3 ENERGY SUPPLY MODEL

For the drawing of the energy supply and demand plan in the REPELITA IV which start in 1983, the current energy policy of the Republic of Indonesia is intended to achieve the following four goals.

1) Development of potential energy sources
2) Diversification of energy sources and conservation of oil
3) Conservation of energy
4) Efficient utilization of energy

Under these goals, the purpose of the supply model for the analysis of energy supply and demand is to find out what types of energy sources should be supplied and converted in order to meet the results of the demand model or other energy demand forecast made from a different viewpoint.

With these basic consents in mind, we have conducted thorough discussion with Indonesian counterparts on such matters at types of energy sources, characteristics of each energy source and regional characteristics of energy consumption in Indonesia, and consequently have decided to employ the linear planning method. However, since the period subject to the analysis of energy supply is very long (10 or 20 years) due to its nature, we have introduced the structure which allows the analysis of long-term and dynamic energy supply patterns as a time-series linear planning model. As will be mentioned later, since energy sources which are dealt by this model are those expected to be utilized in the future, they include a number of energies which are considered as new ones in Indonesia. Hence, in order to operate the model and conduct sufficient analysis based on simulation results, there still remain uncertainty in the aspect of data compilation. We have also conducted thorough discussion on this aspect with Indonesian counterparts and come to the following conclusion. Although it is difficult to handle all the energy sources at the current stage, the structure of the model, that is, the model as a system must be designed in such a way to enable handling of any energy source in taking account of the future needs.

3-1 Outline of the Model

3-1-1 Energy Flow

Fig. 3-1-1 illustrates the general flow scheme of the primary energy sources, the transportation sector, and the secondary energies of the supply model.

