1.2 Estimation of the Total Capital Requirement

1.2.1 Major Assumptions Employed for the Estimation

(1) Currency and exchange Rates

For the purpose of this study, U.S. Dollar is used as the standard currency, and all other currencies are to be converted into U.S. Dollar by the following fixed exchange rates.

One U.S. Dollar = 2.65 Malaysian Ringgit
167 Japanese Yen

(2) Price escalation factors

In order to assess financial viability of the project in current term and to estimate project construction budget, the following escalation rates are assessed at the meeting in October 1986.

ESCALATION FACTOR

(%)

	- 1990	1991 onwards
For Local Portion	1.4	3.5
For Foreign Portion	3.2	5.0
For Crude Oil (GPS)	5.0	5.0

The above escalation factor to 1990 for local portion is the average figure during 5 years and 1% in 1986 and 2.1% in 1990 are estimated. For the foreign portion, 3.2% is assumed as figure in 1990. The following table shows the assumption of inflation rate during 5 years.

	Local	Foreign (%)
1986	1.0	1.0
1987	1.1	1.3
1988	1.3	1.8
1989	1.5	2.4
1990	2.1	3.2

(3) Base date for base cost estimate

The end of June, 1986 (i.e. 30 June, 1986) is assumed to be the base date for all cost estimation and projection, therefore all costs and price information obtained through field survey are adjusted and expressed as of 30 June, 1986 basis (called "Base Costs"), and they are escalated each assumed disbursement time using escalation rates specified in paragraph 1.2.1 (2) hereabove. The estimated incremental amounts by such escalation are called "price contingency".

In case the project implementation is caused to be changed, the estimated project cost could be re-adjusted in the same manner.

(4) Physical contingency

Physical contingency which represents extraordinary budget to cover unforeseen costs which may arise due to inability to clarify in time of estimation, such as:

1) pipeline route conditions (e.g. subsurface conditions, physical/topographic/social/legal and environmental restrictions and other site conditions)
2) degree of precision of estimation
3) other design conditions

This time, physical contingency is estimated to be twenty percent (20%) of the construction cost.

(5) Type of contract for project implementation

According to the popular practice in Malaysia on new project development, fixed lump-sum price contract is considered to be applied for this project.

(6) Taxes and duties

Taxes and duties examined in this study are mentioned in Table VI.5. The points which are to be given attention for them are as follows.

1) Import duties

According to the tax rates given in Tariff code, import duties on imported equipment and material are levied by ad-valorem percent on CIF value or by unit amount per volume, and those tariff rates are different depending on the items.

Further, surtax and sales tax on such items are levied. In this study, average taxes and duties on imported equipment and materials are assumed to be levied by five percent (5%). These amounts are included in the construction cost.

2) Corporate income tax

Corporate tax income is assumed to be imposed at a rate of forty percent (40%) of taxable income without tax holiday and initial and annual capital allowance.

3) Excise tax

Excise tax on petroleum products such as fuel oil and LPG is levied by unit amount per volume.

1.2.2 Estimation of the Total Capital Requirement

In addition to the construction cost estimates in the preceding PART V hereabove, other costs and expenses constituting the total capital requirement are estimated.

(1) Base cost estimate

Base cost estimate (B.C.E.) which is estimated on the basis of "base date" consist of following cost items.

1) Land acquisition cost
2) Site preparation cost
3) Construction cost of gas distribution system
4) Pre-operational expenses

Other two cost items as follows required for the project are estimated on expected disbursement time basis including price contingency.

5) Initial working capital
6) Interest during construction

Specific assumptions on estimation of above costs are as follows.

(2) Land acquisition cost

Costs for acquisition of land are for a town regulator is included in this cost item.

1) Land area:	24 m^2/station x 100 station
2) Land acquisition cost:	192,000 US$
3) Physical contingency:	2) x 20%
4) Base cost estimate:	US$ 230,400

(3) Site preparation cost

This cost is included in the land acquisition cost.

(4) Construction cost of city gas system

The base costs for construction cost of city gas system is estimated in Part V.

In addition to the above, the following items are estimated.

- Cost of engineering service consisting of basic engineering and contractor's engineering is estimated as follows. Basic engineering fee is estimated as 10% of construction cost of Phase I and contractor's engineering fee is estimated as 6% of construction cost of each year.

- Computer and data processing costs

The computer and data processing cost including its software is estimated based on the current information obtained by other ASEAN project in order to facilitate to operate with city gas distribution system.

The cost item is assumed as follows:

1) Computer and data processing : US$1,077,600
   - Central processor including reader, printer (1 unit) : US$898,000
   - Terminal station (30 unit) : US$179,600

2) Software : US$718,400
   The software is made a use of the following business.
   - Operation
   - Administrative
   - Procurement
   - Maintenance
   - Billing

(5) Pre-operational expenses

The pre-operational expenses includes costs and expenses required for the owner's direct undertakings throughout the project implementation stage, such as:

- Project promotion and planning expenses
- Administrative overhead including office supplies
- Technical advisory fees and expenses
- Training fees and expenses
- Loss in test run
- Institutional fees and expenses
- Physical contingencies
- Taxes and levies

Although the nature of entity of city gas supply company is an independent subsidiary under PETRONAS, and thus initial organization to promote the project may not be necessarily new and independent organization. For budgeting purpose the feasibility study hereof, the pre-operational expenses will be estimated on the basis of completely new and independent organization.

1) Project promotion and planning expenses

This cost items consist mainly employees salary costs and other personnel costs including subcontracting cost incurred mainly in the initial investment stage.

2) Administrative overhead including office supplies

This cost item includes rental fee of office space, office supplies, costs and expenses for overhead personnel, etc.

3) Technical advisory fees and expenses

This cost item includes fees and expenses for professional task force including foreign consultants, legal experts, CPA, etc. who will be employed temporarily to assist the owner during implementation of the project. They will be organized in the owner's project team supplementing his own activities.

4) Training fees and expenses

This expenses is required for training of the owner's engineers and operators who are required for operation of the city gas distribution system in the initial stage. The training program will be provided by experienced consultants. The trai ing at similar system in abroad is included in this cost item, although on-the-trainning at construction site is included in the construction cost.

5) Loss in test operation

This costs cover loss and initial stock of gas in the pipeline system, utilities and relevant consumables such as innert gas for purging, spare parts for replacement, etc. required during the test operation. The innert gas is included in construction cost.

In the time of commissioning of the completed project, initial natural gas (or LPG in reticulation case) is charged and filled up all pipeline network. Such initial gas stock in the pipeline, however, is not deemed as inventory but loss in test run due to its "unrecoverable" nature. So the initial stock of gas is included in this cost item.

6) Institutional expenses

This expenses covers fees and expenses for formalities, permits, license, registration, etc. including legal transactions.

7) Physical contingencies

In order to secure the extraordinary costs and expenses exceeding the estimated amount hereabove which may arise due to unforeseen cause and degree of precision of the estimation hereof, ten percent (10%) of the above estimated amount is budgeted as a contingency.

8) Taxes and levies

This cost items consists taxes and levies other than those estimated in the other cost items.

The following pre-operational expenses are included in this cost item;

- Equivalent to 6 months of the labor cost including administrative overhead

- Training fees in abroad:
  $4.491/person - 2 weeks x 12 person

- Gas stock and dead gas in test operation
  $70.93/1000 m^3 x 96.8(1000 m^3)

- Physical contingencies: 10% of above item

(6) Initial working capital

Initial working capital is estimated on the following items.

- Material inventory in LPG storage (10 days equivalent)
- Account receivable minus account payable
  (i.e. 30 days equivalent of sales revenue
  30 days equivalent of variable cost)

As progressing, the investment which will be successively accumulated throughout 2005, working capital requirement will be increased. Whilst, if certain LPG reticulation system which had been constructed ahead of natural gas system extension to the area would be converted to natural gas system, LPG inventory will be released, and total working capital requirement will be decreased accordingly. The working capital assumed to be capitalized.

(7) Interest during construction

Interest during construction is calculated on the debt portion of disbursed capital expenditure in each year for the period from such disbursement time through end of the preceding year of the repayment's due (at year end). Debt portion of each disbursement is assumed to be seventy percent (70%) as base. The capital disbursement schedule for interest calculation is prepared as base cost estimates plus price contingency through such expected disbursement time. Annual interest rate is taken to be five percent (5%).

(8) Estimated total project cost

Table VI.6 shows total project cost including price contingency.

1.3 Project Operation Plan

1.3.1 Financing Plan

The total capital requirement as estimated in the paragraph 1.2 hereof is assumed to be financed as per the following conditions.

(1) Debt-equity ratio

The debt-equity ratio on total project cost is 70 : 30 as base. The effect of increase of equity ratio to 40% and 50% is studied. Disbursement of the required capital is assumed to be made from two sources according to the proportions of debt-equity ratio by long-term loan and paid-up capital respectively.

(2) Financing term on long-term loan

The source of the loans has not yet been determined, but for the purpose of this study it is assumed that the loan will be financed by foreign financing institution with financing terms as follows:

Interest rate	:	Five (5) percent per annum
Grace period	:	Seven (7) years
Loan repayment	:	Eighteen (18) times annual equal installments after grace period

The effect of increase of interest rate (as 10 percent per annum) on cash flow is analyzed.

According to the division of project, financing schedule is also divided. Financing schedule and repayment schedule of each phase are as follow:

FOR BASE CASE

Phase	Financing period	Grace period	Repayment period
I	1990 - 1995	1990 - 1996	1997 - 2014
II	1996 - 2000	1996 - 2002	2003 - 2020
III	2001 - 2005	2001 - 2007	2008 - 2025

FOR MEDIUM AND LOW CASE

Phase	Financing period	Grace period	Repayment period
I	1993 - 1998	1993 - 1999	2000 - 2017
II	1999 - 2005	1995 - 2005	2006 - 2023

(3) Financing terms on short-term loan

In the event that the cash shortage occurs during operation period, it is assumed that short-term loan from local financial institutions will be obtained and the annual interest rate for such loan will be thirteen percent (13%).

1.3.2 Project Operating Plan

(1) Management and organization

Management system and organization are planned, taking into account the NEB's system which is well practiced in the local environment, recommendations by PETRONAS and the consultants' experience based on the current practice by a similar enterprise in Japan.

Managerial responsibility within the organization is defined by means of a hierarchical structure shown in Figures VI.1 and VI.2. This hierarchical representation is of value only as an approximate representation of company organization, since various features not represented on such diagram usually complicated the organizational design and practice.

Newly established organization of Head Quarter consists of four divisions; planning division, administrative division, sales and service division, and construction division.

The scale of organization is designed to expand according to the increase in gas demand. Although the final picture on organizational structure is proposed in Figures VI.1 and VI.2, the organization in transition will be also taken into consideration.

Business operation is assumed to be made under two/three-shift continuous operation system. Annual operating days for design basis is 300 days per annum.

(2) Selling price of the gases

1) LPG

LPG selling price applied to the reticulation projects is to be the same level as retail price of cylindered LPG.

Domestic selling price in June, 1986: US$8.71/MMBTU

2) City Gas

The price of the city gas is, in principle, to be determined as "matching" or "competitive" basis against each of the predominant energies in each sector, which are to be substituted by the city gas; as follows:

Users' Sector	Substituted Energy
Household	LPG (cylinder), Kerosene, Electricity
Industry	LPG (bulk), Diesel oil, MFO
Commercial	LPG (cylinder, bulk), Electricity, Diesel Oil

Based on the crude oil price in the future which is assumed to be varied substantially due to demand-supply balance in the world market, FOB Singapore prices of such energies are forecasted as per Table I.77 (PART I). Further, considering the structure and mechanism of retail prices of petro-products in Malaysia, future prices of such energies which are replaced by the city gas are estimated as per Table VI.7.

(3) Purchase price of gases and cosumables

1) LPG price

The price of bulk LPG which is currently supplied by PETRONAS Dagangan to the reticulation system is applied as the base purchasing price of LPG for the project.

Purchasing price in June, 1986: US$5.80/MMBTU

Future price is mentioned in Table I.91(3).

2) Natural gas price

The natural gas will be supplied by PETRONAS GAS to the company at an anticipated point of the Trans Peninsular Pipeline.

The price of the natural gas is assumed to be the same level as a price of MFO, currently supplied to the domestic thermal power station (i.e. domestic MFO retail price minus duty). Future price is mentioned in Table I.91(1).

3) Consumables

The expenses for consumption of gasoline etc. is estimated to be one percent (1%) of the variable costs.

(4) Sales procedure of gases

Measuring of the consumed gas by clients are made monthly by reading gas flow meter installed at the clients' property area.

Upon reading the meter by the meter reading staff of the company, billable volume for the month is calculated by subtracting volume of the preceding month, and bill for the month is submitted to the client.

(5) LPG inventory

Existing LPG reticulation is operated with inventory of 20 days consumption, however, 10 days stock is assumed as a base for the study.

(6) Labour cost for employee

Direct labour cost including bonus of two months equivalent salary is assumed based on the current wage data obtained from PETRONAS.

Based on the PETRONAS' wage level, wage level (direct salary) of employees including management staff is assumed as follows:

Grade	Position	Gross Salary(M$)
I	General Manager, Deputy G.M	135,440
II	Manager, Executive	67,240
III	Superintend	25,284
IV	Skilled Worker, Clarical Worker	15,860
V	Unskilled Worker	11,872

Salary scales is designed on the basis of PETRONAS' practice and will be linked to job evaluation and merit rating within each grade. No retirement benefit and social security organization (SOCSO) are included in gross salary.

Total direct labour cost is assumed to be escalated at 3.5 percent per annum after 1990.

(7) Administrative overhead

Taking into account the current status of PETRONAS' subsidiaries, administrative overhead including following items is assumed to be twenty percent (20%) of the direct labour cost.

1) Office rental
2) Stationery and other office supplies
3) Trip and communication
4) Computer/printing/library
5) Overhead personnel

(8) Depreciation (capital allowance)

1) Initial and annual capital allowance

The Malaysian tax law allows for no depreciation nor amortization but it does allow initial and annual capital allowances to be deducted from gross earnings for the computation of taxable income.

Initial Capital Allowance

20% of the total capital cost (except working capital) is deductible in the years immediately subsequent to the expiration of the tax holiday period.

Annual Capital Allowance

7.5% of the total capital cost (except working capital) is deductible in the years immediately subsequent years to the expiration of the tax holiday period. In subsequent years the same rate is applied, but against the balance of the capital cost after the deduction of allowance applied in the preceeding years.

2) The construction cost (depreciable assets) is depreciated according to the following rule:

- Mode of depreciation	:	Straight line method
- Salvage value	:	zero
- Depreciated period		
Pipeline	:	25 years
Meter, instruments	:	12 years
Governor, regulator	:	12 years
Computer	:	6 years

(9) Amortization

Interest during construction and pre-operational expense are amortized for five years in equal amount.

(10) Maintenance cost

The annual cost of maintenance materials required after 2000 for base case and after 2003 for medium and low case is calculated as one percent (1.0%) of the construction cost.

This does not include the cost of subcontractors, since it is already included as part of labour cost.

(11) Local taxes and insurance

Equivalent to 0.1% of the book value of fixed capital is assumed to be required for local taxes such as real estate tax, vehicle tax and insurance premium against damage to the company's assets and third parties.

(12) Sales expenses

Sales expenses are not considered but are assumed to be included in labour cost and administrative overhead.

(13) Dividend

No dividend payment is considered in the initial study, and thus all of net profits are retained throughout the project life.

1.4 Financial Analysis

1.4.1 Major Assumptions on Financial Analysis

(1) Economic life span of the project

The economic life span of the project is assumed to be thirty-six (36) years (i.e. 1990 - 2025 for base case and 1993-2028 for medium and low cases) from the starting date of construction.

(2) Base cost for financial projections

All financial projections are made in U.S. dollars current term basis, and such projections are made according to relevant escalation rates specified in the paragraph 1.2.1(2).

(3) Methodology of financial analysis

Financial analysis is made mainly by means of various financial and operating ratio analysis and financial internal rate of return (FIRR) by discounted cash flow method.

(4) Pricing system

Financial projections and analysis are made on the following three pricing system.

a. Current price
b. Fixed (1986) price at June 1986
c. Fixed (1986) price at June 1986 adjusted by crude oil price estimation.

(5) Cut off rate

Cut off rate to be applied for financial net present value is assumed fifteen percent (15%).

1.4.2 Result of Financial Analysis

Based on the above mentioned conditions, the following results are obtained and are attached in the Annex as tables.

(1) Supply and sales plan
(2) Production cost statement
(3) Working capital statement
(4) Income statement
(5) Funds flow statement
(6) Balance sheet
(7) Long term debt repayment schedule

For making financial analysis, two major assumptions were used. One concerns the assumption of economic growth and the other is the price of natural gas which will be supplied to the city gas system and of city gas which will be sold.

As to economic growth, the growth rate estimated in the 5th Five Year Plan is taken as for the base case and in addition to the above, a medium case and a low case are taken into consideration due to the recent stagnation as follows.

	Annual GDP Growth Rate(%)		Starting Time of Construction	The period of Economic Analysis	Target Year
	to 1990	1991-			
Base Case	5	5	1990	2025	2005
Medium Case	3	5	1993	2028	2005
Low Case	1	3	1993	2028	2005

For the financial analysis, the demand after 2006 is estimated as the same as the demand in 2005 and the actual additional demand can be satisfied by the additional investment. The demand forecast, the required investment amount and financial analysis for each case are mentioned in Table VI.8.

The inflation rate for current price base analysis is assumed as follows at the suggestion of EPU.

		(%)
	to 1990	1991 onwards
Malaysia	1.4	3.5
Foreign	3.2	5.0

The wide drop of crude oil price in 1986 has had the result that fuel oil price is much lower than the estimated natural gas price at the west coast.

From the above reason, natural gas price for use as city gas is estimated as the same with the price of fuel oil for electric power generation.

On the other hand, the sales price of city gas is estimated as the same as the price of LPG in cylinders for households and restaurant and LPG bulk for hotel and manufacturing industries.

The above prices of fuel oil and LPG are calculated by addition of domestic handling charge to the FOB Singapore prices which are calculated based on the estimated crude oil price.

The crude oil price is estimated by using the low price scenario of crude oil given by EPU and the effect on the IRR of other scenarios is observed by sensitivity analysis.

Prices of crude oil, fuel oil, LPG and natural gas at the west coast of the Peninsula are mentioned in Table VI.9.

If the natural gas price is much lower than fuel oil, when the crude oil price increases higher than a certain level, diesel oil and fuel oil which are used in manufacturing will be replaced by city gas and if natural gas price is much lower than the electricity price, adoption of gas cooling system will increase in the newly-constructed buildings. And if CNG comes to be used as fuel for automobiles, the city gas system is used to supply CNG.

Natural gas price, which will be affected by crude oil price, was not given, therefore, financial analysis can not be made and the additional demand and investment only are mentioned in Table VI.10.

In 'this study, all construction cost is covered from the inlet at Trans Peninsula Pipeline to the facility at user.

(1) The evaluation of the project using the financial internal rate of return (FIRR) and financial net present value (FNPV).

1) The effect of the economic growth rate on FIRR is not so big as mentioned below. The reason for this is that the share of household demand in the total demand is big and household demand is strongly affected by population but not so heavily by the income of households.

Also the cost share of distribution pipeline and inhouse pipes (which greatly affect demand) in total construction cost, is big. pipes (which greatly affect demand) in total construction cost, is big.

FINANCIAL INTERNAL RATE OF RETURN

(%)

	Current Price Base		Fixed Price Base	
	Bfr.Tax	Aft.Tax	Bfr.Tax	Aft.Tax
Base Case	17.67	14.18	11.19	9.11
Medium Case	16.91	13.69	10.60	8.74
Low Case	15.67	12.76	9.52	7.96

FINANCIAL NET PRESENT VALUE AT 15% DISCOUNT

(US$ Million)

	Current Price Base		Fixed Price Base	
	Bfr.Tax	Aft.Tax	Bfr.Tax	Aft.Tax
Base Case	71.0	-19.1	-57.8	-81.4
Medium Case	60.3	-36.4	-70.2	-91.7
Low Case	20.3	-60.2	-85.2	-100.9

2) The effect of raw material cost and sales price of city gas on FIRR

The sensitivity analysis on FIRR with the cost of raw material and sales price as variables is shown in Figure VI.3 and Table VI.16.

As mentioned above, in this study, as raw material cost, fuel oil price is used and as sales price, LPG price is used, and fuel oil price and LPG price are estimated based on the crude oil price which is calculated based on the low price scenario given by EPU. In the case of the high price scenario, the crude oil price in 1995 is 1.2 times greater than the crude oil price based on the low scenario and 1.345 times in 2005 and 1.65 times in 2025. The difference of crude oil price between the low scenario and high scenario is increased as mentioned above.

Therefore, in the case of the high scenario, FIRR becomes higher than 13.95% on a fixed price bases and 18.67% as the current price which shows for 20% higher than the fuel oil price of low scenario. However, 18.67% is not so big in comparison with 17.67% of base because LPG price includes several expenses which have no relation with the crude oil price (Table VI.9)

If the price of fuel oil and LPG based on the low price scenario on a constant base are used instead of the prices in 1986, FIRR of fixed price base becomes 14.28% (before tax) and 11.35% (after tax) which are higher than the 11.19% and 9.11% of the base.

When natural gas price is calculated based on cost and is much lower than fuel oil price, the effect on FIRR becomes big. This effect can be seen from sensitivity analysis by natural gas price on FIRR.

If natural gas price becomes 20% lower than base, FIRR becomes to 11.99% as fixed price base and 20.15% as current price base.

As mentioned in Table VI.9, the natural gas estimated price (3.84 US$/MMBTU which includes company profit) is lower than the price of fuel oil in 1995 (4.38US$/MMBTU). The price of crude oil in 1995 becomes to 25US$/Bbl even in the low price scenario which is not so low in comparison with 28 US$/Bbl in 1985. Therefore, natural gas price will be much lower than fuel oil price after 1995 and FIRR becomes higher than the above of 20% lower case.

When natural gas price is lower than fuel oil price, the demand of city gas will be increased because city gas can be used in manufuacturing industry by replacing fuel oil and diesel oil and in the gas cooling system for building newly constructed.

Such demand improves FIRR as mentioned below:

ADDITIONAL CASE (BASE CASE PLUS ADDITIONAL INDUSTRY (LOW))

(%)

	Current Price Base		Fixed Price Base	
	Bfr.Tax	Aft.Tax	Bfr.Tax	Aft.Tax
Base Case	17.67	14.18	11.19	9.11
N.G. Price (20% down)	20.15	16.02	11.99	9.67
Additional Case	20.64	16.46	11.47	9.31

If raw material cost, that is natural gas, is decided by use of the crude oil price and LPG price only is lower than the calculated one by 10% and 20%, FIRR becomes to 14.54% by 10% and 10.86% by 20% on the current price base.

