiliary line	Type 17S x 2	Type 17S x 1

Design calculations are shown in Table III.16.

8.2 Service Pipes

For corrosion prevention and construction cost saving, polyethylene pipes shall be used. In case of common households, the pipe diameter will be 20 mm to suit their consumption amount, and steel-to-poly-ethylene transition joints shall be used near the gas-meter pipe turn-up.
For commercial consumers, the pipe diameters of 32 to 40 mm will be used, depending upon the design flow rate. For industrial and hotel purposes, 100 mm steel pipes will be required.

8.3 Gas-meters and House Regulators

For common households, the diaphram type gas-meters capable of passing max. 1 m^3 of natural gas per hour will be used. For commercial purposes, the diaphram type gas-meters capable of passing 10 - 15 m^3 per hour will be needed. For industrial purposes, the rotary type gas-meters with a pressure compensation mechanism are recommendable to meet medium pressure gas supply.
The house regulator shall be small diaphram type regulators capable of regulating the pressure from 0.3 kg/cm^2 to approximately 300 mm of water column. It will be installed immediately before the gas-meter.

8.4 Installation Piping and Cocks

Material for installation piping are to be galvanized steel pipes with threaded joints. Polyethylene pipes should not be used. Pipe diameter for common household purposes will be minimum 15 mm.

8.5 LPG Storage and Supply

When the demand is located at distance from the constructed trans-mission line an LPG reticulation system will be provided.

For this purpose the following two types of LPG storage and supply facilities are proposed.

8.5.1 Storage Tank System

For permanent or long-term large-scale reticulation system, this type of storage and supply system is recommended. Following facilities are generally required for this system.

a. Unloading lines
b. LPG tank
c. Vaporizer
d. Vaporized gas pressure regulator

However, if natural vaporization in the tank is sufficient for the required amount, the vaporizer is not necessary. This is the case with the reticulation system now operated by PDSB in Klang Valley.

For 4,000 customers, a 10 ton LPG tank facility, an example of which is shown in Figure III.25 is necessary. The design basis for this as as follows.

i)	Unit consumption per customer	0.45 kg/day
ii)	Capacity of tank lorry	7,000 kg
iii)	Tank replenishing interval	4 days
iv)	Storage safety interval	2 days

Assuming 2.5 hours of peak use per day and 20% of safety factor for vaporization rate, required vaporization capacity of the system is calculated to be approximately 200 kg/hour.

$$4,000 \times 0.45 \times 1.2 \times \frac{2.5}{24} = 225 \text{ (kg/hour)}$$

Considering the necessity of a stand-by and maintenance relief, two storage tanks should be provided (See Figure II.26).

8.5.2 Cylinder Exchange System

For interim or small-scale reticulation system, this type of system is suitable. Required facilities are an LPG cylinder storage house equipped with two sets of manifolds for collecting gas and an automatically changing pressure regulator. This pressure regulator automatically changes the supply line to the newer set of cylinders, when the feeding pressure drops as the supplying cylinders come to empty (See Figure III.27). For 1,000 customers, a system with two sets of 36 cylinders, which is depicted in Figure III.28, is required.

The design basis is given below.

i)	Unit consumption per customer	0.45 kg/day
ii)	Vaporization capacity per cylinder	1.5 kg/hour
iii)	Peak hours per day	2.5 hours/day
iv)	Safety factor (vaporization)	20%

Chapter 9 RESULT OF CONCEPTIONAL DESIGN

The result of the conceptional design will be given in the tables listed below.

No. of city gas actual consumers units	Base case	Table III.5
	Base route 2 case	Table III.6
	Medium case	Table III.7
	Low case	Table III.8
City gas sales volume	Base case	Table III.9
	Base route 2 case	Table III.10
	Medium case	Table III.11
	Low case	Table III.12
	Summary case	Table III.13
	Additional case	Table III.14

Table III.1 DESIGN OF TRANSMISSION SYSTEM

Case	Total sales volume (10^3 Nm^3/Year)	Flow-rate (m^3/H)	Average diameter (mm)	P (inch)	Construction cost* (10^3 US$)
Base Route 1	266,056	128,107	227.8	9.1	26,723.5
Route 2	265,803	128,072	227.8	9.1	26,729.7
Medium	247,741	120,237	223.8	9.0	26,526.0
Low	222,267	107,711	219.7	8.8	26,299.9
Base + Industry High	771,556	406,132	329.5	13.2	34,025.9
Base + Industry Low	518,807	267,120	289.8	11.6	30,967.6
Base + Cooling High	335,763	179,225	269.7	10.8	29,771.5
Base + Cooling Low	296,667	150,555	242.9	9.7	28,020.7
Base + C.N.G.	427,493	202,099	278.9	11.2	30,424.5
Maximum	1,002,699	531,242	382.0	15.3	39,961.3

* Main transmission pipe and 3 govener stations.

Table III.2 RESULTS OF TRANSMISSION PIPELINE DESIGN

TRANSMISSION PIPE LINE DIAMETER BY EACH CASE (MM)

PIPE-NO	KM	BASE	ROUTE2	MEDIUM	LOW	IND-H	IND-L	COOL-H	COOL-L	C.N.G	MAXIMUM
1	5.0	500	500	500	500	600	600	600	500	600	750
2	2.5	500	500	500	500	600	600	600	500	600	750
3	1.8	500	500	500	500	600	600	600	500	600	750
4	1.5	400	400	400	400	500	500	400	400	500	600
5	4.7	300	300	300	300	400	400	300	400	400	500
6	6.8	300	300	300	300	400	400	300	400	400	500
7	.5	200	200	200	200	200	200	200	200	300	300
8	2.8	200	200	200	200	200	200	200	200	300	300
9	2.7	100	100	100	100	200	100	100	100	150	200
10	6.5	200	200	150	150	300	200	200	150	200	200
11	4.6	200	200	200	200	300	200	300	200	200	300
12	3.3	100	100	100	100	100	100	100	100	100	150
13	3.0	150	150	150	200	200	200	300	200	200	300
14	1.5	200	200	200	200	300	300	300	300	300	300
15	4.6	200	200	200	200	300	300	300	300	300	400
16	2.4	300	300	300	300	400	400	400	300	400	500
17	4.0	300	300	300	300	400	400	400	300	400	500
18	7.9	300	300	300	300	400	400	400	300	400	500
19	2.5	300	300	300	300	400	400	400	300	400	500
20	5.7	300	300	300	300	500	400	400	300	400	500
21	3.9	300	300	300	300	400	400	400	300	400	500
22	5.8	100	100	100	100	300	200	100	100	150	300
23	2.5	300	300	200	200	300	300	300	300	300	400
24	3.9	300	300	200	200	300	300	300	300	300	400
25	2.6	100	100	100	100	100	100	150	100	100	100
26	2.2	150	150	150	150	200	150	100	100	150	200
27	2.3	200	200	200	200	300	300	300	200	300	300
28	2.4	200	200	200	200	300	200	200	200	200	300
29	3.0	150	150	150	150	300	200	150	150	200	200
30	5.4	100	100	100	100	100	100	100	100	100	150
31	5.9	200	200	200	150	200	200	300	200	300	300
32	3.0	150	150	100	100	100	150	100	100	100	150
33	7.4	150	150	150	150	300	150	150	150	200	300
41	10.3	400	400	400	400	600	500	500	500	500	750
42	3.8	300	300	300	300	500	400	400	400	400	500
43	3.0	300	300	300	300	300	300	300	300	300	400
44	5.9	300	300	300	300	300	300	300	300	300	400
45	6.1	300	300	300	300	300	300	300	300	300	400
46	2.9	200	200	300	200	300	300	300	300	300	300
47	6.5	300	300	300	300	400	400	400	300	400	500
48	4.6	300	300	300	300	400	400	400	300	400	500
49	3.0	300	300	300	300	400	400	400	300	400	500
51	3.8	200	200	200	200	400	300	200	200	300	500
52	4.9	200	200	200	150	400	300	200	200	300	400
53	2.8	150	150	150	150	400	300	150	150	150	400
54	3.2	100	100	100	100	300	300	150	100	100	300
55	1.5	200	200	200	200	500	400	300	300	300	600
56	2.1	200	200	150	150	400	300	200	200	200	400
57	1.3	150	150	150	150	300	200	150	150	150	300
58	4.6	100	100	100	100	100	100	100	100	100	100
59	6.0	150	150	150	100	300	200	150	150	150	300
60	4.7	200	200	200	200	400	300	200	200	200	400
61	1.8	100	100	100	100	100	100	150	150	150	150
62	6.1	100	100	100	100	200	200	150	150	150	300
63	2.4	100	100	100	100	100	150	100	100	100	150
64	2.3	100	100	100	100	150	100	150	100	100	100
65	3.8	150	150	150	150	300	200	200	150	150	300
66	2.0	200	200	200	200	400	300	200	200	200	400
67	1.8	200	200	200	200	400	300	200	200	200	400
68	4.7	100	100	100	100	100	100	100	100	100	100
69	2.0	100	100	100	100	100	100	100	100	100	100
70	3.7	200	200	200	200	400	300	200	200	200	400

Table III.3 SELECTED SAMPLE AREAS FOR DISTRIBUTION NETWORK DESIGN

Category	Name of area	Feature of area	Other similar area
1. Residential area			
A. High class residential area	(1) Damansara Heights	This area can be considered to be a typical high cost residential area scattered with condominiums, detached houses, bungalows and terrace houses generally having large floor areas.	Bangusar Bukit Tunk Ukay Heights
B. Middle class residential area	(2) Subang Jaya	This area has been developed mainly as a middle class residential area with terrace houses and detached houses and partially with higher class housings, which will be considered to be the standard residential area. There also exists commercial demand in this area.	Shah Alam Petaling Jaya Other majority of existing areas
C. Middle-low class residential area	(3) Ampang Ulu Klang	This is the most densely populated area with a mixture of terrace houses, high-rise middle class and low cost housings. It is a typical example of a housing area located relatively close to city areas.	
D. Suburban residential area	(4) Kajang	This is a suburban community comprising a mixture of farms and houses and privately developed small housing complexes with occasional shopping areas. This area, as a whole, does not seem to be populated enough for a city gas supply.	Underdeveloped suburban towns
2. Commercial area			
A. Common shop and store area	(5) Petaling Street area	A typical commercial area with 3 to 5 story buildings scattered with high-rise commercial buildings.	Jalan Tunk Pudu
B. Concentrated building area	(6) Golden Triangle	This is an area of high-rise commercial buildings including many hotels.	
3. Concentrated industrial area	(7) Petaling Jaya (#83 Zone)	This is a typical concentrated industrial area. A similar area can be found in Port Klang and Subang Jaya.	Industrial zones in Port Klang Shah Alam

Table III.4 SAMPLE AREA DESIGN DATA

			DAMANSARA	HULL KLANG	SUBANG JAYA	KAJANG	PETALING JAYA (#83 ZONE)	GOLDEN TRIANGLE	PETALING STREET AREA
Purpose	Residence		5,286 consumers	15,851	13,992	2,322			1,117
	Commercial		(135 consumers)						
	Building							31	50
	Hotel							5	3
	Industrial					1	153		
	Total		5,286	15,851	13,992	2,323	153	36	1,242
Pipeline	Dia-meter	50	PE 50,198.3	PE 41,600.2	PE 66,608.9	PE 66,647	MPB(SGP)2,044.1	MPB(SGP)2,929.6	PE 12,033.1
		80	" 3,428.4	" 4,382.5	" 8,559.8	" 1,834	" (")3,734.3	" (")1,005.8	" 1,800.1
		100	" 2,213.2	" 3,228.9	" 5,483.3		" (") 414.6	" (")1,056.3	" 2,112.4
		150	SGP 33.2	SGP 700.5	SGP 3,821.6		" (")1,144.0	" (") 554.7	SGP 1,131.0
		200		61.1	1,248.2		" (")2,742.0	" (") 529.6	" 987.8
		300							
	Linear length		55,873.1	49,973.2	85,721.8	68,480	9,078.9	6,075.9	18,064
	Aver. diameter		(2.1) 52.5	(2.5) 62.1	(2.6) 64.5	(2") 50	(4.7) 117.5	(3.4) 85	(2.9) 72
	Length per consumer		10.6	3.15	6.13	29.49	59.3	168.8	14.5
Existing area estimates - US$ -	Total const. cost		2,161,249	1,960,902	3,460,540	2,622,209	500,417	287,886	797,610
	Cost per consumer		408.9	123.7	246.6	1,128.8	3,270.7	7,996.8	642.2
Future area estimates - US$ -	Total const. cost		1,049,693	981,153	1,854,709	1,259,254.5	399,537	189,457	451,961
	Cost per consumer		198.6	61.9	132.6	542.1	2,611.4	5,262.7	367.9

Table III.5 NO. OF ACTUAL CONSUMER (BASE CASE)

CONSUMER (BASE)

NO.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	#1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	#1992	229	28	257	257	68	7	75	75	533	46	579	579	4482	418	4900	4900
4	#1993	716	94	810	1067	141	18	159	234	274	70	344	923	2036	629	2665	7565
5	#1994	735	108	843	1911	162	22	183	417	5286	487	5773	6696	1889	817	2706	10270
6	#1995	489	119	608	2519	134	24	158	575	719	545	1264	7960	1205	1093	2298	12568
7	#1996	364	146	510	3028	84	34	118	693	181	553	734	8694	2334	1851	4186	16754
8	#1997	151	150	301	3330	45	34	79	772	0	555	555	9249	0	1852	1852	18606
9	#1998	49	149	199	3528	12	34	47	819	0	554	554	9803	0	1837	1837	20443
10	#1999	20	150	170	3698	5	34	39	858	0	553	553	10356	0	1835	1835	22278
11	#2000	0	149	149	3847	0	34	34	892	0	556	556	10912	0	1854	1854	24133
12	#2001	0	124	124	3972	0	34	34	926	0	557	557	11469	0	1832	1832	25965
13	#2002	0	123	123	4095	0	34	34	960	0	552	552	12021	0	1841	1841	27806
14	#2003	0	95	95	4190	0	33	33	993	0	555	555	12576	0	1829	1829	29635
15	#2004	0	152	152	4343	0	34	34	1027	0	554	554	13130	0	1835	1835	31469
16	#2005	0	124	124	4467	0	34	34	1060	0	558	558	13688	0	1828	1828	33298

COLUMN ELEMENT LABELS

1	POPULATION	EXS
2	(1,000)	NEW
3		E + N
4		ACCUMULATED
5	RESTAURANT	EXS
6	(1,000 SEAT)	NEW
7		E + N
8		ACCUMULATED
9	HOTEL	EXS
10	(ROOM)	NEW
11		E + N
12		ACCUMULATED
13	INDUSTRIAL	EXS
14	(1,000 NM3)	NEW
15		E + N
16		ACCUMULATED
17	RET POPULATION	ACCUMULATED
18	RET RESTAURANT	ACCUMULATED

NO.		17	18
1	#1990	0	0
2	#1991	0	0
3	#1992	73	11
4	#1993	50	9
5	#1994	48	11
6	#1995	35	11
7	#1996	7	7
8	#1997	17	10
9	#1998	28	12
10	#1999	38	15
11	#2000	48	17
12	#2001	59	19
13	#2002	70	22
14	#2003	81	24
15	#2004	92	27
16	#2005	103	29

Table III.6 NO. OF ACTUAL CONSUMER (BASE ROUTE 2 CASE)

ACTUAL CONSUMER (ROUTE2)

NO.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	#1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	#1992	255	31	286	286	66	7	73	73	533	46	579	579	4886	486	5372	5372
4	#1993	615	58	673	959	181	17	197	270	5911	543	6454	7032	2676	891	3567	8938
5	#1994	585	70	655	1614	155	20	175	445	0	541	541	7573	932	1013	1945	10883
6	#1995	578	117	695	2309	105	24	129	574	0	545	545	8118	855	1093	1948	12831
7	#1996	476	146	622	2931	91	34	126	699	181	553	734	8852	2334	1851	4186	17017
8	#1997	194	150	344	3275	36	34	69	769	0	555	555	9407	0	1852	1852	18869
9	#1998	94	149	244	3518	15	34	49	818	0	554	554	9961	0	1837	1837	20706
10	#1999	23	150	172	3691	6	34	40	858	0	553	553	10514	0	1835	1835	22541
11	#2000	0	149	149	3840	0	34	34	892	0	556	556	11070	0	1854	1854	24395
12	#2001	0	124	124	3964	0	34	34	926	0	557	557	11627	0	1832	1832	26228
13	#2002	0	123	123	4088	0	34	34	960	0	552	552	12179	0	1841	1841	28069
14	#2003	0	95	95	4183	0	33	33	993	0	555	555	12734	0	1829	1829	29897
15	#2004	0	152	152	4335	0	34	34	1027	0	554	554	13288	0	1835	1835	31732
16	#2005	0	124	124	4459	0	34	34	1060	0	558	558	13846	0	1828	1828	33560

COLUMN ELEMENT LABELS

1	POPULATION	EXS
2	(1,000)	NEW
3		E + N
4		ACCUMULATED
5	RESTAURANT	EXS
6	(1,000 SEAT)	NEW
7		E + N
8		ACCUMULATED
9	HOTEL	EXS
10	(ROOM)	NEW
11		E + N
12		ACCUMULATED
13	INDUSTRIAL	EXS
14	(1,000 NM3)	NEW
15		E + N
16		ACCUMULATED
17	RET POPULATION	ACCUMULATED
18	RET RESTAURANT	ACCUMULATED

NO.		17	18
1	#1990	0	0
2	#1991	0	0
3	#1992	73	11
4	#1993	121	16
5	#1994	161	19
6	#1995	44	12
7	#1996	7	7
8	#1997	17	10
9	#1998	28	12
10	#1999	38	15
11	#2000	48	17
12	#2001	59	19
13	#2002	70	22
14	#2003	81	24
15	#2004	92	27
16	#2005	103	29

Table III.7 NO. OF ACTUAL CONSUMER (MEDIUM CASE)

ACTUAL CONSUMER (MEDIUM CASE)

NO.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	#1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	#1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	#1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	#1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	#1995	259	29	288	288	75	8	83	83	631	48	679	679	4644	409	5052	5052
7	#1996	814	81	895	1183	159	21	180	263	322	70	392	1071	2136	694	2830	7882
8	#1997	832	111	943	2126	179	26	205	468	6164	488	6652	7724	2010	917	2928	10810
9	#1998	553	128	681	2807	148	30	178	646	832	542	1374	9097	1561	1281	2842	13652
10	#1999	426	150	576	3383	96	34	130	776	207	553	760	9857	2709	1664	4372	18024
11	#2000	184	149	333	3717	52	34	86	862	0	556	556	10413	0	1678	1678	19702
12	#2001	60	124	184	3901	15	34	48	911	0	557	557	10970	0	1658	1658	21359
13	#2002	26	123	150	4050	7	34	40	951	0	552	552	11522	0	1668	1668	23028
14	#2003	0	95	95	4146	0	33	33	984	0	555	555	12077	0	1658	1658	24686
15	#2004	0	152	152	4298	0	34	34	1018	0	554	554	12631	0	1663	1663	26349
16	#2005	0	124	124	4422	0	34	34	1052	0	558	558	13189	0	1653	1653	28002

COLUMN ELEMENT LABELS

1	POPULATION	EXS
2	(1,000)	NEW
3		E + N
4		ACCUMULATED
5	RESTAURANT	EXS
6	(1,000 SEAT)	NEW
7		E + N
8		ACCUMULATED
9	HOTEL	EXS
10	(ROOM)	NEW
11		E + N
12		ACCUMULATED
13	INDUSTRIAL	EXS
14	(1,000 NM3)	NEW
15		E + N
16		ACCUMULATED
17	RET POPULATION	ACCUMULATED
18	RET RESTAURANT	ACCUMULATED

NO.		17	18
1	#1990	0	0
2	#1991	0	0
3	#1992	0	0
4	#1993	0	0
5	#1994	0	0
6	#1995	73	11
7	#1996	79	11
8	#1997	90	16
9	#1998	85	15
10	#1999	38	11
11	#2000	48	13
12	#2001	59	16
13	#2002	70	18
14	#2003	81	21
15	#2004	91	23
16	#2005	102	25

Table III.8 NO. OF ACTUAL CONSUMER (LOW CASE)

ACTUAL CONSUMER (LOW CASE)

NO.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	#1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	#1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	#1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	#1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	#1995	259	29	288	288	72	8	80	80	631	48	679	679	3899	191	4091	4091
7	#1996	814	81	895	1183	153	19	172	252	322	70	392	1071	1760	223	1983	6073
8	#1997	832	111	943	2126	171	25	196	448	6164	488	6652	7724	1635	313	1948	8021
9	#1998	553	128	681	2807	141	29	170	618	832	542	1374	9097	1204	563	1767	9788
10	#1999	426	150	576	3383	92	33	125	744	207	553	760	9857	2068	758	2826	12614
11	#2000	184	149	333	3717	50	32	82	826	0	556	556	10413	0	768	768	13381
12	#2001	60	124	184	3901	14	30	44	870	0	557	557	10970	0	776	776	14157
13	#2002	26	123	150	4050	6	30	36	906	0	552	552	11522	0	767	767	14925
14	#2003	0	95	95	4146	0	30	30	936	0	555	555	12077	0	768	768	15693
15	#2004	0	152	152	4298	0	30	30	966	0	554	554	12631	0	777	777	16470
16	#2005	0	124	124	4422	0	30	30	996	0	558	558	13189	0	774	774	17244

NO.		17	18
1	#1990	0	0
2	#1991	0	0
3	#1992	0	0
4	#1993	0	0
5	#1994	0	0
6	#1995	73	11
7	#1996	79	12
8	#1997	90	16
9	#1998	85	15
10	#1999	38	11
11	#2000	48	13
12	#2001	59	15
13	#2002	70	17
14	#2003	81	20
15	#2004	91	22
16	#2005	102	24

COLUMN ELEMENT LABELS

1	POPULATION	EXS
2	(1,000)	NEW
3		E + N
4		ACCUMULATED
5	RESTAURANT	EXS
6	(1,000 SEAT)	NEW
7		E + N
8		ACCUMULATED
9	HOTEL	EXS
10	(ROOM)	NEW
11		E + N
12		ACCUMULATED
13	INDUSTRIAL	EXS
14	(1,000 NM3)	NEW
15		E + N
16		ACCUMULATED
17	RET POPULATION	ACCUMULATED
18	RET RESTAURANT	ACCUMULATED

Table III.9 CITY GAS SALES VOLUME (BASE CASE)

SALES VOLUME BASE (1000NM3)

NO.		1	2	3	4	5	6	7	8	9
1	#1990	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0
3	#1992	3475	2387	71	4900	10833	1090	339	1429	12262
4	#1993	18330	9827	185	7565	35907	1878	611	2489	38397
5	#1994	42082	20708	941	10270	74002	1523	637	2161	76163
6	#1995	64054	31566	1810	12568	109998	1320	708	2027	112025
7	#1996	82265	40358	2057	16754	141434	690	572	1262	142696
8	#1997	96695	46638	2216	18606	164155	412	539	951	165106
9	#1998	106907	50642	2353	20443	180345	767	695	1463	181807
10	#1999	115303	53370	2490	22278	193440	1135	850	1985	195426
11	#2000	123200	55702	2627	24133	205661	1517	1006	2523	208184
12	#2001	130533	57860	2764	25965	217122	1924	1162	3086	220208
13	#2002	137565	60008	2901	27806	228279	2356	1313	3669	231948
14	#2003	144194	62143	3038	29635	239009	2800	1464	4264	243273
15	#2004	151493	64276	3175	31469	250412	3257	1619	4875	255288
16	#2005	159506	66421	3312	33298	262536	3729	1773	5503	268039
17	#2006	161889	67489	3381	33298	266056	3938	1851	5789	271845

COLUMN ELEMENT LABELS

1	CITY GAS	HOUSEHOLD
2		RESTAURANT
3		HOTEL
4		INDUSTRY
5		SUB-TOTAL
6	RETICULATION	HOUSEHOLD
7		RESTAURANT
8		SUB-TOTAL
9	TOTAL	

Table III.10 CITY GAS SALES VOLUME (BASE ROUTE 2 CASE)

SALES VOLUME ROUTE2 (1000NM3)