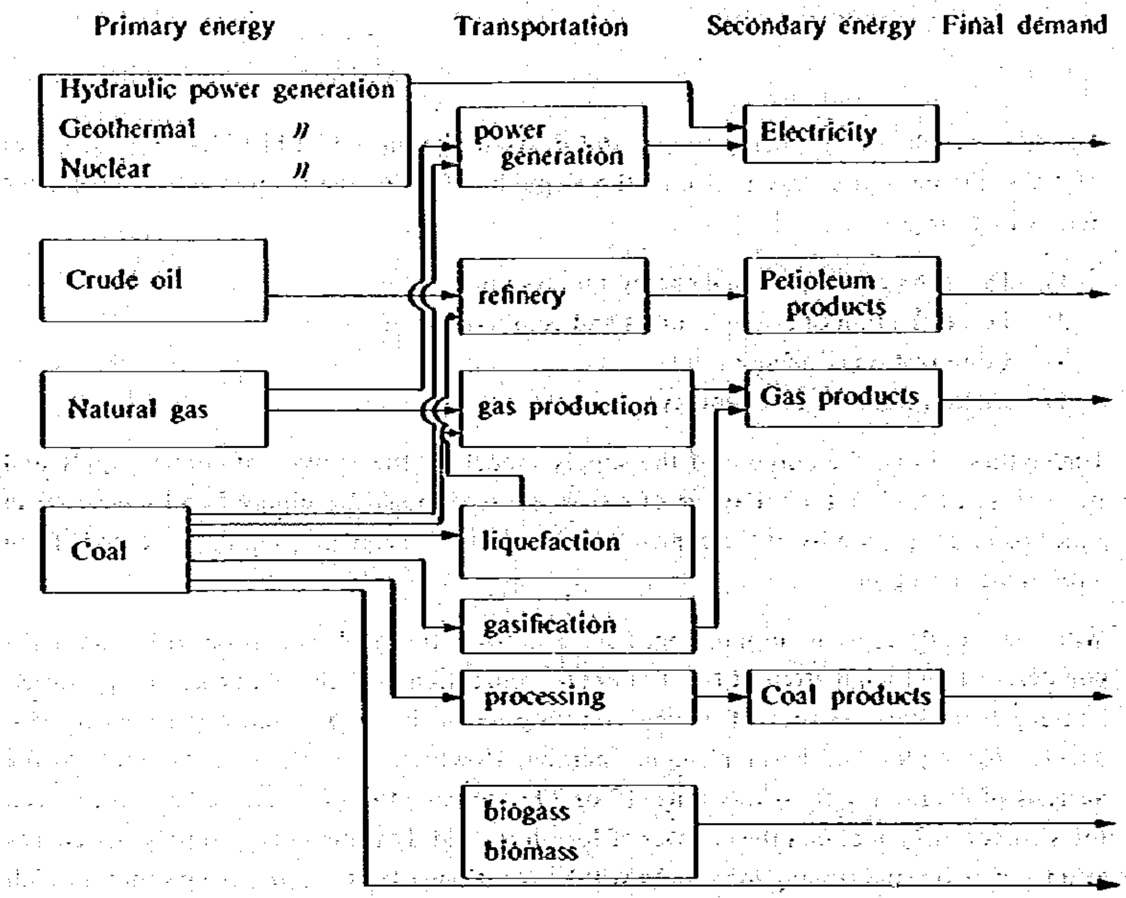


Fig. 3-1-1 General Flow

Details of the primary energy sources and the transportation sector will be discussed later (3-2: Structure of the Model). By looking at the list of products as final energies, one may be able to grasp the overall view of the model.

(1) Petroleum products

1) Gasoline
2) Jet fuel
3) Naphtha
4) Kerosene oil
5) Automobile diesel
6) Industrial diesel
7) Heavy oil
8) Polypropylene
9) Lubricating oil

10) Wax

11) Asphalt

12) Coke

(2) Gas products

1) LPG

2) LNG

3) NGL

4) Methanol

5) Town gas

As fuels for town gas, the model handles three types including oil, coal and natural gas.

(3) Other products manufactured from coal

1) Briquettes

2) Coal gas

3) Coal liquefaction

Similar to crude oil, it is fed to a refinery process.

(4) Others

1) Biomass (ethanol)

2) Biogas

3) Wood and agricultural wastes, etc.

These are not introduced in the model positively.

(5) Types of power generation

1) Hydraulic power generation

2) Geothermal power generation

3) Nuclear power generation

4) Coal thermal power generation

5) Heavy oil thermal power generation

6) Diesel thermal power generation

7) Gas thermal power generation

3-1-2 Demand Sector

There are the following five sectors for final demand obtained based on the classification of final demand in the demand model and the statistical classification used in Indonesia.

(1) Residentional and Commercial sector

(2) Industrial sector

(3) Transportation sector

(4) Government sector

(5) Non-energy sector

As for the supply of final energy products for each of the final demand sectors, each final energy product is linked to the final demand sectors based on the actual data as well as the results of discussions with Indonesian experts.

Barrel Oil Equivalent (BOE) is used as a unit for an amount of final demand in the demand sectors. On the other hand, up to the manufacturing of final energy products, the unit unique to each energy (BBL, TON, MSCF, etc.) is used. Therefore, when each final energy product is linked to final demand, it is converted based on calories to the common unit of BOE using a conversion factor.