In some countries, for example Japan, city gas price is lower than LPG price, however, in such a country some portion of the construction cost of city gas is born by the user.

In this study, the total construction cost included the cost which will be borne by users, in total investment cost, therefore, it is unnecessary to consider the price lower than LPG price.

The influence, on the internal rate of return by a change from the assumed values of major parameter such as the price of crude oil, estimated natural gas price, city gas sales price and capital requirement is shown in Figure VI.3.

The results of sensitivity analysis for base case is shown in Table VI.16.

(2) Financial indicators

Various financial indications including ratio analysis such as break-even point and ratio of net profit on sales revenue are as per ANNEX.

(3) Production cost analysis

The results of production cost components for each case are shown in Table VI.11.

(4) Funds flow analysis

To judge the soundness of cash flow, debt service ratio (D.S.R) as one of most important indicators is obtained from the following formula.

It is generally said that the D.S.R is the safety value more than 2.0 and 1.5 at least.

$$D.S.R = \frac{\text{Profit on after Tax + Depreciation + Interest on L/T Loan}}{\text{Repayment on L/T Loan + Interest on L/T Loan}}$$

The results for each case by a use of this formula are mentioned below.

	Base Case	Medium Case	Low Case
D.S.R (6 years after start of operation)	1.92	1.83	1.74
D.S.R (mean value)	5.09	4.86	4.45

6 years after start of operation is the first of repayment and is the most tight year. D.S.R even in the most tight year is over 1.5 which shows the soundness of cash flow.

If capital ratio in the investment is increased from 30% to 40% and 50%, D.S.R for base case is improved as follow. Interest during construction is recalculated by changing the debt-equity ratio.

(US$ 1,000)

	30%	40%	50%
D.S.R (6 years after start of operation)	1.92	2.21	2.63
D.S.R (mean value)	5.09	5.99	7.25
Interest during construction	59,615	50,376	41,394

In the first year of start of operation only, short term loan is necessary due to the low income against the high investment cost, however, after first year, no shortage is occurred.

The soundness of finance was obtained by the assumption of the good finance conditions.

Furthermore, if annual interest rate on long-term loan is fluctuated from 5.0% to 7.5% and 10.0%, D.S.R for base case is decreased as follows.

(US$ 1,000)

	5.0%	7.5%	10.0%
D.S.R (6 years after start of operation)	1.92	1.61	1.38
D.S.R (mean value)	5.09	4.18	3.49
Interest during construction	59,615	97,506	142,600

Chapter 2 ECONOMIC EVALUATION

2.1 Analysis on Direct Economic Costs and Benefits

Evaluations of direct economic costs and benefits is made by means of economic internal rate of return (EIRR) and economic net present value (ENPV).

2.1.1 Major Assumptions

(1) Currency and exchange rate

U.S. currency is used as the standard currency for economic analysis with following exchange rates which is decided at the meeting in October, 1986.

US$1.00 = 2.65 Malaysian Ringgit
= 167 Japanese Yen

(2) Escalation rates

All economic costs and benefits are assumed to be escalated as the same rates as in the financial analysis.

(3) Cut off rate

Cut off rate to be used for calculation of economic net present value is assumed ten percent (10%) as practiced for government project in Malaysia.

2.1.2 Economic Direct Benefits

(1) Selling price of city gas

Opportunity price of city gas is changed, when it is transferred through consumed place where the city gas is expected to replace predominant fuel energies in equal conditions.

The fuel energies to be replaced by the city gas are:

1) Cylinder LPG for household and restaurant use
2) Bulk LPG for hotel and manufacturing industries

The opportunity price of the city gas, therefore, can be represented by the opportunity price of such replaced energies.

As mentioned in Table VI.12, EPU has estimated that LPG supply will exceed the LPG demand in Malaysia. EPU has requested to use Saudi FOB price plus transportation cost difference between Saudi - Japan and Malaysia - Japan.

EPU has indicated the LPG price forecast at FOB Saudi as mentioned as follows and shown the difference of transportation cost as 15 - 20 US$/ton.

LPG PRICES FOB MIDDLE EAST

(US$/Tonne in 1985 Constant Price)

	1985	1986	1990	1995	2000	2015	2010
LPG	213	127	136	150	166	186	207

The Study Team has calculated the transportation cost difference which will be changed by changing crude oil price and added to FOB Saudi price as mentioned in Table I.97.

LPG in Malaysia is separated at/and exported from Kerteh, therefore, LPG price at West Coast is calculated as follows.

LPG SELLING PRICE (1986)

A. Cylindered LPG (M$/kg)

FOB Kerteh	0.3697
Local Transport. Cost	0.1000
Marketing Cost	0.1438
Dealer's Commission	0.2142
Company's Profit	0.0900
Total	0.9177

B. Bulk LPG

FOR Kerteh	0.3697
Local Transport. Cost	0.1000
Company's Profit	0.0900
Total	0.5597

(2) Selling price of LPG by reticulation

LPG selling price is the same as the case of above item (1) A, B "Cylindered LPG".

2.1.3 Economic Direct Costs

(1) Purchase price of natural gas

Economical value of natural gas at west coast was given by EPU as follows and the figure of low fuel scenario converted in US$ is used. For fixed price base, the price in 1990 was taken.

ECONOMIC VALUE OF NATURAL GAS AT WEST COAST

(M$/MMBTU in 1985 constant price)

	1990	1995	2000	2005	2010	2015
Low Fuel Scenario	3.5	3.9	4.4	5.2	6.4	7.2
High Fuel Scenario	3.6	4.1	4.8	5.8	7.4	8.6

(2) Purchase price of LPG

For this project, LPG's, economic purchase price is applicable only to the case of reticulation where the LPG is handled in bulk.

Based on the figures given in the paragraph 2.1.2(1), such purchase price of LPG in bulk is assumed as follows,

LPG Purchased Price (1986) (M$/kg)

FOR Kerteh	0.3697
Local Transportation Cost	0.1000
Total	0.4697

(3) Transferable costs

All transferable costs such as taxes and duties, contributions and similar kind of impositions by central and local government authorities are to be eliminated on assessment basis. Transferable costs are as shown in Table VI.5.

(4) Opportunity cost of labour resources

The National Parameter for project appraisal is used as the opportunity cost of unskilled labour as 78% of actual labour cost including income tax.

For the skilled labour, tax is deducted and is estimated 85% of actual cost.

For the foreign staffs, tax is deducted and is estimated as 95% of actual cost.

(5) Construction cost

Based on the National Parameter for project appraisal, the average conversion factor for local construction cost is estimated as 88% of actual cost.

For the foreign portion of construction cost, import duty was deducted and 95% on the actual cost is adopted.

Tables VI.13 and VI.14 are shown the summary of economic costs.

2.1.4 Result of Economic Analysis

(1) The evaluation of the project using the economic internal rate of return (EIRR) and the effect of the economic growth rate on EIRR is not so big as mentioned below.

(%)

	EIRR (Fixed)	EIRR (Current)
Base case	10.78	17.20
Medium case	10.21	16.66
Low case	9.20	15.52

EIRR on fixed price base is almost same with FIRR, however, EIRR on current price base is worse than FIRR for each cases. Because the increase rate of price of LPG estimated by EPU based on the FOB price of LPG in Saudi is as low in comparison with the price increase of crude oil that the price difference between LPG sales price based on LPG price and natural gas price on fuel oil price is decreased.

(2) The economic net present values (ENPV) on fixed price base only for low case becomes minus.

(US$ Million)

	EIRR (Fixed)	EIRR (Current)
Base case	20.3	334.0
Medium case	7.5	363.1
Low case	-16.2	290.9

(3) Foreign exchange savings/earnings of the project

The contribution to improve the foreign balance in Malaysia owing to the implementation of this project is calculated in the following manner.

1) LPG price replaced by city gas is assumed as the same with FOB Kerteh based on FOB Saudi.

2) The sales volume of city gas times LPG price is assumed as the earning amount of inflow of foreign exchange.

3) All maintenance cost is regarded as outflow of the foreign exchange.

4) The foreign loans are inflow of the foreign exchange, which will be set off in the same amount by outflow of the payment for the construction cost. The reimbursement of the loan is outflow of the foreign exchange.

5) The interest on the foreign loans is outflow of the foreign exchange.

This project can be considered as the LPG substitution sustantially, therefore, the result of calculation including 10% interest rate case for the foreign exchange earnings is as shown in Table VI.15.

Table VI.1 MAN-POWER SCHEDULE: WHOLE ORGANIZATION OF NEW COMPANY
(1) BASE CASE

GRADE	DIVISION	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRADE I	General Manager		3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Sub-total		3	3	3	3	3	3	3	3	3	3	3	3	3	3
GRADE II	Planning		2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Administration		6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Sales and Services		2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Construction		2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Local Branch		4	6	8	10	10	10	10	10	10	10	10	10	10	10
	Sub-total		16	18	20	22	22	22	22	22	22	22	22	22	22	22
GRADE III	Planning		4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Administration		10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Sales and Services		10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Construction		6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Local Branch		16	24	32	40	40	40	40	40	40	40	40	40	40	40
	Sub-total		46	54	62	70	70	70	70	70	70	70	70	70	70	70
GRADE IV	Planning		5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Administration		40	40	40	40	40	40	40	40	40	40	40	40	40	40
	Sales and Services		32	35	38	41	42	44	44	45	46	46	47	47	48	48
	Construction		24	24	24	24	24	24	24	24	24	24	24	24	24	24
	Local Branch		100	309	331	247	207	131	91	85	77	75	81	77	88	86
	Sub-total		201	413	438	357	318	244	204	199	192	190	197	193	205	203
GRADE V	Planning		2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Administration		8	8	8	8	8	8	8	8	8	8	8	8	8	8
	Sales and Services		6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Construction		10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Local Branch		69	276	428	512	591	625	651	683	707	726	752	766	805	825
	Sub-total		95	302	454	538	617	651	677	709	733	752	778	792	831	851
TOTAL			361	790	977	990	1030	990	976	1003	1020	1037	1070	1080	1131	1149

Table VI.1 MAN-POWER SCHEDULE: WHOLE ORGANIZATION OF NEW COMPANY
(2) MEDIUM CASE

GRADE	DIVISION	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GRADE I	General Manager		3	3	3	3	3	3	3	3	3	3	3	3
	Sub-total		3	3	3	3	3	3	3	3	3	3	3	3
GRADE II	Planning		2	2	2	2	2	2	2	2	2	2	2	2
	Administration		6	6	6	6	6	6	6	6	6	6	6	6
	Sales and Services		2	2	2	2	2	2	2	2	2	2	2	2
	Construction		2	2	2	2	2	2	2	2	2	2	2	2
	Local Branch		4	6	8	10	10	10	10	10	10	10	10	10
	Sub-total		16	18	20	22	22	22	22	22	22	22	22	22
GRADE III	Planning		4	4	4	4	4	4	4	4	4	4	4	4
	Administration		10	10	10	10	10	10	10	10	10	10	10	10
	Sales and Services		10	10	10	10	10	10	10	10	10	10	10	10
	Construction		6	6	6	6	6	6	6	6	6	6	6	6
	Local Branch		16	24	32	40	40	40	40	40	40	40	40	40
	Sub-total		46	54	62	70	70	70	70	70	70	70	70	70
GRADE IV	Planning		5	5	5	5	5	5	5	5	5	5	5	5
	Administration		40	40	40	40	40	40	40	40	40	40	40	40
	Sales and Services		33	36	39	42	44	45	46	46	47	47	48	48
	Construction		24	24	24	24	24	24	24	24	24	24	24	24
	Local Branch		115	352	377	281	242	149	99	89	77	84	84	63
	Sub-total		217	457	485	392	355	263	214	204	193	200	201	180
GRADE V	Planning		2	2	2	2	2	2	2	2	2	2	2	2
	Administration		8	8	8	8	8	8	8	8	8	8	8	8
	Sales and Services		6	6	6	6	6	6	6	6	6	6	6	6
	Construction		10	10	10	10	10	10	10	10	10	10	10	10
	Local Branch		81	308	479	574	669	704	720	743	756	796	816	789
	Sub-total		107	334	505	600	695	730	746	769	782	822	842	815
TOTAL			389	866	1075	1087	1145	1088	1055	1068	1070	1117	1138	1090

Table VI.1 MAN-POWER SCHEDULE: WHOLE ORGANIZATION OF NEW COMPANY
(3) LOW CASE

GRADE	DIVISION	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GRADE I	General Manager		3	3	3	3	3	3	3	3	3	3	3	3
	Sub-total		3	3	3	3	3	3	3	3	3	3	3	3
GRADE II	Planning		2	2	2	2	2	2	2	2	2	2	2	2
	Administration		6	6	6	6	6	6	6	6	6	6	6	6
	Sales and Services		2	2	2	2	2	2	2	2	2	2	2	2
	Construction		2	2	2	2	2	2	2	2	2	2	2	2
	Local Branch		4	6	8	10	10	10	10	10	10	10	10	10
	Sub-total		16	18	20	22	22	22	22	22	22	22	22	22
GRADE III	Planning		4	4	4	4	4	4	4	4	4	4	4	4
	Administration		10	10	10	10	10	10	10	10	10	10	10	10
	Sales and Services		10	10	10	10	10	10	10	10	10	10	10	10
	Construction		6	6	6	6	6	6	6	6	6	6	6	6
	Local Branch		16	24	32	40	40	40	40	40	40	40	40	40
	Sub-total		46	54	62	70	70	70	70	70	70	70	70	70
GRADE IV	Planning		5	5	5	5	5	5	5	5	5	5	5	5
	Administration		40	40	40	40	40	40	40	40	40	40	40	40
	Sales and Services		33	36	39	42	44	45	46	46	47	47	48	48
	Construction		24	24	24	24	24	24	24	24	24	24	24	24
	Local Branch		115	352	377	281	241	149	99	88	77	84	84	63
	Sub-total		217	457	485	392	354	263	214	203	193	200	201	180
GRADE V	Planning		2	2	2	2	2	2	2	2	2	2	2	2
	Administration		8	8	8	8	8	8	8	8	8	8	8	8
	Sales and Services		6	6	6	6	6	6	6	6	6	6	6	6
	Construction		10	10	10	10	10	10	10	10	10	10	10	10
	Local Branch		81	308	479	574	669	704	720	743	756	796	816	789
	Sub-total		107	334	505	600	695	730	746	769	782	822	842	815
TOTAL			389	866	1075	1087	1144	1088	1055	1067	1070	1117	1138	1090

Table VI.2 MAN-POWER SCHEDULE: ALL LCOAL BRANCHES
(1) BASE CASE

GRADE	DIVISION	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRADE II	General Manager		4	6	8	10	10	10	10	10	10	10	10	10	10	10
	Sub-total		4	6	8	10	10	10	10	10	10	10	10	10	10	10
GRADE III	Division Chief		16	24	32	40	40	40	40	40	40	40	40	40	40	40
	Sub-total		16	24	32	40	40	40	40	40	40	40	40	40	40	40
GRADE IV	Clerk		4	4	5	6	6	7	7	7	8	8	8	8	9	9
	Sales		0	3	6	9	10	12	12	13	14	14	15	15	16	16
	Customer Service		0	2	4	6	7	8	8	9	9	9	10	10	10	11
	Collection Chief		0	1	2	3	4	4	5	5	5	5	6	6	6	6
	Collection Leader		0	3	6	9	10	12	12	13	14	14	15	15	16	16
	Accounting															
	Pipeline		9	29	30	22	18	11	7	6	5	5	5	4	6	5
	House Piping		2	8	10	11	13	13	14	14	14	12	12	9	14	12
	Maintenance		3	3	4	5	5	6	6	6	6	6	6	6	7	7
	Conversion Work		82	256	264	176	134	58	20	12	2	2	4	4	4	4
	Sub-total		100	309	331	247	297	131	91	85	77	75	81	77	88	86
GRADE V	Clerk		3	15	27	36	43	48	51	54	56	58	60	62	64	66
	Sales		3	15	27	36	43	48	51	54	56	58	60	62	64	66
	Customer Service		2	10	18	24	29	32	34	36	37	38	40	41	42	44
	Billing		11	47	85	113	136	150	160	168	176	182	188	193	201	208
	Collection		18	76	137	181	218	241	256	270	281	291	302	310	322	332
	Special Collection		3	15	27	36	43	48	51	54	56	58	60	62	64	66
	Pipeline		27	87	91	66	56	33	22	20	17	15	15	12	18	15
	House Piping		2	8	10	11	13	13	14	14	14	12	12	9	14	12
	Maintenance		0	3	6	9	10	12	12	13	14	14	15	15	16	16
	Sub-total		69	276	428	512	591	625	651	683	707	726	752	766	805	825
TOTAL			189	615	799	809	848	806	792	818	834	851	883	893	943	961

Table VI.2 MAN-POWER SCHEDULE: ALL LCOAL BRANCHES
(2) MEDIUM CASE

GRADE	DIVISION	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GRADE II	General Manager		4	6	8	10	10	10	10	10	10	10	10	10
	Sub-total		4	6	8	10	10	10	10	10	10	10	10	10
GRADE III	Division Chief		16	24	32	40	40	40	40	40	40	40	40	40
	Sub-total		16	24	32	40	40	40	40	40	40	40	40	40
GRADE IV	Clerk		4	4	5	6	7	7	7	8	8	8	8	8
	Sales		1	4	7	10	12	13	14	14	15	15	16	16
	Customer Service		0	2	5	6	8	9	9	9	10	10	10	10
	Collection Chief		0	1	3	4	4	5	5	5	6	6	6	6
	Collection Leader		1	4	7	10	12	13	14	14	15	15	16	16
	Accounting													
	Pipeline		10	32	34	25	21	12	7	6	4	6	5	0
	House Piping		2	7	10	11	14	14	11	11	9	14	12	0
	Maintenance		3	4	4	5	6	6	6	6	6	6	7	7
	Conversion Work		94	294	302	204	158	70	26	16	4	4	4	0
	Sub-total		115	352	377	281	242	149	99	89	77	84	84	63
GRADE V	Clerk		4	17	30	40	49	54	57	59	61	63	65	65
	Sales		4	17	30	40	49	54	57	59	61	63	65	65
	Customer Service		2	11	20	27	32	36	38	39	40	42	43	43
	Billing		13	53	96	127	154	170	179	186	191	199	206	206
	Collection		20	85	154	204	246	272	286	298	306	319	329	329
	Special Collection		4	17	30	40	49	54	57	59	61	63	65	65
	Pipeline		31	97	102	75	64	37	21	18	12	18	15	0
	House Piping		2	7	10	11	14	14	11	11	9	14	12	0
	Maintenance		1	4	7	10	12	13	14	14	15	15	16	16
	Sub-total		81	308	479	574	669	704	720	743	756	796	816	789
TOTAL			216	690	896	905	961	903	869	882	883	930	950	902

Table VI.2 MAN-POWER SCHEDULE: ALL LCOAL BRANCHES
(3) LOW CASE

GRADE	DIVISION	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GRADE II	General Manager		4	6	8	10	10	10	10	10	10	10	10	10
	Sub-total		4	6	8	10	10	10	10	10	10	10	10	10
GRADE III	Division Chief		16	24	32	40	40	40	40	40	40	40	40	40
	Sub-total		16	24	32	40	40	40	40	40	40	40	40	40
GRADE IV	Clerk		4	4	5	6	6	7	7	7	8	8	8	8
	Sales		1	4	7	10	12	13	14	14	15	15	16	16
	Customer Service		0	2	5	6	8	9	9	9	10	10	10	10
	Collection Chief		0	1	3	4	4	5	5	5	6	6	6	6
	Collection Leader		1	4	7	10	12	13	14	14	15	15	16	16
	Accounting													
	Pipeline		10	32	34	25	21	12	7	6	4	6	5	0
	House Piping		2	7	10	11	14	14	11	11	9	14	12	0
	Maintenance		3	4	4	5	6	6	6	6	6	6	7	7
	Conversion Work		94	294	302	204	158	70	26	16	4	4	4	0
	Sub-total		115	352	377	281	241	149	99	88	77	84	84	63
GRADE V	Clerk		4	17	30	40	49	54	57	59	61	63	65	65
	Sales		4	17	30	40	49	54	57	59	61	63	65	65
	Customer Service		2	11	20	27	32	36	38	39	40	42	43	43
	Billing		13	53	96	127	154	170	179	186	191	199	206	206
	Collection		20	85	154	204	246	272	286	298	306	319	329	329
	Special Collection		4	17	30	40	49	54	57	59	61	63	65	65
	Pipeline		31	97	102	75	64	37	21	18	12	18	15	0
	House Piping		2	7	10	11	14	14	11	11	9	14	12	0
	Maintenance		1	4	7	10	12	13	14	14	15	15	16	16
	Sub-total		81	308	479	574	669	704	720	743	756	796	816	789
TOTAL			216	690	896	905	960	903	869	881	883	930	950	902

Table VI.3 MAN-POWER SCHEDULE: GRADE IV

A. Head Office

1. Planning Division

Public Relations Section	2 clerks
Planning Section	2 clerks + 1 technician

2. Administration Division

General Administration Dept.	16 clerks
Accounting and Finance Dept.	24 clerks

3. Sales and Service Division

Commercial and Industrial Customers Development Section	N = A/0.5 million
Other Four Sections	32 clerks

4. Construction Division

Each Section	6 clerks

B. Local Branch

Clerks	N = 4 + (B/10 million(M^3)) x 0.2
Sales	N = (A/10,000(H)) x 0.2
Custom Service	N = (A/15,000(H)) x 0.2
Tariff Affairs Chief	N = D/50(P)
Tariff Affairs Leader	N = D/20(P)
Accounting Assistant	N = 4(A<10,000(H)) or
	N = 4 + (A-10,000)/10,000(H) (A≥10,000)
Pipeline	N = (A-A') x 6(M)/30,000(M)
House Piping	N = A/2,000(H)
Maintenance	N = 3 + (A/0.2 million(H))
Conversion Work	N = (A-A'-C) x 2(P)

LEGEND:

A = Total No. of consumers in the present year
A'= Total No. of consumers in the previous year
B = Sales volume of NG
C = No. of new consumers
D = No. of collection (persons)
H = Households
P = Persons

Table VI.4 MAN-POWER SCHEDULE: GRADE V

A. Head Office

1. Administration Division

General Administration Dept.	4 clerks
Accounting and Finance Dept.	6 clerks

2. Sales and Service Division

Four Sections except for Commercial and Industrial Customers Development Section	6 clerks