NO.		1	2	3	4	5	6	7	8	9
1	#1990	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0
3	#1992	3857	2324	71	5372	11624	1090	339	1429	13053
4	#1993	17188	10920	940	8938	37986	2970	844	3814	41801
5	#1994	36265	22753	1804	10883	71705	4401	1120	5522	77226
6	#1995	56591	32416	1938	12831	103776	3259	988	4248	108023
7	#1996	77519	40516	2096	17017	137148	832	604	1436	138583
8	#1997	94150	46725	2255	18869	161999	412	539	951	162950
9	#1998	105643	50506	2392	20706	179246	767	695	1463	180709
10	#1999	114756	53333	2529	22541	193159	1135	850	1985	195145
11	#2000	122688	55682	2666	24395	205432	1517	1006	2523	207954
12	#2001	130017	57841	2803	26228	216888	1924	1162	3086	219974
13	#2002	137044	59988	2940	28069	228040	2356	1313	3669	231710
14	#2003	143669	62123	3077	29897	238766	2800	1464	4264	243030
15	#2004	150962	64256	3214	31732	250164	3257	1619	4875	255039
16	#2005	158971	66402	3351	33560	262284	3729	1773	5503	267786
17	#2006	161354	67469	3420	33560	265803	3938	1851	5789	271592

COLUMN ELEMENT LABELS

1	CITY GAS	HOUSEHOLD
2		RESTAURANT
3		HOTEL
4		INDUSTRY
5		SUB-TOTAL
6	RETICULATION	HOUSEHOLD
7		RESTAURANT
8		SUB-TOTAL
9	TOTAL	

Table III.11 CITY GAS SALES VOLUME (MEDIUM CASE)

SALES VOLUME MEDIUM (1000NM3)

NO.		1	2	3	4	5	6	7	8	9
1	#1990	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0
3	#1992	0	0	0	0	0	0	0	0	0
4	#1993	0	0	0	0	0	0	0	0	0
5	#1994	0	0	0	0	0	0	0	0	0
6	#1995	3821	2648	84	5052	11606	1076	342	1418	13024
7	#1996	20006	11024	216	7882	39129	2291	707	2999	42128
8	#1997	46158	23273	1086	10810	81328	2604	885	3489	84817
9	#1998	70604	35454	2077	13652	121787	2761	1002	3764	125551
10	#1999	90887	45249	2341	18024	156501	1979	829	2808	159309
11	#2000	106894	52131	2503	19702	181230	1408	771	2179	183409
12	#2001	117533	56412	2641	21359	197946	1792	927	2719	200665
13	#2002	125636	59234	2778	23028	210675	2200	1078	3278	213954
14	#2003	132488	61577	2915	24686	221666	2621	1229	3850	225516
15	#2004	139571	63710	3052	26349	232682	3056	1383	4439	237121
16	#2005	147310	65856	3189	28002	244357	3506	1538	5044	249401
17	#2006	149557	66923	3258	28002	247741	3703	1615	5318	253059

COLUMN ELEMENT LABELS

1	CITY GAS	HOUSEHOLD
2		RESTAURANT
3		HOTEL
4		INDUSTRY
5		SUB-TOTAL
6	RETICULATION	HOUSEHOLD
7		RESTAURANT
8		SUB-TOTAL
9	TOTAL	

Table III.12 CITY GAS SALES VOLUME (LOW CASE)

SALES VOLUME LOW (1000NM3)

NO.		1	2	3	4	5	6	7	8	9
1	#1990	0	0	0	0	0	0	0	0	0
2	#1991	0	0	0	0	0	0	0	0	0
3	#1992	0	0	0	0	0	0	0	0	0
4	#1993	0	0	0	0	0	0	0	0	0
5	#1994	0	0	0	0	0	0	0	0	0
6	#1995	3752	2544	84	4091	10471	1052	360	1412	11883
7	#1996	19505	10556	216	6073	36351	2225	727	2952	39303
8	#1997	44687	22274	1086	8021	76068	2512	887	3398	79466
9	#1998	67886	33942	2077	9788	113694	2646	997	3643	117337
10	#1999	86828	43343	2341	12614	145126	1885	820	2705	147831
11	#2000	101503	49940	2503	13381	167328	1333	760	2094	169422
12	#2001	110960	53958	2641	14157	181716	1688	906	2594	184311
13	#2002	117952	56510	2778	14925	192164	2062	1045	3107	195271
14	#2003	123743	58613	2915	15693	200963	2445	1183	3629	204592
15	#2004	129732	60514	3052	16470	209768	2838	1322	4160	213928
16	#2005	136325	62410	3189	17244	219168	3243	1461	4703	223871
17	#2006	138404	63362	3258	17244	222267	3425	1531	4956	227223

COLUMN ELEMENT LABELS

1	CITY GAS	HOUSEHOLD
2		RESTAURANT
3		HOTEL
4		INDUSTRY
5		SUB-TOTAL
6	RETICULATION	HOUSEHOLD
7		RESTAURANT
8		SUB-TOTAL
9	TOTAL	

Table III.13 CITY GAS SALES VOLUME (SUMMARY)

CITY GAS SALES VOLUME

NO.		1	2	3	4
1	Y1990	0	0	0	0
2	Y1991	0	0	0	0
3	Y1992	10833	11624	0	0
4	Y1993	35907	37986	0	0
5	Y1994	74002	71705	0	0
6	Y1995	109998	103776	11606	10471
7	Y1996	141434	137148	39129	36351
8	Y1997	164155	161999	81328	76068
9	Y1998	180345	179246	121787	113694
10	Y1999	193440	193159	156501	145126
11	Y2000	205661	205432	181230	167328
12	Y2001	217122	216888	197946	181716
13	Y2002	228279	228040	210675	192164
14	Y2003	239009	238766	221666	200963
15	Y2004	250412	250164	232682	209768
16	Y2005	262536	262284	244357	219168
17	Y2006	266056	265803	247741	222267
18	TOTAL	2579191	2564020	1946647	1775084

COLUMN ELEMENT LABELS

1	BASE	(1000NM3)
2	BASE ROUTE-2	(1000NM3)
3	MEDIUM	(1000NM3)
4	LOW	(1000NM3)

Table III.14 CITY GAS SALES VOLUME (ADDITIONAL CASE)

ADDITIONAL SALES VOLUME

NO.		1	2	3	4	5	6
1	Y1990	0	0	0	0	0	0
2	Y1991	0	0	0	0	0	0
3	Y1992	74387	37194	0	0	882	75269
4	Y1993	114841	57421	0	0	7128	121970
5	Y1994	155925	77962	0	0	13375	169299
6	Y1995	190799	95400	0	0	19621	210420
7	Y1996	254341	127171	3479	278	25868	283688
8	Y1997	282466	141233	10501	1124	32114	325081
9	Y1998	310346	155173	17524	2526	52558	380428
10	Y1999	338204	169102	24503	4481	73002	435709
11	Y2000	366359	183179	31429	6971	93446	491234
12	Y2001	394180	197090	38462	10073	113891	546532
13	Y2002	422125	211062	45517	13735	134335	601977
14	Y2003	449891	224946	52399	17864	141110	643400
15	Y2004	477744	238872	59270	22536	147886	684900
16	Y2005	505500	252750	66206	27810	154661	726367
17	Y2006	505500	252750	69707	30610	161437	736643

COLUMN ELEMENT LABELS

1	INDUSTRY HIGH	(1000NM3)
2	INDUSTRY LOW	(1000NM3)
3	COOLING HIGH	(1000NM3)
4	COOLING LOW	(1000NM3)
5	C.N.G.	(1000NM3)
6	TOTAL MAXIMUM	(1000NM3)

Table III.15 TOTAL NUMBER OF SQUATTERS AND ACTUAL NUMBER OF PEOPLE IN KLANG VALLEY

District	Land area of squatters (Hectare)	1985 (December)		Squatter ratio
		Number of squatters[1]	Actual population[2]	
Federal territory	904	229,615	1,103,200	20%
Petaling	1,603	103,972	436,220	23%
Klang	122	5,071	341,605	1%
Gombak	208	32,307	204,562	12%
H. Langat	518	24,300	216,553	15%
Total	3,355	395,265	2,302,140	17%

Source: 1. Local District Office and K. L. City Hall

2. Statistics Office

Table III.16 MAGNESIUM ANODE QUANTITIES AND CAPACITIES FOR TRANSMISSION PIPELINES

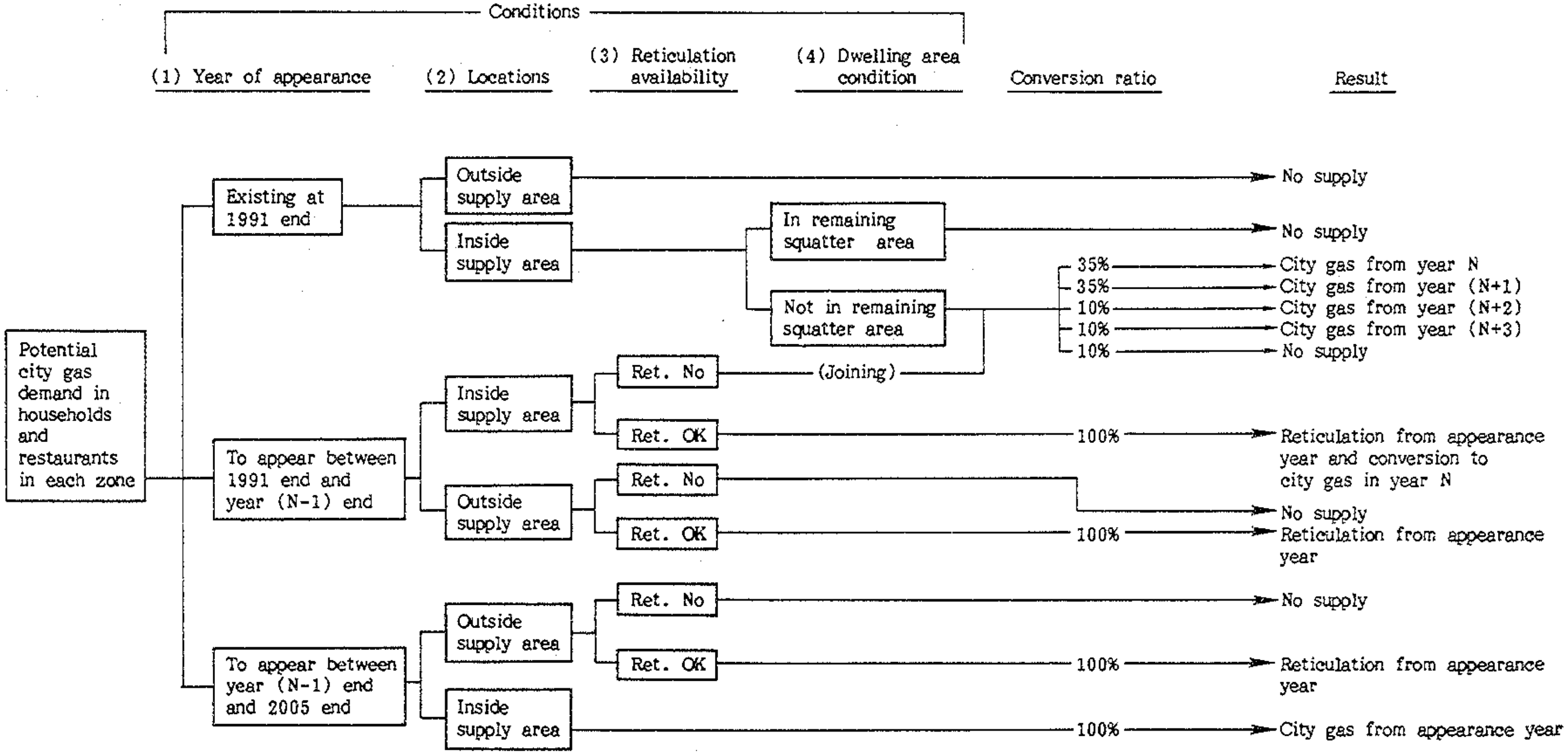
Corrosion prevention area $A = \pi \times D \times L = 188.5\ m^2$

Pipe-to-earth resistance $5,000/188.5 = 26.5\ \Omega$

Area	Soil resistance average value cm Ω	Grounding resistance per anode Ω	Electric current generated per anode mmA	Effective anode electricity capacity A Year
A	6627	26.5	18.9	0.756
B	19452	77.8	9.6	0.384

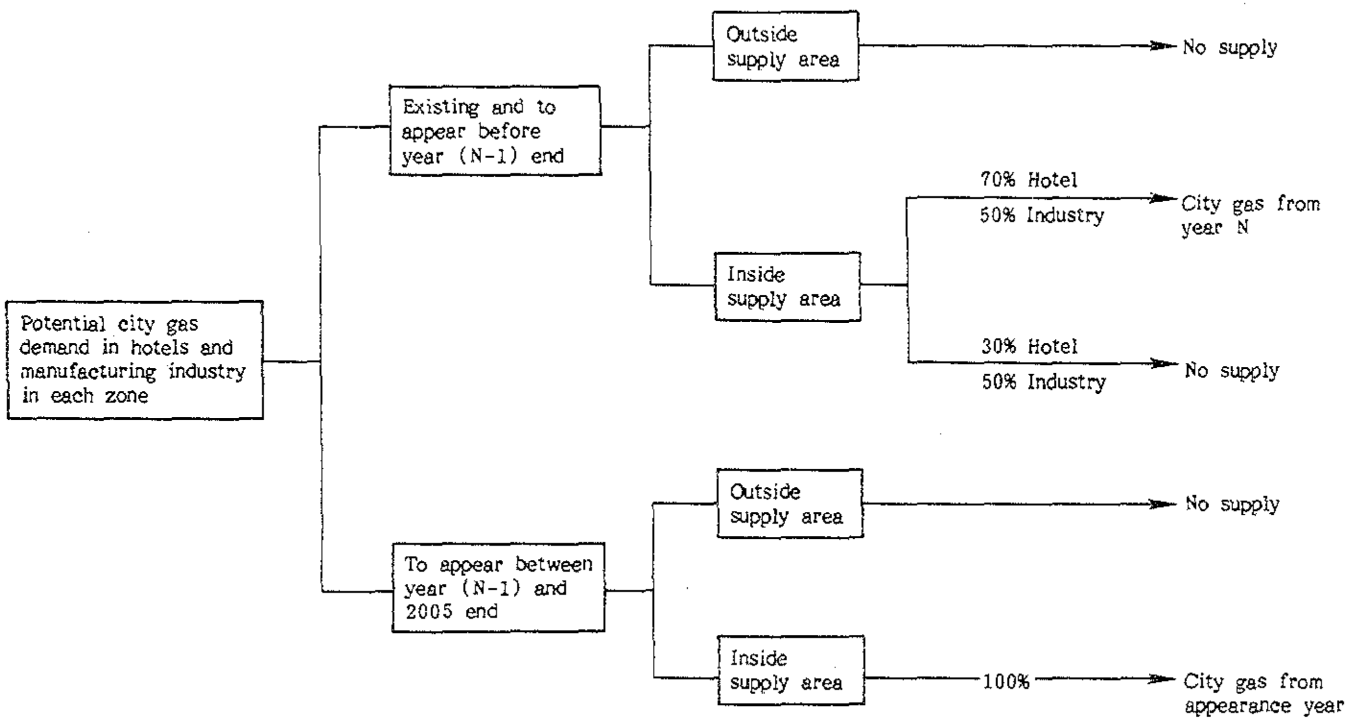
Area	Magnesium anodes theoretically required	Magnesium anodes to be actually installed	
		Trunk line	Distribution line
A	9S - 2 ea.	25S - 2 ea.	17S - 2 ea.
B	9S - 1 ea.	25S - 1 ea.	17S - 1 ea.

Figure III.2 SUPPLY-SIDE CITY GAS CONVERSION MODEL FOR HOUSEHOLD AND RESTAURANT DEMANDS



Note: Year N is the year of beginning city gas supply to the zone. Transmission system is to be completed as far as to that zone just before year N.

Figure III.3 SUPPLY-SIDE CITY GAS CONVERSION MODEL FOR HOTELS AND MANUFACTURING INDUSTRY

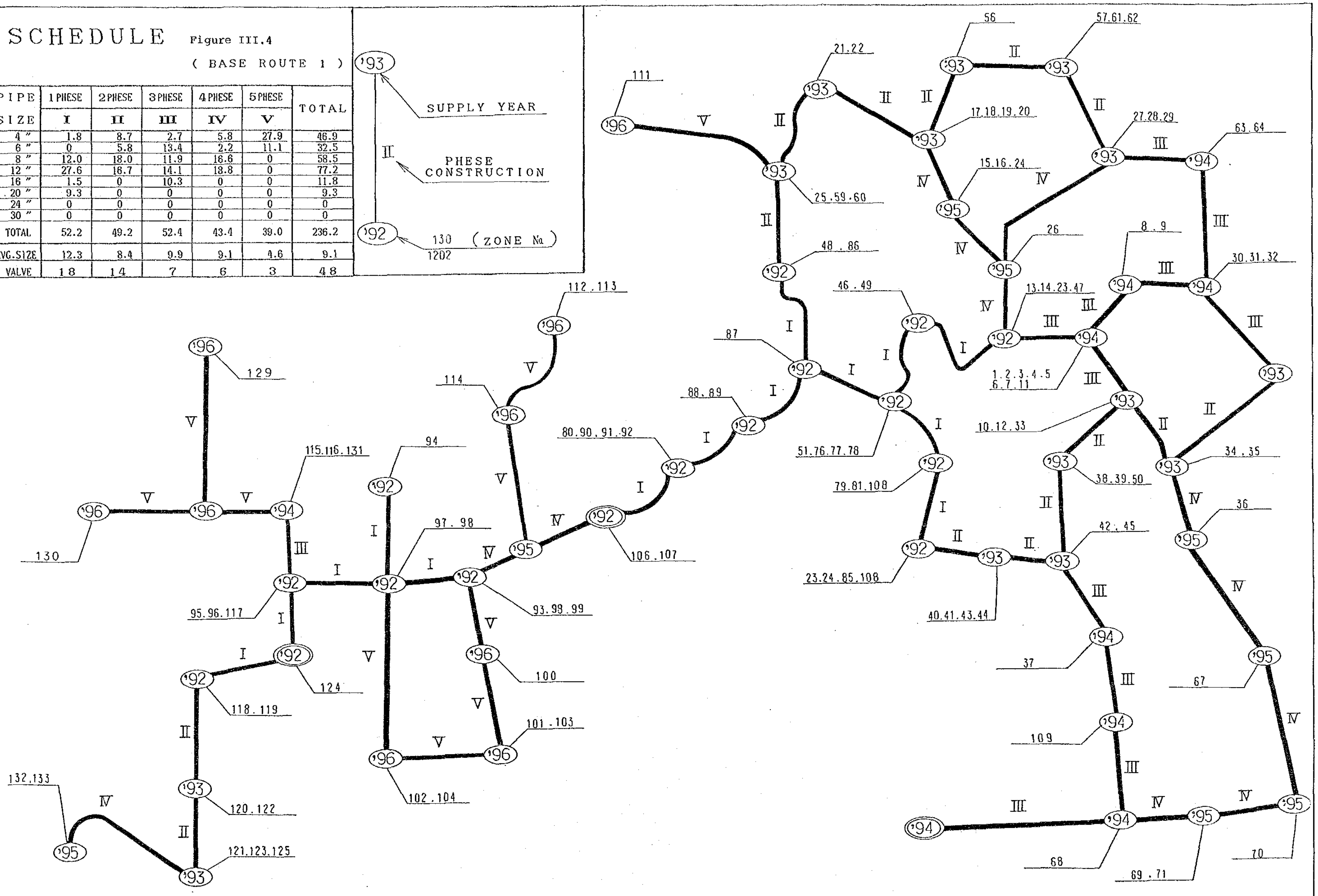


SCHEDULE

Figure III.4

(BASE ROUTE 1)

PIPE SIZE	1 PHESE I	2 PHESE II	3 PHESE III	4 PHESE IV	5 PHESE V	TOTAL
4 "	1.8	8.7	2.7	5.8	27.9	46.9
6 "	0	5.8	13.4	2.2	11.1	32.5
8 "	12.0	18.0	11.9	16.6	0	58.5
12 "	27.6	16.7	14.1	18.8	0	77.2
16 "	1.5	0	10.3	0	0	11.8
20 "	9.3	0	0	0	0	9.3
24 "	0	0	0	0	0	0
30 "	0	0	0	0	0	0
TOTAL	52.2	49.2	52.4	43.4	39.0	236.2
AVG.SIZE	12.3	8.4	9.9	9.1	4.6	9.1
VALVE	18	14	7	6	3	48

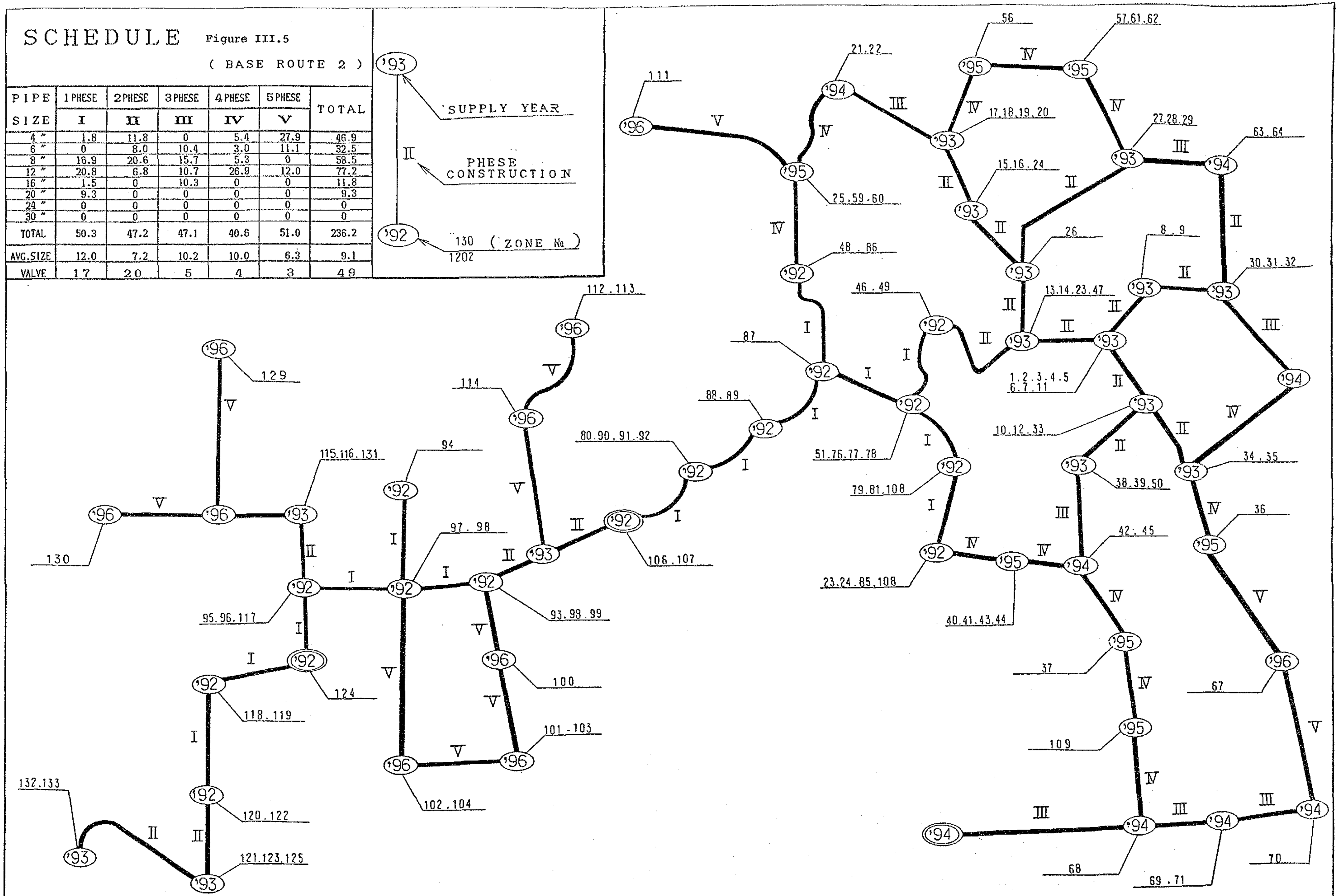


SCHEDULE

Figure III.5

(BASE ROUTE 2)

PIPE SIZE	1 PHESE I	2 PHESE II	3 PHESE III	4 PHESE IV	5 PHESE V	TOTAL
4 "	1.8	11.8	0	5.4	27.9	46.9
6 "	0	8.0	10.4	3.0	11.1	32.5
8 "	16.9	20.6	15.7	5.3	0	58.5
12 "	20.8	6.8	10.7	26.9	12.0	77.2
16 "	1.5	0	10.3	0	0	11.8
20 "	9.3	0	0	0	0	9.3
24 "	0	0	0	0	0	0
30 "	0	0	0	0	0	0
TOTAL	50.3	47.2	47.1	40.6	51.0	236.2
AVG.SIZE	12.0	7.2	10.2	10.0	6.3	9.1
VALVE	17	20	5	4	3	49