3. Construction Division

All Sections	6 clerks

B. Local Branch

Clerks	N = (B/10 million(M^3)) x 0.8
Sales	N = (A/10,000(H)) x 0.8
Custom Service	N = (A/15,000(H)) x 0.8
Billing	N = A/4,000(H)
Collection	N = A/2,500(H)
Special Collection	N = D/5(P)
Pipeline	N = (A-A') x 6(M)/10,000(M)
House Piping	N = A/2,000(H)
Maintenance	N = A/50,000(H)

LEGEND:

A = Total No. of consumers in the present year
A'= Total No. of consumers in the previous year
B = Sales volume of NG
C = No. of new consumers
D = No. of collection (persons)
H = Households
P = Persons

Table VI.5 TAXES AND DUTIES

Description	Code	Tax Rate	Application	Remarks
(1) Individual Income Tax				
For Resident	(T.1.1)	13% *	Construction Labour	* Estimated
For Resident	(T.1.2)	15% *	Skilled Labour & Executive	
For Resident	(T.1.3)	10% *	Unskilled Labour	
For Non-Resident	(T.1.4)	5% (Tax Act 1982)	Expatriated Engineers, Technical Advisors	
(2) Corporate Income Tax				
For Resident	(T.2.1)	40% on Taxable Income	Gas Company's Profit	
For Resident, and for Non Resident	(T.2.2)	10% on Contractor Payment	Contractor's Profit	Deemed Tax
(3) Withholding Tax				
For Non-Resident	(T.3.1)	15%	Interest on Foreign Loan	Exempted
For Non-Resident	(T.3.2)	15%	Royalty, Know-how	Not Considered
(4) Excess Profit Tax				
For Resident	(T.4.1)	Share Capital x 25% or over M$200,000 whichever longer x 5%	Company's Profit	Not Considered
For Resident	(T.4.2)	Taxable Income over M$100,000 x 5%	Individual Income	Not Considered
(5) Development Tax	(T.5)	Business Earning or Earning from Rent x 5%	Company's Profit	Not Considered
(6) Real Property Gains Tax	(T.6)	10 - 40%	Land, Building-Trade Profit	Neglected
(7) Tin Profit Tax	(T.7)	(Omitted)	-	Not Applicable
(8) Timber Profit Tax	(T.8)	(Omitted)	-	Not Applicable
(9) Export Duties	(T.9)	(Omitted)	-	Not Applicable
(10) Import Duties	(T.10)	Volume or Value of Imported Goods x % (Customs Act 1967) (Customs Duty Order 1972)	Imported Equipment, Materials and Supplies	Average Tax is assumed Five Percent (5%)
(11) Import Surtax	(T.11)	Additional 5% to the Import Duty	Same as above	
(12) Sales Tax	(T.12.1)	10% (Tax Act 1983)	Same as above	
(13) Excise Tax	(T.13.1)	Volume or Value of Local Goods x %	Petroleum Products	Study Team's Estimate
	(T.13.2)	" (Excise Tax 1976)	Tabacco, Alcohol	
(14) Stamp Tax	(T.14.1)	x M$ per Document	Specific Items	Not Considered
	(T.14.2)	0.5 M$ per Document	Others	
(15) Service Tax	(T.15)	(Omitted)	Hotel, Restaurant	Not Applicable
(16) Motor Vehicle Tax	(T.16)	x M$ per Vehicle	Motorcar, Motor-cycle	

Table VI.6(1) ESTIMATED PROJECT COST

- BASE CASE -

(Unit: US$1,000)

Description	Foreign	Local	Total
A. Land Acquisition	-	192	192
B. Site Preparation Cost	-	-	-
C. Construction Cost			
1) Transmission	23,174	7,942	31,116
- Pipeline	19,456	6,427	25,883
- MPB	2,972	1,421	4,393
- Governor, Valve	747	93	840
2) Distribution	96,691	51,648	148,339
- Existing	70,890	45,268	116,158
- New	25,801	6,380	32,181
3) Service Pipe	3,098	5,344	8,442
4) Gas Meter	43,716	0	43,716
5) Installation	27,907	41,439	69,346
6) Conversion to N.G.	1,309	3,274	4,583
7) Reticulation	7,906	3,028	10,934
- Distribution	3,563	882	4,445
- Others	4,343	2,146	6,489
8) Engineering Service	40,022	0	40,022
- Basic Engineering	20,821	0	20,821
- Contractor's Engineering	19,201	0	19,201
9) Computer & Data Processor	1,796	0	1,796
Base Project Cost (BPC) (as of June, 1986 Prices)	245,619	112,867	358,486
D. Physical Contingency	40,760	22,573	63,333
E. Price Contingency	135,125	40,491	175,616
Projected Construction Cost	421,504	175,931	597,435
F. Pre-Operating Expenses	-	1,986	1,986
G. Initial Working Capital	-	13,082	13,082
I. Interest during Construction	59,615	-	59,615
Total Project Cost	481,119	190,999	672,118

Table VI.6(2) ESTIMATED PROJECT COST

- MEDIUM CASE -

(Unit: US$1,000)

Description	Foreign	Local	Total
A. Land Acquisition	-	192	192
B. Site Preparation Cost	-	-	-
C. Construction Cost			
1) Transmission	23,026	7,893	30,919
- Pipeline	19,308	6,378	25,686
- MPB	2,972	1,421	4,393
- Governor, Valve	747	93	840
2) Distribution	99,327	55,897	155,224
- Existing	80,082	51,137	131,219
- New	19,246	4,759	24,005
3) Service Pipe	3,407	5,878	9,285
4) Gas Meter	42,410	0	42,410
5) Installation	27,351	40,614	67,965
6) Conversion to N.G.	1,495	3,739	5,234
7) Reticulation	9,266	3,559	12,825
- Distribution	4,133	1,023	5,156
- Others	5,133	2,536	7,669
8) Engineering Service	41,738	0	41,738
- Basic Engineering	23,081	0	23,081
- Contractor's Engineering	18,657	0	18,657
9) Computer & Data Processor	1,796	0	1,796
Base Project Cost (BPC) (as of June, 1986 Prices)	249,817	117,771	367,588
D. Physical Contingency	41,257	23,554	64,811
E. Price Contingency	182,186	56,560	238,746
Projected Construction Cost	473,260	197,885	671,145
F. Pre-Operating Expenses	-	2,324	2,324
G. Initial Working Capital	-	12,222	12,222
I. Interest during Construction	84,696	-	84,696
Total Project Cost	557,956	212,431	770,387

Table VI.6(3) ESTIMATED PROJECT COST

- LOW CASE -

(Unit: US$1,000)

Description	Foreign	Local	Total
A. Land Acquisition	-	192	192
B. Site Preparation Cost	-	-	-
C. Construction Cost			
1) Transmission	194,857	7,836	30,693
- Pipeline	191,138	6,322	25,460
- MPB	2,972	1,421	4,393
- Governor, Valve	747	93	840
2) Distribution	98,916	55,704	154,621
- Existing	79,850	50,990	130,840
- New	19,066	4,715	23,781
3) Service Pipe	3,389	5,845	9,234
4) Gas Meter	41,329	0	41,329
5) Installation	27,220	40,420	67,640
6) Conversion to N.G.	1,484	3,711	5,195
7) Reticulation	9,242	3,551	12,793
- Distribution	4,114	1,018	5,132
- Others	5,128	2,533	7,661
8) Engineering Service	41,601	0	41,601
- Basic Engineering	22,961	0	22,961
- Contractor's Engineering	18,640	0	18,640
9) Computer & Data Processor	1,796	0	1,796
Base Project Cost (BPC) (as of June, 1986 Prices)	247,834	117,260	365,094
D. Physical Contingency	40,887	23,452	64,339
E. Price Contingency	180,417	56,300	236,717
Projected Construction Cost	469,138	197,012	666,150
F. Pre-Operating Expenses	-	2,324	2,324
G. Initial Working Capital	-	11,097	11,097
I. Interest during Construction	83,953	-	83,953
Total Project Cost	553,091	210,433	763,524

Table VI.7 PROJECTED PURCHASING AND RETAIL PRICES OF PETRO-PRODUCTS, KUALA LUMPUR (AS NATURAL GAS EQUIVALENT)

(Unit: US$/normal cubic meter of NG equivalent)

Year	Fuel Oil		LPG/Cylinder	LPG/Bulk	Kerosene	Diesel Oil
	Excl. Duty	Incl. Duty				
1986*1	0.071	0.077	0.341	0.227	0.215	0.185
1990	0.169	0.175	0.500	0.378	0.297	0.273
1991	0.183	0.190	0.529	0.402	0.319	0.294
1992	0.200	0.207	0.561	0.430	0.344	0.317
1993	0.218	0.225	0.594	0.459	0.371	0.343
1994	0.237	0.245	0.631	0.490	0.400	0.370
1995	0.259	0.266	0.670	0.525	0.431	0.399
1996	0.276	0.284	0.704	0.553	0.458	0.424
1997	0.294	0.303	0.739	0.584	0.486	0.450
1998	0.314	0.322	0.777	0.616	0.515	0.478
1999	0.335	0.344	0.819	0.652	0.548	0.508
2000	0.358	0.367	0.861	0.688	0.581	0.540
2001	0.382	0.392	0.907	0.728	0.618	0.574
2002	0.408	0.417	0.954	0.769	0.655	0.609
2003	0.435	0.446	1.006	0.814	0.697	0.649
2004	0.465	0.476	1.060	0.862	0.741	0.690
2005	0.497	0.508	1.118	0.913	0.788	0.734
2006	0.531	0.542	1.179	0.967	0.838	0.781
2007	0.567	0.578	1.244	1.024	0.890	0.830
2008	0.607	0.619	1.315	1.087	0.949	0.886
2009	0.647	0.660	1.387	1.152	1.009	0.942
2010	0.691	0.705	1.465	1.221	1.073	1.002
2011	0.738	0.752	1.548	1.296	1.142	1.067
2012	0.790	0.804	1.637	1.376	1.216	1.137
2013	0.844	0.859	1.731	1.461	1.295	1.212
2014	0.902	0.917	1.831	1.551	1.379	1.291
2015	0.964	0.979	1.937	1.647	1.468	1.375
2016	1.032	1.048	2.052	1.753	1.566	1.468
2017	1.102	1.118	2.171	1.861	1.667	1.562
2018	1.179	1.196	2.301	1.980	1.778	1.667
2019	1.261	1.279	2.439	2.107	1.896	1.778
2020	1.348	1.367	2.585	2.241	2.021	1.897
2021	1.441	1.461	2.740	2.384	2.155	2.022
2022	1.540	1.560	2.904	2.535	2.296	2.156
2023	1.646	1.666	3.078	2.697	2.446	2.298
2024	1.762	1.783	3.267	2.873	2.611	2.454
2025	1.885	1.907	3.469	3.061	2.787	2.620
2026	2.017	2.039	3.683	3.260	2.973	2.796
2027	2.157	2.180	3.909	3.472	3.171	2.983
2028	2.305	2.329	4.150	3.697	3.382	3.183

Note: See Table I.91. Heat value of natural gas: 9,876 kcal/normal cubic meter.

Table VI.8 RESULTS OF FINANCIAL AND ECONOMIC ANALYSIS

	Base Case			Medium Case			Low Case		
	1995	2000	2005	1995	2000	2005	1995	2000	2005
(1) Sales Volume ($10^3 Nm^3/y$)									
Household	64,054	123,200	159,506	3,821	106,894	147,310	3,752	101,504	136,325
Commercial									
Restaurant	31,566	55,702	66,421	2,648	52,131	65,856	2,544	49,940	62,411
Hotel	1,810	2,627	3,312	84	2,503	3,189	84	2,503	3,189
Industry	12,568	24,133	33,298	5,053	19,702	28,002	4,091	13,381	17,244
(Total)	(109,998)	(205,661)	(262,537)	(11,606)	(181,230)	(244,357)	(10,471)	(167,328)	(219,168)
Reticulation	2,027	2,523	5,503	1,418	2,179	5,044	1,418	2,094	4,703
(2) Investment (10^3US$)									
	Fixed Price		Current Price	Fixed Price		Current Price	Fixed Price		Current Price
Construction Cost 1/	421,819		597,435	432,399		671,145	429,433		666,150
Pre-operating Expense	1,790		1,986	1,889		2,324	1,889		2,324
Initial Working Capital	5,630		13,082	5,265		12,222	4,798		11,097
Interest Drg. Construction	43,023		59,615	54,626		84,696	54,233		83,953
(Total)	472,262		672,118	494,179		770,387	490,353		763,524
(3) Financial Analysis 2/									
FIRR (Before Tax, %)	11.19(14.28)		17.67	10.60(14.02)		16.91	9.52(12.81)		15.67
FIRR (After Tax, %)	9.11(11.35)		14.18	8.74(11.19)		13.69	7.96(10.33)		12.76
FNPV before tax(@15%, 10^6US$)	-57.8(-11.6)		71.0	-70.2(-16.7)		60.3	-85.2(-36.3)		20.3
FNPV after tax (@15%, 10^6US$)	-81.4(-53.4)		-19.1	-91.7(-59.0)		-36.4	-100.9(-70.5)		-60.2
(4) Economic Analysis 2/									
EIRR (%)	10.78(12.32)		17.20	10.21(11.92)		16.66	9.20(10.85)		15.52
ENPV (at 10% discount, 10^6US$)	20.3 (58.8)		334.0	7.5 (51.1)		363.1	-16.2 (23.3)		290.9

Note: 1/ Including land, engineering service and computer
2/ Fixed price adjusted by crude oil price in a parethesis

Table VI.9 ENERGY PRICE

	1985	1986	1990	1995	2000	2005	2010	2015	2020	2025
Crude Oil Price										
Constant Price 1985										
Low Scenario US$/Bbl	28	5	25	25	27.60	30.50	33.65	37.10	41.00	45.20
High Scenario US$/Bbl	28	15	25	30	35.35	41.00	47.50	55.10	63.80	74.60
Ratio	1	1	1.25	1.20	1.28	1.34	1.41	1.48	1.54	1.65
Current Price										
Low Scenario US$/Bbl	28	15	24.31	38.78	54.65	77.07	108.52	152.71	215.39	303.06
Fuel Oil Price (Low Scenario US$/MMBTU/ for Power Station)										
Constant Price 1985 US$		1.81	3.61	4.38	4.78	5.22	5.71	6.24	6.84	7.48
Current Price US$		1.81	4.30	6.60	9.13	12.68	17.64	24.59	34.41	48.11
LPG in Cylinder										
Constant Price 1985										
US$/MMBTU		8.71	11.40	12.50	13.08	13.72	14.41	15.17	16.03	16.96
US$/$Nm^3$		0.341	0.447	0.490	0.513	0.538	0.565	0.594	0.628	0.665
Current Price US$										
US$/MMBTU		8.71	12.76	17.10	21.96	28.53	37.39	49.42	65.96	88.52
US$/$Nm^3$ *		0.341	0.500	0.670	0.861	1.118	1.465	1.937	2.585	3.469
LPG Bulk										
Constant Price										
US$/MMBTU		5.80	8.49	9.59	10.16	10.86	11.50	12.26	13.12	14.05
US$/$Nm^3$		0.227	0.333	0.376	0.398	0.423	0.451	0.480	0.514	0.551
Current Price										
US$/MMBTU		5.80	9.64	13.39	17.56	23.29	31.17	42.04	57.19	78.11
US$/$Nm^3$		0.227	0.378	0.525	0.688	0.913	1.221	1.647	2.241	3.061
Natural Gas Price (Cost Base Constant- US$/MMBTU)										
without Comp. Profit		2.69								
with Comp. Profit		3.84								
Economical Value (Constant in 1985)										
Low Scenario M$/MMBTU			3.50	3.90	4.40	5.20	6.40	7.20		
US$/MMBTU			1.32	1.47	1.66	1.96	2.42	2.72		
High Scenario M$/MMBTU			3.60	4.10	4.80	5.80	7.40	8.60		
US$/MMBTU			1.36	1.55	1.81	2.19	2.79	3.25		
LPG Price in Cylinder - Fuel Oil Price										
Constant Price US$/MMBTU		6.90	7.79	8.12	8.30	8.50	8.70	8.93	9.19	9.48

Note: * Heat value of natural gas: 9,876 kcal/Nm^3

Table VI.10 ADDITIONAL DEMAND AND CONSRUCTION COST

Use		Additional Demand (Unit: 1,000 Nm^3/year)					Additional Construction Cost (US$ 1,000)
		1985	1990	1995	2000	2005	
Industry	High	227,372	306,969	421,156	576,228	731,330	23,115
	Low	113,686	153,484	210,578	288,113	365,650	12,151
Cooling	High	0	0	0	31,429	66,206	50,756
	Low	0	0	0	6,971	27,810	22,247
C.N.G		0	0	19,621	93,446	154,661	3,701
Maximum		227,372	306,969	440,777	701,103	962,197	76,759

Table VI.11 PRODUCTION COST ANALYSIS

(Unit: US$/normal cubic meter and %)

Description	Base Case			Medium Case			Low Case		
	1995	2000	2005	1995	2000	2005	1995	2000	2005
Variable Cost	0.272 (52.6)	0.370 (57.8)	0.521 (66.9)	0.325 (32.4)	0.370 (52.1)	0.521 (59.7)	0.333 (30.8)	0.370 (50.2)	0.522 (57.4)
Natural Gas	0.259 (50.1)	0.358 (55.9)	0.497 (63.8)	0.258 (25.7)	0.358 (50.4)	0.497 (57.0)	0.259 (23.9)	0.358 (48.6)	0.497 (54.6)
LPG	0.010 (1.9)	0.008 (1.3)	0.019 (2.5)	0.064 (6.4)	0.008 (1.1)	0.019 (2.2)	0.071 (6.6)	0.008 (1.1)	0.020 (2.2)
Consumables	0.003 (0.6)	0.004 (0.6)	0.005 (0.6)	0.003 (0.3)	0.004 (0.6)	0.005 (0.5)	0.003 (0.3)	0.004 (0.5)	0.005 (0.6)
Direct Fixed Cost	0.085 (16.4)	0.091 (14.2)	0.101 (13.0)	0.372 (37.1)	0.065 (9.2)	0.114 (13.1)	0.413 (38.2)	0.070 (9.5)	0.127 (14.0)
Labour Cost including overhead	0.082 (15.9)	0.051 (8.0)	0.053 (6.9)	0.363 (36.2)	0.062 (8.7)	0.056 (6.4)	0.403 (37.3)	0.067 (9.1)	0.062 (6.8)
Maintenance Cost	- (-)	0.038 (5.9)	0.047 (6.0)	- (-)	- (-)	0.056 (6.4)	- (-)	- (-)	0.063 (6.9)
Tax and Insurance	0.003 (0.6)	0.002 (0.3)	0.001 (0.1)	0.009 (0.9)	0.003 (0.5)	0.002 (0.3)	0.010 (0.9)	0.003 (0.4)	0.002 (0.3)
Depreciation	0.160 (31.0)	0.128 (20.0)	0.110 (14.2)	0.303 (30.2)	0.182 (25.6)	0.150 (17.2)	0.335 (31.0)	0.197 (26.7)	0.165 (18.1)
Interest on Long Term	- (-)	0.051 (8.0)	0.046 (5.9)	- (-)	0.093 (13.1)	0.087 (10.0)	- (-)	0.100 (13.6)	0.096 (10.5)
Interest on Short Team	- (-)	- (-)	- (-)	0.003 (0.3)	- (-)	- (-)	0.001 (-)	- (-)	- (-)
Unit Production Cost	0.517(100.0)	0.640(100.0)	0.779(100.0)	1.003(100.0)	0.710(100.0)	0.872(100.0)	1.082(100.0)	0.737(100.0)	0.910(100.0)

Table VI.12 LPG SUPPLY-DEMAND BALANCE

(1,000 tonnes)

	1990	1995	2000
Supply			
Kerteh GPP (GPS)	600 - 670	710 - 830	780 - 1,130
Terengganu Refinery (NEPS)	12	12	12
Port Dickson Refinery (NEPS)	100	110	110
Lutong Refinery (NEPS)	2	2	2
Total	714 - 784	834 - 954	904 - 1,254
Demand			
Transport (NEPS) 1/	58	203	351
Others (NEPS)	192	255	337
MTBE (GPS)	-	240	240
Total	250	698	928
Surplus/Deficit (-)	464 - 534	136 - 256	-24 -+ 326

Source: EPU Infrastructure, 26th February 1987
Note: 1/ : Currently under review and may be reduced
NEPS : National Energy Planning Study, 1985
GPS : Gas Pricing Study, 1986/87

Table VI.13(1) ECONOMIC PROJECT COST (BASE CASE)

Description	Currency 1/	Type 2/	Tax Rate 3/ (Kind of Tax)	Correction Factor	Financial Cost (US$1000, as of 1986)	Economic Cost 4/ (US$1000, as of 1986)	Remarks 5/
A. Land & Site Preparation							
1) Land Acquisition	L	N.T	-	1.00	192	192	Refer to Table V.2
2) Site Preparation	L	N.T	-	-	-	-	
B. Construction Cost							City Gas : 305,734 Reticulation: 10,934
1) Equipment & Material	F	T	5%(T.10)	0.95	106,747	101,410	
	L	N.T	-	0.88	33,747	29,697	Total : 316,668
2) Construction Labour	L	N.T	13%(T.1.1)	0.78	68,678	53,569	
3) Construction Equipment	F	T	5%(T.10)	0.95	83,493	79,318	
4) Field Expenses	F	T	5%(T.10)	0.95	13,562	12,884	
	L	N.T	-	0.88	10,250	9,020	
5) Engineering Services	F	T	5%(T.1.4)	0.95	40,022	38,021	
6) Computer	F	T	5%(T.10)	0.95	1,796	1,706	
Sub Total (1) - 6))	F	-	-	-	245,619	233,338	
	L	-	-	-	112,675	92,286	
C. Physical Contingency	F	T	5%(T.10)	0.95	40,760	38,772	
	L	N.T	-	* 0.83	22,573	18,722	* Adjusted due to change of local portion of construction cost
D. Pre-operating Expenses							
1) Labour Cost	L	N.T	15%(T.1.2)	0.85	1,723	1,465	
2) Others	L	N.T	-	1.00	67	67	
E. Initial Working Capital	L	N.T	-	1.00	5,630	5,630	
F. Interest drg. Construction	F	T.C	-	0	45,023	ZERO	
G. Total Project Cost	F	-	-	-	331,402	272,060	
	L	-	-	-	142,860	118,362	

Note: 1/ Currency : F= Foreign, L= Local
2/ Type : T= Tradable Goods, N.T= Non-tradable Goods, T.C= Transferable Cost
3/ Kind of Tax : Refer to Table VI.5
4/ Economic Cost: Financial Cost x Correction Factor
5/ Construction Costs as shown in Table V.2 correspond to the sum of financial cost (i.e. Land & Site prepartion and Construction cost from B.1) to B.4)) in this Table.

Table VI.13(3) ECONOMIC PROJECT COST (LOW CASE)

Description	Currency 1/	Type 2/	Tax Rate 3/ (Kind of Tax)	Correction Factor	Financial Cost (US$1000, as of 1986)	Economic Cost 4/ (US$1000, as of 1986)	Remarks 5/
A. Land & Site Preparation							
1) Land Acquisition	L	N.T	-	1.00	192	192	Refer to Table V.5
	L	N.T	-	-	-	-	
B. Construction Cost							City Gas : 308,904 Reticulation: 12,793
1) Equipment & Material	F	T	5%(T.10)	0.95	104,830	99,589	--------------------
	L	N.T	-	0.88	37,179	32,717	Total : 321,697
2) Construction Labour	L	N.T	13%(T.1.1)	0.78	69,317	54,067	
3) Construction Equipment	F	T	5%(T.10)	0.95	85,738	81,451	
4) Field Expenses	F	T	5%(T.10)	0.95	13,869	13,176	
	L	N.T	-	0.88	10,573	9,304	
5) Engineering Services	F	T	5%(T.1.4)	0.95	41,601	39,521	
6) Computer	F	T	5%(T.10)	0.95	1,796	1,706	
Sub Total (1) - 6))	F	-	-	-	247,834	235,443	
	L	-	-	-	117,068	96,088	
C. Physical Contingency	F	T	5%(T.10)	0.95	40,887	38,843	
	L	N.T	-	* 0.83	23,452	19,536	* Adjusted due to change of local portion of construction cost
D. Pre-operating Expenses							
1) Labour Cost	L	N.T	15%(T.1.2)	0.85	1,822	1,549	
2) Others	L	N.T	-	1.00	67	67	
E. Initial Working Capital	L	N.T	-	1.00	4,798	4,798	
F. Interest drg. Construction	F	T.C	-	0	54,233	ZERO	
G. Total Project Cost	F	-	-	-	342,954	274,286	
	L	-	-	-	147,399	122,230	

Note: 1/ Currency : F= Foreign, L= Local
2/ Type : T= Tradable Goods, N.T= Non-tradable Goods, T.C= Transferable Cost
3/ Kind of Tax : Refer to Table VI.5
4/ Economic Cost: Financial Cost x Correction Factor
5/ Construction Costs as shown in Table V.5 correspond to the sum of financial cost (i.e. Land & Site prepartion and Construction cost from B.1) to B.4)) in this Table.

Table VI.13(2) ECONOMIC PROJECT COST (MEDIUM CASE)

Description	Currency 1/	Type 2/	Tax Rate 3/ (Kind of Tax)	Correction Factor	Financial Cost (US$1000, as of 1986)	Economic Cost 4/ (US$1000, as of 1986)	Remarks 5/
A. Land & Site Preparation							
1) Land Acquisition	L	N.T	-	1.00	192	192	Refer to Table V.4
	L	N.T	-	-	-	-	
B. Construction Cost							City Gas :311,229 Reticulation: 12,825
1) Equipment & Material	F	T	5%(T.10)	0.95	106,222	100,911	
	L	N.T	-	0.88	37,323	32,844	Total :324,054
2) Construction Labour	L	N.T	13%(T.1.1)	0.78	69,639	54,318	
3) Construction Equipment	F	T	5%(T.10)	0.95	86,129	81,823	
4) Field Expenses	F	T	5%(T.10)	0.95	13,932	13,235	
	L	N.T	-	0.88	10,617	9,343	
5) Engineering Services	F	T	5%(T.1.4)	0.95	41,738	39,651	
6) Computer	F	T	5%(T.10)	0.95	1,796	1,706	
Sub Total (1) - 6))	F	-	-	-	249,817	237,326	
	L	-	-	-	117,579	96,505	
C. Physical Contingency	F	T	5%(T.10)	0.95	41,257	39,194	
	L	N.T	-	* 0.83	23,554	19,623	* Adjusted due to change of local portion of construction cost
D. Pre-operating Expenses							
1) Labour Cost	L	N.T	15%(T.1.2)	0.85	1,822	1,549	
2) Others	L	N.T	-	1.00	67	67	
E. Initial Working Capital	L	N.T	-	1.00	5,265	5,265	
F. Interest drg. Construction	F	T.C	-	0	54,626	ZERO	
G. Total Project Cost	F	-	-	-	345,700	276,520	
	L	-	-	-	148,479	123,201	

Note: 1/ Currency : F= Foreign, L= Local
2/ Type : T= Tradable Goods, N.T= Non-tradable Goods, T.C= Transferable Cost
3/ Kind of Tax : Refer to Table VI.5
4/ Economic Cost: Financial Cost x Correction Factor
5/ Construction Costs as shown in Table V.4 correspond to the sum of financial cost (i.e. Land & Site prepartion and Construction cost from B.1) to B.4)) in this Table.

Table VI.14 ECONOMIC COSTS FOR OPERATING COST COMPONENTS

Description	Currency 1/	Type 2/	Tax Rate 3/ (Kind of Tax)	Shadow Price	Correction Factor	(1986 Prices) Financial Cost (Unit)	Economic Cost 4/ (Unit)
H. Purchased Materials							
1) Natural Gas	L	N.T	-	-	0.93	1.81 (US$/MMBTU)	1.32(US$/MMBTU)
2) LPG	L	T	-	-	0.69	5.80 (US$/MMBTU)	(1990-'99)3.16(US$/MMBTU)
					0.68		(2000 on)3.76(US$/MMBTU)
3) Consumables	L	N.T	-	-	1.0	1% of NG, LPG	1% of NG, LPG
I. Labour Cost							
1) Unskilled Labour	L	N.T	10%(T.1.3)	78%	0.78	(V) 4,480(US$/M-y)	3,494(US$/M-y)
2) Others	L	N.T	15%(T.1.2)		0.85	(I)51,109(US$/M-y)	43,443(US$/M-y)
						(II)25,374(US$/M-y)	21,568(US$/M-y)
						(III) 9,541(US$/M-y)	8,110(US$/M-y)
						(IV) 5,985(US$/M-y)	5,087(US$/M-y)
J. Administrative Overhead	L	N.T	-	-	1.0	20% of Labour Cost	
K. Maintenance Cost (Materials)	F	T	5%(T.10)	-	0.95	1% of Construction Cost	0.95% of Financial Value
L. Local Tax & Insurance	L	N.T	x%(T.16)	-	0.5	0.1% of Book Value	50% of Financial Cost
M. Sales Expenses	L	N.T	-	-	1.0	None	None
N. Working Capital							
1) LPG Storage	L	N.T	-	-	1.0	10 days of LPG material	
2) A/C Receivable - A/C Payable	L	N.T	-	-	1.0	30 days of (Revenue - Variable Cost)	
O. Income Tax	L	T.C	40%(T.2.1)	-	0	40% of Taxable Income	ZERO
P. Dividends	L	T.C	-	-	-	None	None

Note: 1/ Currency : F= Foreign, L= Local
2/ Type : T= Tradable Goods, N.T= Non-Tradable Goods, T.C= Transferable Cost
3/ Kind of Tax : Refer to Table VI.5
4/ Economic Cost: Financial Cost x Correction Factor

Table VI.15(1) CITY GAS SUPPLY PROJECT IN MALAYSIA
FOREIGN CURRENCY EARNING (IN CURRENT PRICE)
- BASE CASE - (US$ MILLION)

YEAR	(1) IN-FLOW FROM SALES	ACC. IN-FLOW	MAINTENACE COST	INTEREST ON L/T	REPAYMENT ON L/T	(2) TOTAL OUT-FLOW	ACC. OUT-FLOW	(3) NET IN-FLOW (1)-(2)	ACC.NET IN-FLOW
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	3.4	3.4	0.0	0.0	0.0	0.0	0.0	3.4	3.4
1993	13.0	16.3	0.0	0.0	0.0	0.0	0.0	13.0	16.3
1994	28.7	45.1	0.0	0.0	0.0	0.0	0.0	28.7	45.1
1995	45.4	90.4	0.0	0.0	0.0	0.0	0.0	45.4	90.4
1996	61.3	151.7	0.0	12.6	0.0	12.6	12.6	48.7	139.2
1997	75.3	227.0	0.0	12.6	14.0	26.5	39.1	48.8	187.9
1998	87.1	314.1	0.0	11.9	14.0	25.8	64.9	61.3	249.2
1999	98.5	412.6	0.0	11.2	14.0	25.1	90.0	73.3	322.6
2000	110.4	523.0	7.8	10.5	14.0	32.2	122.2	78.2	400.8
2001	122.9	645.9	8.5	15.6	14.0	38.0	160.2	84.9	485.7
2002	136.6	782.5	9.3	14.9	14.0	38.1	198.3	98.5	584.2
2003	151.1	933.6	10.2	14.2	20.4	44.7	243.0	106.4	690.6
2004	167.3	1100.9	11.2	13.2	20.4	44.8	287.8	122.5	813.1
2005	185.3	1286.3	12.4	12.1	20.4	44.9	332.7	140.4	953.6
2006	198.6	1484.8	13.0	15.5	20.4	48.9	381.6	149.7	1103.2
2007	209.7	1694.6	13.6	14.5	20.4	48.5	430.2	161.2	1264.4
2008	222.0	1916.5	14.3	13.5	25.3	53.1	483.3	168.8	1433.3
2009	235.5	2152.0	15.0	12.2	25.3	52.6	535.8	182.9	1616.2
2010	249.0	2401.1	15.8	11.0	25.3	52.1	587.9	197.0	1813.2
2011	263.3	2664.4	16.6	9.7	25.3	51.6	639.5	211.8	2025.0
2012	279.0	2943.4	17.4	8.4	25.3	51.1	690.6	227.9	2252.8
2013	295.9	3239.4	18.3	7.2	25.3	50.7	741.4	245.2	2498.0
2014	312.9	3552.3	19.2	5.9	25.3	50.4	791.7	262.5	2760.6
2015	331.7	3884.0	20.1	4.6	11.4	36.1	827.9	295.6	3056.2
2016	351.9	4235.9	21.1	4.1	11.4	36.6	864.4	315.3	3371.4
2017	373.0	4608.9	22.2	3.5	11.4	37.1	901.5	336.0	3707.4
2018	396.6	5005.5	23.3	2.9	11.4	37.6	939.1	359.0	4066.4
2019	420.6	5426.1	24.5	2.4	11.4	38.2	977.3	382.4	4448.8
2020	445.8	5871.9	25.7	1.8	11.4	38.9	1016.2	406.9	4855.7
2021	473.8	6345.7	27.0	1.2	4.9	33.1	1049.3	440.7	5296.4
2022	503.7	6849.4	28.3	1.0	4.9	34.2	1083.5	469.4	5765.9
2023	533.8	7383.2	29.8	0.7	4.9	35.4	1118.9	498.4	6264.3
2024	567.7	7950.9	31.2	0.5	4.9	36.6	1155.6	531.0	6795.3
2025	603.1	8554.0	32.8	0.2	4.9	38.0	1193.5	565.1	7360.4
	8553.9	94697.0	488.5	249.4	455.6	1193.5	17959.9	7360.4	76737.1

Table VI.15(2) CITY GAS SUPPLY PROJECT IN MALAYSIA
FOREIGN CURRENCY EARNING (IN CURRENT PRICE)
- INTEREST RATE; 10.0% - (US$ 1000)

YEAR	(1) IN-FLOW FROM SALES	ACC. IN-FLOW	MAINTENACE COST	INTEREST ON L/T	REPAYMENT ON L/T	(2) TOTAL OUT-FLOW	ACC. OUT-FLOW	(3) NET IN-FLOW (1)-(2)	ACC.NET IN-FLOW
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	3.4	3.4	0.0	0.0	0.0	0.0	0.0	3.4	3.4
1993	13.0	16.3	0.0	0.0	0.0	0.0	0.0	13.0	16.3
1994	28.7	45.1	0.0	0.0	0.0	0.0	0.0	28.7	45.1
1995	45.4	90.4	0.0	0.0	0.0	0.0	0.0	45.4	90.4
1996	61.3	151.7	0.0	27.8	0.0	27.8	27.8	33.5	124.0
1997	75.3	227.0	0.0	27.8	15.4	43.2	70.9	32.1	156.1
1998	87.1	314.1	0.0	26.2	15.4	41.6	112.6	45.5	201.6
1999	98.5	412.6	0.0	24.7	15.4	40.1	152.7	58.4	259.9
2000	110.4	523.0	7.8	23.1	15.4	46.3	199.0	64.1	324.0
2001	122.9	645.9	8.5	35.2	15.4	59.1	258.1	63.8	387.8
2002	136.6	782.5	9.3	33.6	15.4	58.3	316.4	78.3	466.1
2003	151.1	933.6	10.2	32.1	23.0	65.2	381.7	85.9	552.0
2004	167.3	1100.9	11.2	29.8	23.0	64.0	445.7	103.3	655.2
2005	185.3	1286.3	12.4	27.5	23.0	62.8	508.5	122.5	777.7
2006	198.6	1484.8	13.0	35.1	23.0	71.0	579.6	127.5	905.3
2007	209.7	1694.6	13.6	32.8	23.0	69.4	648.9	140.4	1045.7
2008	222.0	1916.5	14.3	30.5	28.4	73.2	722.2	148.7	1194.4
2009	235.5	2152.0	15.0	27.6	28.4	71.1	793.3	164.4	1358.8
2010	249.0	2401.1	15.8	24.8	28.4	69.0	862.3	180.0	1538.8
2011	263.3	2664.4	16.6	21.9	28.4	67.0	929.2	196.4	1735.2
2012	279.0	2943.4	17.4	19.1	28.4	64.9	994.2	214.1	1949.3
2013	295.9	3239.4	18.3	16.2	28.4	63.0	1057.1	233.0	2182.3
2014	312.9	3552.3	19.2	13.4	28.4	61.0	1118.1	251.9	2434.2
2015	331.7	3884.0	20.1	10.6	13.0	43.7	1161.9	288.0	2722.2
2016	351.9	4235.9	21.1	9.3	13.0	43.4	1205.3	308.4	3030.6
2017	373.0	4608.9	22.2	7.9	13.0	43.2	1248.5	329.9	3360.5
2018	396.6	5005.5	23.3	6.6	13.0	43.0	1291.5	353.6	3714.0
2019	420.6	5426.1	24.5	5.3	13.0	42.8	1334.3	377.8	4091.8
2020	445.8	5871.9	25.7	4.0	13.0	42.8	1377.1	403.0	4494.8
2021	473.8	6345.7	27.0	2.7	5.5	35.2	1412.3	438.6	4933.4
2022	503.7	6849.4	28.3	2.2	5.5	36.0	1448.3	467.7	5401.1
2023	533.8	7383.2	29.8	1.6	5.5	36.9	1485.1	497.0	5898.1
2024	567.7	7950.9	31.2	1.1	5.5	37.8	1522.9	529.9	6427.9
2025	603.1	8554.0	32.8	0.5	5.5	38.8	1561.8	564.3	6992.2
	8553.9	94697.0	488.5	561.2	512.1	1561.8	25227.0	6992.2	69470.1

Table VI.16 SENSITIVITY ANALYSIS ON RETURN ON INVESTMENT

- Base Case -

Variables		Current Price		Fixed Price	
		Before Tax(%)	After Tax(%)	Before Tax(%)	After Tax(%)
N.G. Price	20% down	20.15	16.02	11.99	9.67
	10% down	18.94	15.13	11.59	9.39
	0%	17.67	14.18	11.19	9.11
	10% up	16.33	13.16	10.79	8.81
	20% up	14.88	12.06	10.38	8.52
LPG Price	20% down	10.86	9.00	7.29	6.16
	10% down	14.54	11.84	9.31	7.72
	0%	17.67	14.18	11.19	9.11
	10% up	20.51	16.24	12.98	10.37
	20% up	23.17	18.13	14.69	11.57
Crude Oil Price	20% down	16.63	13.39	8.20	6.87
	10% down	17.16	13.79	9.73	8.04
	0%	17.67	14.18	* 11.19	9.11
	10% up	18.19	14.57	12.59	10.10
	20% up	18.67	14.93	13.95	11.05
Investment	20% down	20.97	16.56	14.02	11.11
	10% down	19.18	15.27	12.49	10.02
	0%	17.67	14.18	11.19	9.11
	10% up	16.39	13.24	10.09	8.30
	20% up	15.27	12.41	9.12	7.59

Note: * Assemed to be changed by natural gas price and LPG price at the same time