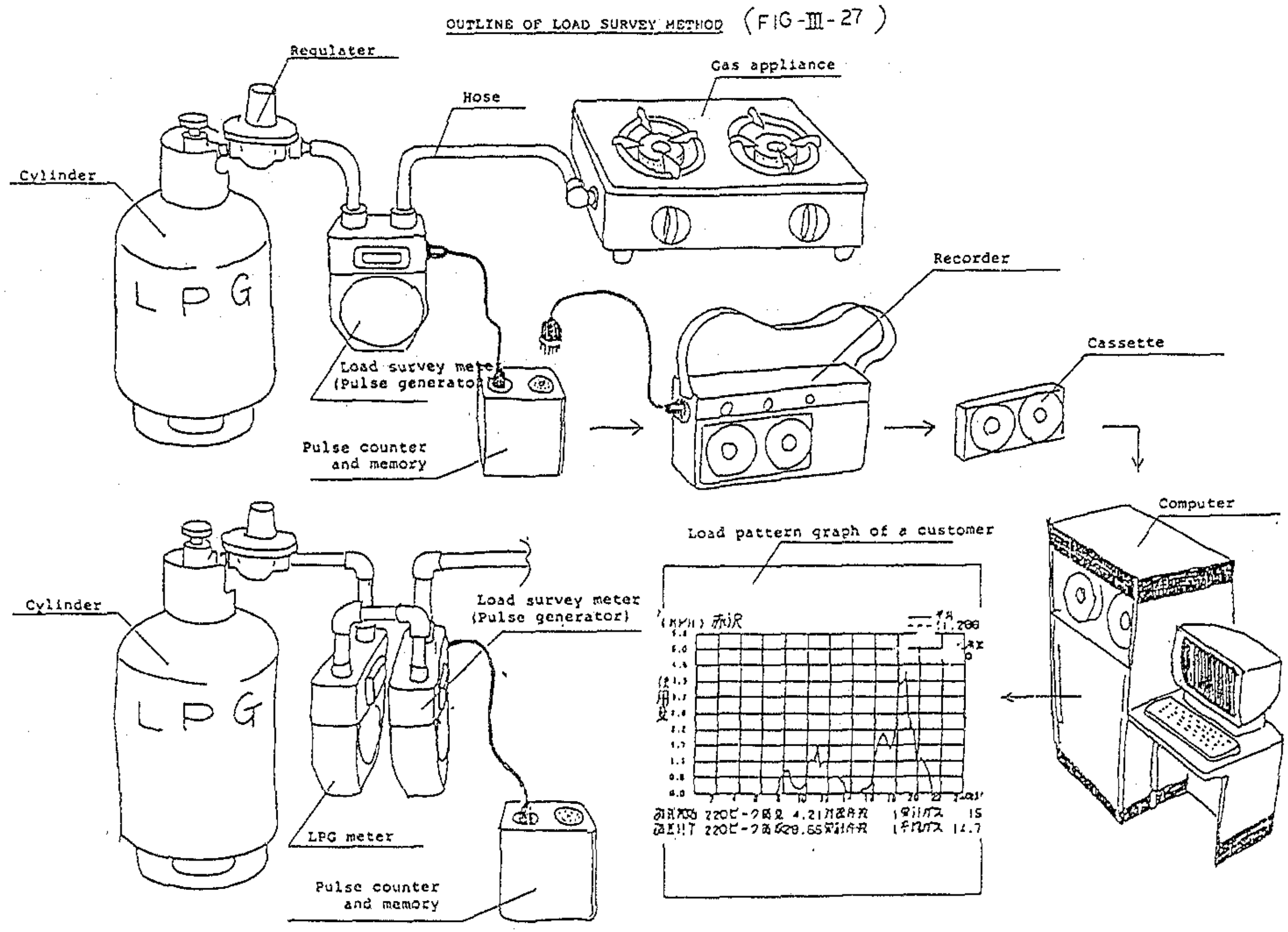
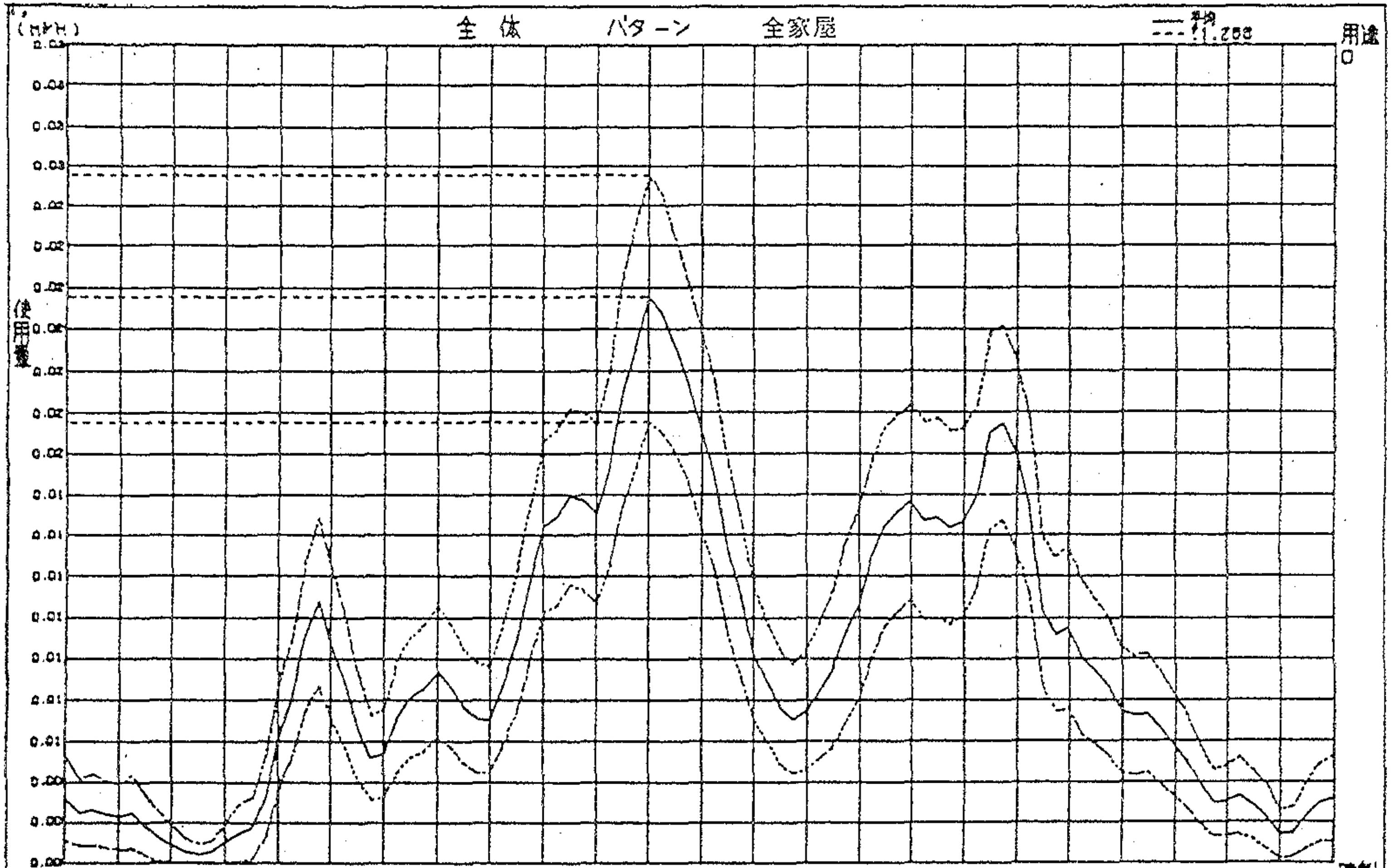


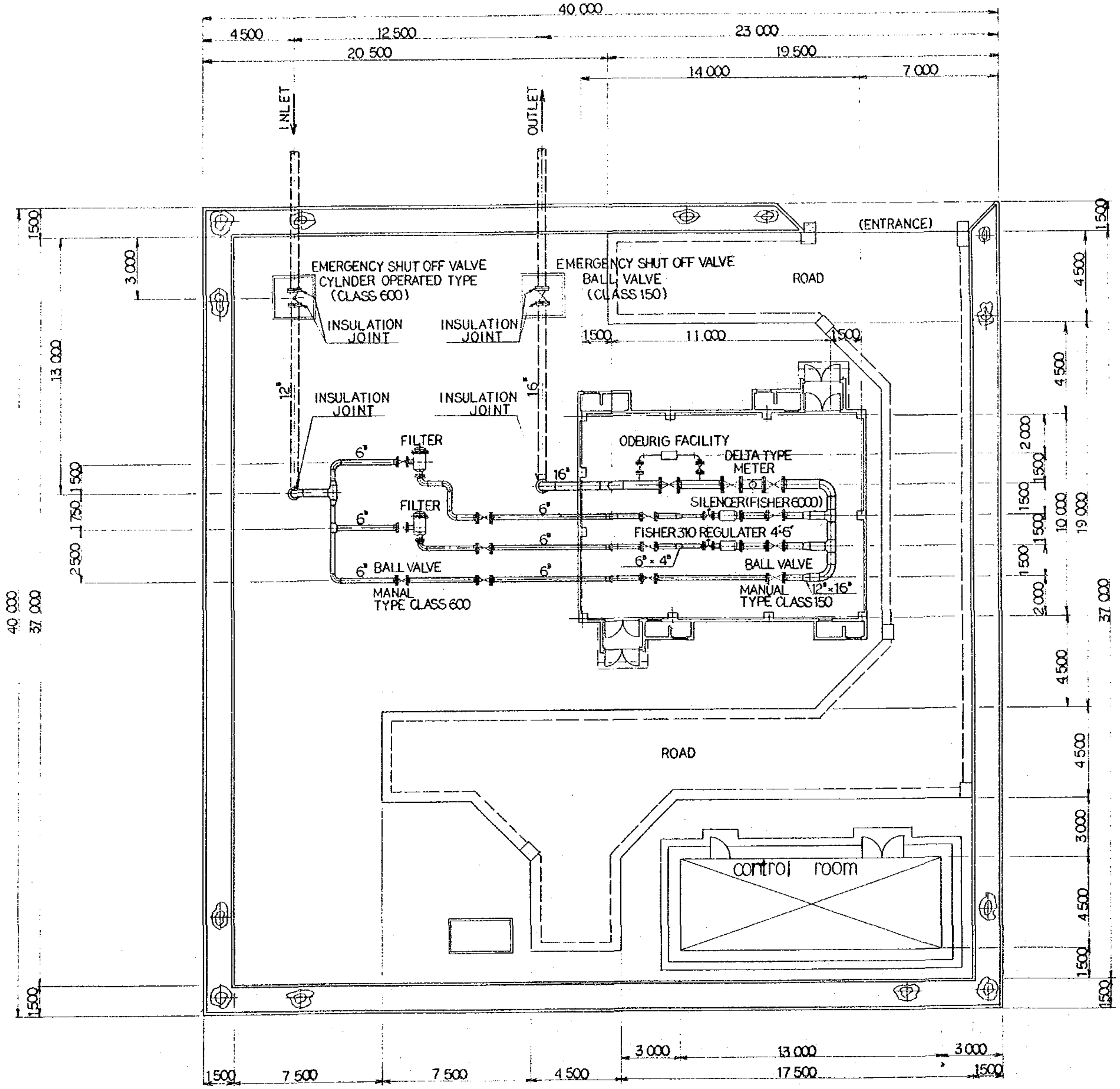
Figure III.6 OUTLINE OF LOAD SURVEY METHOD



時刻	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
MWH	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.18
%	1.00	0.87	0.27	1.30	4.40	2.71	3.44	3.15	5.16	7.13	9.83	9.57	5.96	3.21	4.32	6.62	8.88	8.30	5.49	3.86	2.78	1.83	1.00	1.02	100
	1.03	1.03	0.23	0.61	3.22	2.89	2.99	3.60	3.66	6.97	7.96	11.07	7.92	3.57	3.50	6.14	6.91	7.42	7.24	4.16	2.99	2.05	1.36	0.61	
15*	1.07	0.78	0.19	0.70	4.88	2.78	3.36	3.17	4.61	7.41	9.82	10.43	6.36	3.18	3.91	6.79	8.96	8.86	5.09	3.86	3.03	1.59	1.17	0.83	
曜%	0.96	0.51	0.23	1.31	5.28	2.15	3.68	2.94	5.66	7.32	10.45	9.86	5.37	2.91	4.66	7.06	8.77	8.87	4.82	3.60	2.71	1.21	0.93	1.21	
	0.53	0.37	0.42	2.67	4.44	2.24	3.66	2.90	6.78	7.06	11.35	8.74	4.24	3.05	5.24	7.29	8.86	8.22	4.78	3.08	2.36	1.25	0.56	1.31	

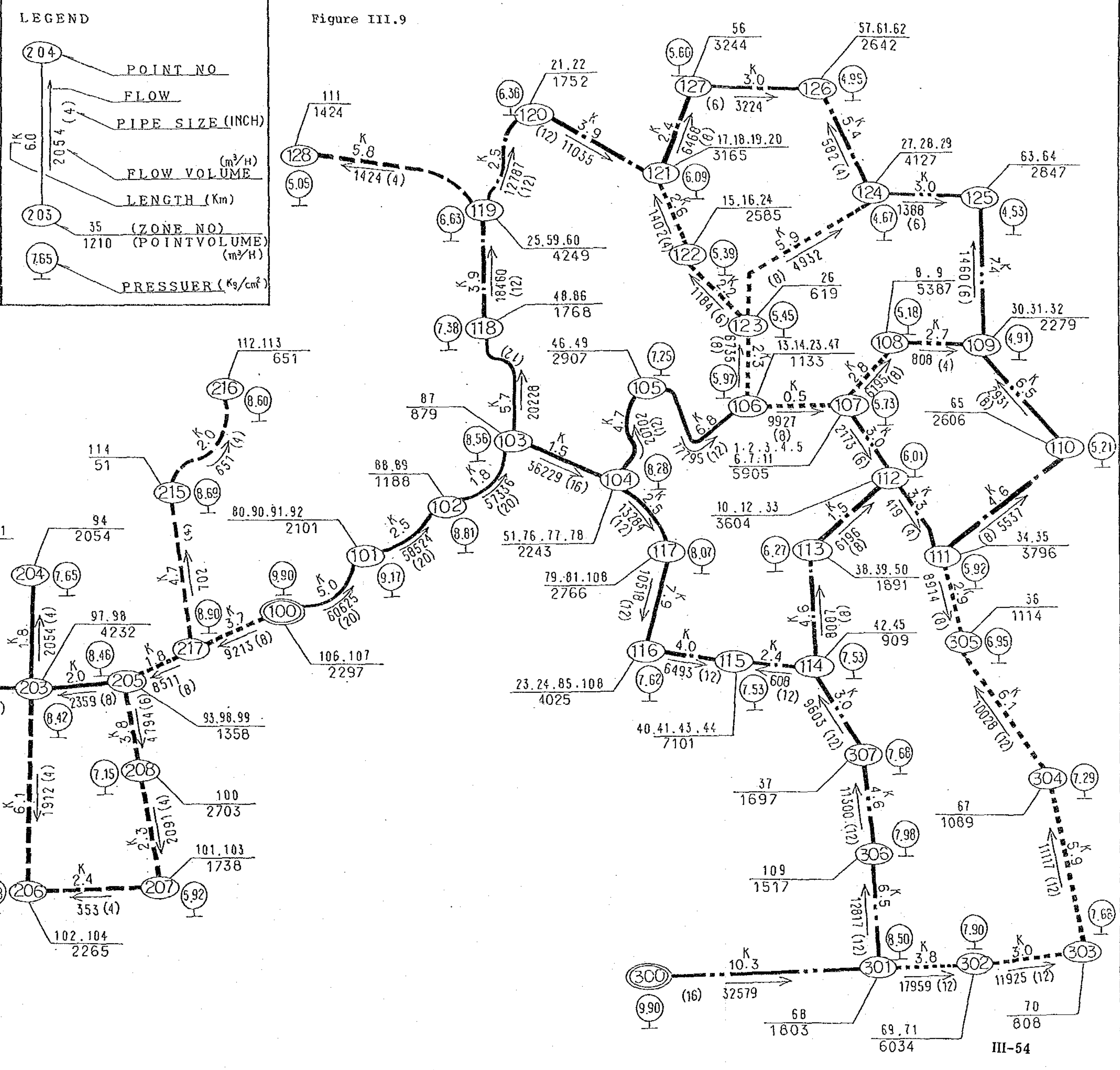
Figure III.7 RESULT OF LOAD SURVEY

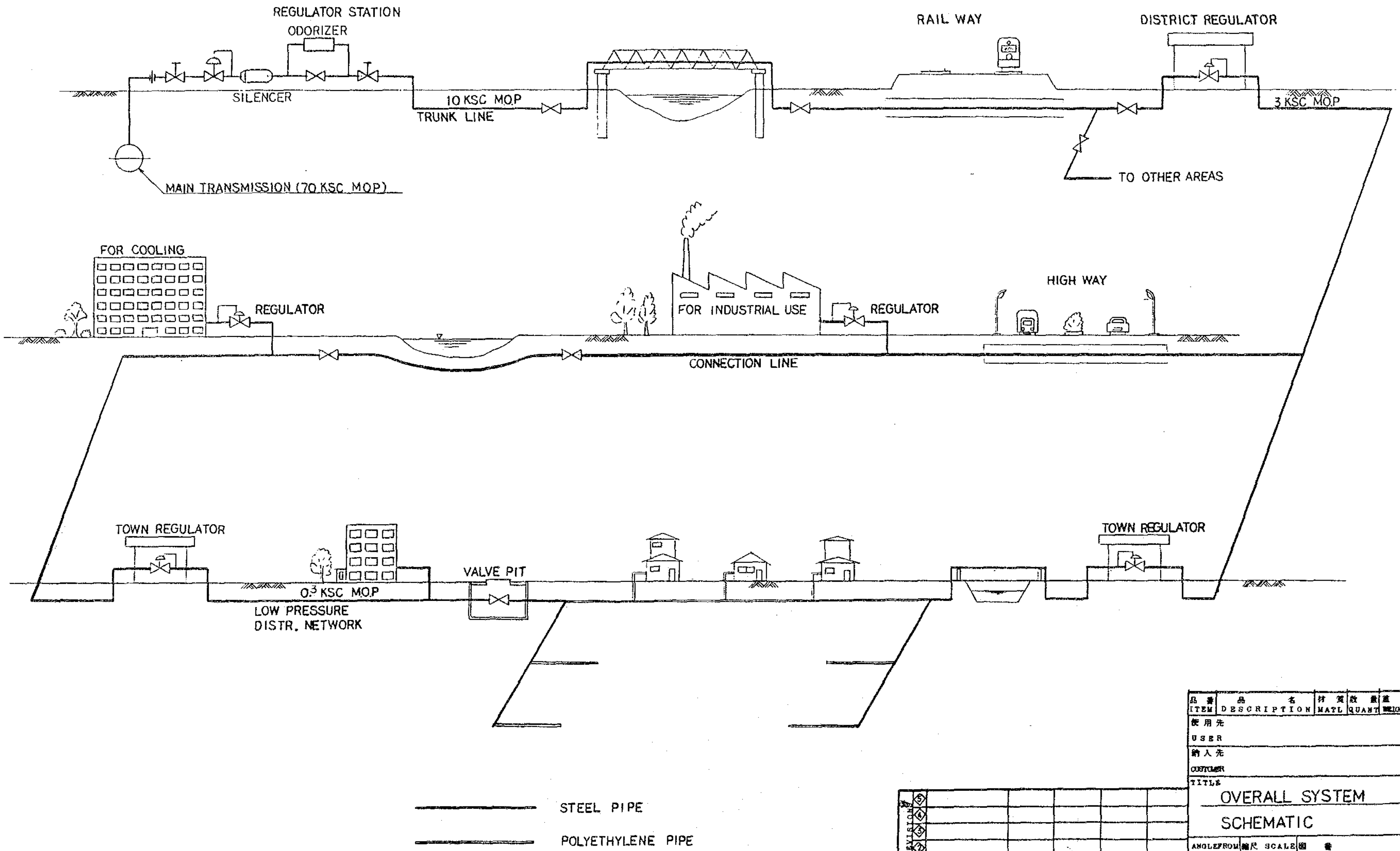
Figure III.8 DISTRICT REGULATER STATION (TRANK LINE) S=1/150



DESIGN RESULT OF TRANSMISSION SYSTEM (BASE ROUTE 1)

PIPE SIZE	1 PHESE	2 PHESE	3 PHESE	4 PHESE	5 PHESE	TOTAL
4"	1.8	8.7	2.7	5.8	27.9	46.9
6"	0	5.8	13.4	2.2	11.1	32.5
8"	12.0	18.0	11.9	16.6	0	58.5
12"	27.6	16.7	14.1	18.8	0	77.2
16"	1.5	0	10.3	0	0	11.8
20"	9.3	0	0	0	0	9.3
24"	0	0	0	0	0	0
30"	0	0	0	0	0	0
TOTAL	52.2	49.2	52.4	43.4	39.0	236.2
AVG.SIZE	12.3	8.4	9.9	9.1	4.6	9.1
VALVE	18	14	7	6	3	48





品番 ITEM | 品名 DESCRIPTION | 材質 MATL | 数量 QUANT | 重量 WEIGHT | 備考 REMARKS

使用先 USER

納入先 CUSTOMER

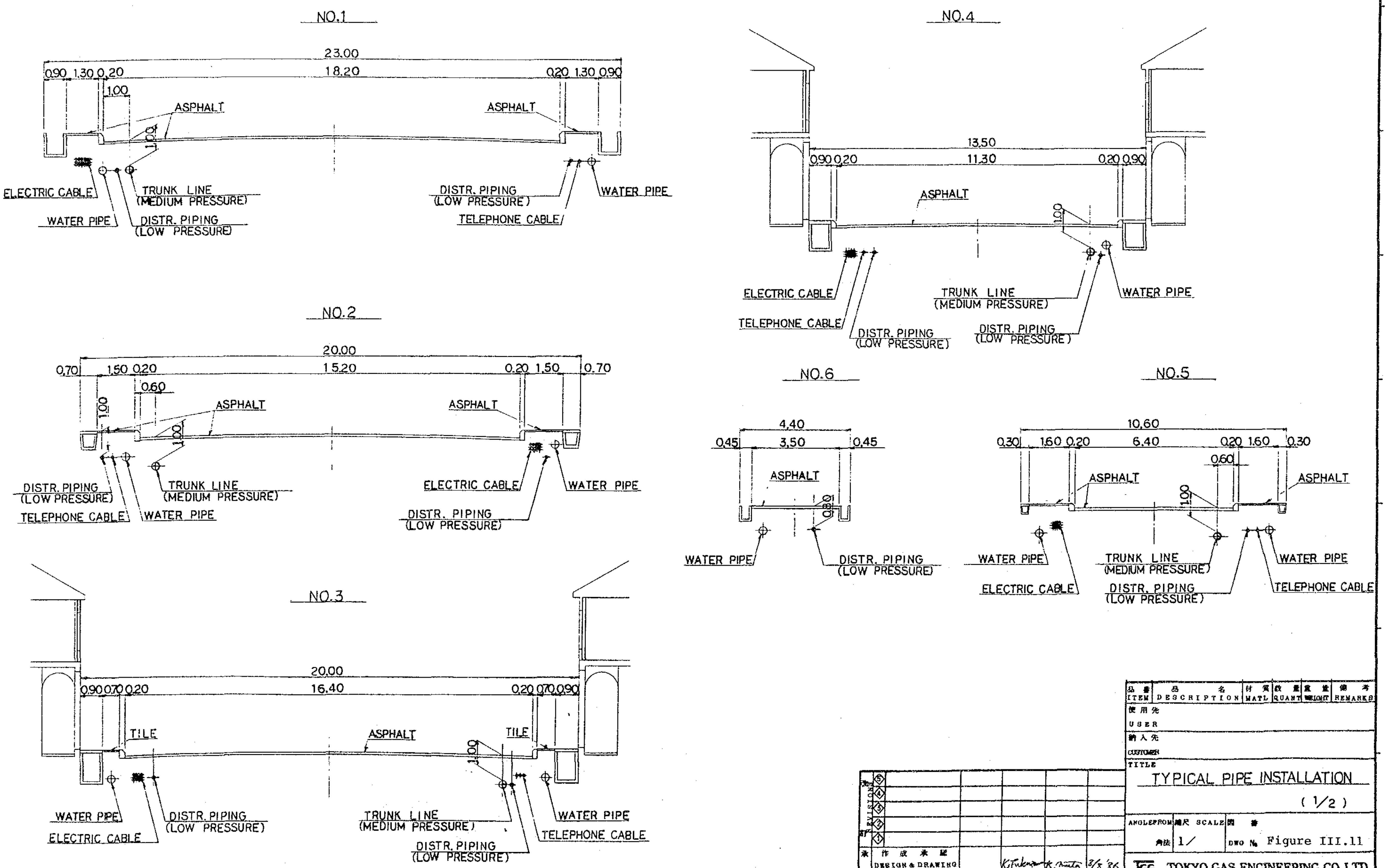
TITLE: OVERALL SYSTEM SCHEMATIC

ANGLE FROM 角法 | 縮尺 SCALE 1/ | 図番 DWG № Figure III.10

DESIGN & DRAWING | APPROVED | CHECKED | DRAWN OR REVISED | DATE 8/3 '86

TGE TOKYO GAS ENGINEERING CO.,LTD.

CROSS SECTIONS OF MAIN ROADS IN A CITY AREA



品番 ITEM	品名 DESCRIPTION	材質 MATL	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER

納入先 CUSTOMER

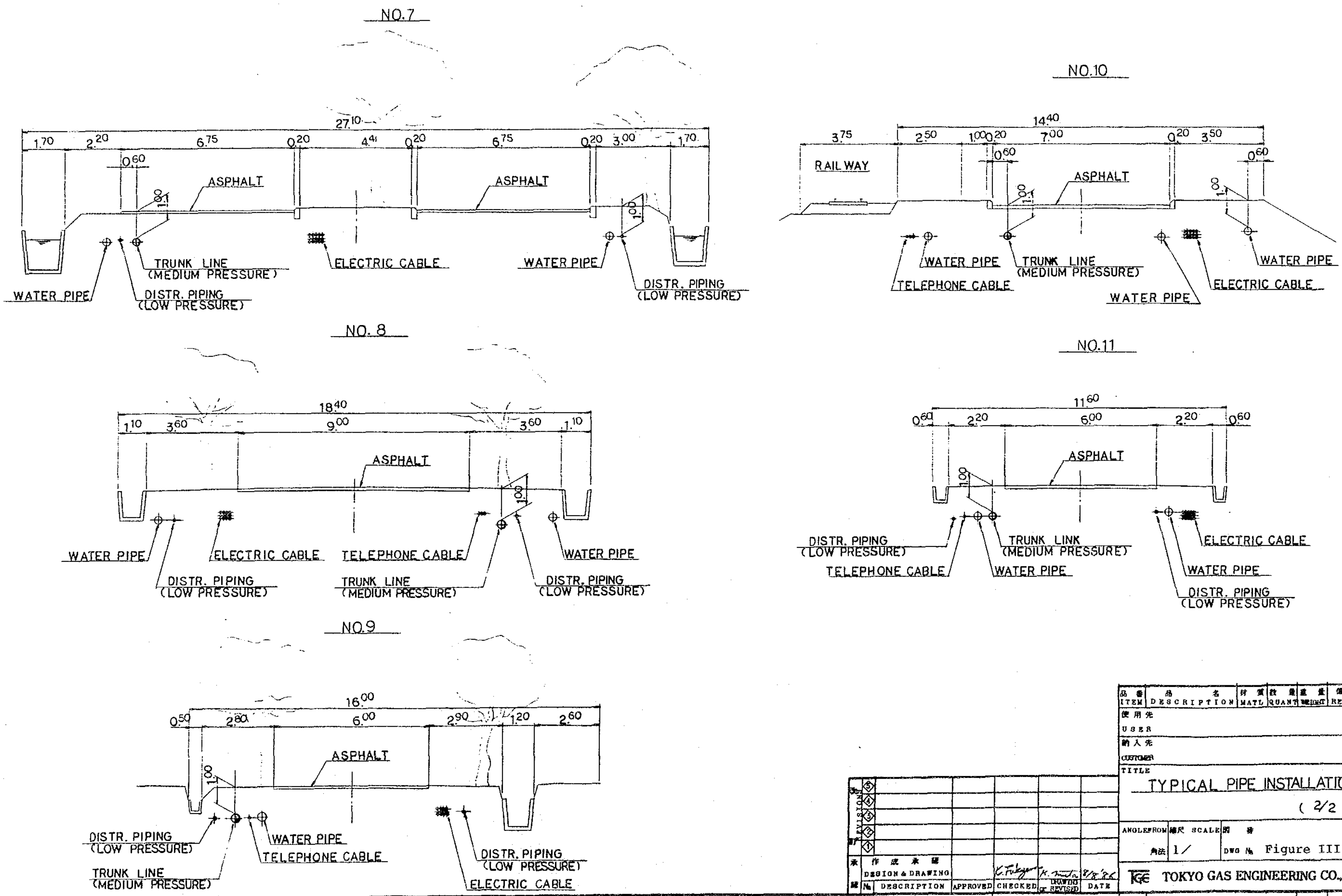
TITLE: TYPICAL PIPE INSTALLATION (1/2)

ANGLE FROM 縮尺 SCALE 1/ 図番 DWG No. Figure III.11

REVISION	DESCRIPTION	APPROVED	CHECKED	DRAWN OR REVISED	DATE
作成承認 DESIGN & DRAWING			K. Fukaya	K. Naito	3/8 '86

TGE TOKYO GAS ENGINEERING CO.,LTD.

CROSS SECTIONS OF MAIN ROADS IN THE SUBURBS



品番 ITEM	品名 DESCRIPTION	材質 MATL	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER

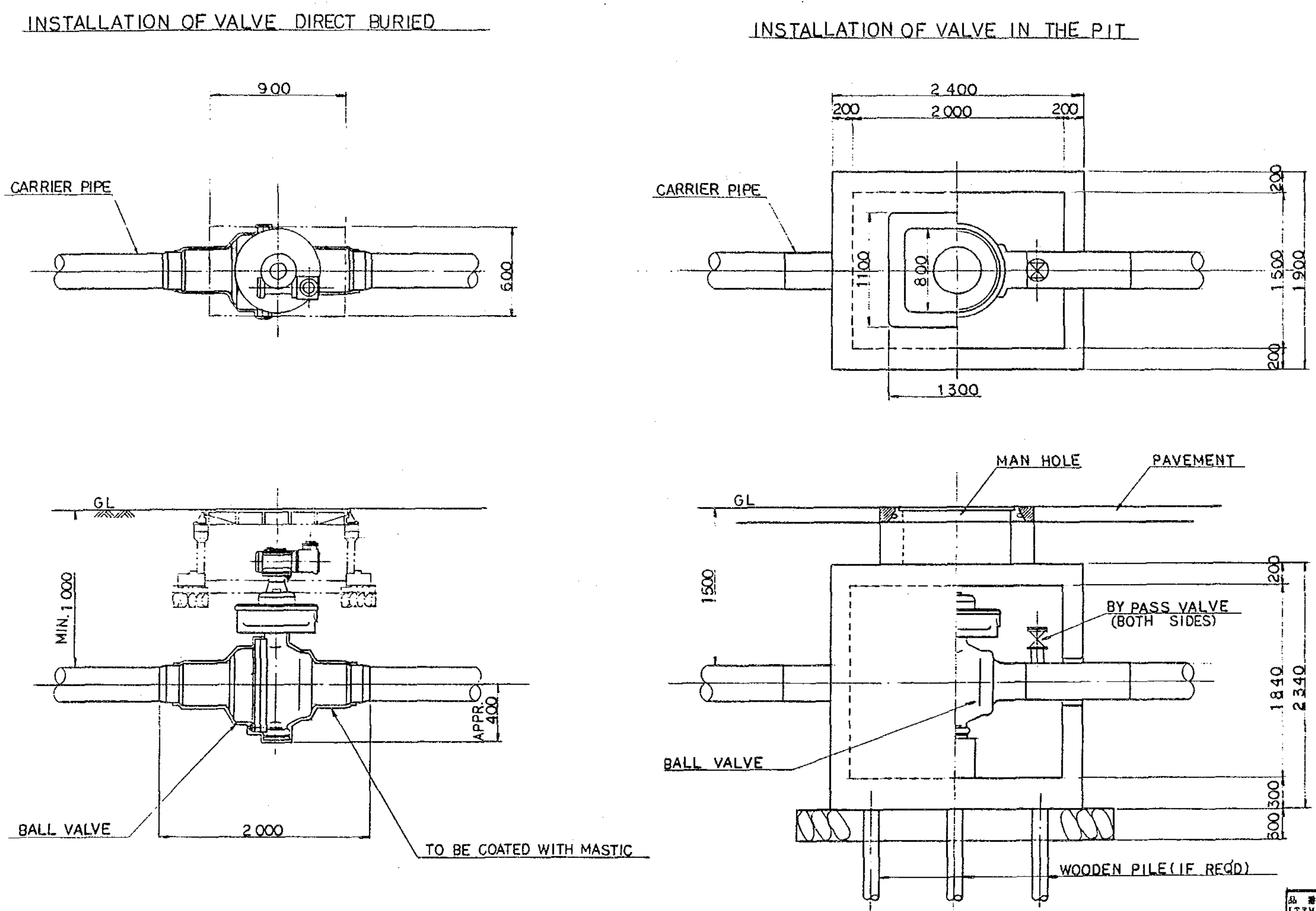
納入先 CUSTOMER

TITLE TYPICAL PIPE INSTALLATION (2/2)

ANGLE FROM 角法 | 縮尺 SCALE 1/ | 図番 DWG No. Figure III.12

作成承認 DESIGN & DRAWING | No. | DESCRIPTION | APPROVED | CHECKED | DRAWN OR REVISED | DATE

TOKYO GAS ENGINEERING CO.,LTD.



品番 ITEM	品名 DESCRIPTION	材質 MATL	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER

納入先 CUSTOMER

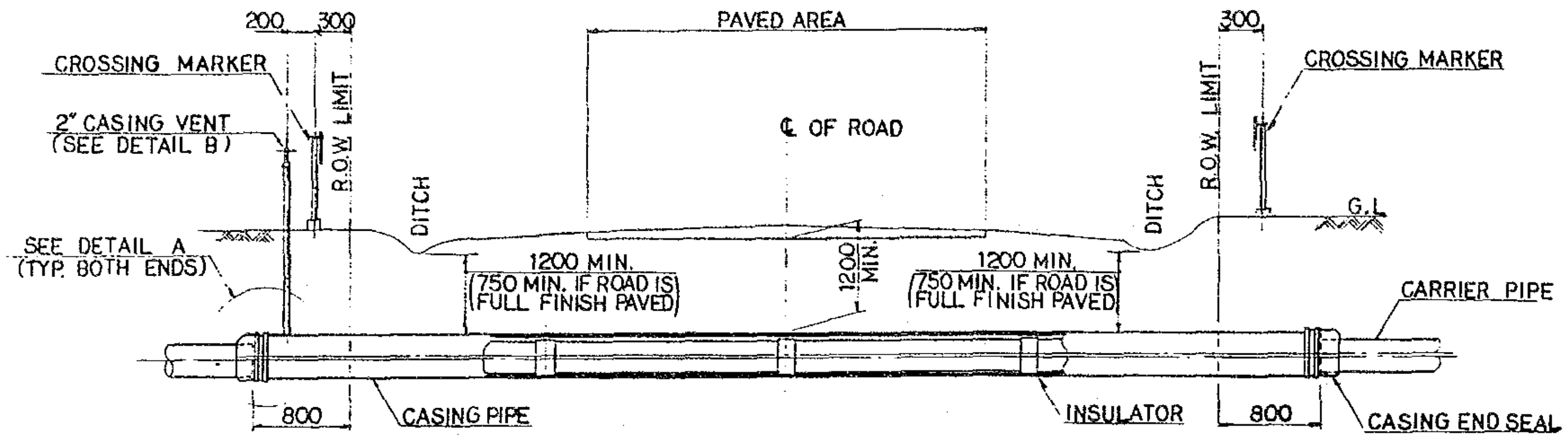
TITLE: TYPICAL INSTALLATION OF VALVES

ANGLE FROM 角法 | 縮尺 SCALE 1/ | 図番 DWG No. Figure III.13

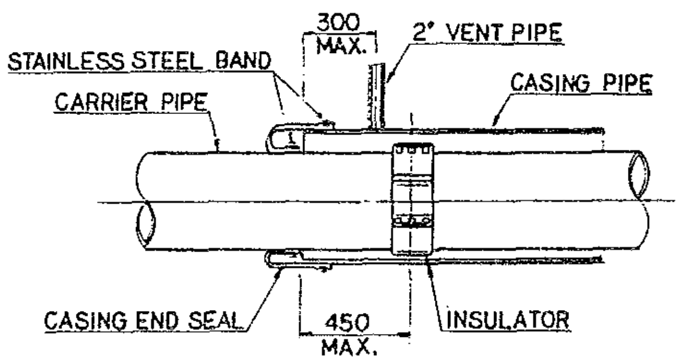
作成承認 DESIGN & DRAWING: K. F... (APPROVED) | K. M... (CHECKED) | 8/8 '86 (DRAWN OR REVISED / DATE)

REVISION: 1, 2, 3, 4, 5 | No. | DESCRIPTION | APPROVED | CHECKED | DRAWN OR REVISED | DATE

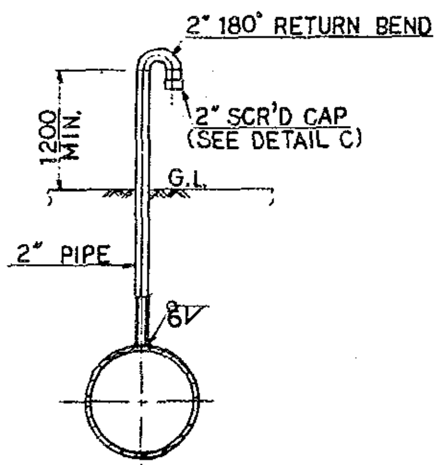
TGE TOKYO GAS ENGINEERING CO.,LTD.



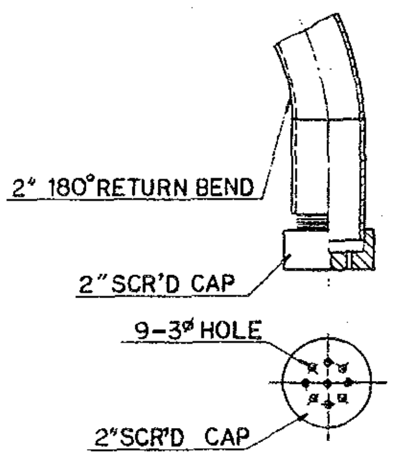
TYPICAL CASED CROSSING



DETAIL A



DETAIL B



DETAIL C

品番 ITEM	品名 DESCRIPTION	材質 MAT'L	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER

納入先 CUSTOMER

TITLE: TYPICAL HIGH WAY CROSSING

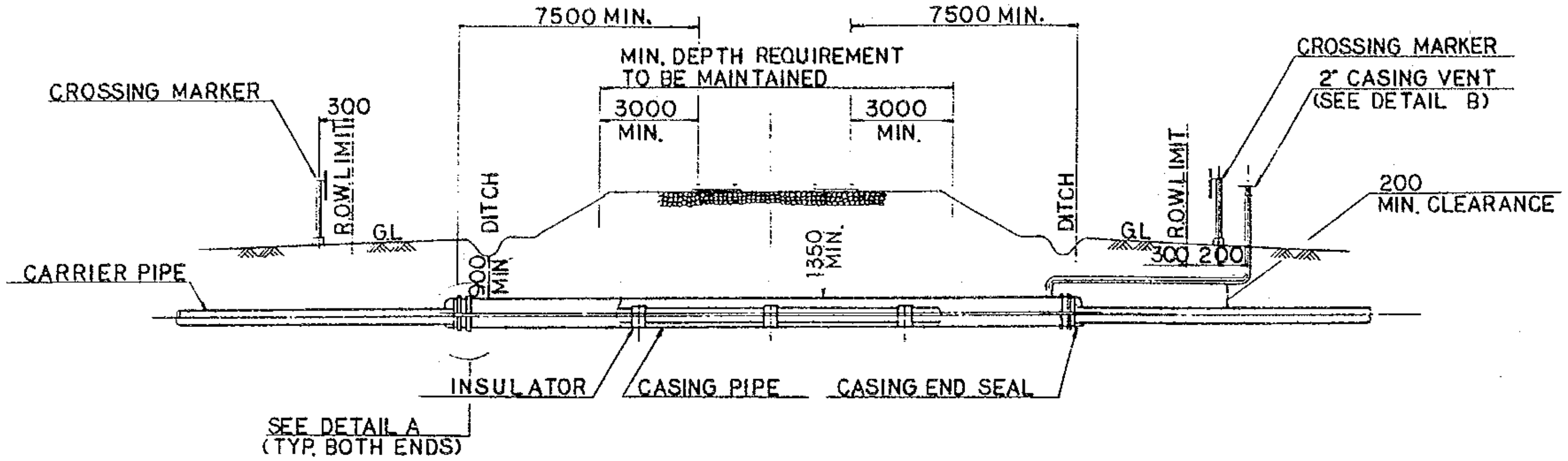
角法 ANGLE PROJ. / 縮尺 SCALE: 1/ / 図番 DWG No. Figure III.14

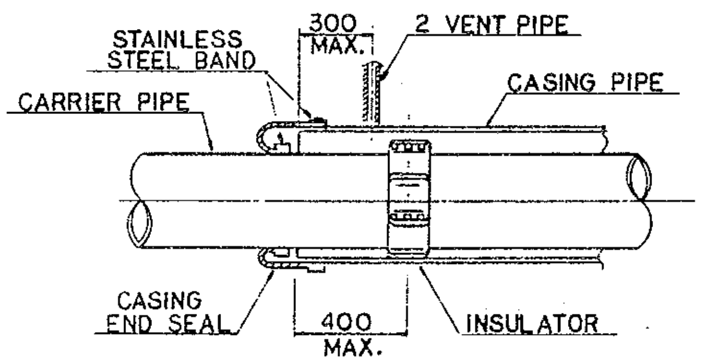
REVISION: 1–5

作成承認 DESIGN & DRAWING — K. Tokuyama (APPROVED), K. Muta (CHECKED), 8/5 '86 (DATE)

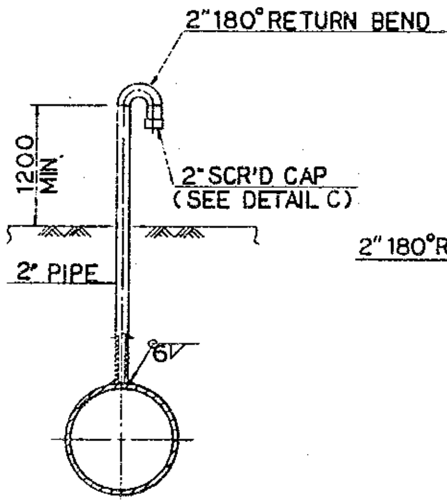
No. DESCRIPTION | APPROVED | CHECKED | DRAWING or REVISED | DATE

TGE TOKYO GAS ENGINEERING CO.,LTD.





DETAIL A



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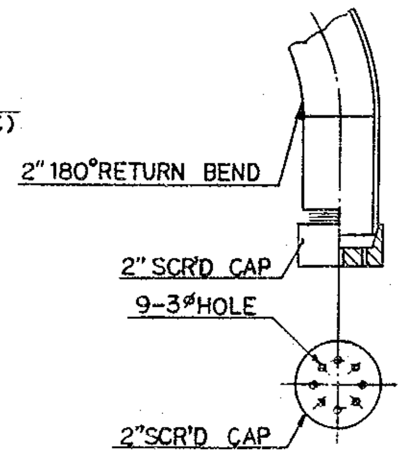


DETAIL C

品番 ITEM | 品名 DESCRIPTION | 材質 MATL | 数量 QUANT | 重量 WEIGHT | 備考 REMARKS

使用先 USER

納入先 CUSTOMER

TITLE
TYPICAL CASED
RAILWAY CROSSING

ANGLE FROM 角法 | 縮尺 SCALE 1/ | 図番 DWG No. Figure III.15

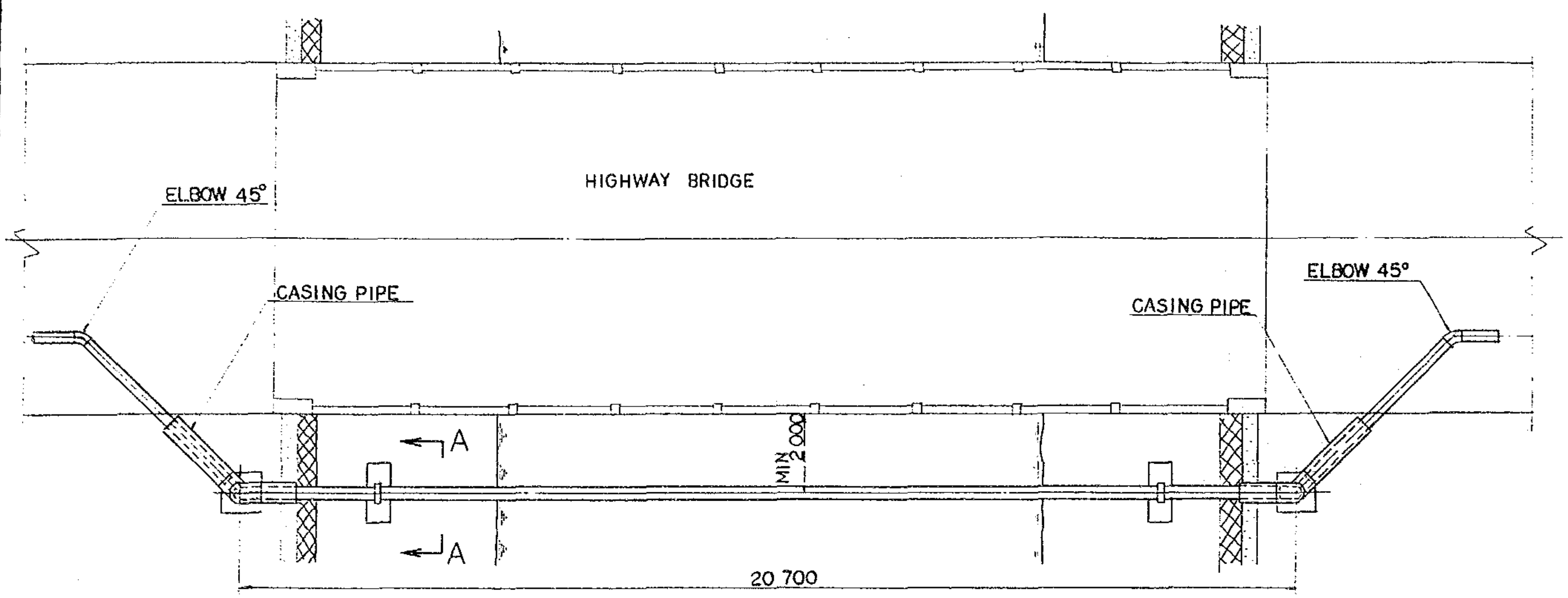
TOKYO GAS ENGINEERING CO.,LTD.