Figure VI.1 ORGANIZATION OF HEAD QUARTER

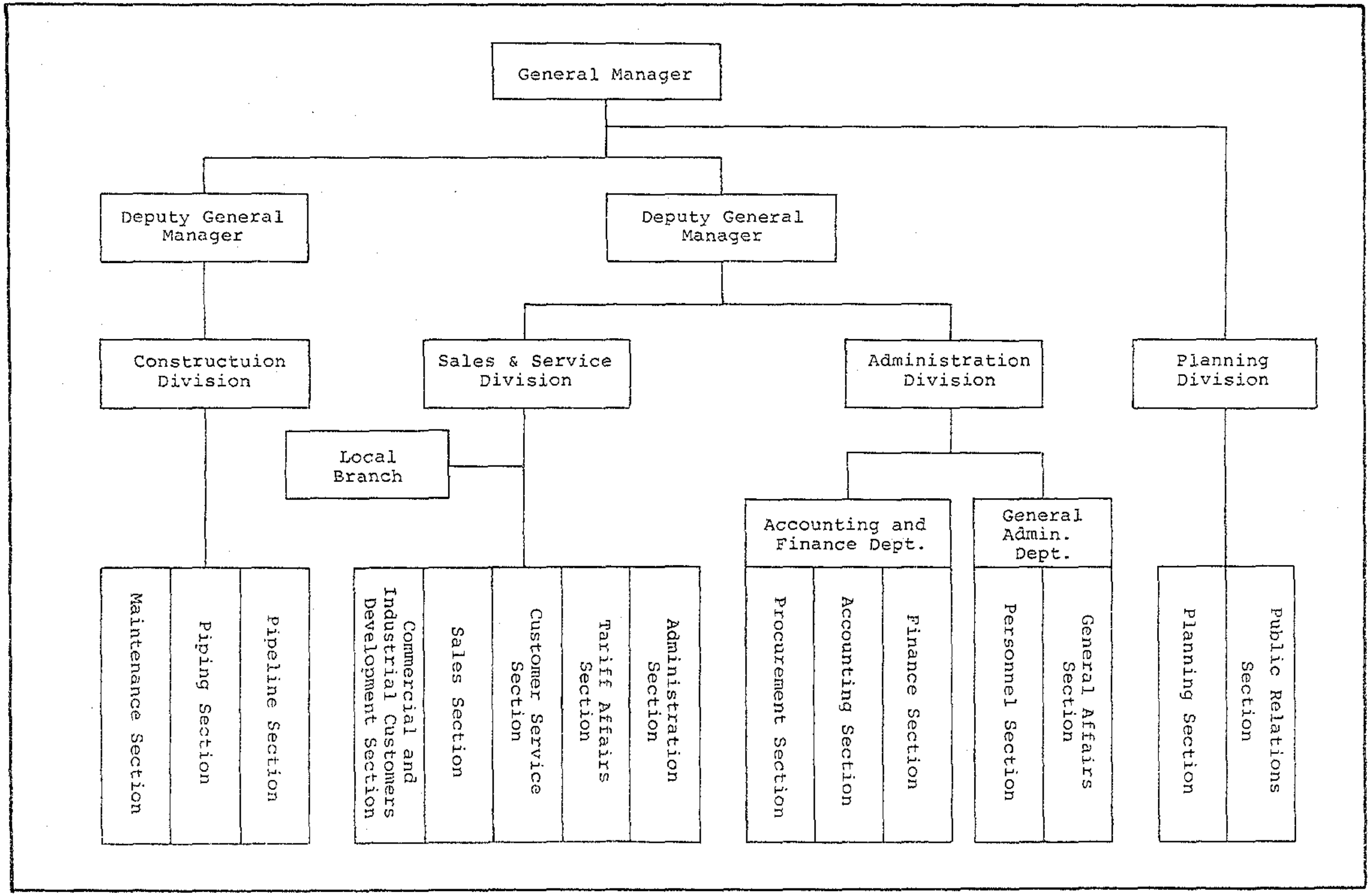


Figure VI.2 ORGANIZATION OF LOCAL BRANCH

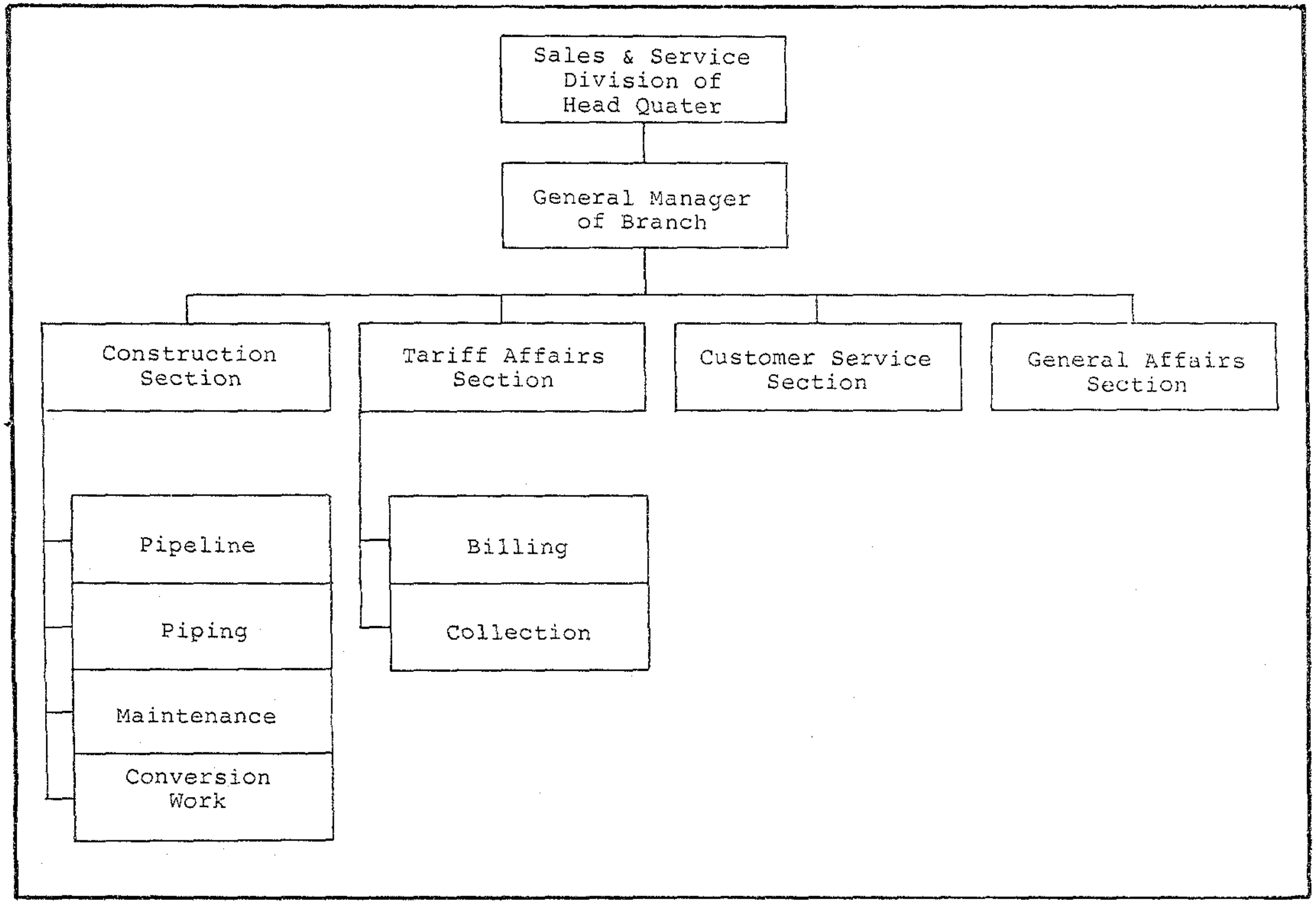
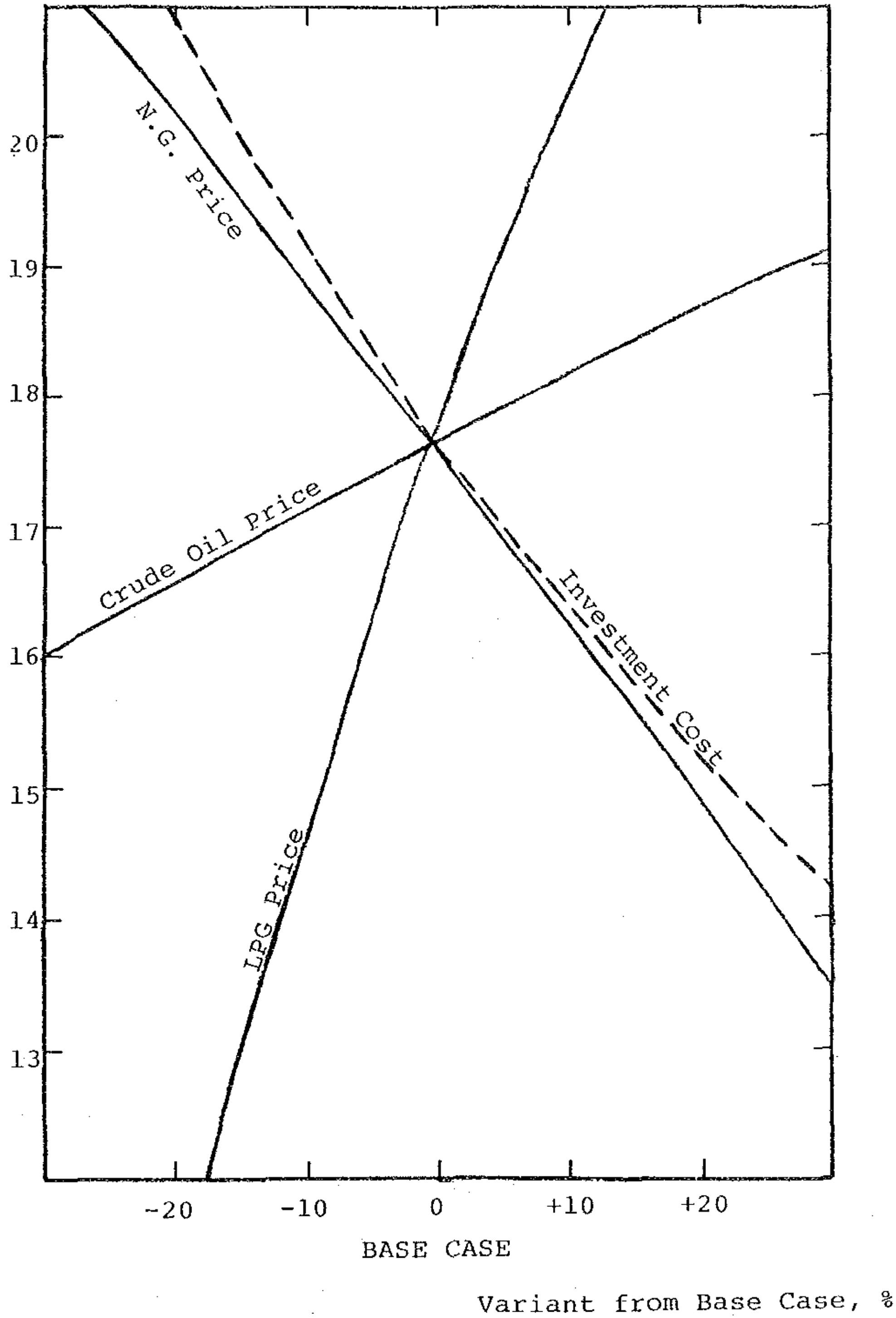


Figure VI.3 SENSITIVITY ANALYSIS OF RETURN ON INVESTMENT FOR BASE CASE

- CURRENT TERM (BEFORE TAX) -



PART VII CONCLUSION AND RECOMMENDATION

Part VII CONCLUSION AND RECOMMENDATION

Chapter 1 THE RESULT OF ANALYSIS

1.1 The Viability of the Project

The difference due to change of economic growth rate and between financial and economic analysis is not so big as mentioned in Table VI.8.

Due to the difference of cut off rate, in principle, the present value of economic analysis is plus and of financial analysis is minus excepting before tax at current price base.

The required foreign currency for repayment, interest and maintenance can be covered by the foreign currency earning amount by LPG export replaced by city gas in each year and from before completion of repayment, foreign currency balance is surplus, therefore, the project can contribute to the improvement of foreign currency balance. (Table VI.15(1)(2))

Also, this project has the merit of supplying clean and convenient energy to clients in the Klang Valley area and it will contribute to reducing pollution.

As mentioned above result, this project is recommendable as a national project.

Financial internal rate of return is 17.67% before tax at current price base in case of the low price scenario of crude oil for base case. This rate can be considered as enough for a public project, however, it is not enough for private investment.

Even in case of the low price scenario of the crude oil, there is a possibility that the natural gas price will become lower than the price of fuel oil after 1995. In such a case, FIRR will be improved to be higher than 20%.

Futhermore, natural gas price will become much lower than the price of fuel oil, city gas demand will increase by replacement of diesel oil and fuel oil used by manufacturing industry.

As mentioned above, this project is profitable as a national project, however, though there is a possibility of improvement of FIRR by re-estimation of crude oil and natural gas, the risk is too big for a private company.

1.2 Cash Flow

In the first year of start of operation, short term loan is necessary to cover the shortage of fund, but after that no shortage will not occure. For base case, even interest rate 10%, repayment of long term credit is also no problem due to the good financial conditions.

1.3 Organization

Because of high profitability as a national project but low profitability as a private project, it is desirable for this project to be realized by public investment. In case of public investment, the long term loan with low interest could be available from a foreign government and will be useful for this project.

As the base of this study, the company is suppossed to be as a not subscribed private company of which share capital is fully owned by PETRONAS and or its subsidiaries.

Now in Malaysia, there is a policy to promote privatization and the possibility of privatization of this project is also studied.

The merit of privatization is to introduce private capital, to activate the company and to prevent the excessive enlargement of the organization.

As mentioned in the reference information-1, most of city gas companies in the world are private, however, this project is not so profitable for the private company, therefore, without any incentive, it will be very difficult to attract private investment.

To activate and/or to prevent the enlargement of the organization, some portion of the operation of the company can be entrusted to a private company.

There are several methods of entrustment of operation, for example, counting meter and collecting fee which require many staffs can be entrusted as in Japan and part of sales promotion and maintenance can be also entrusted.

Chapter 2 THE PROBLEMS TO BE CONSIDERED WHEN THIS PROJECT IS EXECUTED

This project is considered as a good project to be promoted by the nation, and the following items should be taken into account when the project is realized.

2.1 The Forecast of Natural Gas Price

In this study, the economical value of natural gas was given by EPU, however, the estimated value of natural gas for FIRR was not given and was estimated as the same price with fuel oil.

This project is to utilize the natural gas which will be conveyed through the Trans-Peninsula Pipeline, therefore, the viability of this project stands on the same ground as the Trans Peninsula Pipeline. Therefore, if the natural gas price is forecasted in relation to crude oil price, it is desirable to re-calculate of FIRR.

2.2 Promotion of Reticulation System by LPG before Construction of City Gas System

The viability of a reticulation system (by LPG) is not so high as mentioned in Table VII.1 because the difference of price between LPG in bulk and in cylinders is not so big. In consideration that this project is useful as a national project, it is desirable to promote reticulation before installation of city gas system.

At that time, it is desirable that some portion of construction cost of reticulation is borne by the land developer because the cost of reticulation system is minor in comparison with the total cost of land development.

2.3 Monopoly to be granted

Due to the high public character of this project and the high investment cost, a monopoly in the service area should be given. Therefore, reticulation is also recommendable for promotion by PETRONAS.

2.4 Establishment of Safe Measure

City gas is more safe as a project in comparison with LPG distribution if the necessary safety measures are taken as mentioned in Reference Information-3. In this study, at the stage of construction, transportation and utilization, the necessary cost for safety for installation, for training and for delegation of foreign experts are included for this reason.

2.5 Preparation of Law Concerning City Gas Business

City gas business should be fitted to the existing various laws as mentioned in the Reference Information-2, however, as executed in Japan and other countries, one law such as the gas utility industry law of Japan attached in ANNEX can be considered as one of measure.

Table VII.1 FINANCIAL INTERNAL RATE OF RETURN OF RETICULATION IN FIXED PRICE BASE IN 1986

Conditions	
Number of Household	8,000
Construction per Household	230.4 US$
Table Construction Cost	1,843,200 US$
Construction Period	1 year
Sales volume per Household	160Nm^3/year
Raw Material (LPG Bulk) Cost	5.80 US$/MMBTU
Sales Price (LPG Cylinder Price)	8.71 US$/MMBTU
Total Raw Material Cost per Year	290,944 US$
Total Sales Amount per Year	436,864 US$
Labour Cost per Year	10,465 US$
The Project Life	35 years
Maintenance Cost	1% of Construction Cost
FIRR	
For Total Construction Cost	4.94%
For 70% 1/ of Construction Cost	7.82%
For 50% 1/ of Construction Cost	11.16%
For 30% 1/ of Construction Cost	17.92%

Note: 1/ The balance of construction cost is considered to be born by land developer

PART VIII REFERENCE INFORMATION

REFERENCE 1

PRIVATIZATION OF KLANG VALLEY CITY GAS BUSINESS

As described in "Conclusion & Recommendation", it is desirable that the Klang Valley city gas business be started as a governmental or semi-governmental enterprise. However, depending on the national policy on the procurement of investment, the business may possibly be started as a private enterprise. Alternatively, the business may first be started as a governmental enterprise and then be privatized. Whatever reason may induce a private form of enterprise, there are two possible forms of private enterprise as follows:

1) Unified privatization

One company will control all the system.

2) Dividing and Privatizing

The system will be separated in two or three blocks or more, and a company of private sector will own and manage the each block.

The merits and demerits of each of the above cases will be discussed hereinafter.

1. Unified Privatization

There are not many problems in case a private enterprise is to be established to cover all areas of Klang Valley. In that case, however, that private enterprise should be given the right to monopolize the business in the entire district and to use space under roads and streets and other rights necessary to guarantee the operation of the gas enterprise, and on the other hand, the obligations must be placed upon the enterprise to accept the Government control on consumer gas prices, accept the responsibility to supply gas under pre-established conditions and submit statements of account and so forth to the Government in order to protect the interest of customers and ensure a fair management of the enterprise. Numerous experiences prove that a private enterprise who is thus accorded with the exclusive rights and in return whose freedom of operation is restricted to a certain extent is sufficiently able to conduct a fair management and operation worthy of its public nature and, still as a private enterprise, to carry on a vigorous management and operation, making the most of the general merits of a private enterprise. The merits that may be expected from a private gas enterprise are as follows:

(1) For higher profitability, serious efforts will be made to promote sales and management rationalization.

(2) Flexibility of business conditions, such as labor conditions, that cannot be expected from a governmental enterprise can be expected.

(3) Auxiliary business such as gas apparatus sales to support the gas enterprise can be easily practiced.

(4) Better customer services through business-conscious management can be offered to the satisfaction of customers.

(5) Stronger responsiveness to competition will be maintained.

Worldwidely, the private gas enterprise is more general than the governmental gas enterprise. It is true with Europe and America, where developed gas enterprises have long been in existence and also with East Asia, where gas enterprises have recently been started. Although there are many governmental gas enterprises such as Gaz de France, but they still belong to the minority. British Gas Corporation, which had been the largest single city gas enterprise, was privatized in November last year. In Japan, as shown in the following table, the governmental enterprise occupy 30% but they share only 5% of the total customers.

	Number of enterprises	Ratio	Number of meters installed		Ratio
Government	73	30 %	868	thousand	5 %
Private	175	70	17,377		95
Total	248	100	18,245		100

2. Dividing and Privatizing

2.1 Form of Divided Management

The following form will be assumed for divided management of city gas business by private enterprises:

1) Areal divisions shall be made based on supply areas assigned for respective operating enterprises.

2) Each operating enterprise will receive a natural gas wholesale from another gas transmission company and distribute the gas to the customers in his supply area.

3) Each operating company owns its main distribution facilities.

4) The gas transmission facilities up to the point of wholesale may be owned by the gas transmission company or co-owned by the operating companies.

There could be other forms of operation. For instance, there could be an operating company who does not own main distribution facilities. However, a city gas enterprise who depends on others for distribution facilities which are the main subjects of investment as well as the source of profit will be completely different in nature from the general type of gas enterprise. Therefore, such an exceptional case will not be considered here.

2.2 Merits of Divided Operation

The largest merit of divided operation will be easiness with which investments can be invited. This must be the major purpose whenever divided operation is adopted. Furthermore, the following two advantages may be counted as merits:

1) Better customer services and more vigorous business activities based on the theory of competition.

2) Flexibility of management which is characteristic of a small enterprise.

2.3 Demerits of Divided Operation

It must however be noted that divided operation may generate the following demerits:

1) Inefficiency of distribution network

As long as the form of management and operation described in 2.1 is adhered to, the supply pipeline network of each enterprise must be independent and isolated from other enterprises. It is a principle that city gas supply pipelines are, unless otherwise required, constructed so as to form loops so that uninterrupted gas supply be maintained even if a pipeline is sectionally and temporarily closed due to an accident or construction work. In order to keep this principle, the amount of distribution pipes required in the vicinity of the dividing border will necessarily increase in the case of divided operation. Notwithstanding this increase of pipe quantity, the stability of supply as a whole will still be lowered generally than the continuous pipeline network.

2) Division loss in technical power

In order to manage and operate a gas enterprise, the acquisition and use of the gas supply and utilization techniques, the safety and maintenance techniques and other wide ranges of associated technology are essential. However, if the enterprise is divided, the transfer of such techniques among them will be difficult, and each one must make an effort separately to upgrade his technology. Not only technology but also computerized administration may be blocked from improvement and development, and in order to maintain a sufficient technical level, duplicated investments will be required.

3) Inequity between service areas

The demand structure and the speed of development are different from area to area, and therefore different enterprises may develop different business results to generate imbalance that efforts cannot offset. As a result, not only a lowered level of customer services but also, depending on the outcome of the profitability, saving of necessary maintenance cost could occur. Table VII.1 shows comparisons, based on six divisions of Klang Valley, between the anticipated profit of each district and the amount of investment on the facilities on the downstream sides of the distribution pipeline in that district. The Table reveals that Shah Alam and Petaling Jaya excel other districts in profitability. This Table is intended only to show the areal differences and should not be construed as to recommend division into six districts.

4) Reversed scale merits

Any kind of enterprise receives scale merits. For instance, when two co-existing enterprises of the same kind merge, a man-power curtailment is usually possible. Procurement of investments and materials and advertisement and public relations will be less expensive as the scale is larger. British Gas Corporation has recently been privatized without being divided. Divided operation may possibly lose the benefit of these scale merits which are otherwise generally enjoyed.

2.4 Minimizing Divided Operation Demerits

1) The divided operation demerits increase as the number of divisions increases. Therefore, it is most important that the division should be kept to the required minimum to minimize the demerits.

2) Co-possession of speciality departments

The following organizational departments, which if divided may suffer serious loss, may be co-possessed:

- Research and development department
- Supply facility construction technology control department
- Administrative control center (including computerized customer controls)

The form of co-possession could be through a joint investment company or by the gas transmission company accepting limited responsibilities under an assignment contract.

3) Promotion of joint undertakings

The following undertakings may be jointly performed since they offer large scale merits if performed jointly:

- Joint sales of gas appliances
- Joint procurement of general piping materials
- Establishment of a joint emergency back-up force by contractors of the same trade

4) Promotion of mutual assistance organization

The followings could be considered:

- Assistance in an emergency
- Connection of major pipes across boundaries (valves normally closed)

5) Establishment of management control organization

An organization may be established, which, being on the outside of each divided operation company, will constantly monitor the levels of customer services and facility maintenance and safety and as necessary give management guidance. The management guidance, desirably, may be a substantial one including dispatching of experts and financial assistance. The form of such organization most reliable as to operational capability will be that the gas transmission company participate in the capital investments of the divided operation companies and establish the said organization within itself. The monitoring of the maintenance and safety, etc. should initially be undertaken by the authorities concerned in the position of consumer protection and the said organization may take action upon the information furnished by such authorities concerned. Table VIII.2 shows the demerits described in the above and their countermeasures.

Reference 2

LEGISLATION CONCERNING CITY GAS BUSINESS

1. Preconditions for Establishment of City Gas Enterprise

In order that a city gas enterprise be established as an effective social enterprise, the following described three major preconditions should be satisfied.

Preconditions	Requirements	Particulars
1. Guarantee of enterprise operation basic conditions	1.1 Areal monopoly	In order to avoid excessive competition and enable systematic facility investments, in principle, more than two enterprises shall not be authorized in one area.
	1.2 Use of road for burial facility installation	The right to install pipes along road for gas supply to city areas should be generally admitted.
	1.3 Entry into private properties in emergencies	Entry into privately owned properties in an emergency such as gas leakage to take safety measures should be authorized.
2. Protection of customers' interest	2.1 Guarantee of stable supply	Facility construction and maintenance should be executed so as to supply gas under a constant pressure without interruption.
	2.2 Maintenance of low price	The enterprise should be operated efficiently, and the profit in excess of a certain level should be returned to customers, in order to maintain a low city gas price.
	2.3 Fair supply conditions	Fair supply conditions, including fair prices, should be applied to existing customers while potential customers in the supply areas be guaranteed the use of city gas under fair established conditions.
3. Guarantee of public and consumer safety	3.1 Public safety	The general public should be efficiently protected from dangers associated with city gas transportation and supply.
	3.2 Consumer safety	Sufficient means should be provided to protect consumers from dangers associated with gas consumption.

2. Legislation in Japan

(1) Gas Utility Industry

In Japan the above preconditions except those concerning the use of roads (1.2) are mainly regulated by the Gas Utility Industry Law and the related legislations based on that law. Also, the basic matters concerning the public and consumer safety protection (3) are regulated by the following two ministry ordinances issued on the basis of the same Gas Utility Industry Law:

Ministry of International Trade and Industry Ordinance to Regulate Gas Facilities Technical Standards

Ministry of International Trade and Industry Ordinance Concerning Gas Appliance Testing, etc.

The translation of the articles of the Gas Utility Industry Law is attached in ANNEX.

(2) Road Law

The Road Law provides that the space beneath roads may be used only when the road administering and controlling agency determines that such use of the space is appropriate and issues its approval. However as long as the below-mentioned conditions are satisfied, the road administering and controlling agency must authorize the gas enterprise to bury the gas facilities in accordance with the provisions of the Gas Utility Industry Law:

a. There are no other space to install the facilities except the road space in question.

b. Road occupation period, location, facility structure, work execution method, timing of work and road reinstatement method conform to the prescribed standards.

c. Schedule of work was submitted one month prior to commencement of the work.

It is added that similar regulations exist on other public utilities such electric and water supply facilities.

(3) Other Laws

The following laws are playing important roles in promoting the safety of the public and consumers by regulating the construction of city gas supply facilities and the installation of gas utilization facilities:

a. Road Traffic Law
b. Building Standard Law
c. Fire Prevention Law

3. Matters to be Discussed Concerning Legislation

(1) Legislation and Voluntary Efforts

In order that the preconditions described in 1 above be satisfied, various social conditions should be improved, where it cannot be denied that the legal regulations are important means of improving the social conditions. However, many of those conditions cannot be regulated only by laws. They largely depend upon the business and technical efforts of city gas enterprises, gas appliance industry and other related sectors. Therefore, it is important to study how to harmonize the legal regulations with the enterprisers' voluntary efforts.

(2) The present country is going to have city gas for the first time, but there already exist public investments such as electrical and water supply facilities and related laws and regulations. There also exist public or private regulations concerning technical standards and technical qualification systems. Therefore, the question of what kind of legal systems should be arranged to pave the way for the introduction of city gas cannot be but solved within the frame of the existing systems, including, among others, the law and regulations, which are the very results of her history and cultural development.

(3) In the light of the above philosophy, we only bring forward the preconditions requiring social facility improvements for city gas introduction supported by information on the methods of such improvements adopted in Japan, and we will not propose any specific laws or regulations that may be necessary for city gas introduction.

REFERENCE 3

SAFETY MEASURES IN CITY GAS SUPPLY AND UTILIZATION

1. Requirements on Safety Measures

With the introduction of city gas to Klang Valley, a large amount of combustible gas is to be sent to buildings through underground pipes, burnt there and transformed into an efficacy such as cooking and hot water production intended by the consumers. In order to complete this energy handling process safely and let the consumer enjoy such efficacy without uneasiness, the following safety measures are required.

1) Safety measures against accidents in connection with construction work to install underground pipes underneath roads and streets, etc.

2) Safety measures against a fire or an explosion which may be caused by leakage of combustible gas.

3) Safety measures against poisoning by incomplete combustion of combustible gas.

The safety measures of 1) above is also common to construction of public facilities such as water pipelines, sewer lines, power lines etc. Now, the gas facility construction work is going to newly participate and it should be armored with the same or more improved countermeasures.