REVISION ① ② ③ ④ ⑤

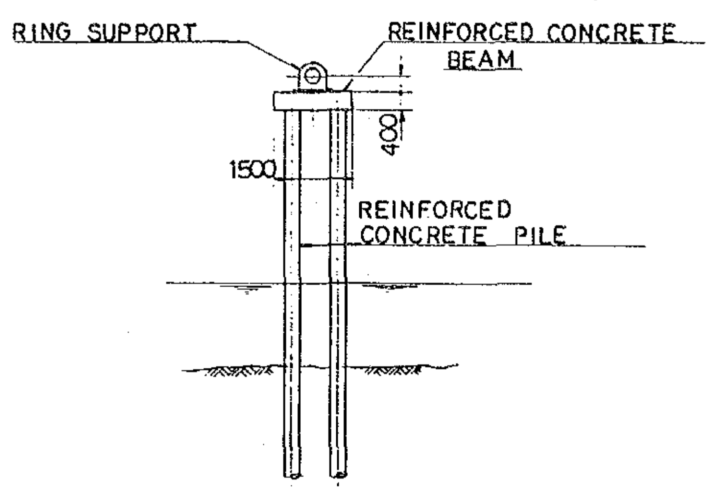
作成承認 DESIGN & DRAWING | K. Fukaya | K. Ymda | 8/5 '86

No. | DESCRIPTION | APPROVED | CHECKED | DRAWN OR REVISED | DATE

PLAN SCALE 1 : 100



SECTION A - A SCALE 1 : 100



PROFILE SCALE 1 : 100

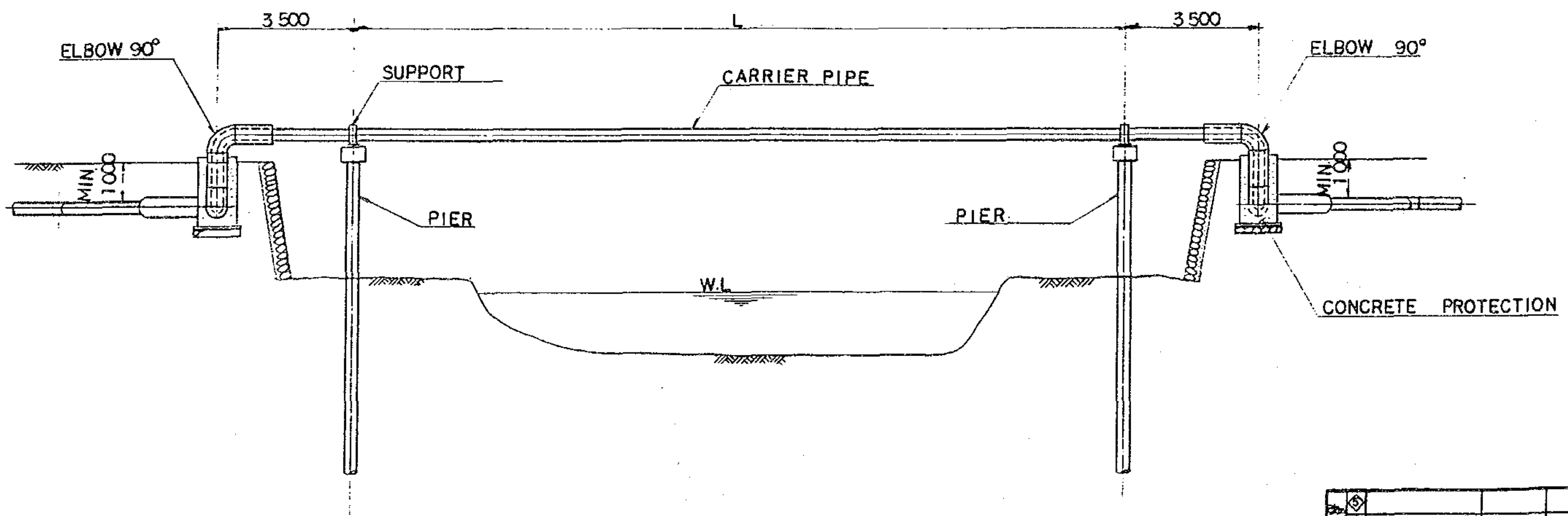


TABLE I MAXIMUM SPAN LENGTH : L

DIAMETER INCHES	MAXIMUM SPAN . L METERS
4	7.0
6	9.0
8	13.0
12	20.0
16	25.0
20	30.0
24	35.0

品番 ITEM	品名 DESCRIPTION	材質 MAT'L	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER

納入先 CUSTOMER

TITLE RIVER CROSSING BY PIPE BEAM BRIDGE

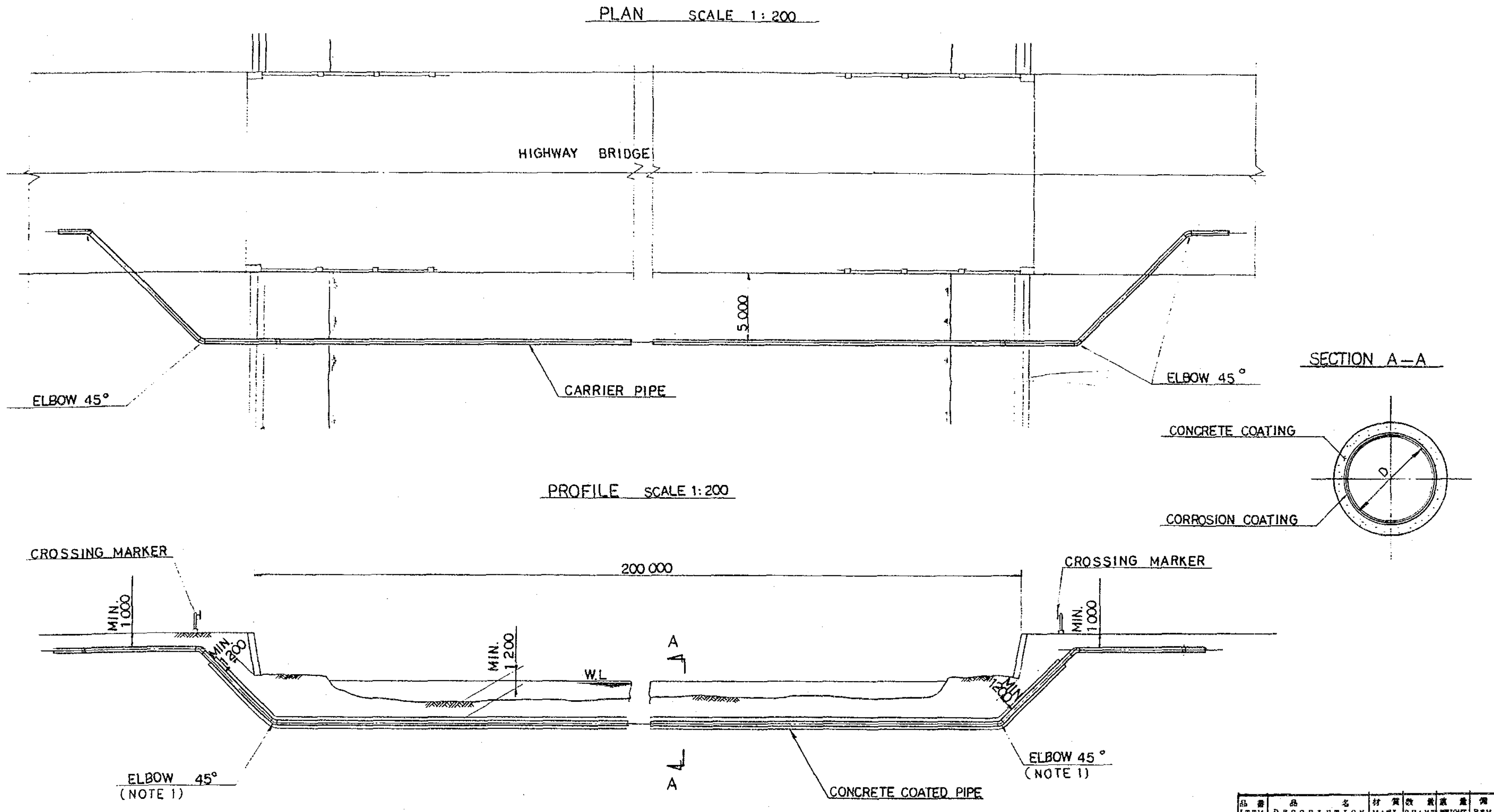
ANGLE PROJ. 角法 | 縮尺 SCALE 1/ | 図番 DWG No. Figure III.16

REVISION 1 2 3 4 5

作成承認 DESIGN & DRAWING | K. Fukuya | K. Murata | 8/8 '86

No. | DESCRIPTION | APPROVED | CHECKED | DRAWN OR REVISED | DATE

TGE TOKYO GAS ENGINEERING CO.,LTD.



NOTE 1 : NATURAL BEND MAY BE APPLIED ACCORDING TO SITE CONDITIONS.

品番 ITEM	品名 DESCRIPTION	材質 MATL	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER

納入先 CUSTOMER

TITLE: TYPICAL RIVER CROSSING DIRECT BURIED

ANGLE FROM 角法 | 縮尺 SCALE 1/ | 図番 DWG No. Figure III.17

No.	DESCRIPTION	APPROVED	CHECKED	DRAWN or REVISED	DATE
作成承認 DESIGN & DRAWING		K. Fukuyama	K. Mutsu		3/8 '86

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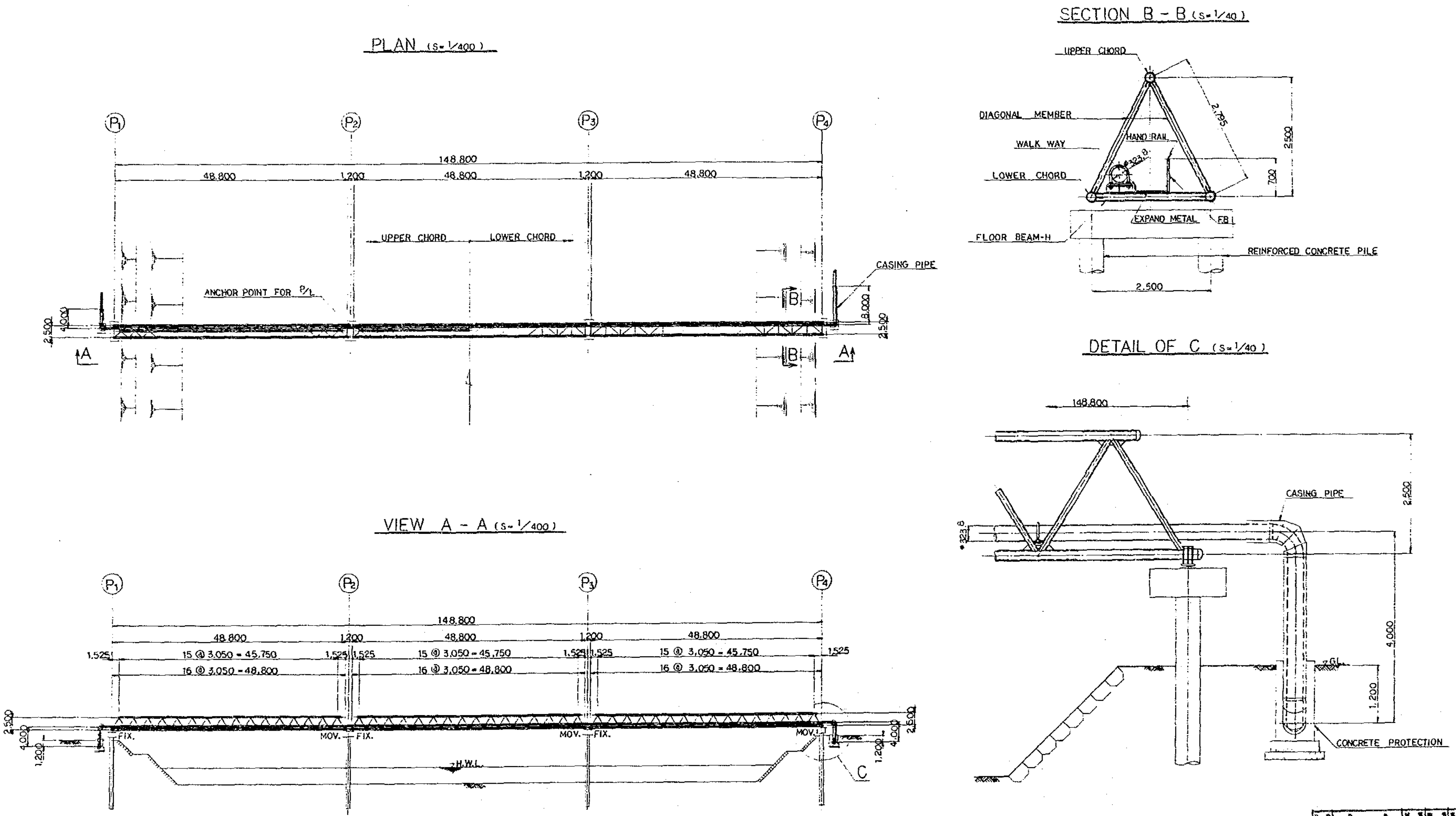


RIVER CROSSING BRIDGE FOR 12"PIPE(150M SPAN)

SCALE 1/

Figure III.18

TOKYO GAS ENGINEERING CO.,LTD.

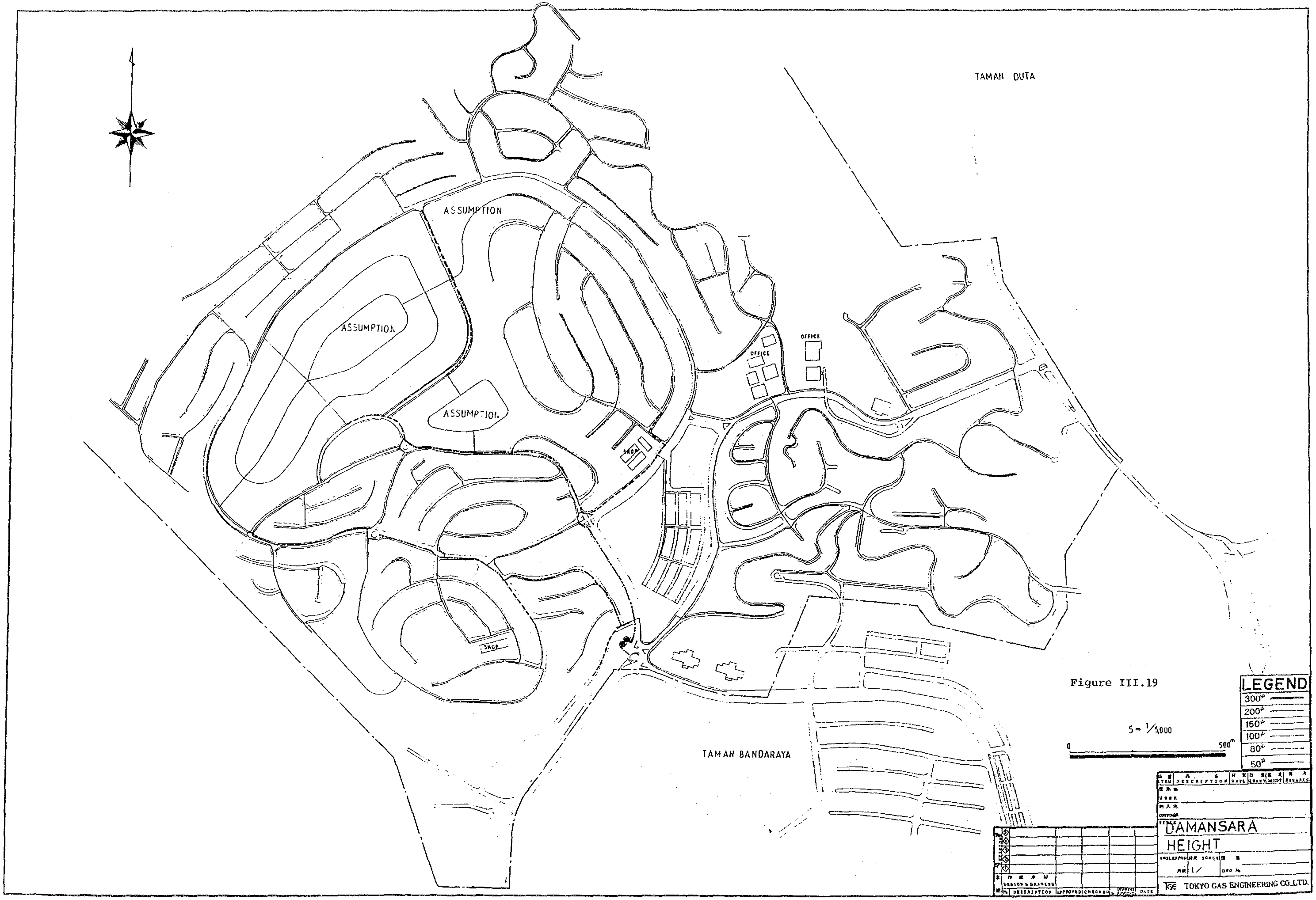


Figure III.19

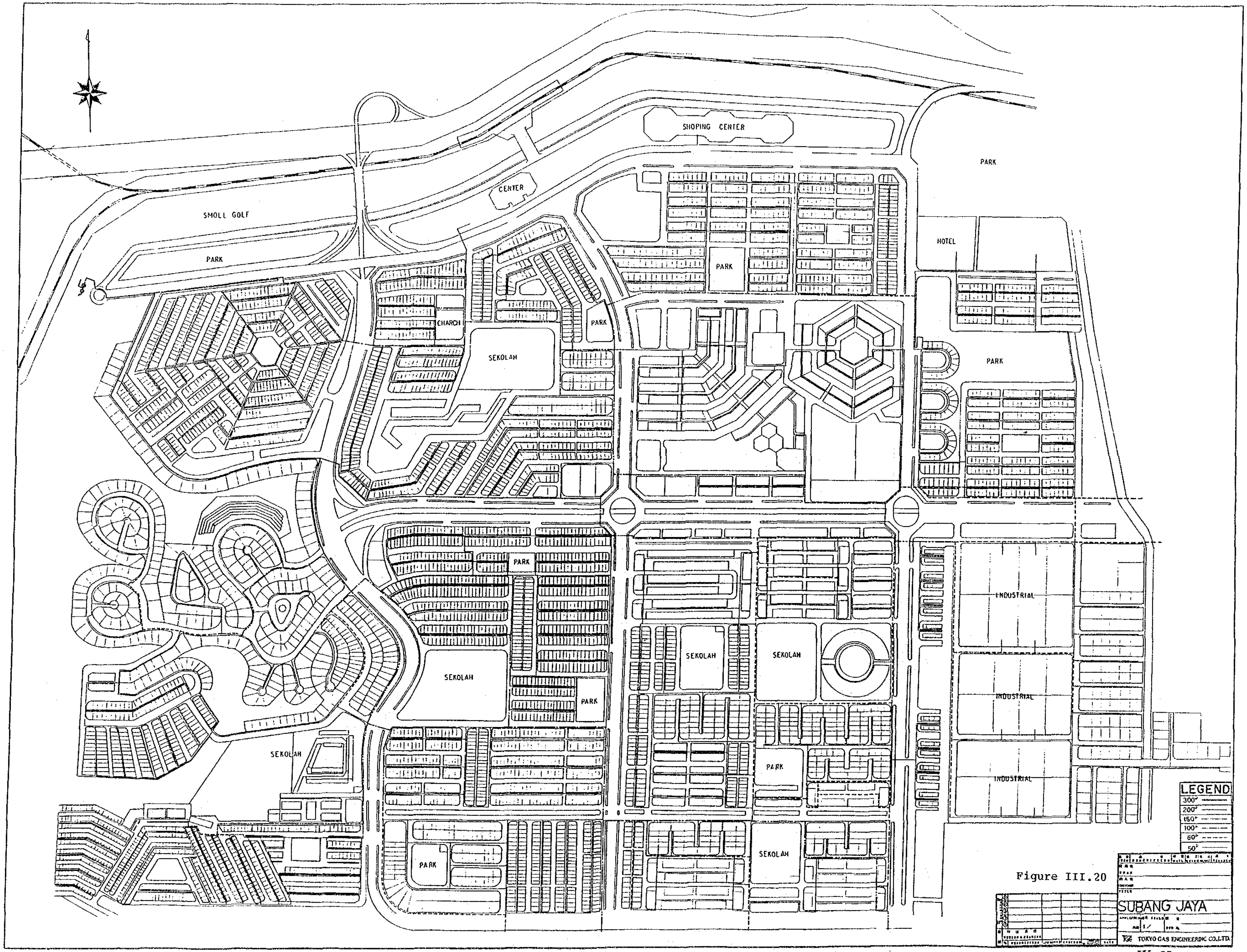


Figure III.20

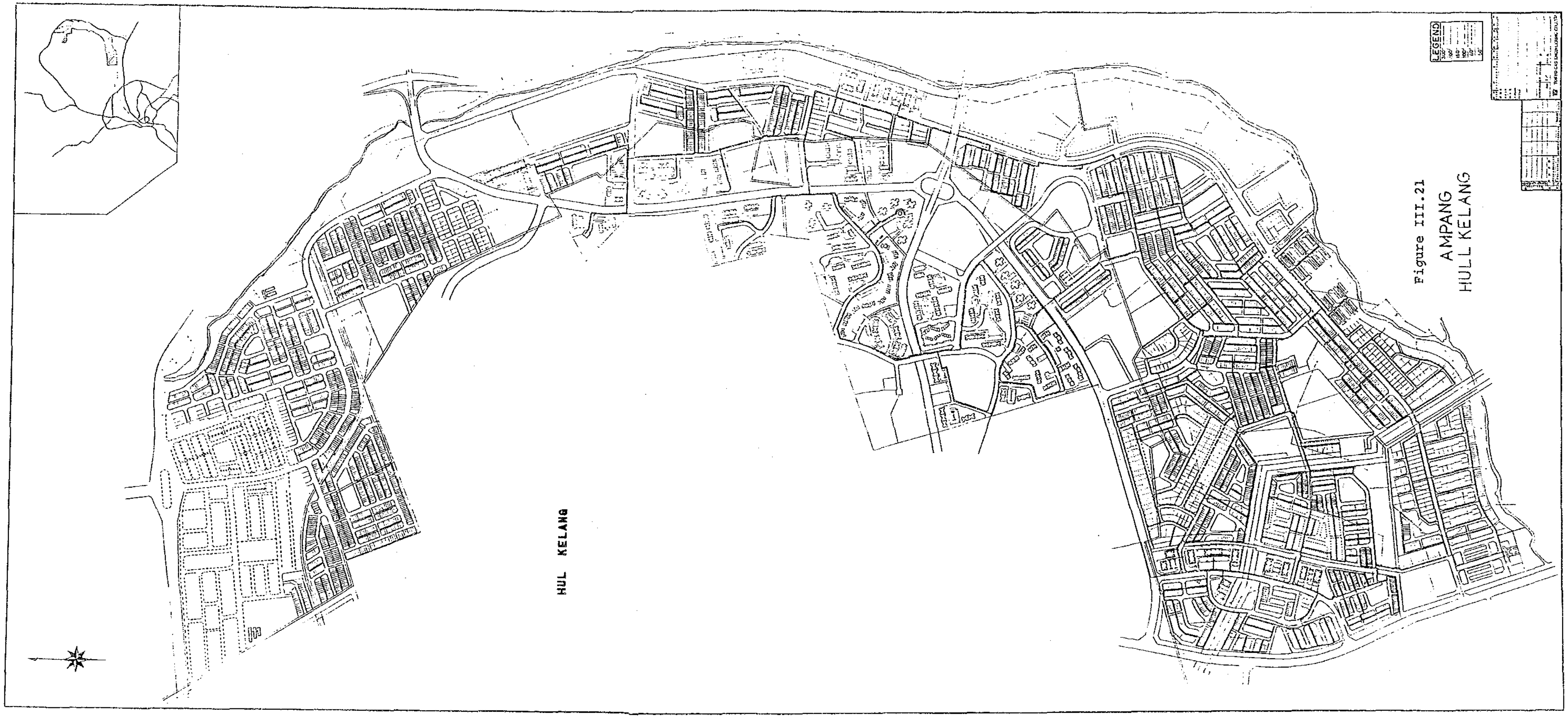


Figure III.21
AMPANG
HULL KELANG

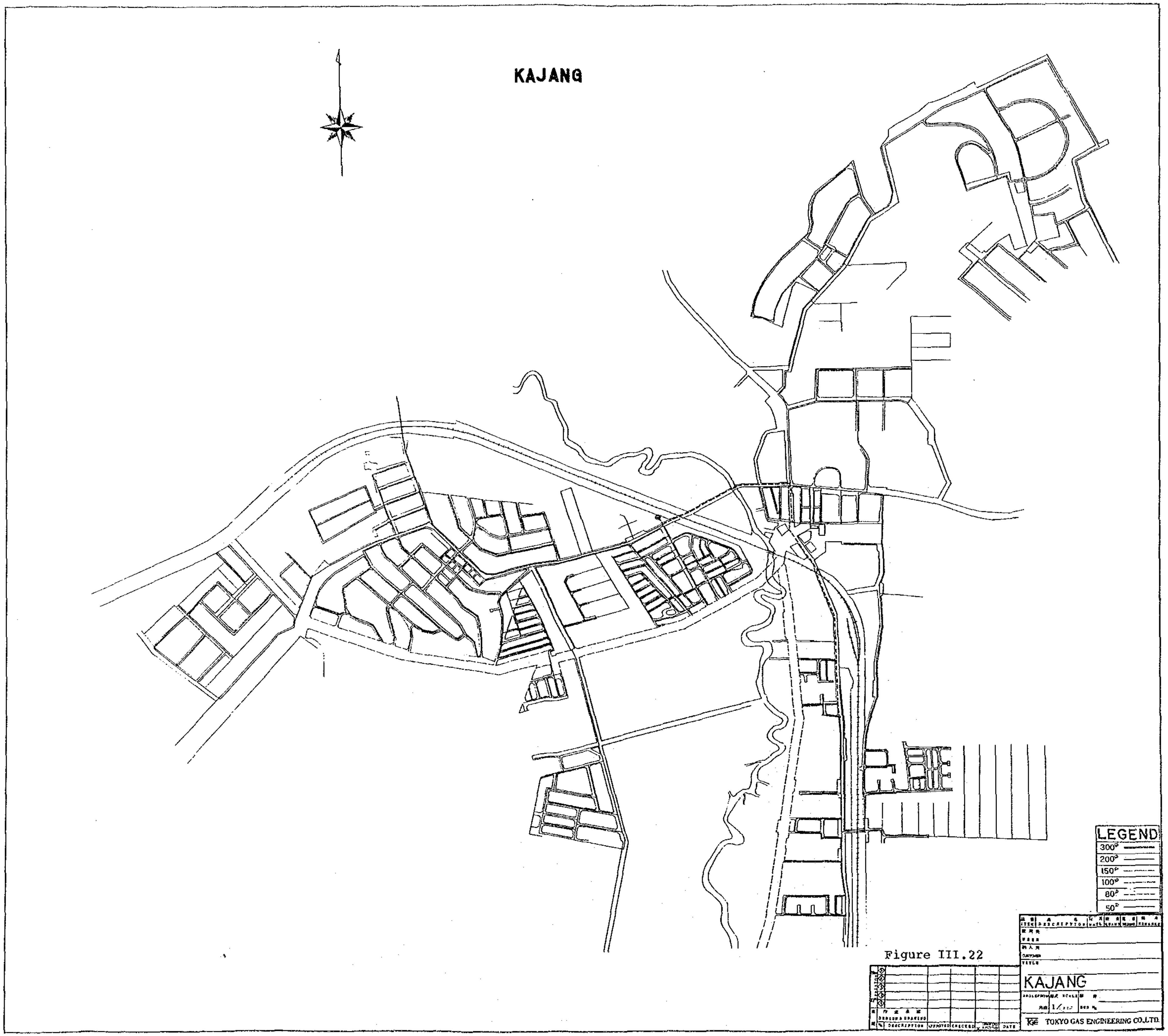


Figure III.22

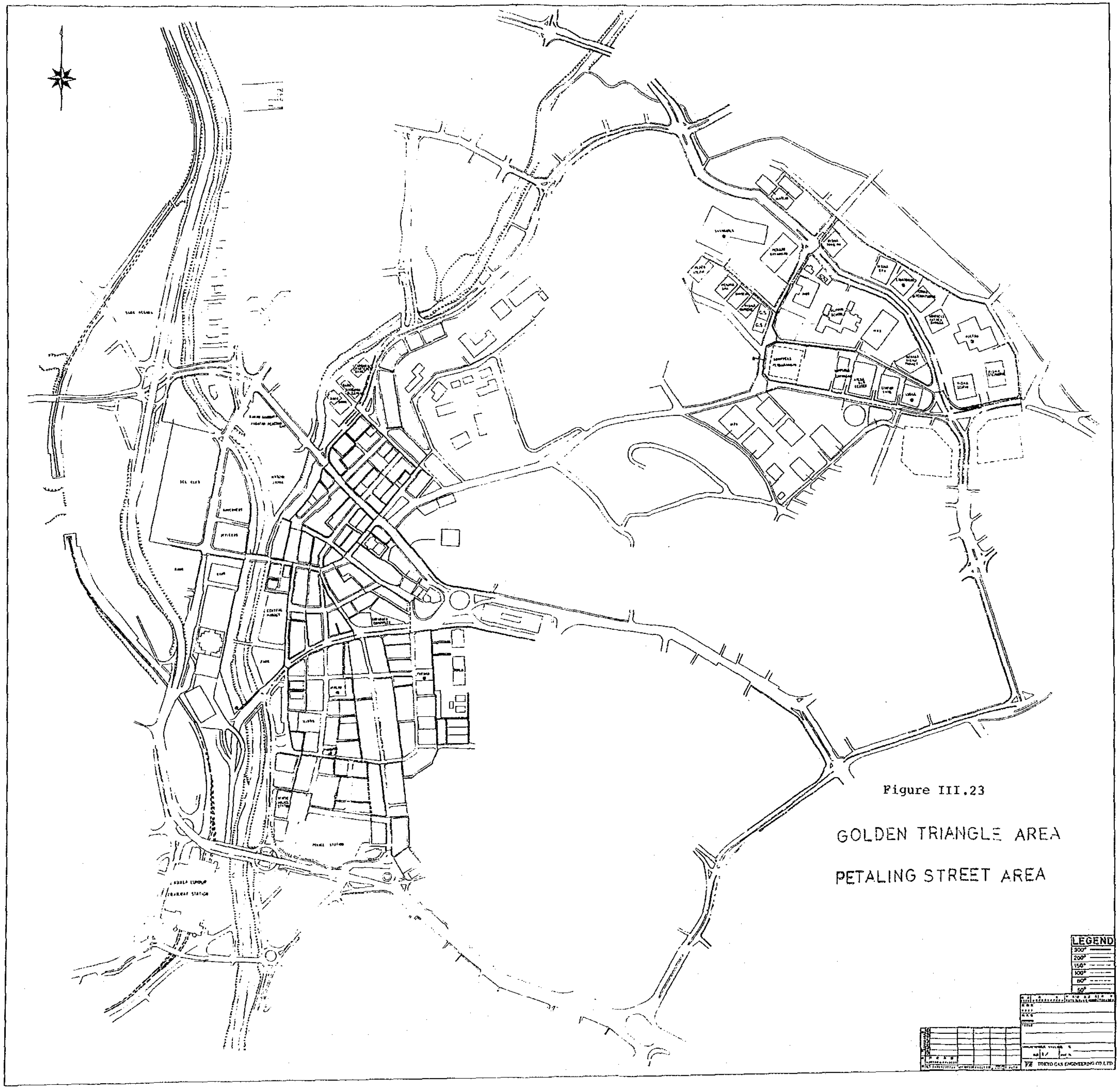


Figure III.23

GOLDEN TRIANGLE AREA

PETALING STREET AREA

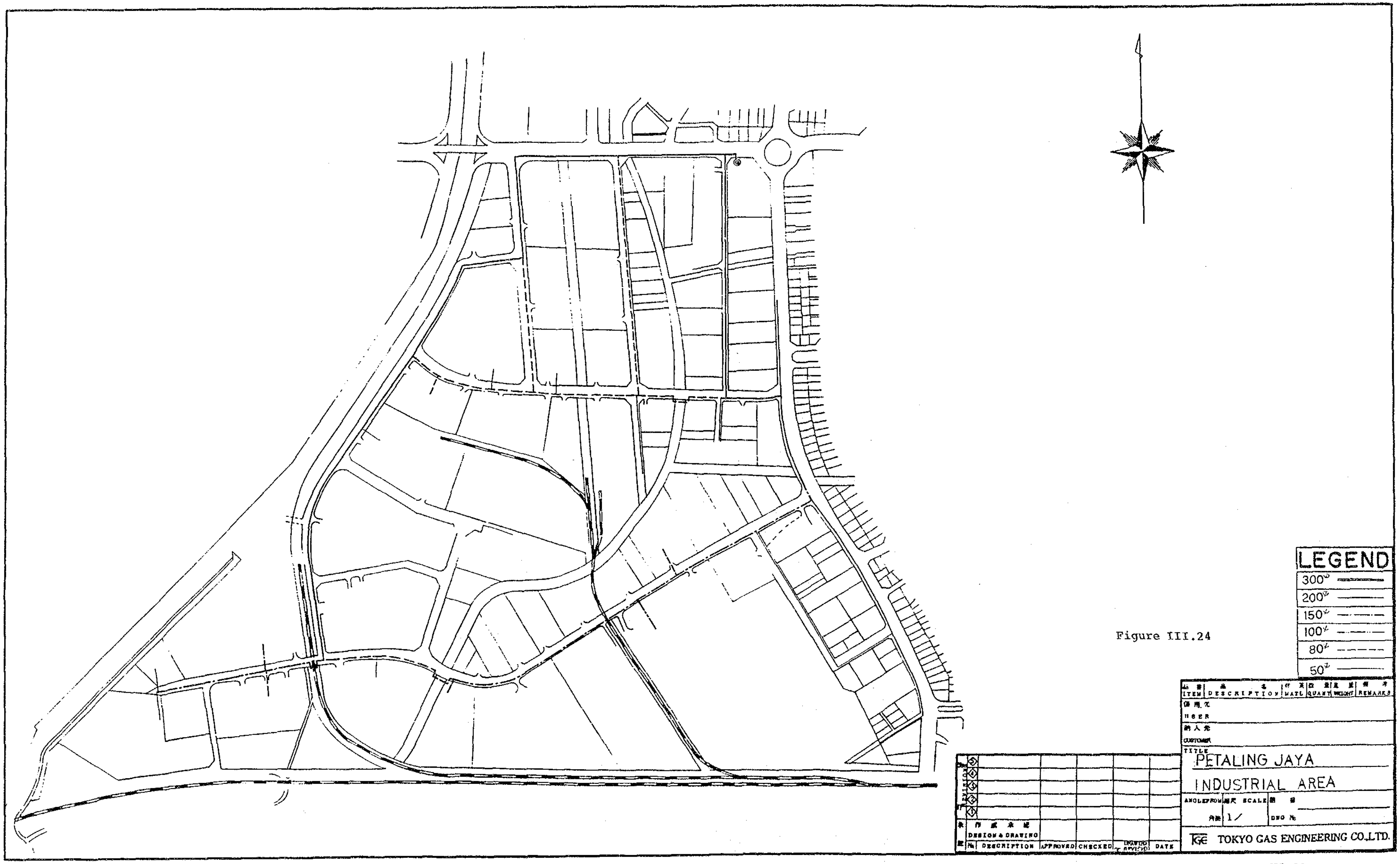
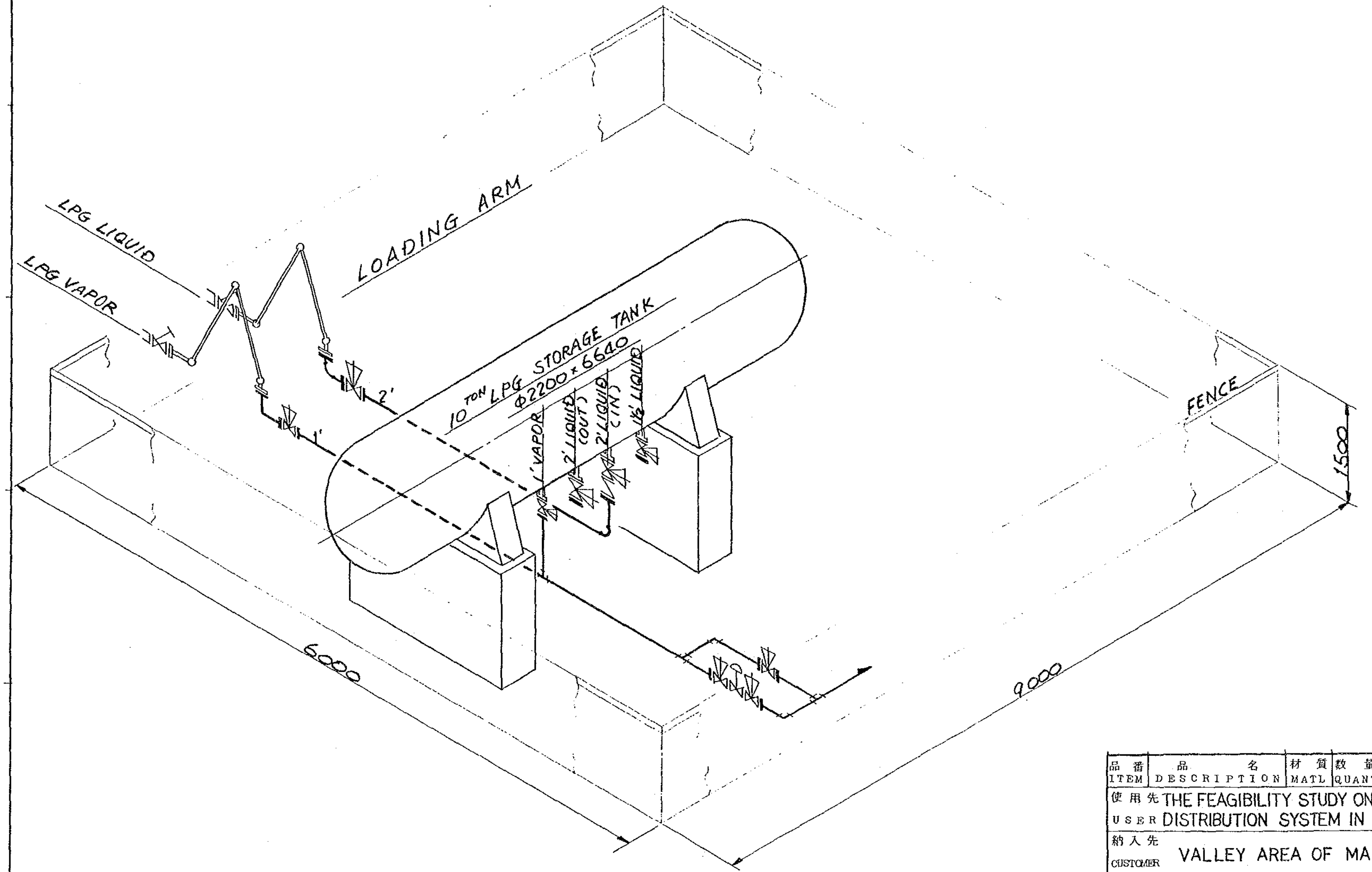


Figure III.24



品番 ITEM	品名 DESCRIPTION	材質 MATL	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER: THE FEAGIBILITY STUDY ON CITY GAS DISTRIBUTION SYSTEM IN THE KLANG

納入先 CUSTOMER: VALLEY AREA OF MALAYSIA

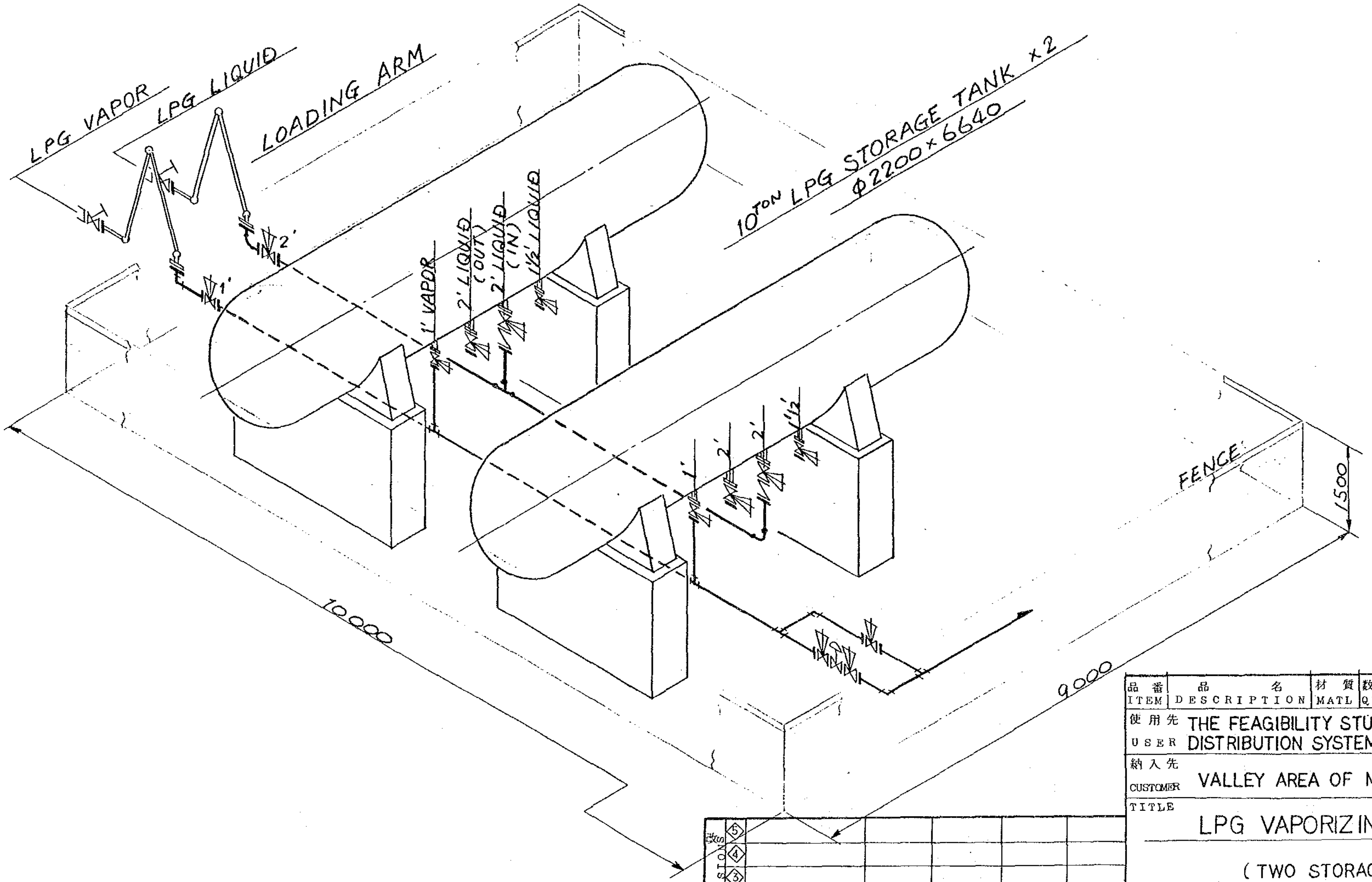
TITLE: LPG VAPORIZING PLANT

(ONE STORAGE)

ANGLEFROM 角法	縮尺 SCALE	図番 DWG No
	1／	Figure III.25

改訂 REVISION					
5					
4					
3					
2					
1					
承認	作成承認 DESIGN & DRAWING				
No	DESCRIPTION	APPROVED	CHECKED	DRAWING or REVISED	DATE

TGE TOKYO GAS ENGINEERING CO.,LTD.



品番 ITEM	品名 DESCRIPTION	材質 MATL	数量 QUANT	重量 WEIGHT	備考 REMARKS

使用先 USER: THE FEAGIBILITY STUDY ON CITY GAS DISTRIBUTION SYSTEM IN THE KLANG

納入先 CUSTOMER: VALLEY AREA OF MALAYSIA

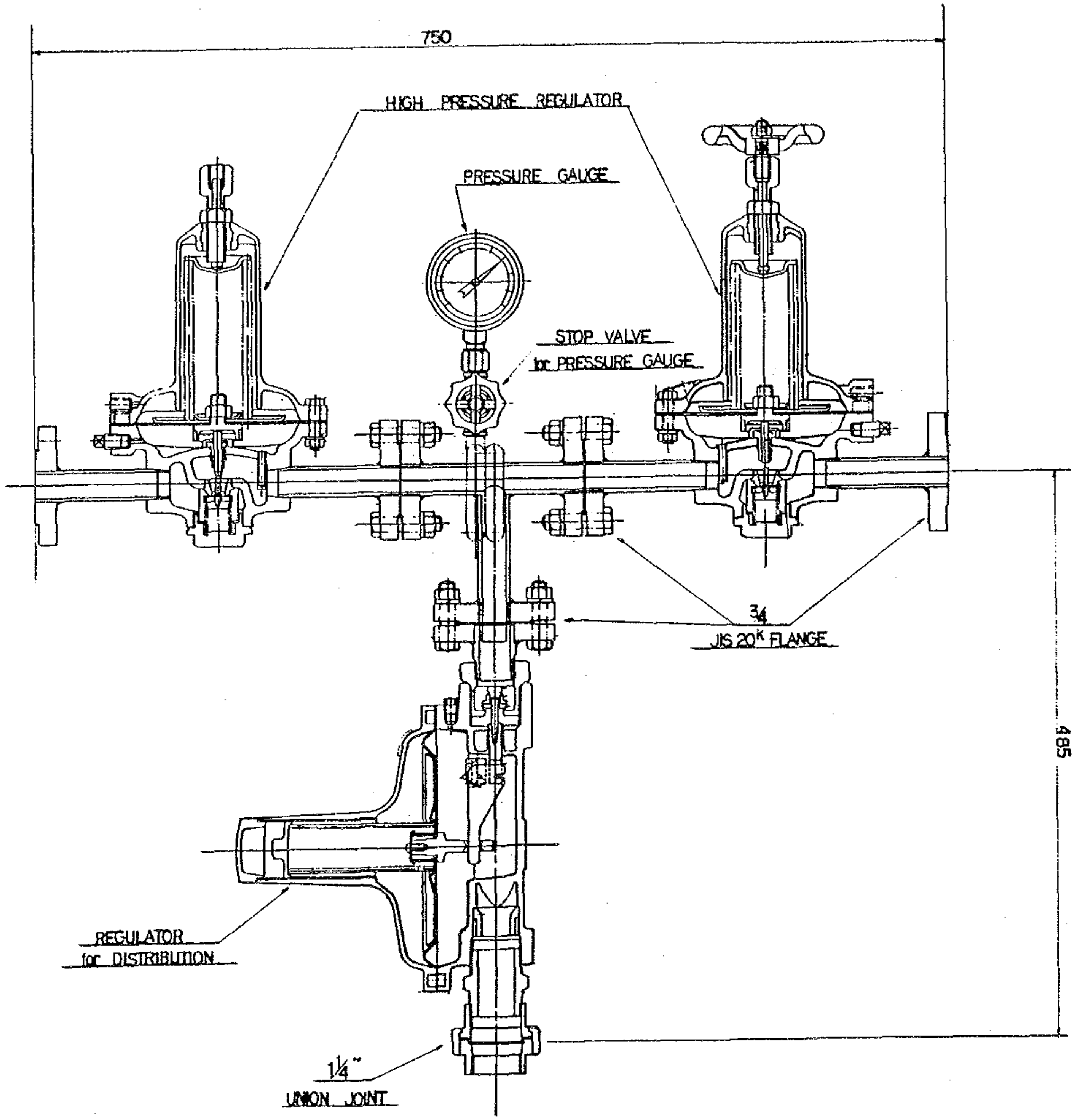
TITLE: LPG VAPORIZING PLANT

(TWO STORAGE)

ANGLEFROM 角法 | 縮尺 SCALE 1／ | 図番 DWG No Figure III.26

訂正 REVISION					
5					
4					
3					
2					
1					
承認	作成承認 DESIGN & DRAWING				
No	DESCRIPTION	APPROVED	CHECKED	DRAWING or REVISED	DATE

TGE TOKYO GAS ENGINEERING CO.,LTD.



使用先 USER 納入先 CUSTOMER: THE FEASIBILITY STUDY ON CITY GAS DISTRIBUTION SYSTEM IN THE KLANG VALLY AREA OF MALAYSIA

TITLE: 70 kg/h AUTO-CHANGEABLE REGULATOR

ANGLE PROJ. 角法 | 尺 SCALE 1/ | 図番 DWG No. Figure III.27

記号 No.	DESCRIPTION	APPROVED	CHECKED	DRAWN or REVISED	DATE
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3					
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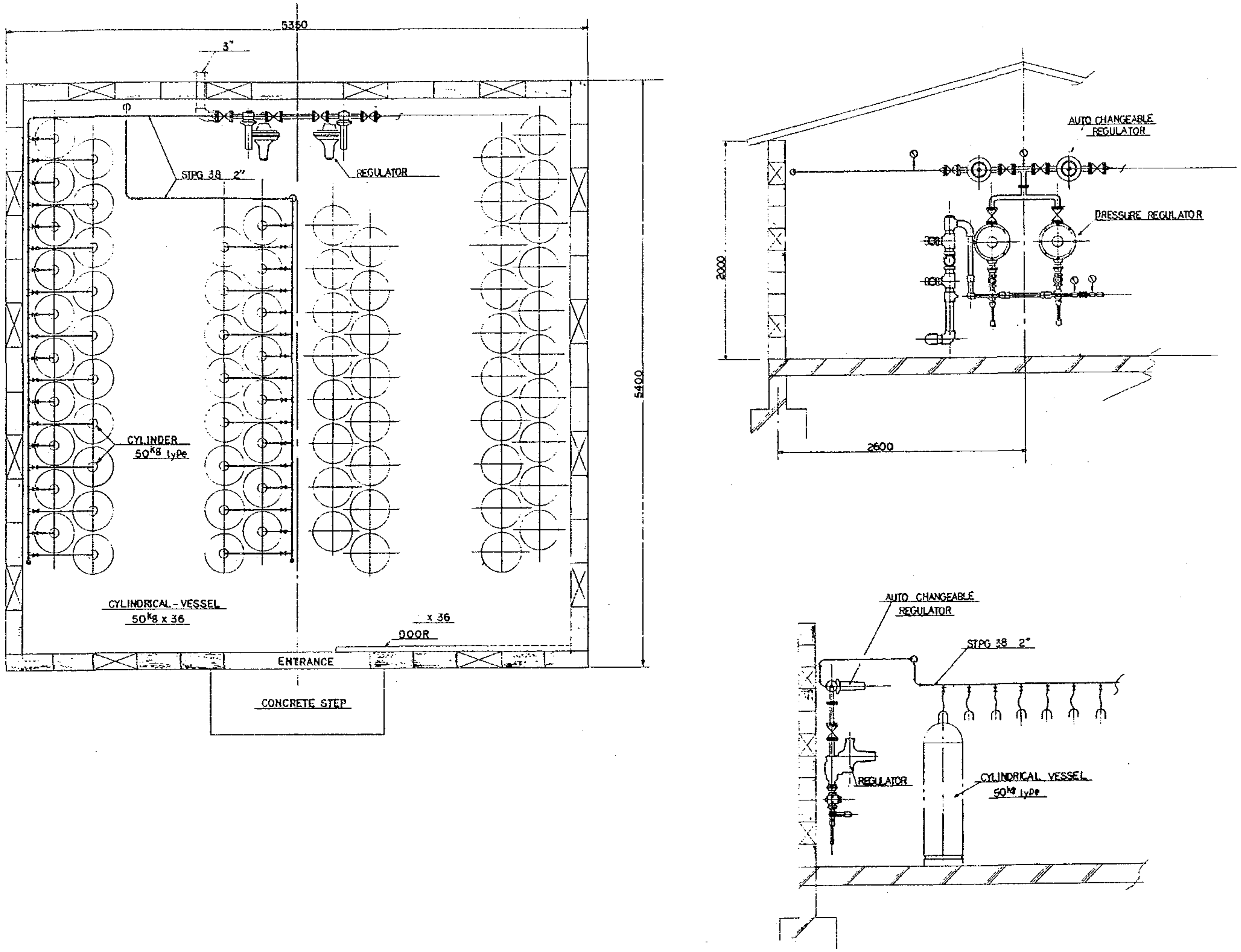
1					
作成承認 DESIGN & DRAWING					

TGE TOKYO GAS ENGINEERING CO.,LTD.