The risk arising from leakage of combustible gas in 2) above has also been experienced in utilization of LPG in the Klang Valley area. However it should be emphasized that completely different countermeasures are required against this risk, as the land transportation of LPG cylinders will be replaced by the underground pipeline gas transmission.

Poisoning related to incomplete combustion of fuels in 3) above is common with any kind of fuels, and it will not have much significance as long as the energy consumption remains at the same level as it has been. However, the introduction of city gas will inevitably create new demand for energy and prior consideration on the countermeasures against the risk which may arise from large volume consumption of city gas is strongly recommended.

Thus, when city gas is to be introduced, sufficient safety measures should be taken against the risk accompanying that form of energy utilization. It can be predicted from the experiences of the existing gas enterprisers that if such safety measures should be neglected, such hazards as will diminish the social value of city gas would occur, but at the same time it can be said that the business performance records over the world prove that such risk can be completely tamed and harnessed.

2. Outline of Safety Measures

The countermeasures can be broken down to the following three steps:

1) Countermeasures for prevention of causes of accident such as improper operation in construction work, gas-leakage from gas facilities and incomplete combustion.

2) Countermeasures to prevent a cause of accident, if any, from developing into an accident such as fire, explosion, poisoning, etc.

3) Countermeasures to prevent expansion of the scope of area influenced by the accident which has once occurred.

It, of course, goes without saying that the most serious effort should be made concerning the measures of 1) above, which are most fundamental. However, it should be kept in mind that the cause of accidents cannot completely prevent to occur as a large-scale gas enterprise is operated and that to keep the frequency of such occurrence to a possible minimum is the very purpose of 1) above. The occurrence of the cause of accidents cannot be precluded and therefore the effort of 2) above must not be neglected.

Further, it is of importance that accidents such as gas explosion and poisoning are caused only as the result of an accumulation of leaked gas or continued aggravation of room air contamination by incomplete combustion, and in any case the fact of the matter is that there is a lapse of time before the primary accident grows into a hazard. From this point of view, the measures of 2) are important substantial accident prevention measures. The measures of 3) are the safety requirements that must be fulfilled by gas companies who are responsible for supplying of city gas to large areas. Even if such necessity cannot be clearly envisaged, the countermeasures must be taken as a necessary insurance to fulfill their responsibilities. The safety measures to be considered are shown in the following Table. These measures have been constructed from experiences in gas enterprise operation and management and are at present in practice. Detailed explanation item by item will be given after the following table:

Phase	Cause of accident	Accident	Related facility	1) Removal of cause of accident	2) Prevention of accident occurrence	3) Prevention of accident expansion
Facility construction	Defective work	° Damage to other properties ° Traffic accident ° Injury to workmen	Transmission facilities	1A-1 Standardization of work specifications and procedures 1A-2 Contractor selection and workmen's training		C-1 Readiness of mobilization
Gas transportation	Gas leakage	° Fire ° Explosion	Transmission facilities	2A-1 Construction of facilities capable of resisting adverse environment 2A-2 Proper maintenance of facilities	2B Preparation of emergency dispatch crews	C-2 Interaction with public accident prevention agencies
Gas utilization	Gas leakage	° Fire ° Explosion	Gas using installations	3A-1 Promotion of fail-safe gas using facilities 3A-2 Enforcement of safe gas using methods	3B Installation of gas leak sensors and gas inter-ception devices	
	Gas incomplete combustion	CO poisoning	Gas using installations	4A-1 Use of complete outdoor exhaust type gas appliances 4A-2 Inspection and improvement of gas appliance installation conditions	4B Installation of incomplete combustion detectors	

1A-1 Standardization of Work Specifications and Procedures

(1) Standards for excavation work in urban district

The basic safety requirements in road excavation and underground pipeline installation work are to partition off the work space clearly, to protect traffic, to protect other existing underground utilities and to retain and shore the excavation in a safe manner, etc. On these matters, "Public Accidents Prevention Requirements in Urban District Civil Work," a notice issued by the Ministry of Construction of Japan, serves as a reference. The outline of these requirements is shown as follows:

a. Work space shall be clearly partitioned off with a fence or the like conforming to the applicable standards and be properly guarded against inadvertent entry by pedestrians.

b. Traffic danger and stagnation shall be prevented by the following methods:

   i) Provisions shall be made so that the place under construction be recognized from afar.

   ii) Pedestrian passage shall be secured.

   iii) Car lanes shall be secured, vehicles be conducted, detour signs be conspicuously posted and other necessary measures be taken to protect vehicle traffic.

c. Existing underground utilities shall be protected by the following methods:

   i) Execute the "Preparatory Safety Measures" including investigation of the positions, types, constructions and deterioration statuses of existing underground utilities and consultations with the owners of those utilities on their protection and safety measures.

ii) Confirm the positions of existing underground utilities by trial excavation.

iii) Expose underground utilities by trench excavation, etc.

iv) Provide the exposed underground utilities with safety and protective work (relocation, reinforcement, protection, inspection, etc.) as agreed through consultation with the utilities owners.

d. Safety of earth work shall be maintained during and after the work in accordance with the approved standards as to earth retaining, shoring, backfilling and covering with plates, etc.

(2) Standardized work space

The work space temporary installations to be provided in accordance with a. above should be standardized to the maximum extent. Figure VII.1 shows an example in the case of city gas pipeline installation work. It is necessary to standardize the safety fences, safety cones, construction work signs, etc. which are to be installed in such work space.

(3) Gas handling work standards

In the case of city gas pipeline installation work, gas must be handled in the last phase of the work. The gas handling work includes 2 types of work, namely the work to tie the new pipeline to the old pipeline and the other to introduce gas newly to a pipeline system including newly installed pipes. A failure in the former work could be a cause for a fire or an explosion and in the latter for a gas leak at a distant place. Therefore, detailed work operation standards have been established. They are outlined as follows:

Connection to existing piping

- A newly installed pipeline, prior to connection, shall be tested for air-tightness in accordance with the established specifications.
- Connection to a live pipeline should be performed after stopping the gas flow to the connection point by the following methods:
  - Where a valve exists near the point of connection, close it.
  - Where no valve exists near the point of connection, gas shall be stopped by inserting stoppers temporarily. Always use two stoppers at a time, and a vent hole shall be opened in the section between the two stoppers so that the gas which has passed the first stopper be discharged into air.
- In case the length between the stopper and the connection point is long, nitrogen gas or the like shall be used to completely purge the gas remaining in that section.
- In case the connection is to be made to a pipe containing no gas, the connection should be made after making sure that the remaining gas has completely been purged. Purging with nitrogen gas, etc. should be performed as necessary.

Gas introduction to new or temporarily depressurized system

- In case there are customers along the introduction section, the main valves of all the customers should be closed.
- Air-tightness test must be performed before gas introduction to confirm that the section is completely closed.
- After the gas introduction, the air shall be drawn from the end of the closed section, and the fact that the air within has completely been replaced should be confirmed by means of an instrument.
- After introduction of gas into the closed section, gas will be then introduced to each customer and then it should be confirmed that gas has replaced the air in the pipe throughout the building. When the building cannot be entered, the closed condition should be maintained and the work shall not be proceeded with until the entry is allowed.

1A-2 Contractor Selection and Workmen's Training

(1) Contractor selection

As described in 1A-1 (3), a special safety caution must be used in city gas pipeline installation work, and in the light of the importance of the quality of the completed work with reference to the safety of the general public, it is recommended that the work be always and exclusively sublet to a number of carefully selected contractors. It is also recommended that a basic general construction contract including the below-mentioned contents be concluded with those selected contractors to clarify their responsibilities and have them always prepared for gas work undertaking.

a. Prohibition to let the whole work to subcontractors
b. Maintenance of the construction supervision organization directed by the client
c. Full-time assignment of a qualified and approved supervisor to each construction work
d. Prior submission of detailed construction plans
e. Contractor's liability for defects and damages

(2) Workmen's qualification system

There are some official qualification systems for workmen based on laws and regulations. However, in order to guarantee the quality of the completed work in city gas enterprises, the present official qualification systems are not sufficient, and it is often said that the city gas enterprisers' own system applicable throughout the country is in need. In Japan, however, there are no such system except that each individual enterpriser has a different system of their own.

The outline of the qualification system of Tokyo Gas Co., Ltd. for gas facility construction and maintenance workmen, as an example, is shown in Table VIII.3.

Official Qualification Systems (In case of Japan)

- ° Qualification of "supervisory engineers" and "technical superintendents" to be in charge of technical supervision of construction work of a certain scale or larger (Construction Enterprise Law).
- ° Qualification of "work superintendents" to be in charge of the safety of workmen on each of the classified types of work.

2A-1 Construction of Facilities to Resist Adverse Environment

The major environmental forces that damage the city gas supply facilities and cause gas leakage are corrosion, natural external forces and artificial external forces. The city gas supply facilities should be designed and constructed so as to gain strong resistance against such environmental forces. For this purpose, the following matters deserve special attention:

(1) Protection from corrosion

a. Use of non-corrosive materials or materials provided with protective treatments

The representative non-corrosive material is the pipe made of plastics. The medium density polyethylene appeared about 20 years ago after trials and errors on many types of plastics. Since its appearance, its use has increased explosively until now its reliability is still on the increase through various quality improvements. Steel pipes, if to be used, should be coated on their outer surfaces. Various coating materials are being used, but it is necessary to select one which totally excels in electric insulation quality, durability and resistance against damages.

b. Parallel use of electric corrosion protection

Coated steel pipe, unlike non-corrosive materials, is not completely corrosion-proof by itself. There is always a possibility of the coating being injured, and the portion once injured will develop corrosion which will expand fast. The electric corrosion protection will prevent such expansion, and it should always be provided whenever a coated steel pipe is used.

c. Electric insulation of piping from building

Indoor pipes and underground steel pipes should be electrically insulated. The macro-cell formed by iron and concrete in mutual contact often corrodes underground pipes fast. If the building is of reinforced concrete, this corrosive force is especially strong, calling for special attention.

(2) Protection from natural external forces

a. Maintenance of appropriate burial depth

The effect of the normal load including earth pressure and wheel load can be kept to the minimum by maintaining an appropriate burial depth which is considered to be 1.0 - 1.5 m. The optimum depth of pipeline is discussed in detail in a report attached in ANNEX. The standard burial pipe depth is 1.2 meters for low pressure pipes and 1.5 meters for medium and high pressure pipes in Japan. In Europe and America, shallower depths are adopted.

b. Adoption of appropriate wall thickness

Pipelines to be used under high or medium pressure should be made of materials of a strength and have a wall thickness sufficient to resist their internal pressures. To calculate the wall thickness, the ANSI Formula is most widely used.

c. Flexible piping

Stress concentration from ground settlement, etc. is liable to occur at the following locations wherein an appropriate piping method should be carefully chosen:

Pipe turn-up at bridge, etc.

Connection section between main pipe and service pipe Underground pipe near building exterior wall

At these locations, the pipes should be installed so as to have a deflection absorptive capacity by using the loop piping method, a snake pipe or a plural number of fittings, etc. as shown in Figure VII.2.

d. Protective measures

Where gas pipes should be isntalled underneath water or sewer pipes, or other utility pipes, they should be physically protected by placing them in sheathing pipes of a sufficient strength, etc.

(3) Protection from artificial external forces

a. Protection from vehicles, etc.

Above-ground exposed pipes installed at bridges, etc. and above-ground facilities such as regulators should be protected by concrete structures, etc. from damage by colliding vehicles.

b. Fixing of pipes

Pipes along bridges and indoor pipes, etc. should be firmly fixed to the main structure with brackets and anchor bolts, etc. so as to resist accidental forces such as winds, falling matters and human forces, etc.

2A-2 Maintenance of Facilities in Proper Conditions

(1) Periodical inspection

Various periodical inspections are practiced to ensure that the city gas transmission facilities are in proper conditions. An example of inspection frequency is shown in Table VII.4.

a. Leak investigation

b. Electric corrosion prevention condition inspection

c. Installation environment investigation
Soil foundation subsidence conditions, protective work conditions and existence of work by a third party in the vicinity are investigated.

d. Facility functions investigation
The functions of valves, regulators, etc. are investigated.

(2) Execution of remedial measures

Necessary countermeasures, such as follows, should be taken on the basis of the information obtained by the inspections:

a. Leakage repairs

b. Improvement of electric corrosion protection conditions

c. Releasing of stresses

d. Execution of third party works control

(3) Systematical control of third party works

To properly control third party works such as water pipes, sewer pipes, electric and communication cables and railway facilities over or near the city gas supply facilities is very important in safeguarding those gas facilities.

For this purpose, simply to make periodical inspections to discover third party works and take some countermeasures is totally insufficient. It is necessary to establish a systematical and comprehensive third party works handling organization within city gas operation company. And it is also necessary to establish a cooperation system over the enterprisers concerned and the following procedures have to be established through that cooperation system.

a. Information exchange with third party

A rule should be established so that work plans may be exchanged among enterprisers. Work information to be exchanged may first be in the form of annual work schedules and then individual work details.

b. Determination of protective measures by consultation

A rule should be established whereby the method of protecting the facilities to be affected by the work be determined through consultation between the enterprises of the affecting and affected sides. Protective methods may include relocation, reinforcement, temporary protection, work under presence of witnesses, periodical patrol, etc.

c. Clarification of protection work cost allocation

In order for this system to function smoothly, it is necessary to establish a mutually agreed rule that the cost of protective work as above-mentioned be borne by the party who has generated the necessity for such work.

(4) Preparation of facilities maintenance drawings

In the execution of all that are shown in (1) through (3) above, it is very important that the information of underground facilities on location and major specifications are maintained in the form of maintenance drawings or the like for prompt searching and picking up. Public facility enterprises have long been making diligent efforts in this area. However, in case a completely new facility enterprise is to be started, it is recommended that a computerized mapping system which by far excels the conventional systems in information renewal and index searching be adopted.

3A-1 Promotion of Fail-safe Facilities in Gas Utilization

The gas facilities which the users operate daily include gas cocks in the rooms, gas appliances and connectors to connect them. Gas leaks occur when these items are erroneously operated or connectors are dislodged or flames are accidentally blown out. When this kind of gas leak occurs in a narrow space, it could be very dangerous and therefore should be prevented by all means. It is of primary importance that the gas facilities must have a sufficient performance capacity, and for this purpose, quality assurance systems such as standard specifications and testing systems, etc. should be established. Further, gas facilities should be of such types as will preclude erroneous operation and/or be equipped with such mechanism as will preclude gas leakage even if erroneously operated. Such fail-safe mechanism includes the followings:

Gas cock : Locking mechanism, whereby the gas cock cannot be turned unless it is unlocked by pushing a handle or pulling a lever.
Excess flow safety device, which intercepts gas flow when it increases abnormally due to connector dislodgement, etc.

Connector : Displacement prevention mechanism

Gasappliance : Flame surveillance device which intercepts gas flow when the flame is put out.

3A-2 Enforcement of Safe Gas Using Methods

If the perfectly fail-safe gas using facilities cannot be attained, the users must be encouraged to operate them safely. The users should be thoroughly informed, through constant PR, of the following matters for safe operation of their installations:

a. Then the gas appliance is not in use, both appliance cock and room cock should be closed.
b. In case of a long absence, the main valve of the house or the store should be closed.
c. Too long a connector should not be used.
d. Inflammable materials should not be placed near the gas appliance.
e. When gas leaks in the room, the window should be opened and no fire should be used and any electric switch should not be operated. Emergency contacts (Gas company, Fire station, etc.) should be posted on the wall.

4A-1 Use of Complete Outdoor Exhaust Type Gas Appliances

Gas poisoning will not occur if the gas appliances in use is designed so as to discharge the combustion exhaust gas completely out of doors. Positive efforts must be made to diffuse gas appliances designed in such a manner except kitchen gas equipment. Such appliances include, as shown in Figure VII.3, balanced-flue type, forced-flue type and outdoor installation type apppliances. It must be noted that an appliance simply equipped with a chimny or a flue (called convection-flue type) is not a complete outdoor exhaust discharge type. If the flue of this type appliance is erroneously installed, depending on the wind direction, the exhaust gas may not be discharged out of doors completely and may be leaked in the room.

4A-2 Inspection and Improvement of Gas Appliance Installation Conditions

There are the following two types of unsafe appliance installation conditions that possibly cause gas poisoning:

(1) Installing in a narrow space such as bathroom a gas appliance of a type other than complete outdoor exhaust discharge type.

(2) Installing a smoke stack in such a manner that the end of it is so positioned that the exhaust gas may possibly flow back, depending on the wind direction (in the case of an appliance simply equipped with a flue).

The users must be repeatedly taught by PR that the above type installations should not be practiced. Periodical inspections by experts are desirable.

2B Emergency Back-up Crews

(1) 24-Hour readiness organization

Even if a erroneous site work operation, a gas leak, an incomplete combustion or other unsafe conditions may occur, a disaster can be prevented if such conditions are reported to the gas company and the gas valve is closed, the stagnating gas purged, the room/house occupants or pedestrians evacuated or other emergency countermeasures are taken in time. Especially, as will be described in 3B hereunder, there usually is a certain lapse of time before a gas leak develops into a disaster such as an explosion, and in such a case, taking a proper emergency action could be very effective. For this purpose, it is necessary to organize emergency crews who may be kept in readiness conditions 24 hours a day and upon receipt of a call, rush to the site of the accident and take appropriate action on their own judgement.

(2) The emergency crew vehicles should be bestowed with the right of way and be equipped with a siren or the like. Those vehicles should be further equipped with a means of wireless communication to be used in requesting orders of the higher officers at the base concerning actions to be taken on the site, receiving information on pipeline burial positions and communicating with other emergency vehicles at distant positions for cooperative actions. Further, those vehicles should be equipped with a loudspeaker to be used in addressing the public not to use fire, to stop the use of gas or in conducting evacuation, etc. Furthermore, those vehicles should be loaded with various necessary tools and machines which are necessary in performing necessary emergency operations on the site. In many cases, emergency back-up crews are required to perform excavation work. Therefore, universal type pavement breakers and excavation equipment with operators must always be kept ready. This may be fulfilled by mobilizing subcontractors. It must be specially emphasized here that the pipeline maintenance drawings referred to in 2A-2 could be of vital importance in executing emergency measures properly and promptly.

3B. Installation of Gas Leak Detection and Interception Facilities

The development of a gas leak into an explosion, which may cause a disaster, requires two preconditions, namely formation of an explosive gas mixture and presence of an ignition source. In the case of natural gas, when its concentration in air is 5% or over, the mixed gas will be explosive. The concentration in air k(%) is a function of leaked gas quantity G(m^3/h), size of the room V(m^3), air change of the room Q(m^3/h) and lapse of time T(hour) as follows:

$$K = 100 \frac{G}{Q+G} [1 - \exp(- \frac{Q+G}{V}) \cdot T]$$

As can be seen from the above formula, the gas concentration after a sufficient lapse of time is approximately 100 G/Q. Therefore, when G is less than 5% of Q, there will be no explosion. Even if G is larger than that, a relatively long time (0.5 - 1.0 hour) is usually required before k exceeds 5%. Therefore, many disasters can be prevented by discovering and stopping a gas leak in an early stage. The following measures are available for the purpose:

Early discovery of gas leakage	Gas interception
Impregnating gas with an odor	Room main valve
	Building main valve
Semiconductor type gas leak sensor	Remote control emergency interception

4B. Installation of Incomplete Combustion Detection Facilities

There are the following two types:

(1) Oxygen density sensor (built in gas apparatus to intercept gas automatically)

(2) Carbon monoxide sensor (installed in room to give out alarm)

C-1. Readiness of Mobilization

Several typical cases which require mobilization will be assumed beforehand and for each case the applicable operational organization and the number of personnel to be mobilized will be pre-established. The list of the personnel subject to mobilization, including their contacts, should be prepared. It is necessary that an emergency mobilization training be performed about once a year.

C-2. Interaction with Public Agencies

Concerted daily activities such as listed below should be prearranged with the Police, Fire Station and other agencies concerned:

1) Mutual information exchange

2) Emergency action at time of a gas leak (gas pipe closure, window opening, etc.)

3) Gas interception at time of a fire (main valve closure, etc.)

Joint training, etc. may be performed to train personnel in necessary techniques.

REFERENCE 4

NATURAL GAS AS MEASURES AGAINST AIR POLLUTION

Fortunately, air pollution is not acturized in the Klang Valley area. However, it is so only under the present energy consumption density and the present environmental quality standard, and both of these conditions may change in the future. Speaking of the energy consumption density, it is hard to imagine the economical development of Malaysia with the energy consumption density of the Klang Valley area kept to the same level as present. Also, speaking of the environmental quality standard, it is intended to be the norm on which a healthy life of the people is expected to be maintained, and it always tends to be lowered if technically and economically possible.

Therefore, no one can now say that air pollution will never be seen in the Klang Valley area in the future. However, if natural gas is introduced into this area as the main source of energy, it can be predicted that air pollution will be virtually prevented in the Klang Valley area. This is because natural gas, unlike fuel oil, produces very little of sulfur oxides (SOx), nitrogen oxides (NOx) and soot and dust, which are considered to be the main air pollutants.

A historical description of Japan's past approach toward air pollution prevention, which will be given hereinafter, will be very persuasive in understanding the effect of natural gas as air pollution preventive measures.

In Japan, the following three major policies for air pollution prevention were enforced with successful results:

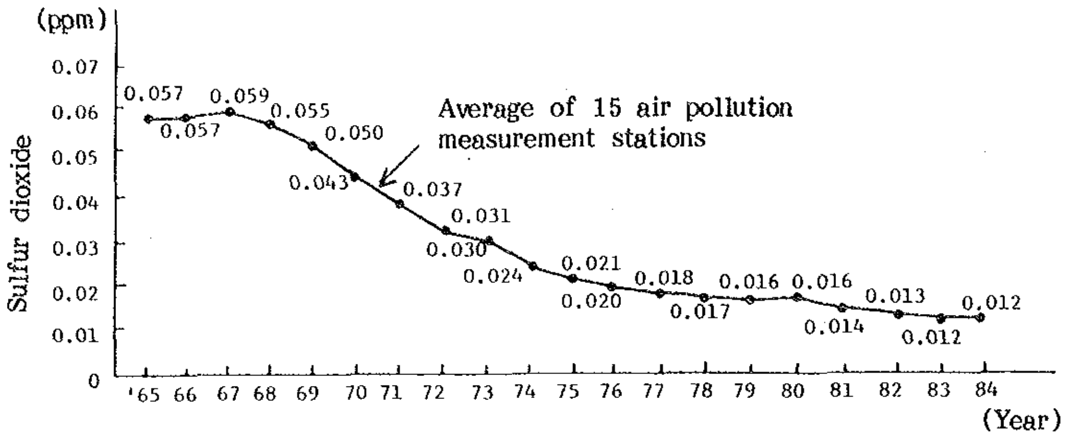
(a) Conversion to low sulfur fuels
(b) Enforcement of smoke stack gas desulfurizing
(c) Application of combustion control techniques

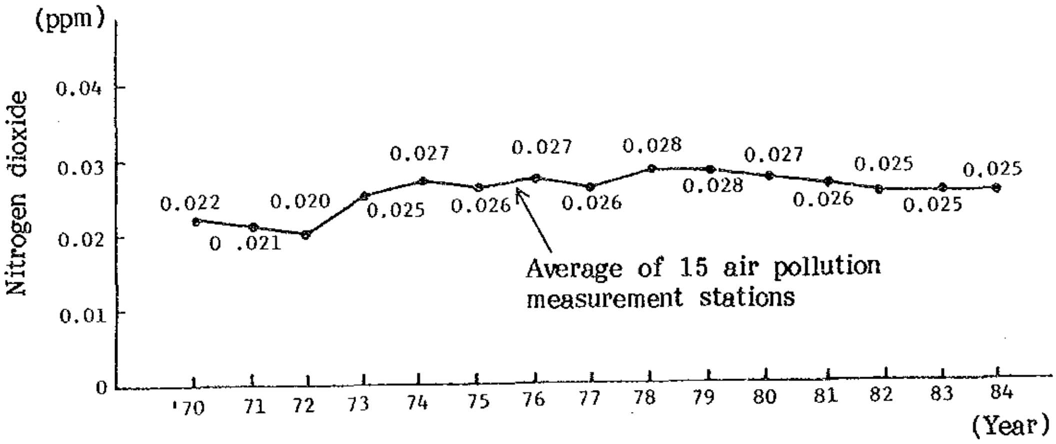
Natural gas is a fuel with the lowest sulfur content and also an excellent fuel to which the combustion control techniques can be applied most easily. Therefore, it is a very efficient energy that can be used in the enforcement of the two of the three basic policies in the above. (except for smoke stack gas desulfurizing).

1. Countermeasures Against Air Pollution in Japan

In Japan, environmental pollution including air pollution proceeded fast in large urban and industrial regions in the 1960's with the progress of a high economic growth, and therefore a full-scale challenge for environmental protection was then launched, answering a serious social request for prevention of environmental pollution. In 1967, the Basic Law for Environmental Pollution Control was enacted, followed by other related legislations. In addition, various pollution preventive techniques have been established. As a result of these activities air environmental pollutions, especially air pollution, was greatly alleviated. Further in the 1980's, the air pollution problems were further improved as the result of the suppressed increase of energy consumption under the economic growth slow-down and the energy conservation policy, which was promoted with the two oil crises as the momentum.

The average values of sulfur dioxide and nitrogen dioxide at the fifteen observation points scattered over Japan are graphically shown below. The value of sulfur dioxide had its peak in 1968 but has decreased since then as the result of various countermeasures taken by the fuel consumers. As to nitrogen dioxide, the value continued to decrease till 1983, but to our regret it has remained on the same level since then. It is because the countermeasures against NOx from mobile sources (automobiles) have not been satisfactory.





2. Pollution Control Legislations

The Basic Law for Environmental Pollution Control was enacted in 1967. The environmental laws which had been enacted hastily before then as emergency measures concerning air pollution, water contamination, ground settlement, etc. were re-organized under the new basic law. The Basic Law for Environmental Pollution Control regulates the following seven typical pollutions:

(1) air pollution
(2) water pollution
(3) soil pollution
(4) noise
(5) vibration
(6) ground subsidence
(7) offensive odor

In order to prevent air pollution, the Basic Law for Environmental Pollution Control first establishes an environmental quality standard (target for improvement of environmental pollution of the whole district). Base on this standard the Air Pollution Control Law and local government ordinances, respecting their local characteristics, establish their permissible contaminants discharge levels. The contaminants include (1) sulfur oxides, (2) nitrogen oxides, (3) soot and dust, (4) toxic substances and (5) coarse particulate. The above legislations aim at preventing air pollution by establishing the standard content rates of pollutants in fuels and the pollutants emission standards for exhaust gas.

3. Pollution Preventive Techniques

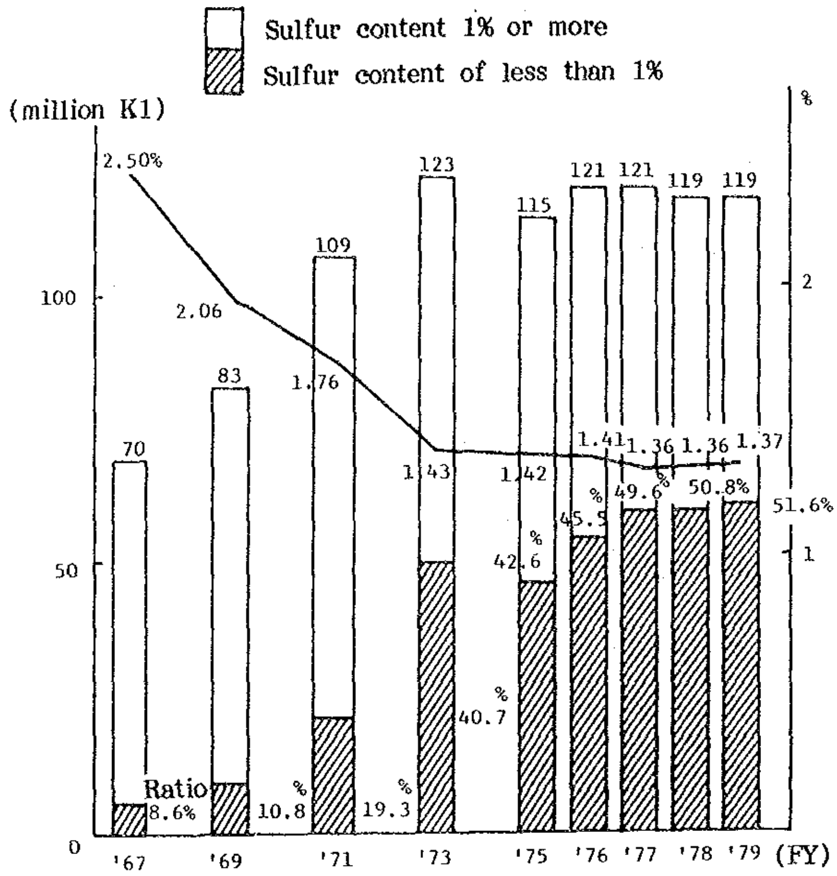
The pollution preventive techniques on the major air pollutants, namely (1) sulfur oxides, (2) nitrogen oxides and (3) soot and dust, will be described hereunder.

(1) Sulfur Oxides

The representative measures against sulfur oxides are (a) low-sulfurization of fuels and (b) smoke stack gas desulfurization. The low-sulfurization of fuels can be accomplished by conversion to gaseous fuels or to low-sulfurized heavy oil.

The conversion to the latter is shown graphically on the next page.

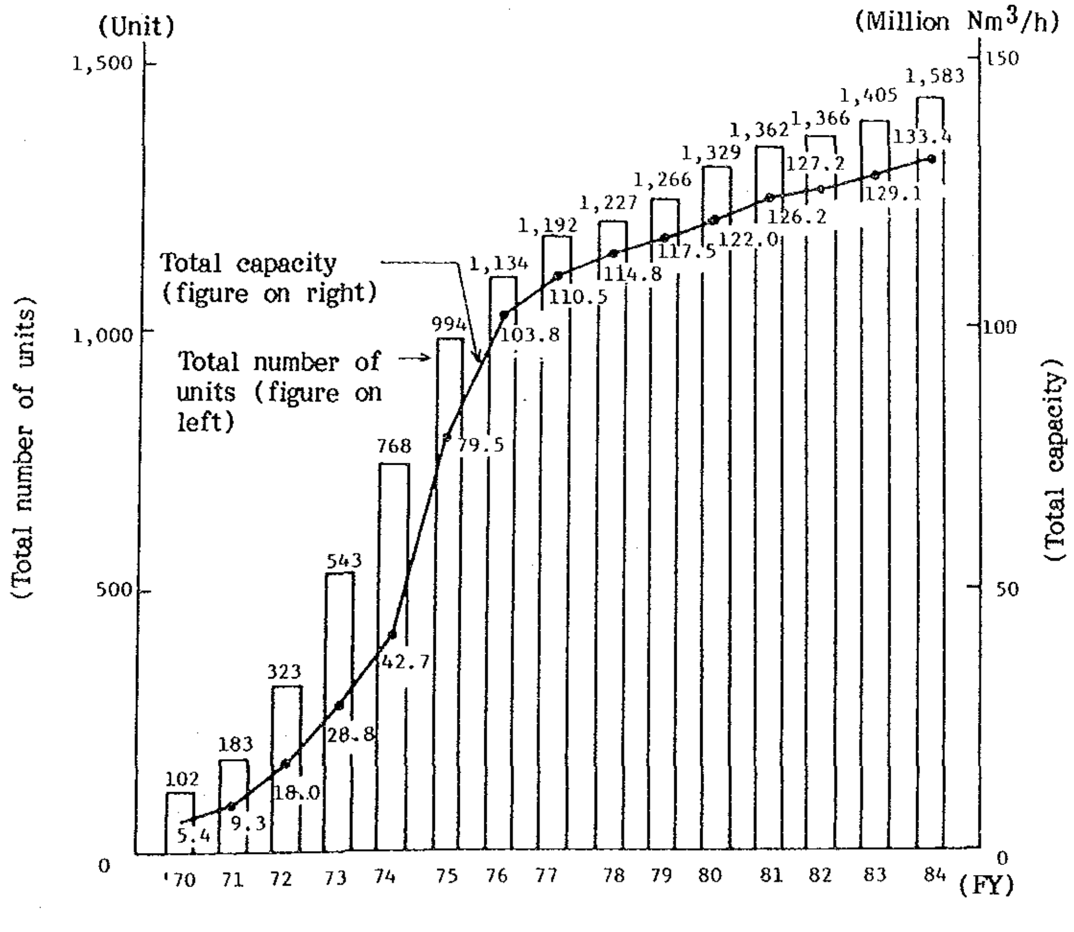
Changes in Heavy-Oil Supply by Sulfur Contents and Changes in the Average Rate of Sulfur Content



Note: Data obtained from Petroleum Association of Japan

The conversion from heavy oil to natural gas may raise the cost by 20 to 100%, while the low-sulfurization of heavy oil will increase the cost by 5 to 10%. Not withstanding this disadvantage, the conversion to natural gas in suburban industrial areas has been promoted as it, aside from being countermeasures against pollution, offers such other merits as energy conservation, stable supply, improvement of working environments, deletion of storage facilities, etc. Smoke stack gas desulfurization can be properly applied to combustion facilities of comparatively large scales such as electric power plants from the stand point of the cost of and the space for the desulfurization equipment. The chronological changes in the number of smoke stack gas desulfurization units and their total desulfurization capacity are shown in the following diagram:

Changes in the Number of Smoke Stack Gas Desulfurization Units and Their Total Desulfurization Capacity



Note) 1. The figures were obtained from the Environment Agency.

2. The figures are as of January 1 for each year except that those for 1983 onward are as of March 31 for each year.

As the result of the above measures taken, the air pollution by sulfur oxides has been significantly alleviated.

(2) Nitrogen oxides

The countermeasures against nitrogen oxides include (a) lowering of the nitrogen content in the fuel, (b) combustion control and (c) exhaust gas denitration. The table given below shows the nitrogen contents of the fuels. This Table also shows the sulfur contents of the fuels. It is seen from this Table that the fuels of low sulfur contents are generally low in nitrogen contents, too. Therefore, the conversion to low sulfur fuels, which was promoted as countermeasures against sulfur oxides, has also contributed to reducing nitrogen oxides in the air.

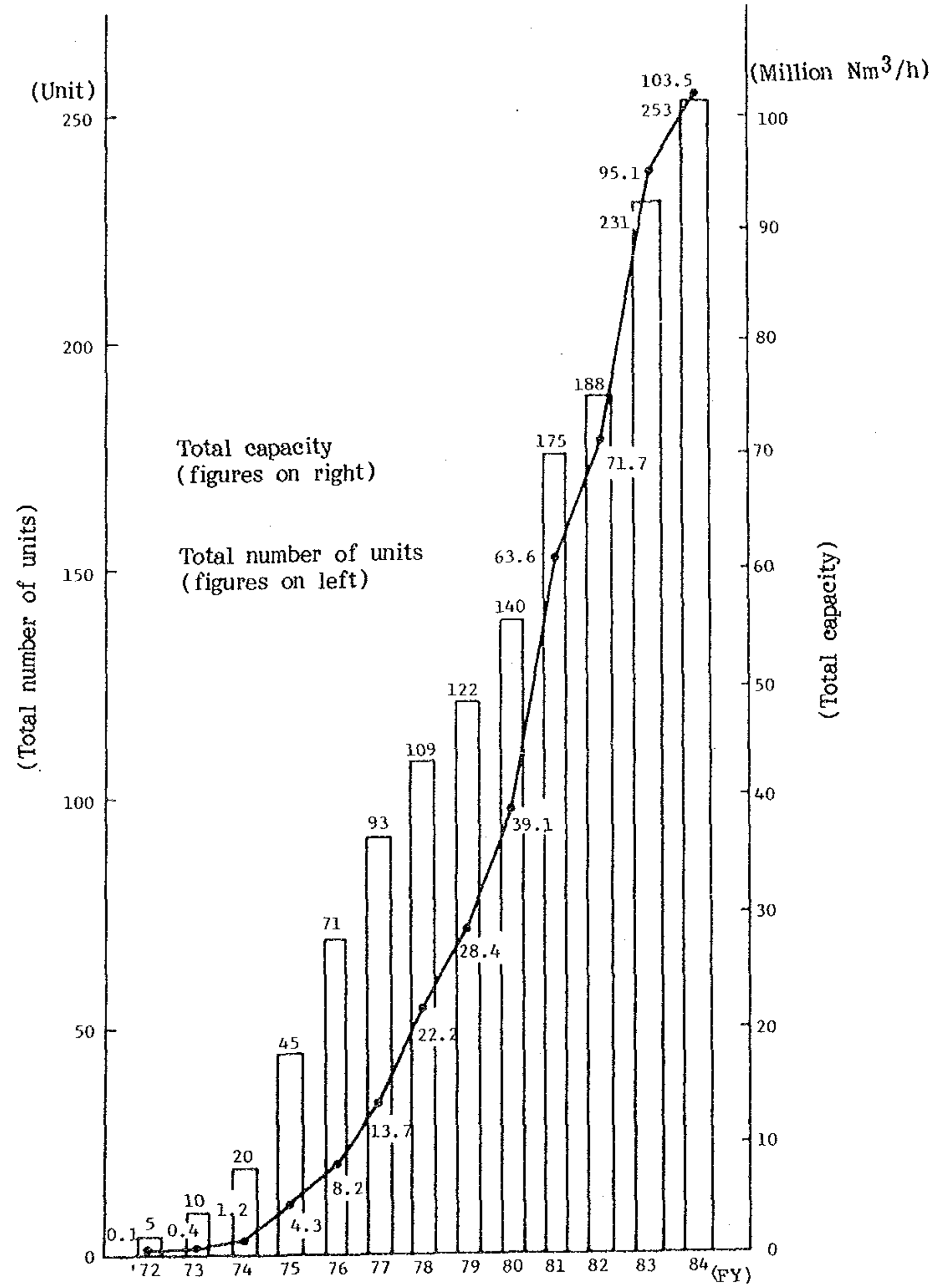
Nitrogen* and Sulfur Contents in Fuels

Type of fuel	Fuel	Nitrogen	Sulfur
Solid fuel (wt%)	Coal	0.7 - 2.2	0.3 - 2.6
	Coke	0.6 - 1.4	0.2 - 1.0
Liquid fuel (wt%)	Crude oil	0.03 - 0.34	0.1 - 3.0
	Kerosene	0.0005 - 0.01	0.001 - 0.2
	Light oil	0.004 - 0.006	0.03 - 0.50
	Heavy oil A	0.005 - 0.08	
	Heavy oil B	0.08 - 0.35	0.2 - 3.0
	Heavy oil C	0.2 - 0.4	
Gaseous fuel (g/Nm^3)	Liquefied natural gas	tr	tr
	Liquefied petroleum gas	tr	tr
	Coal gas (crude)	1 - 9	1.5 - 7
	Coal gas (refined)	0.02 - 0.5	0.05 - 0.7
	Blast furnace gas	tr	tr

* Nitrogen contained in nitrogen compounds

The combustion control includes a number of methods such as 2-step combustion method, varied density combustion method, exhaust gas circulation method, water vapor spraying method and adoption of low NOx burners, etc. As a fuel to be used, however, a gaseous fuel is more efficient as it offers more freedom of combustion methods. Exhaust gas denitration is adopted mainly by large-scale combustion installations which offer scale merits. The changes in the number and capacity of denitration units are graphically shown on the next page.

Changes in the Number and Capacity of Denitration Units



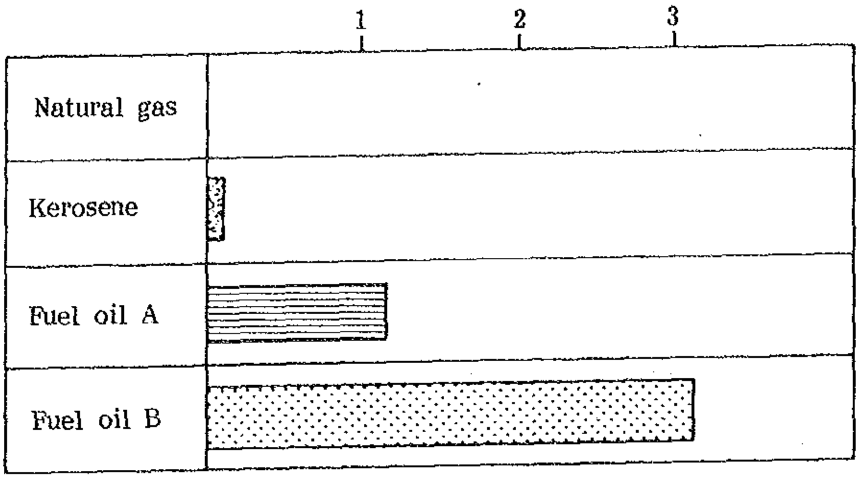
(Note)
1. The figures were obtained from the Environment Agency.
2. The figures for 1984 were obtained from Smoke Generating Facility Notifications Data Preparation Project.
3. The figures for years up to 1982 are as of January 1 for each year and those for 1983 onward are as of March 31 for each year.

(3) Soot and dust

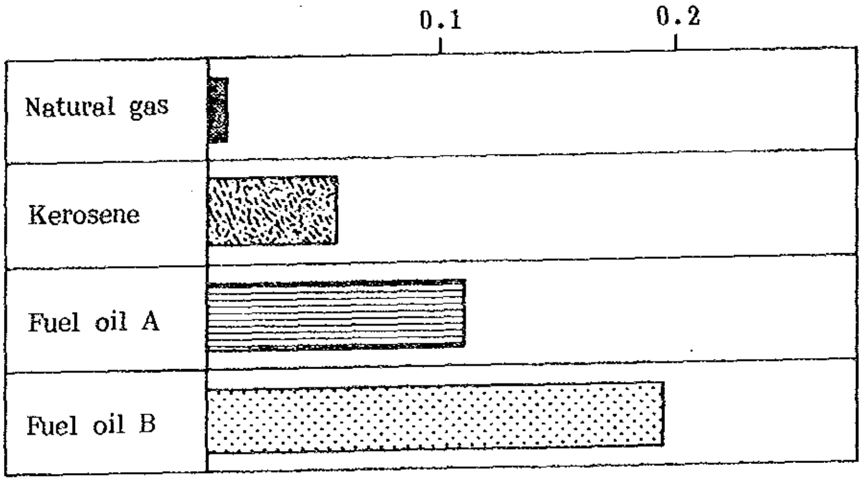
The hydrocarbons in the fuel, in the process of combustion, undergo thermal decomposition, dehydrogenization, polymerization, etc. and, without being oxidized completely, generate isolated carbon and tar, etc., which are discharged into air as soot and dust. Therefore, the countermeasures include (a) use of fuels of higher combustibility, (b) combustion control and (c) installation of a dust collector, etc.

Thus, the countermeasures against the three major pollutants have been discussed so far, and what countermeasures, to take up will depend upon the purpose of the energy utilization, the scale of the energy using facilities and its location.
The following diagrams show comparisons of the pollutants discharges from different fuels without exhaust gas desulfurization or denitration processing. It is apparent from these data that the contribution to pollution prevention is high in the order of city gas (natural gas), kerosene and heavy oil.

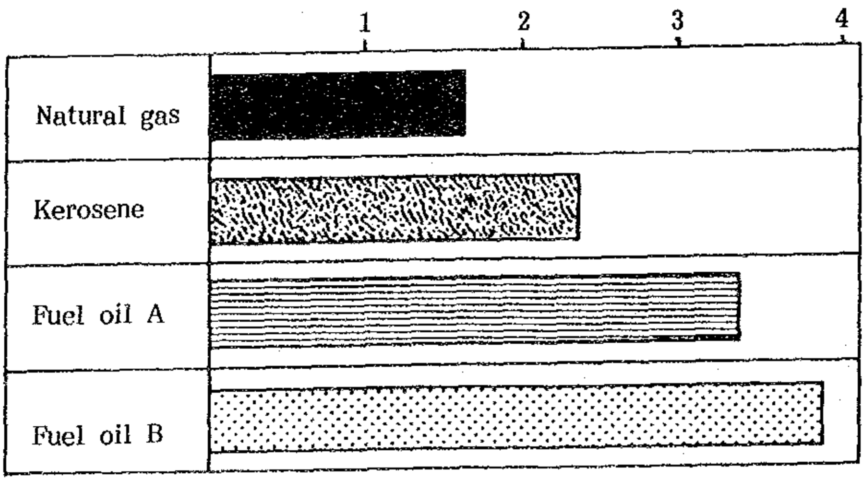
* Sulfur in fuels (wt% max.)



*Soot and dust discharge from boiler by fuels (gr/Nm^3)



*NOx discharge from boiler by fuels (gr/10^4 kcal)



In Japan, the cost of energy is high also in the above order, and therefore desulfurized heavy oil is the main fuel commonly used in Japan.

There were, however, many cases wherein other fuels were converted to natural gas in spite of its cost disadvantage as its introduction was accompanied by such advantage that it does not require storage facilities, that energy conservation can be achieved and that facility modernizations such as automation and improvement of working environments can be planned. As the result, the natural gas consumption, as shown in the following diagram, has increased every year as the fuel for thermal power plants in the vicinity of large cities and as city gas for air-conditioning and production processing in large cities and industrial regions such as Tokyo, Kawasaki and Yokohama.