THE FEASIBILITY STUDY ON CITY GAS DISTRIBUTION SYSTEM IN THE KLANG VALLEY AREA OF MALAYSIA

TITLE: LPG VAPORIZING PLANT

SMALL CYLINDER EXCHANGE METHOD

SCALE 1/

Figure III.28

DESIGN & DRAWING | DESCRIPTION | APPROVED | CHECKED | DATE

TOKYO GAS ENGINEERING CO.,LTD.

PART IV STUDY OF THE CONSTRUCTION SCHEDULE OF THE INTEGRATED GAS DISTRIBUTION SYSTEM

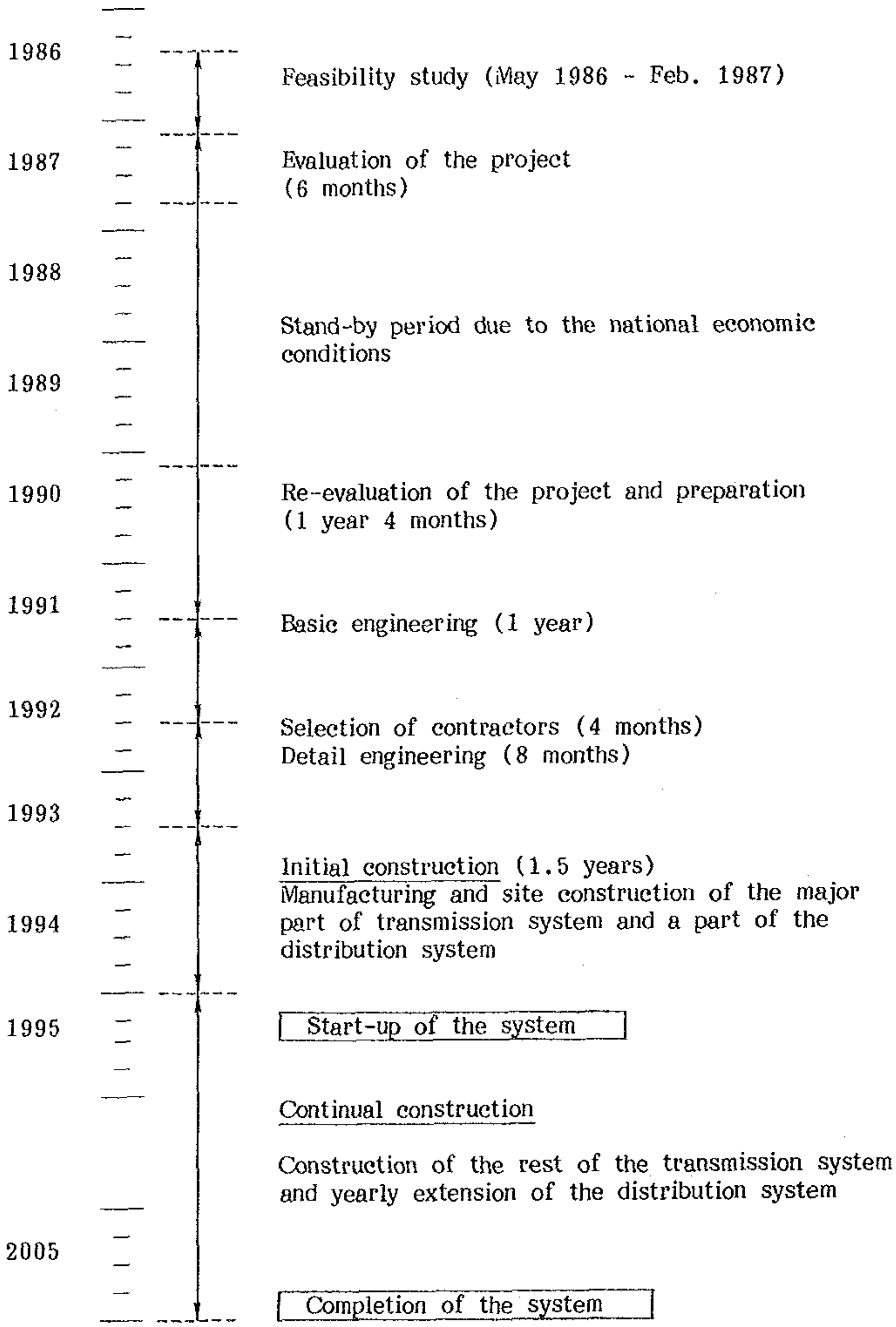
PART 4 STUDY OF THE CONSTRUCTION SCHEDULE OF THE INTEGRATED GAS DISTRIBUTION SYSTEM

Chapter 1 BASIC IMPLEMENTATION SCHEDULE

1.1 Base Case

1986	Feasibility study (May 1986 - Feb. 1987)
1987	Evaluation of the project and preparation (1 year 4 months)
1988	Basic engineering (1 year)
1989	Selection of contractors (4 months) Detail engineering (8 months)
1990	Initial construction (1.5 years) Manufacturing and site construction of the major part of transmission system and a part of the distribution system
1991	
1992	Start-up of the system Continual construction Construction of the rest of the transmission system and yearly extension of the distribution system
2005	Completion of the system

1.2 Medium and Low Cases



Chapter 2 PREPARATORY WORKS FOR THE PROJECT IMPLEMENTATION

2.1 Items and Schedule of the Preparatory Works

For the implementation of this project, when it is approved to be proceeded, various preparatory works will be required. They are categorized as follows.

(1) Setting-up of a project promoting body

(2) Establishment of the project scheme for implementation

(3) Preparations for authorization and control of city gas business in general

(4) Incorporation of operating companies

(5) Basic engineering for constructing facilities and operation systems

(6) Construction of facilities and operation systems

The schedule for the actualization of these preparatory works are proposed in Figure IV.1.

2.2 Setting-up of a Project Promoting Body

After the project is properly evaluated and a take-off decision is made, a project promoting body is required to be set up. Its primary jobs are establishment of the project scheme, promotion to prepare the legislative and administrative conditions for city gas business, arrangement for incorporating a city gas operating company(s) and the management of engineering works for facility and operation system construction.

To make the preparatory works more serious and practical, the project promoting body should not be denied to become either the sole operating company or one of the sharing operating companies of the city gas system.

After the establishment of the operating company(s), the basic engineering work should be performed for and under the management of the operating company(s) and it should be also responsible for promoting the preparation of the conditions for city gas business. The finalization of the basic engineering and actual construction work need to be done by this company(s) itself.

2.3 Establishment of the Project Scheme for Implementation

This work need to be started with purchase gas pricing. This price can be defined either directly or in correlation with other energy prices, as long as it is defined so distinctly and guaranteed so assuredly that the actual implementation plan can be built up on its basis.

The role of the project promoting body here is considered to be to initiate the price negotiation by proposing an idea of the price with its way of definition and urge discussions on the effect of the project on the national economy and call for a settlement as a political decision.

The framework of the system to be established on this purchase gas price, which has not been available and had to be assumed in the feasibility study, are as follows.

(1) *Exact scope of the demand for city gas*

The scope of energy demand for city gas, as a target, is to be determined in terms of the kind of energy in all sector, in respect of the purpose of use and the status of existence (being or not being).

(2) Sales gas pricing

Sales gas price which may vary by demand types is to be studied carefully on both cost and value basis for establishing a practical sales gas price system. The sales gas price is to be considered in relation with customer's contribution on the construction cost. A general rule on the latter should also be established at the same time.

(3) Basic time table

A basic time table for realizing the whole scope of city gas system is to be determined based on the project schemes established in the above. Here different schedules for different areas or demand types should be positively discussed and adopted if they are proved practical. An experimental stage of realization on a restricted scale for obtaining a whole set of experiences related to the city gas or probing exact reactions of the customers is recommended in case that a slow pace is taken for the project implementation.

(4) Requirements for operating company(s)

Studies are to be made as to how to operate the whole city gas system as defined in the above and the characteristics and requirements for the company(s) capable of such operation are to be made clear.

In establishing these framework of the project, the data combined in this feasibility study report on all the aspects of the energy consumption in the Klang Valley area and regarding the construction of the total gas distribution system will be highly informative.

However, in the course of project scheme establishment, which requires a number of decisions on the matters so far not familiar in Malaysia, expertise in city gas operation would help the project promoting body greatly. So a capable consultant specialized in this field of business should be considered to be brought into this stage of the work.

2.4 Preparations for authorization and control of city gas business in general

In order to launch a city gas company, some legislative and administrative conditions are required to be prepared. They are mainly as follows.

(1) Legislation to authorize city gas companies

(2) Admission to occupy the space under the roads for distribution and service pipe installation

(3) Preparation of technical standards and recommendations for securing public safety in relation with city gas

Recommendations and references on these matters are given in Part 7 of this feasibility study.

Experts who have knowledge and experience in the activities in city gas operation as well as in the legislative side of that business will be available and effective in arranging these conditions.

2.5 Incorporation of Operating Company(s)

As mentioned in Part 7 Conclusion, this project should be started with public investment because of its profitability which seems not large enough to attract private investments. For this reason the operating company is most likely to be a not subscribed company whose share capital is fully owned by PETRONAS and/or its subsidiaries.

However, the possibility of privatization cannot be denied, especially in case that such measures as subsidization on energy prices and some selection of demand types and supply areas for city gas are taken. In case of the operation by private sector, division of the business may well be discussed. Our opinion is that the loss arising from the division is not small and it should be carefully minimized by taking precautionary measures as mentioned in the reference information-1.

Anyway a company or companies who are to take the responsibility of operation of the city gas system need to be incorporated and take over the preparatory works from the project promoting body in due time.

2.6 Basic Engineering for Constructing Facilities and Operation Systems

Basic engineering work here means the works both for the construction of city gas distribution facilities and the preparation of the various systems required for the operation of the city gas company. And the basic engineering for the facility construction consists of the two distinguishable portions;

- For transmission system construction
- For distribution system and internal piping construction

These engineering works should be performed by capable engineering firms who have deep knowledge and full-range experience of city gas transmission and distribution as well as its utilization. The works can be either packed in one package or divided into two or three packages.

(1) Basic engineering for transmission system

The transmission system which comprises regulator stations at city gates, main and auxiliary transmission pipelines and district regulators, is expected to be constructed by a contractor or contractors who are internationally selected by bidding. So the basic engineering for this construction should follow the nearly standardized procedure for this kind of engineering, which are mentioned in the following.

Items of Basic Engineering

1) Construction project execution plan
   - Organization, etc.
   - Project schedule
2) Procedures and manuals
   - Project coordination
   - EPCM
   - QC/QA
   - Cost/schedule control
   - Procurement policy

3) Basic engineering
   - Engineering criteria
   - Calculations
   - Basic drawings
4) Engineering specifications
   - Design/engineering
   - Material and equipment
5) Construction specifications
   - Construction
   - Feld QA/QC
   - Commissioning and start-up
6) Preparation of bid package

(2) Basic engineering for distribution and internal piping

The work force to construct these facilities are to be domestic, though temporary reinforcement from overseas for the period of concentrated constructions is admitted.

Distribution system is supposed to be owned by operation companies and internal piping by building owners. But regardless to the final ownership, the possible undertakers of these construction works are the operation companies and the developers of estates and housings.

Though it is possible to close the door to the developers for the sake of safety, we recommend that it should be considered, for ensuring a smooth acceptance of city gas by the Malaysian business world, to entrust the developers the construction of both distribution and internal piping required for their developing projects, on condition that the following systems, which will be prepared and operated either by gas companies and/or other authorities, are established to ensure the soundness of the facilities to be constructed.

- Design and material standard system
- Piping worker qualification system
- Approval system
  - for construction initiation
    (design approval, for distribution system only)
  - for acceptance of take-over
    (for distribution system only)
  - for commissioning

Preparation of the above system will occupy the main portion of the basic engineering work. Besides, the preparation of the following works will be also included in the basic engineering.

- Construction organization
- Work force unit design
  (crew composition with required skills and standard equipment)
- Training program
- Material supply system
- Work procedures

(3) Engineering for city gas operation system

First of all systems for the following works concerning the constructed items are required.

A. Operation and maintenance of transmission and distribution system

B. Extention work of distribution system

Besides, the following systems are indispensable for starting a city gas company.

C. Billing and bill-collection system

- Administrative system for meter reading order, meter reading, bill issuance and charge collection
- Media for meter reading, bill sending and charge collection

D. Customer connection system

- Connection, disconnection and meter removal for temporary disconnection
- Related works to customer connection
  - Internal piping installation and modification
  - Conversion of gas appliances of the customer to natural gas

E. Emergency system

- Emergency crews on 24 hour watch, with skills and equipment for handling the situation and means of rushing to the site
- Back-up work force for emergency repairment, capable of surface breaking and digging

The followings are not indispensable just to keep operation but necessary for the company to upgrade the gas sales.

F. Gas appliance handling

- Sales shops of gas appliances, owned or controlled by the company
- Repairing power of gas appliances, direct or through the sales shops

G. Supply and conversion system for combustion equipment

- For industrial users
- For large-scale commercial users

If the company decides to get further control on the city gas market, the followings are recommended to add the companys' operation system.

H. Gas appliance development system

I. Combustion technology development system

The engineering work aims at the preparation of the framework of these operation systems, which includes organizations in relation with outside forces, manpower with specified skills and capability and required facilities and equipment.

2.7 Construction of Facilities and Operation System

The constrution of the transmission system is supposed to be undertaken by a contractor(s). The contractor will be selected by the company with an assistance of the consultant who has performed the basic engineering concerned.

The detail engineering, items of which are mentioned below, is usually performed by the contractor. But in case of separate packages, detail engineering and procurement service of long-term items will be performed by the consultant. This consultant, or another who replaces it, should also perform, for the operation company, the construction management service which includes supervision and inspection during the progress and test and commissioning in the final stage of the construction.

<u>Items of Detail Engineering</u>

1) Purchase requisitions
   - Bill of materials
   - Material requisitions
   - Material specification for purchase
   - Data sheets

2) Design drawings and calculations
  - Alignment sheets
  - Piping isometrics
  - Piping arrangements
  - Installation details, etc.
3) Procurement
  - Expediting
  - Inspection

The construction of the distribution system and the internal piping is supposed to be carried out mainly by domestic forces who are to be organized under the mangement of the operating company. This management is vital for this scope of construction and is recommended to be supported by the consultant who has performed the basic engineering for the construction.

As for the operation system, it is recommended, as an unmistakable way of preparing reliable operation system, that a battery consisting of a person recruited by the company and an expert dispatched from the consultant who has performed the basic engineering should be set up for each operation system to be prepared in an early stage of the preparation, and then this battery takes the responsibility for the completion of the system.

Chapter 3 ACTUAL CONSTRUCTION SCHEDULE

3.1 Construction Program of Transmission and Distribution System

As shown in the figure in the next page, the construction of the transmission and distribution systems will be executed in 5 phases, Figure III.4 and III.5 show the transmission pipeline section to be constructed in each phase and the area to which gas will be introduced upon completion of that section.

City gas will be supplied in the following speed to satisfy the household and restaurant demands which had already existed at the time of city gas introduction:

city gas introduction year	35%
2nd year	35%
3rd year	10%
4th year	10%

Therefore, the distribution pipelines need to be constructed in such a speed as will meet the above increase of demand. It is shown by D-1, D-2, D-3 and D-4 in the figure. The existing hotel demand and industrial demand will be replaced by city gas to the extent of 70% and 50% respectively in the year of city gas introduction, and the necessary supply pipeline construction (omitted from the figure) need to be performed. For demands that may occur after city gas introduction, the construction of necessary distribution pipelines will continue every year after city gas introduction until 2005. It is shown by d in the figure.

Figure IV.2 shows the construction schedule for Base case. In Medium case as well as Low case, all the timing of construction will be postponed by 3 years from this time schedule.

3.2 Implementation Plans

(1) Transmission pipeline

The total linear length of 236.2 km will be installed in five years. The work will be carried out by field groups, each of which is composed of excavators, plumbers and road reinstatement workers. Three groups may work simultaneously on different work sections. Yearly progress of construction will be 58 km as calculated below and it will take 5 years to complete all the length.

3 groups x 80 m/day x 25 days/month x 12 month/year x *0.8
= 57.6 km/year (*0.8 = weather factor)

(2) Distribution Network

The construction performance capacity of each group is roughly shown below. A necessary number of groups need to be organized in accordance with the total construction linear length of the zone.

1 group x 50 m/day x 25 days/mon. x 12 mon./year x * 0.8
= 12 km/year (*0.8 = weather factor)

Figure IV.1 SCHEDULE OF PREPARATORY WORKS TOWARD THE START-UP

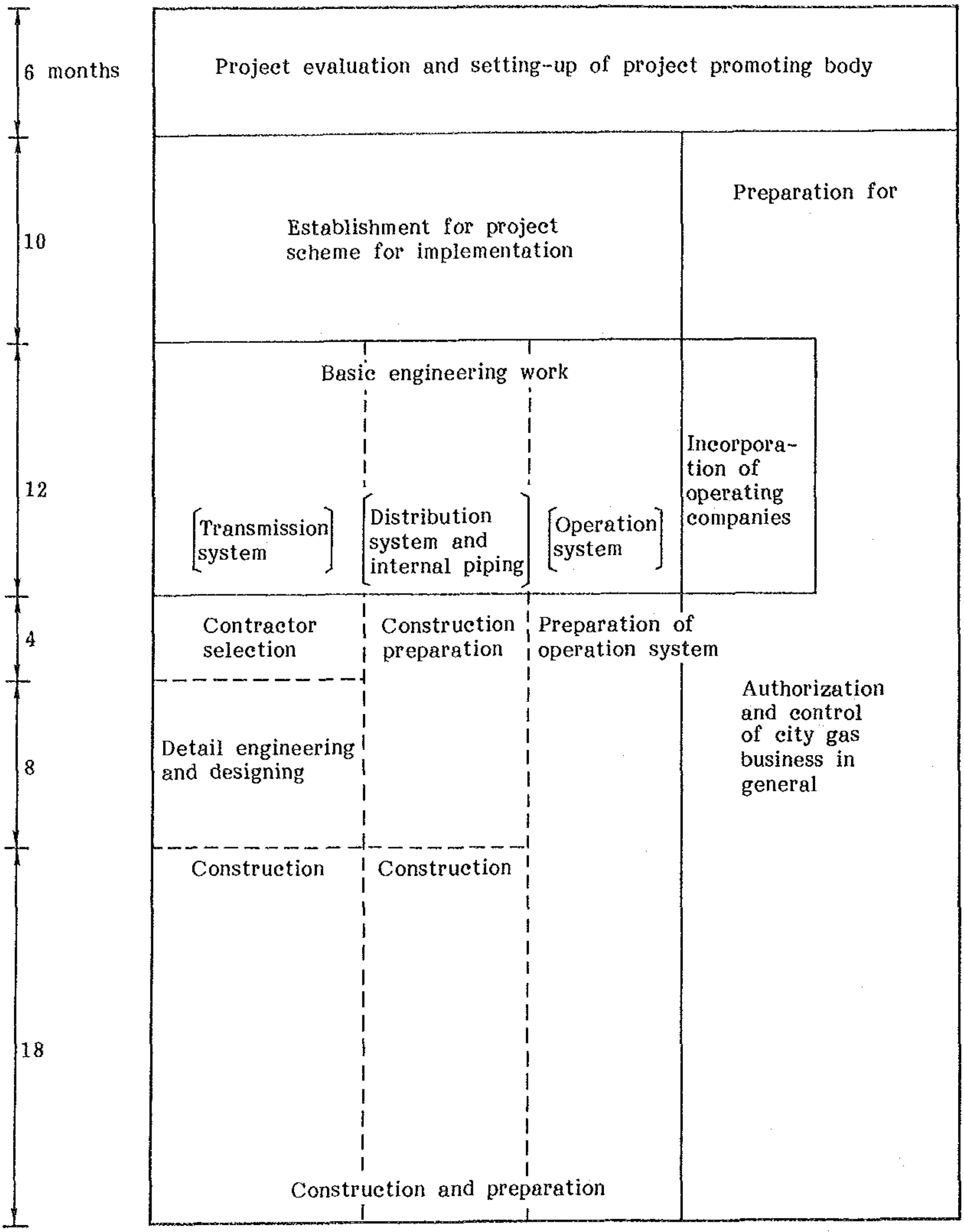


Fig. IV.2 ACTUAL CONSTRUCTION SCHEDULE (for Base Case)

T: Construction of transmission system
D-1,2,3,4: Construction of distribution network for existing demand
d: Construction of distribution network for new demand

Year	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
1990					
1991	T				
1992	D-1/d	T			
1993	D-2/d	D-1/d	T		
1994	D-3/d	D-2/d	D-1/d	T	
1995	D-4/d	D-3/d	D-2/d	D-1/d	T
1996	d	D-4/d	D-3/d	D-2/d	D-1/d
1997	d	d	D-4/d	D-3/d	D-2/d
1998	d	d	d	D-4/d	D-3/d
1999	d	d	d	d	D-4/d
2000	d	d	d	d	d
2001	d	d	d	d	d
2002	d	d	d	d	d
2003	d	d	d	d	d
2004	d	d	d	d	d
2005	d	d	d	d	d

Note: The construction schedule for Medium and Low Cases will be 3 years behind this schedule.

PART V ESTIMATION OF CONSTRUCTION COST

PART 5 ESTIMATION OF CONSTRUCTION COST

Chapter 1 UNIT CONSTRUCTION COST

1.1 Adopted Unit Construction Cost

(1) Transmission Pipelines (US$/m)

Diameter	4"	6"	8"	10"	12"	14"	16"	20"	24"	30"
Unit cost	76.7	92.9	100.9	112.8	123.9	145.7	156.9	208.9	232.4	314.2

(2) Distribution Pipelines (US$/m)

Material/Diameter	Polyethylene pipe			Steel pipe				
	2"	3"	4"	2"	3"	4"	6"	8"
Unit cost for existing area	36.0	39.2	42.3	38.4	42.3	46.0	54.1	72.1
Unit cost for new development area	12.3	20.4	23.5	19.6	24.2	27.3	54.1	72.1

(3) Regulators and Valves (US$/Unit)

a. Regulator station

Av. diameter of pipeline	8"	12"	16"
Unit cost	184,000	264,000	346,000

b. Valve on transmission pipeline (US$/Unit)

Position	Before district regulator	At branch point		
Diameter	——	8"	12"	16"
Unit cost	2,880	6,005	8,600	11,300

c. District regulator 12,400 US$/unit

(4) LPG Vaporizing Facility (US$/Unit)

Permanent facility (3,000 consumers)	71,700
Temporary facility (2,000 consumers)	25,000

(5) Service Pipes (US$/Customer)

	Households	Restaurants	Factories and hotels
Unit cost for existing area	47.5	60.8	90.4
Unit cost for new development area	9.4	22.6	52.3

(6) Installation Piping, Gas Meter and Customer Regulator Cost (US$/Customer)

	Households	Restaurants	Hotels and factories	Factories (oil replacing)
Installation piping	78.8	111.5	3,011.3	4,898.1
Gas meter and regulator	45.5	118.1	8,603.8	12,943.4

(7) Conversion Cost (US$/Customer)

Households	Restaurants	Hotels	Factories	
			LPG replacing	Oil replacing
7.9	35.4	603.8	747.2	33,962.3

1.2 Bases for Unit Construction Cost Calculation

(1) Transmission and Supply Pipelines

a. Piping Materials Cost (US$/m)

Pipe \ Diameter	2"	3"	4"	6"	8"	10"	12"	14"	16"	20"	24"	30"
Steel pipe for transmission pipeline (MPA)			16.4	28.9	34.1	42.8	50.9	55.8	64.1	80.3	96.6	120.4
Steel pipe for transmission and distribution pipeline (MPB)	4.2	8.3	11.2	14.9								
Polyethylene pipe (PE)	2.7	5.7	8.4									

Note: The above data are based on a survey in Malaysia.

b. General Construction Cost

The following construction unit force organizations and work efficiencies were assumed, to which the wages and vehicle/ equipment rental rates obtained in Malaysia were applied to find the basic construction cost.