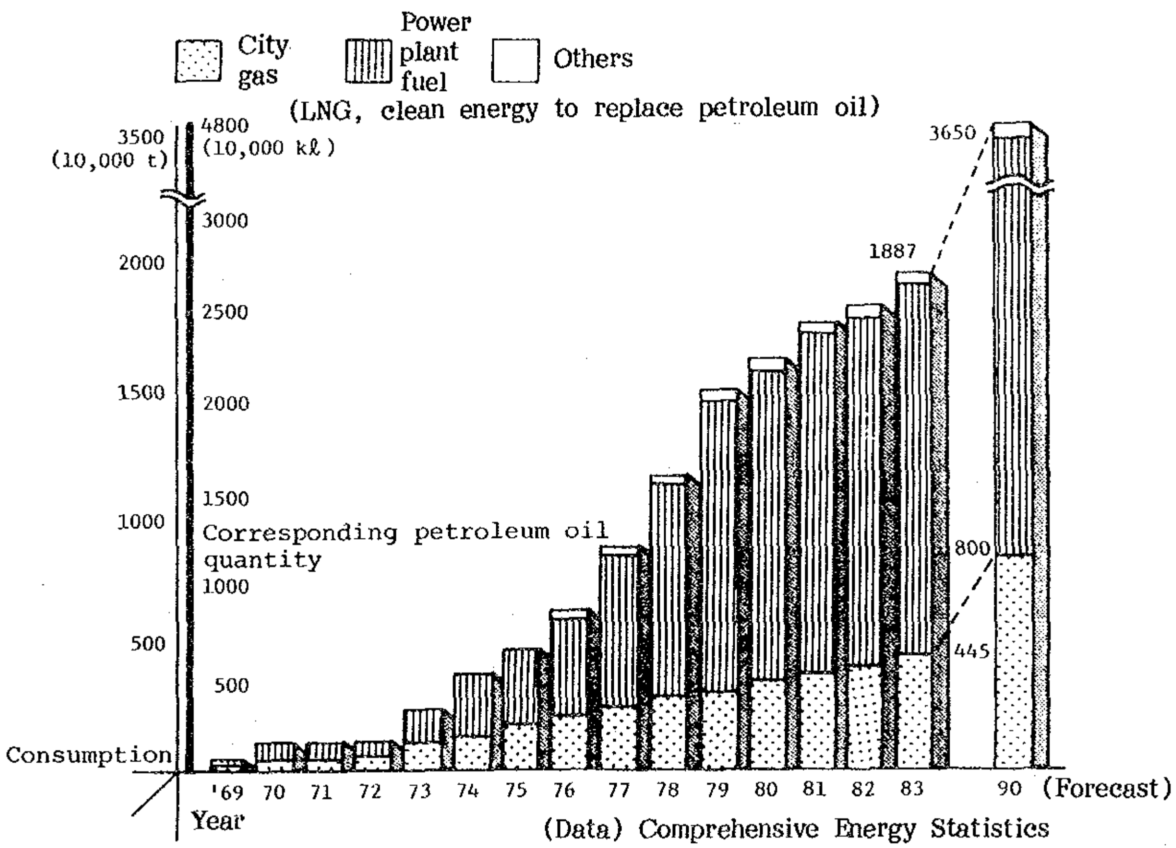


Table VIII.1 COMPARISON OF PROFITABILITY OF SERVICE AREAS

Service area			K.L.	Gombak	Hulu Langat	Petaling Jaya	Shah Alam	Klang	Total
Accumulated investment (excluding transmission pipelines) US\$ 10^6		A	127.3	29.3	28.2	37.5	22.8	37.5	283.6
Final annual sales volume 10^3 Nm^3	Household Restaurant		104.9	23.2	23.4	31.7	20.7	25.5	229.4
	Hotel Industry		5.1	1.5	3.6	7.6	8.9	9.9	36.6
	Total	B	110.0	24.7	27.0	39.3	29.6	35.4	266.0
Estimated profit US\$ 10^6	Household Restaurant		28.32	6.27	6.32	8.56	5.59	6.87	61.93
	Hotel Industry		0.79	0.23	0.57	1.19	1.39	1.55	5.72
	Total	C	29.11	6.50	6.89	9.75	6.98	8.42	67.65
Profitability index		A/C	4.37	4.50	4.09	3.84	3.27	4.45	4.18

Table VIII.2 DEMERITS AND COUNTERMEASURES IN DIVIDED OPERATION

Demerits	Countermeasures
1. Inefficiency of distribution network ° Increase in the required amount of distribution pipes. ° Decrease in the stability of supply	Connection of major pipes across the boundaries through valves which are closed normally and open only in case of emergency. (Effect limited)
2. Division loss in technical power ° Overlapping investment for acquiring, maintaining and developing the technologies for gas supply, gas utilization and safety control by each operating company	Joint ownership of : R & D section Construction technology control section Administrative Center including computerized customer information system
3. Inequity between service areas Inequity in customer service and safety control level to be caused by the difference in business showings which may have basis in the different demand structure and development rate of the service areas.	Establishment of controlling body for : Supervision of safety and customer service level Instruction on operation Assistance for management
4. Reversed scale-merit ° Increase in the number of employees ° Less favorable in finance and procurement ° Decrease in advertizing effect	Joint operation in : Gas appliance sales Common material procurement Emergency back-up force arrangement Cooperation in daily operation of emergency crews

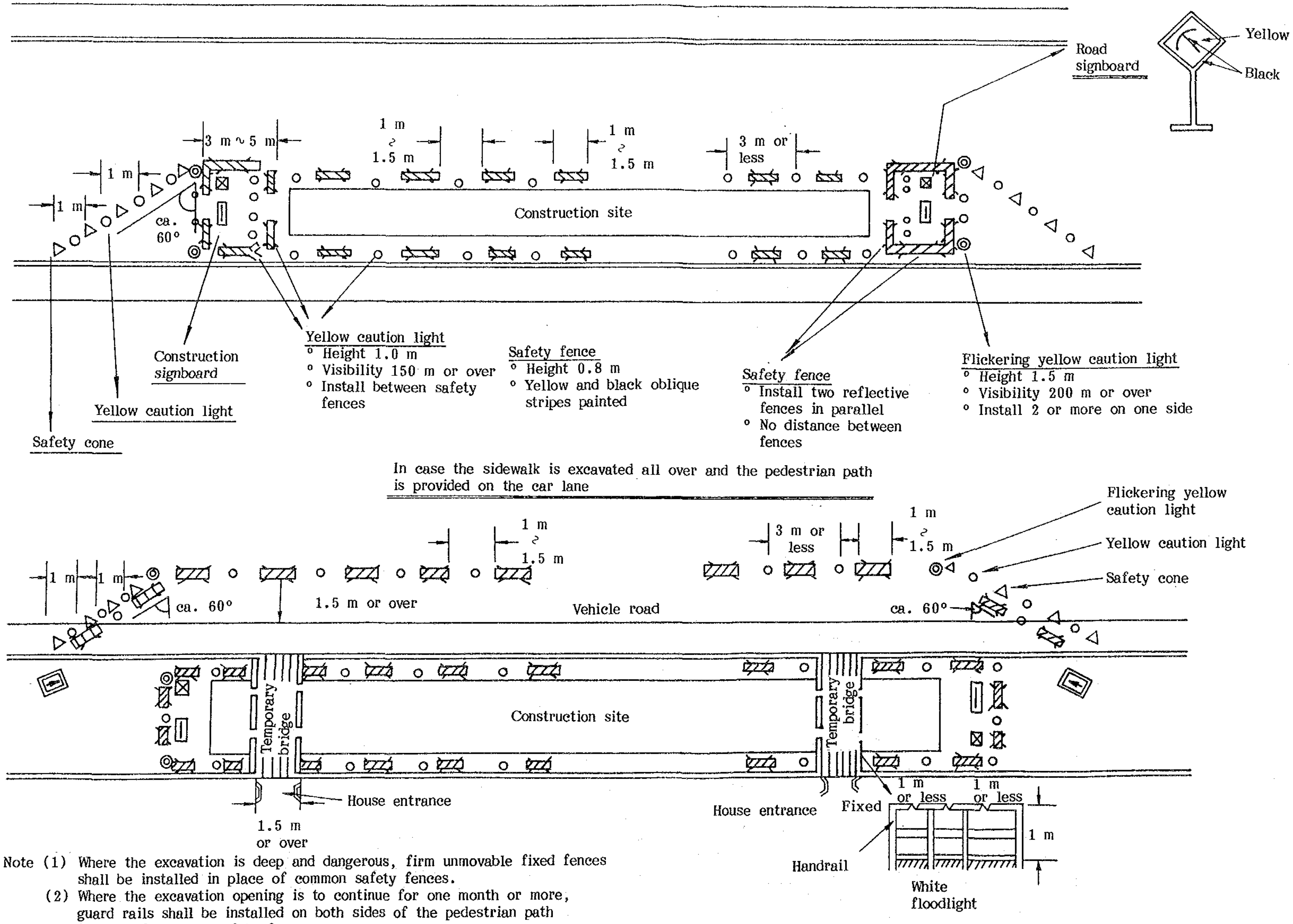
Table VIII.3 QUALIFICATIONS FOR FACILITY CONSTRUCTION AND MAINTENANCE/TOKYO GAS CO., LTD.

Field	Name of qualification	No. of classes
Construction and maintenance of transmission and distribution facilities	Construction supervisor	2
	Road reinstatement supervisor	1
	Plumber	2
	Welder	1
	Ironworker	1
	Third-party construction inspector	4
	District regulator overhauler	1
	District regulator inspector	1
	Pipeline designer	2
	Polyethylene pipe installation supervisor	1
	Polyethylene pipe plumber	1
Construction and maintenance of customer related facilities	Internal pipe installation supervisor	3
	Meter exchange work supervisor	1
	Welding supervisor	1
	Road reinstatement supervisor	1
	Internal pipe plumber	3
	Service pipe installer	2
	Meter exchanger	3
	Welder	1
	Ironworker	1
	Appliance connector	1
	Piping designer	2
	Piping design superintendent	2

Table VIII.4 MAINTENANCE FREQUENCY FOR PIPELINE AND RELEATED FACILITIES (TOKYO GAS CO., LTD.)

Facilities	Type of inspection		Frequency	Requirements according to 'The Gas Utility Industry Law of JAPAN'
Pipeline	Leak survey (Barhole survey)	HP	Once a year or more	Once a year
		MP	Every three years or more	Every three years
		LP	Every three years or more	Every three years
	Corrosion survey (MP)		P/S potential monitoring once a year	Corrosion protection must be applied to pipes installed in places where severe corrosion is likely
	Suspended pipe inspection (MP)		* Once a year for MPA * Once every two years for MPB	
	Surface patroling (MP)		* None	
Regulators (MP)	Routine survey		Once a week	
	Functions inspection		Once a year	
	Major overhaul		Once every three years	* once every six months with no filters * Once every three years with filters
Values (MP)	Functions inspection		* Once a year for MPA valves * Once every two years for MPB valves	
Gas holders (MP)	Routine survey		Once every three days	
	Facility survey		Once every two years	
	Open inspection		Once every three to seven years	

Figure VIII.1 CONSTRUCTION SITE SAFETY FACILITIES INSTALLATION REQUIREMENTS (EXAMPLES)

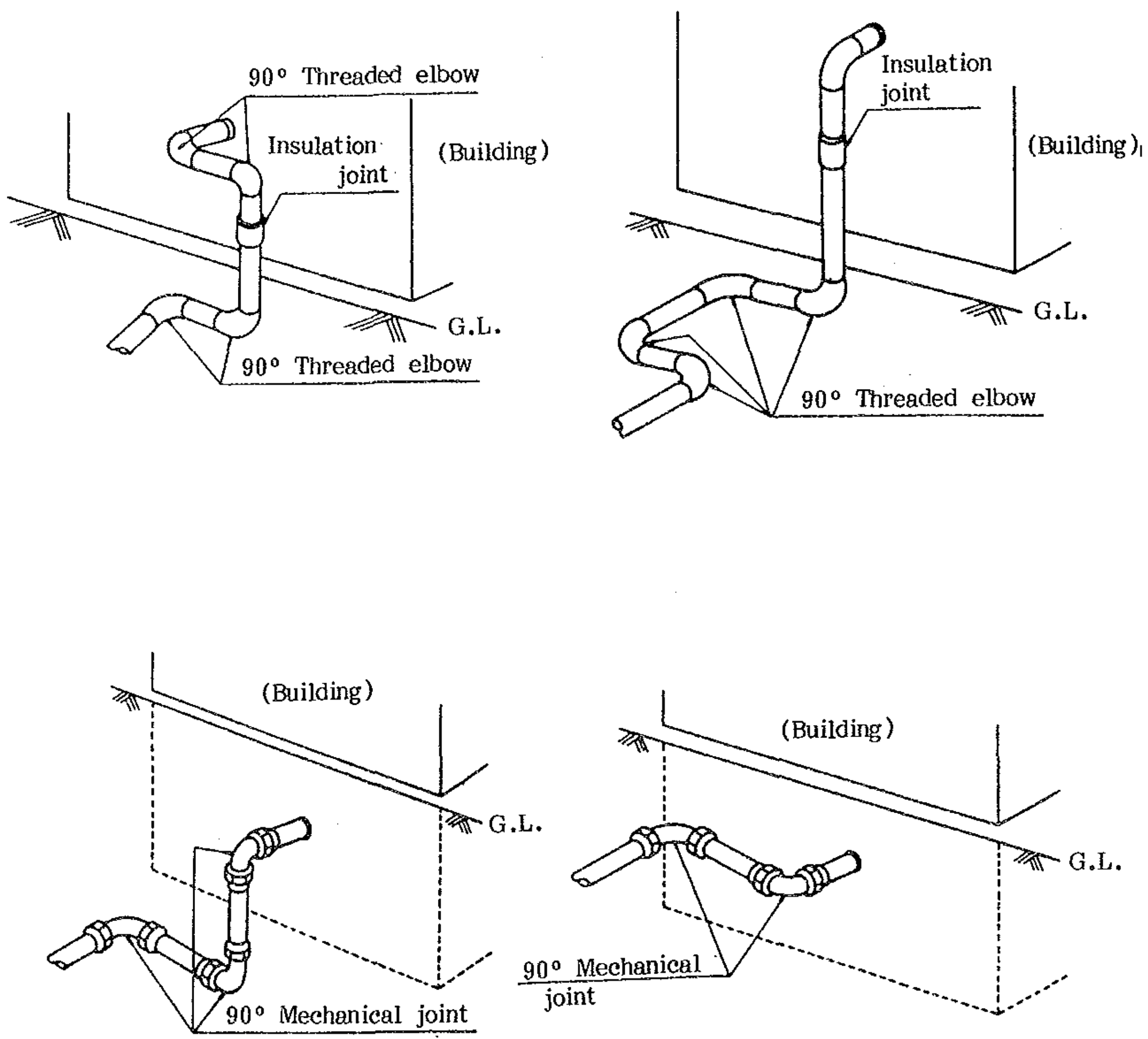


Note (1) Where the excavation is deep and dangerous, firm unmovable fixed fences shall be installed in place of common safety fences.

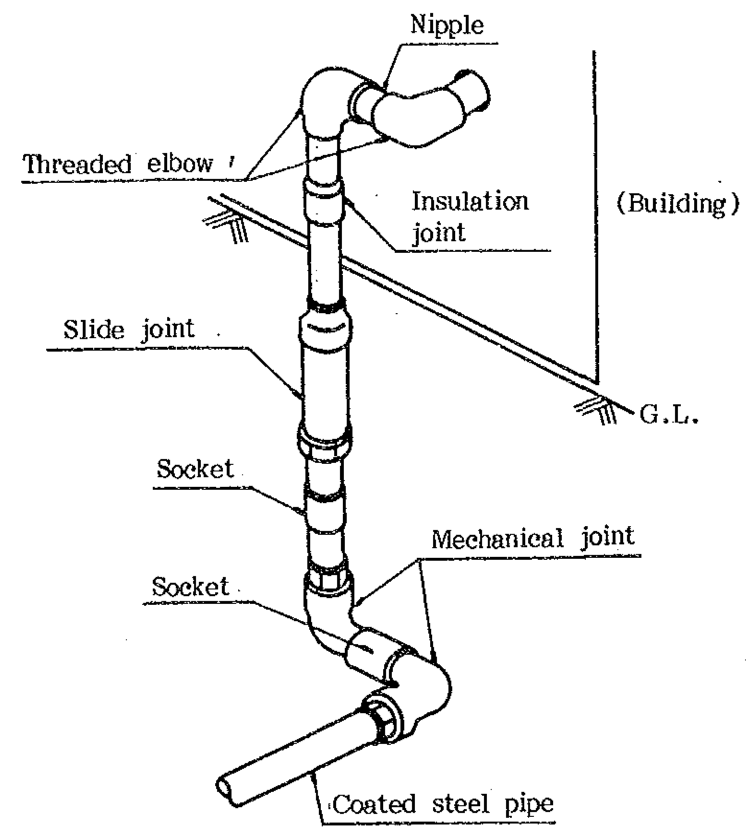
(2) Where the excavation opening is to continue for one month or more, guard rails shall be installed on both sides of the pedestrian path instead of common safety fences.

Figure VIII.2 EXAMPLE OF PIPING WITH HIGH FLEXIBILITY

(1) Flexible piping with multiple fittings



(2) Flexible piping with slide joint



(3) Flexible piping with snake pipe

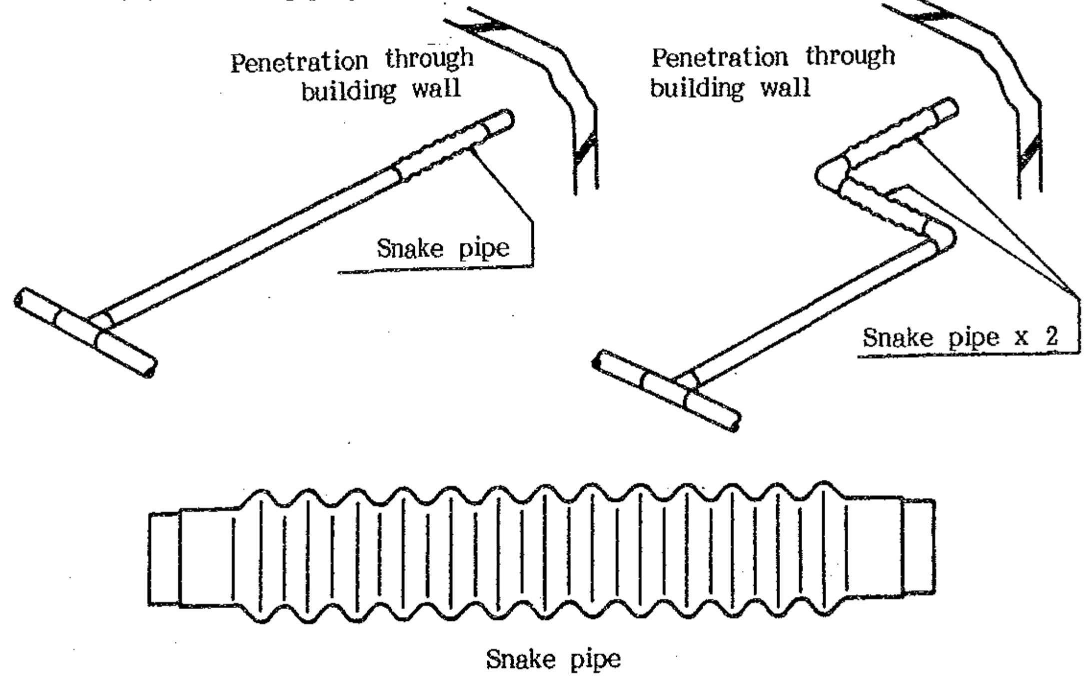
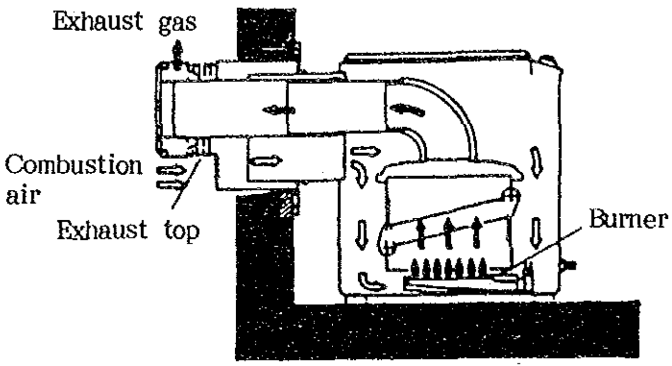
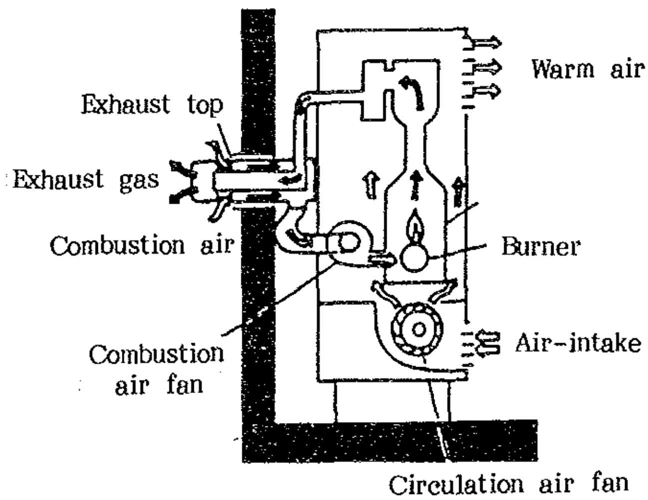


Figure VIII.3 COMPLETE OUTDOOR EXHAUST TYPE GAS APPLIANCES

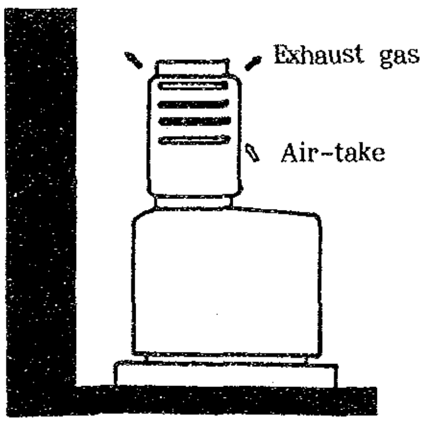
Balanced Flue Type (Bath heater)



Forced Flue Type (Space heater)



Outdoor Installation Type (Bath heater)



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