Construction Unit Make-up 1 (Labor)

	Piping			Paving	Labor cost M$/month
	MPA	MPB	PE		
Supervisor	1	1	1	1	2,500
Plumber	1	1	2		1,500
Operator	2	2	2	2	1,500
Welder	4	2			2,000
Laborer	5	5	5	4	1,000
Guard	2	2	2	2	750
Total	15	13	12	9	

Construction Unit Make-up 2 (Vehicle & Equipment)

	Piping		Paving	Rental US$/month
	MPA	MPB/PE		
Backhoe	1	1		5,000
Dump Truck	3	3	2	3,500
Bulldozer	1			7,000
Truck Crane	2	1		7,000
Factory Car	3	2	1	1,500
Welder	3			3,000
Asphalt Finisher			1	6,000
Road Roller			1	4,000
Total	13	7	5	

Work Efficiencies (m/day)

	MPA	MPB/PE	
		Existing area	New development area
Piping Cost	50	50	80
Reinstatement Cost	120	150	-

Note: No reinstatement cost was assumed for new development areas.

The following material cost was added to the basic construction cost.

Cost of Materials Other than Pipes (M$/m)

	MPA	MPB	PE
Paving Materials	40.4	25.3	20.2
Miscellaneous Materials*	10.0	7.5	5.0

*Sheet piles and sandbags, etc.

10% of the total of the above cost was added as sundry expenses.

c. Speciality Work Cost (US$/m)

	MPA	MPB	PE
River crossing and Other Special Work	15.47	1.51	1.51
Cathodic Protection	0.68	0.68	-

Note: 1) River crossing cost was estimated as US$2,260 (6") and US$3,770 (12") per location.

2) Cathodic protection is estimated based on magnesium anode installation at 200 m intervals.

(2) Others

a. LPG Storage and Supply (For reticulation system)

The permanent facility was based on two (2) 10 ton storage tanks and the temporary facility was based on a concentrated cylinder system.

b. Service Pipes

Piping work cost was included in the distribution pipeline and only the materials cost and reinstatement cost were appropriated. Further, no reinstatement work was assumed for new development areas.

c. Gas Meters, Regulators and Internal Piping Cost and Conversion Cost of Existing Customers

Estimations were made by establishing standard models for households, restaurants, hotels and factories separately.

Chapter 2 APPLICATION OF UNIT CONSTRUCTION COST TO CONCEPTIONAL DESIGN

2.1 Transmission System

(1) Regulator station

The unit price of 1.1 (3) was applied to the three designed regulator stations. In doing so, the average diameter of the transmission pipeline in each case of forecast was as follows:

Case of forecast	Industry High (Additional)	Maximum (Additional)	All other cases
Average diameter	12"	16"	8"

(2) Main transmission pipeline

Yearly construction cost of transmission pipelines was calculated by multiplying the transmission pipeline construction length of each year of each diameter by the unit price of the corresponding diameter pipe as shown in 1.1 (1).
The costs to install valves at branch points, which amounted to 48 for Route 1 and 49 for Route 2, were also calculated and added to the pipeline cost. The unit cost was picked up from 1.1 (3) based on the same average diameter of pipeline mentioned in the above.

(3) Auxiliary transmission pipeline

The unit price for 6", shown in 1.1 (2), was applied to the design linear length of 50 km.

(4) District regulator

The unit prices of the district regulator and the valve on upstream of regulator as described in 1.1 (3) were applied to the 100 designed regulators. The land area required for each regula tor was assumed to be 4 m x 6 m.

2.2 Distribution pipelines

The construction cost of the distribution pipelines necessary to meet the city gas demand was established for each type of demand as shown in the table below. These were calculated on the basis of the following investigation results.

(1) The actual design of the distribution pipelines for model design areas shown in Table III.4.

(2) The construction unit prices of the distribution pipelines described hereinbefore in 1.1 (2).

(3) The demand distribution pattern in each zone as clarified by the field survey.

The construction cost depends upon type of demand and areal division and also depends upon whether the demand had existed before or newly occurred after the city gas introduction.

Use of city gas	Type of zone	Existing demand	New demand	Unit
Household	High density	385.7		US$/unit
	Medium density	233.3	91.7	
	Low density	175.0		
Restaurant	Commercial	36.0	22.3	US$/seat
	Non-commercial	0	0	
Hotel	—	3.90	2.57	US$/Room
Factory	—	15.16	12.11	US$/$10^3$ Nm^3/year
Building cooling	—	—	10.40	US$/$m^2$-floor area
CNG	—	0	0	—

Note: The type of zones are shown in Table V.1.

2.3 Customer Related Facility

The construction costs of the customer related facility necessary to secure city gas demand were calculated for each type of demand based on the construction unit prices described in 1.1 (5), (6) and (7) above as shown in the table in the next page. The customer related facility includes the followings:

a. Service pipe installation cost
b. Gas meter and house regulator
c. Internal pipe installation cost
d. Appliances adjustment cost

Use of city gas	Unit		Service pipe	Gas meter/ house regulator	Internal piping	Appliance adjustment	Total
Household	US$/Unit	Exs.	14.264	45.472	78.792	7.925	146.453
		New	1.887	45.472	78.792	0	126.151
Restaurant	US$/Seat	Exs.	1.121	3.225	4.475	0.635	9.456
		New	0.260	3.225	4.475	0	7.960
Hotel	US$/Room	Exs.	0.301	28.679	10.038	2.013	41.031
		New	0.174	28.679	0	0	28.853
Factory <Replacing LPG>	US$/$10^3$ Nm^3/Y	Exs.	0.904	86.037	30.113	7.472	124.526
		New	0.523	86.037	0	0	86.560
Factory <Replacing oil>	US$/$10^3$ Nm^3/Y	Exs.	0.060	8.629	3.265	22.642	34.596
		New	0.035	8.629	0	0	8.664

Note: (Exs.) For demand existing at city gas introduction

(New) For demand to appear after city gas introduction

2.4 Facilities for Reticulation System

(1) LPG storage and supply facilities

The following construction costs were calculated on the basis of the unit prices described in 1.1 (4):

US$/Unit of Housing

Permanent reticulation system	Temporary reticulation system
23.9	12.5

(2) Other facilities

Of the distribution pipeline construction cost and the customer related facility construction cost for city gas distribution system, those construction costs that relate to new demands were used without modification.

Chapter 3 RESULT OF CONSTRUCTION COST CALCULATION

The calculated construction costs will be shown in the tables listed below.

Total construction cost for Base, Medium and Low Cases	Table V.2
Construction cost by year for Base, Medium and Low Cases	Table V.3 - V.6
Construction cost for additional demands	Table V.7 and V.8

Table V.1 TYPE OF ZONES FOR CALCULATING DISTRIBUTION PIPELINE CONSTRUCTION COST

A: High density zone C: Low density zone

B: Medium density zone R: Commercial zone

Zone No.	Zone type		Zone No.	Zone type		Zone No.	Zone type		Zone No.	Zone type		Zone No.	Zone type		Zone No.	Zone type	
1	B	R	24	B		47	A	R	68	B		90	B		113	B	R
2	B	R	25	C		48	C		69	C		91	B		114	B	
3	B	R	26	A		49	B		70	A		92	B				
4	B	R	27	C		50	B		71	B		93	B		115	A	
5	B	R	28	C		51	B	R	72*	B		94	C		116	A	
6	B	R	29	C					73*	B		95	B		117	A	
7	B	R	30	B		52*	B		74*	B		96	B		118	A	
8	B		31	A		53*	B	R	75*	B		97	C	R	119	A	
9	A	R	32	C		54*	B					98	C		120	B	
10	B		33	C		55*	B		76	B	R	99	B	R	121	B	
11	A		34	C		56	B		77	B		100	B		122	B	
12	B		35	C		57	B		78	B		101	C		123	B	R
13	A	R	36	C		58*	B		79	B		102	C		124	A	
14	A	R	37	C		59	B		80	B	R	103	C		125	B	
15	C		38	B		60	B		81	B	R	104	C	R	126*	B	
16	B		39	B		61	B		82	B		105*	B		127*	B	
17	C		40	B		62*	B		83	B	R	106	B		128*	B	
18	B	R	41	C		63	B		84	B		107	B		129	B	
19	B		42	C		64	C		85	B		108	B		130	B	
20	C		43	C					86	B		109	C		131	B	R
21	C		44	C		65	C		87	B		110*	B		132	B	R
22	C		45	B		66*	B		88	B		111	B		133	B	R
23	A	R	46	A	R	67	C		89	B		112	B				

Table V.2 TOTAL CONSTRUCTION COST WITHOUT CONTINGENCY, 1990 - 2005

- US$ 1,000 -

		Base Case		Medium Case	Low Case
	<u>City Gas System</u>				
1.	*Transmission System	31,308	(31,315)**	31,111	30,885
2.	Distribution System	148,339	(146,585)	155,225	154,622
3.	Service Pipe	8,441	(8,382)	9,286	9,237
4.	Gas meter	43,716	(43,006)	42,410	41,331
5.	Internal Piping (Installation Piping)	69,347	(68,067)	67,966	67,640
6.	Appliance Conversion	4,582	(4,679)	5,234	5,196
7.	Subtotal	305,733	(302,032)	311,232	308,911
	<u>Reticulation System</u>				
8.	Storage Facility (Production Facility)	750	(929)	855	855
9.	Distribution System	4,446	(5,762)	5,157	5,132
10.	Customer Related Facilities	5,741	(7,604)	6,813	6,803
11.	Subtotal	10,937	(14,295)	12,826	12,790
	Integrated Gas <u>Distribution System</u>				
12.	Total	316,670	(316,326)	324,058	321,702

Note * The same numbers are used in Table V.2 through V.4 for indicating column elements

** Figures in parentheses are for Base Case/Route 2

Table V.3 CONSTRUCTION COST (BASE CASE)

CONSTRUCTION COST BASE

NO.		1	2	3	4	5	6	7	8	9	10	11	12
1	Y1990	0	0	0	0	0	0	0	0	0	0	0	0
2	Y1991	8340	0	0	0	0	0	8340	0	0	0	0	8340
3	Y1992	6094	12337	701	2866	4263	416	26677	169	1265	1793	3227	29904
4	Y1993	7159	29898	1962	7177	11915	1163	59272	62	479	665	1207	60479
5	Y1994	5607	32799	2132	7983	13045	1212	62779	38	300	414	752	63531
6	Y1995	4108	24069	1435	5694	9332	818	45455	24	201	272	497	45953
7	Y1996	0	16424	1025	4772	7554	608	30383	31	163	181	375	30758
8	Y1997	0	9655	516	2991	4786	252	18200	45	221	259	525	18725
9	Y1998	0	4773	207	2012	3132	81	10205	46	221	261	528	10733
10	Y1999	0	3589	122	1747	2682	33	8172	45	220	259	524	8696
11	Y2000	0	2756	63	1558	2357	0	6734	46	222	262	530	7264
12	Y2001	0	2322	54	1343	1982	0	5701	49	231	275	555	6256
13	Y2002	0	2319	54	1338	1978	0	5689	49	230	275	553	6242
14	Y2003	0	2259	53	1310	1932	0	5554	48	230	273	551	6105
15	Y2004	0	2813	64	1586	2403	0	6866	49	231	275	555	7422
16	Y2005	0	2326	54	1341	1985	0	5706	49	231	275	555	6262
17	TOTAL	31308	148339	8441	43716	69347	4582	305733	750	4446	5741	10937	316670

COLUMN ELEMENT LABELS

1	CITY GAS	TRANSMISSION
2	(1,000 US$)	DISTRIBUTION
3		SERVICE PIPE
4		GAS METER
5		INSTALLATION
6		CONVERSION
7		SUB-TOTAL
8	RETICULATION	PRODUCTION
9	(1,000 US$)	DISTRIBUTION
10		CUSTOMER
11		SUB-TOTAL
12	TOTAL	

Table V.4 CONSTRUCTION COST (BASE ROUTE 2 CASE)

CONSTRUCTION COST ROUTE2

NO.		1	2	3	4	5	6	7	8	9	10	11	12
1	Y1990	0	0	0	0	0	0	0	0	0	0	0	0
2	Y1991	7986	0	0	0	0	0	7986	0	0	0	0	7986
3	Y1992	5608	13188	769	3141	4683	456	27845	169	1265	1793	3227	31073
4	Y1993	6624	30504	1826	6705	10689	1055	57402	146	1092	1539	2777	60179
5	Y1994	5502	27227	1714	6162	10195	968	51768	128	964	1350	2443	54211
6	Y1995	5595	20680	1346	5358	8861	926	42766	30	238	325	593	43359
7	Y1996	0	20030	1308	5672	9108	779	36897	31	163	181	375	37272
8	Y1997	0	10167	618	3320	5367	309	19781	45	221	259	525	20306
9	Y1998	0	6321	330	2402	3805	149	13006	46	221	261	528	13534
10	Y1999	0	3672	129	1770	2722	37	8330	45	220	259	524	8854
11	Y2000	0	2756	63	1558	2357	0	6734	46	222	262	530	7264
12	Y2001	0	2322	54	1343	1982	0	5701	49	231	275	555	6256
13	Y2002	0	2319	54	1338	1978	0	5689	49	230	275	553	6242
14	Y2003	0	2259	53	1310	1932	0	5554	48	230	273	551	6105
15	Y2004	0	2813	64	1586	2403	0	6866	49	231	275	555	7422
16	Y2005	0	2326	54	1341	1985	0	5706	49	231	275	555	6262
17	TOTAL	31315	146583	8382	43006	68067	4679	302032	929	5762	7604	14295	316326

COLUMN ELEMENT LABELS

1	CITY GAS	TRANSMISSION
2	(1,000 US$)	DISTRIBUTION
3		SERVICE PIPE
4		GAS METER
5		INSTALLATION
6		CONVERSION
7		SUB-TOTAL
8	RETICULATION	PRODUCTION
9	(1,000 US$)	DISTRIBUTION
10		CUSTOMER
11		SUB-TOTAL
12	TOTAL	

Table V.5 CONSTRUCTION COST (MEDIUM CASE)

CONSTRUCTION COST MEDIUM

NO.		1	2	3	4	5	6	7	8	9	10	11	12
1	Y1990	0	0	0	0	0	0	0	0	0	0	0	0
2	Y1991	0	0	0	0	0	0	0	0	0	0	0	0
3	Y1992	0	0	0	0	0	0	0	0	0	0	0	0
4	Y1993	0	0	0	0	0	0	0	0	0	0	0	0
5	Y1994	8340	0	0	0	0	0	8340	0	0	0	0	8340
6	Y1995	5947	13812	790	3165	4750	466	28930	170	1272	1803	3245	32176
7	Y1996	7042	33695	2237	7975	13252	1319	65522	145	998	1372	2515	68036
8	Y1997	5674	36464	2383	8850	14460	1369	69200	115	728	990	1833	71033
9	Y1998	4108	26576	1590	6314	10313	923	49824	92	563	753	1408	51233
10	Y1999	0	18095	1145	5194	8257	711	33403	45	220	259	524	33927
11	Y2000	0	11020	610	3269	5290	305	20493	46	222	262	530	21023
12	Y2001	0	4767	229	1882	2928	98	9904	49	231	275	555	10459
13	Y2002	0	3404	131	1568	2395	43	7541	49	230	275	553	8095
14	Y2003	0	2257	52	1296	1932	0	5537	48	230	273	551	6088
15	Y2004	0	2811	64	1571	2403	0	6849	49	231	275	555	7404
16	Y2005	0	2324	54	1326	1985	0	5689	49	231	275	555	6244
17	TOTAL	31111	155225	9286	42410	67966	5234	311232	855	5157	6813	12826	324058

COLUMN ELEMENT LABELS

1	CITY GAS	TRANSMISSION
2	(1,000 US$)	DISTRIBUTION
3		SERVICE PIPE
4		GAS METER
5		INSTALLATION
6		CONVERSION
7		SUB-TOTAL
8	RETICULATION	PRODUCTION
9	(1,000 US$)	DISTRIBUTION
10		CUSTOMER
11		SUB-TOTAL
12	TOTAL	

Table V.6 CONSTRUCTION COST (LOW CASE)

CONSTRUCTION COST LOW

NO.		1	2	3	4	5	6	7	8	9	10	11	12
1	Y1990	0	0	0	0	0	0	0	0	0	0	0	0
2	Y1991	0	0	0	0	0	0	0	0	0	0	0	0
3	Y1992	0	0	0	0	0	0	0	0	0	0	0	0
4	Y1993	0	0	0	0	0	0	0	0	0	0	0	0
5	Y1994	8340	0	0	0	0	0	8340	0	0	0	0	8340
6	Y1995	5908	13753	785	3074	4713	459	28693	170	1274	1808	3252	31945
7	Y1996	7066	33630	2228	7879	13203	1312	65318	145	997	1370	2512	67831
8	Y1997	5560	36360	2373	8741	14411	1361	68807	115	727	989	1830	70637
9	Y1998	4011	26470	1582	6202	10268	917	49450	92	562	752	1406	50856
10	Y1999	0	18037	1139	5050	8217	704	33147	45	218	259	522	33670
11	Y2000	0	10966	606	3181	5271	303	20328	46	221	261	528	20856
12	Y2001	0	4736	227	1794	2910	97	9764	49	227	274	549	10313
13	Y2002	0	3368	129	1477	2375	43	7392	49	227	273	549	7940
14	Y2003	0	2234	51	1212	1918	0	5416	48	225	271	545	5960
15	Y2004	0	2779	62	1481	2385	0	6707	49	227	273	549	7256
16	Y2005	0	2289	52	1239	1969	0	5549	49	227	274	549	6098
17	TOTAL	30885	154622	9237	41331	67640	5196	308911	855	5132	6803	12790	321702

COLUMN ELEMENT LABELS

1	CITY GAS	TRANSMISSION
2	(1,000 US$)	DISTRIBUTION
3		SERVICE PIPE
4		GAS METER
5		INSTALLATION
6		CONVERSION
7		SUB-TOTAL
8	RETICULATION	PRODUCTION
9	(1,000 US$)	DISTRIBUTION
10		CUSTOMER
11		SUB-TOTAL
12	TOTAL	

Table V.7 CONSTRUCTION COST FOR ADDITIONAL DEMANDS 1990 - 2005 TOTAL

- US$ 1,000 -

	Oil Replacement in Industry		Building Cooling		Auto-mobile	Maximum Case
	High Case	Low Case	High Case	Low Case	CNG	I+III+V
	I	II	III	IV	V	VI
Transmission System	7,303	4,244	3,048	1,298	3,701	13,239
Distribution System	6,706	3,354	47,708	20,949	-	54,414
Service Pipe	22	13	-	-	-	22
Gas Meter	4,385	2,192	-	-	-	4,385
Internal Piping (Installation Piping)	593	296	-	-	-	593
Appliance Conversion	4,106	2,052	-	-	-	4,106
Total	23,115	12,151	50,756	22,247	3,701	76,759

Table V.8 CONSTRUCTION COST FOR ADDITIONAL DEMAND BY YEAR

ADDITIONAL COST (1000US$)

NO.		1	2	3	4	5	6
1	Y1990	0	0	0	0	0	0
2	Y1991	2459	1531	813	443	1357	4869
3	Y1992	4740	2461	585	140	616	5748
4	Y1993	3616	1942	1045	460	1155	5337
5	Y1994	2631	1370	438	156	380	3277
6	Y1995	2065	1043	167	99	193	2214
7	Y1996	2347	1174	4762	381	0	7109
8	Y1997	593	297	4851	776	0	5444
9	Y1998	579	290	4762	1143	0	5341
10	Y1999	579	290	4792	1533	0	5371
11	Y2000	586	293	4688	1875	0	5274
12	Y2001	590	295	4939	2371	0	5530
13	Y2002	581	290	4718	2642	0	5299
14	Y2003	578	289	4703	3010	0	5281
15	Y2004	592	296	4703	3386	0	5294
16	Y2005	579	290	4792	3833	0	5371
17	TOTAL	23115	12151	50756	22247	3701	76759

COLUMN ELEMENT LABELS
1 INDUSTRY HIGH
2 INDUSTRY LOW
3 COOLING HIGH
4 COOLING LOW
5 C.N.G.
6 TOTAL MAXIMUM

PART VI FINANCIAL ANALYSIS AND ECONOMIC EVALUATION

PART VI FINANCIAL ANALYSIS AND ECONOMIC EVALUATION

Chapter 1 FINANCIAL ANALYSIS

1.1 Outline of the Project Scheme

1.1.1 Nature of the Incorporation

For purpose of the study, the enterprise being established as a business entity with major commercial activities of "supply and sale of fuel gas through pipelines" ("the Company"), is tentatively outlined as follows:

(1) The Company is to be granted an exclusive right to supply city gas through pipeline to the consumers existing within the Klang Valley Area ("franchise"). Provided, however, that, facilitating the financial evaluation of this investment project, all of LPG central supply systems (i.e. "LPG reticulations") which are existing and being constructed before start of construction are to be excluded from the project scheme. Although they are most probably integrated into the consolidated gas supply system in the future.

(2) The Company is newly organized and registered as a not subscribed private company under the Company Law of Malaysia (i.e. Sendirian Berhad) of which shared capital is fully owned by PETRONAS SDN. BHD. and/or its subsidiaries as base. The possibility of other organization will be discussed separately.

1.1.2 Management and Organization

For the base case, due to the nature of the Company, managerial systems and relevant organizational structure is designed in accordance with the PETRONAS' current practice in principle. Newly established organizational structure is shown in Figures VI.1 and VI.2.

A schedule of manpower is shown in Tables VI.1 and VI.2.

Number of GRADE IV & V staffs employed for this project is estimated by the formula as shown in Tables VI.3 and VI.4 on the assumption that the business operation is undertaken in an effective and rational manner.

1.1.3 Project Alternative

The study team has compared the alternative construction schedules of trans-pipeline in the area of F.T of K.L.

One is circular case in which pipeline will be installed from the outside of F.T of K.L, however, another is center case in which pipeline will be installed from the center of F.T of K.L.

The results calculated for both cases are almost same as mentioned below, therefore, circular case is taken for the study.

	IRR (%)	
	Before Tax	After Tax
Circular Case	11.19	9.11
Center Case	11.07	9.04

To meet the different economic growth rate, the following three (3) cases are studied.

(%)

	to 1990	1991 onwards
Base case	5	5
Medium case	3	5
Low case	1	3

And the demand and construction cost for the additional demand undermentioned are estimated for base case.

- Replacement of diesel and fuel oil in manufacturing industry (High and low cases)

- Adoption of gas cooling system to the building which will be built newly after installation of city gas system (High and low cases)

- To supply city gas to CNG

1.1.4 Project Investment Segments

For convenience of the study, the project scheme which consists of various investment segments for the period from the start of construction through 2005 is divided into undermentioned project packages.

	Base case	Medium & Low case
Phase I	1990 - 1995	1993 - 1998
Phase II	1996 - 2000	1999 - 2005
Phase III	2001 - 2005	

1.1.5 Project Implementation Schedule

Project implementation schedule timely determined principally in accordance with the growing gas demand in each zone. In other words, when forecast gas demand of certain zone would reach at certain dense-level, such zone will be taken to implement. Provided, however, that the final investment schedule should be completed at the end of 2005, other potential zones of which demand would not reach at qualified level at the end of 2005 is not be considered for financial analysis.