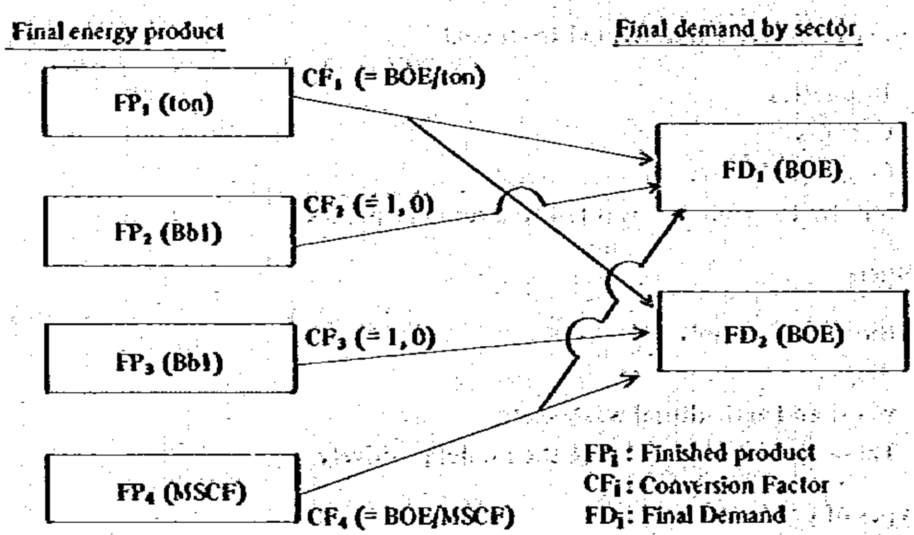


Fig. 3-1-2 Unit Conversion

3-1-3 Geographical Division

Indonesia possesses its own energy resources such as crude oil, natural gas and coal, but the areas they exist and consumed are scattered very widly from east of Sumatra to west of Western Irian as well as from north of Kalimantan Java to south. Thus, it is a very essential issue for the national economy where energy resources are transformed and consumed. For this reason,we have reached the basic agreement with Indonesian counterparts that the supply model should definitely take account of such geographical aspect, and consequently decided to devide the whole region into some areas. What must be considered here is not only the aspect of supply and demand of energy. The smaller each area becomes, the larger the size of the model, and this may in turn result in exceeding the computational capacity of a computer. Based on the analytical aspect as well as the computational capacity, the whole region was divided into the following three areas.

1) Sumatra area
2) Java area
3) Kalimantan and other areas

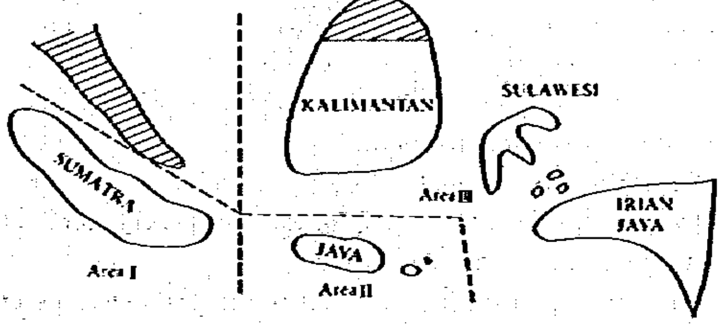


Fig. 3-1-3 Geographical Division

3-1-4 Time-series Model

As mentioned above, in order to analize the energy policy targets of Indonesia including the development of potential energy sources and diversification of energy sources, it is effective to conduct a long-range analysis based on the information concerning which energy source should be industrialized most efficiently for the national economy in what extent of quantity at what time.

Based on this idea, this model is designed to obtain an optimal energy supply path under some preconditions for a specified period of time. In other words, specifically, the energy flow scheme illustrated in section 3-1-1 is transformed into a form of matrix for each period (1 – 5 years), and the total of the cost elements for the period is minimized. Although a large part of the matrix for each period is independent, the part of the energy production facility, that is, life of equipment and investment on plant and equipment, maintain relationships with those of other matrices.

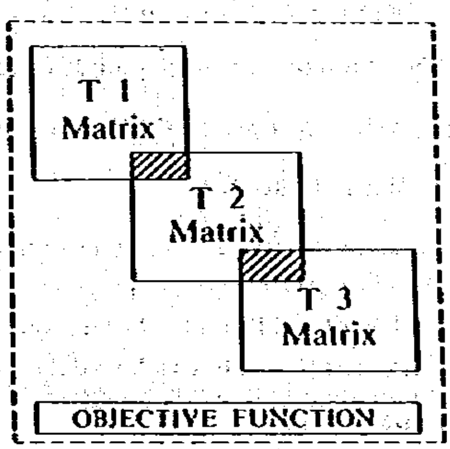


Fig. 3-1-4 Time-series Matrix

3-1-5 Features of the Supply Model

(1) Basic data required for the supply model

1) Upper limit of primary energy production
2) Cost and freight rate of primary energy
3) Existing capacity of energy production facility
4) Par unit cost of energy production facility
   - Operation cost (variable and fixed costs)
   - Investment cost
5) Functions of energy production facility
   - Relationship between input and output
6) Import/export costs and freight rate of each final energy product
7) Par unit calory of each final energy product
8) Destination of each final energy product to the final demand sectors
9) Final demands by sectors

(2) Basic information obtained from the supply model

1) Time-series supply of primary energy
2) Schedules for the introduction of new or additional energy production facility and its amount of investment
3) Time-series amounts of demand for final energy products
4) Estimated values (shadow prices) of final energy products
5) Amounts of imports and exports of final energy products

The above-mentioned information can be obtained from the supply model for each area as well as Indonesia as a whole.

3-1-6 Structure of the Supply Model System

The system to operate the supply model is composed of the following three sub-systems.

(1) Matrix Generator

As mentioned above, Linear Programming (LP) method is applied to the supply model. MPSX/370 (Mathematical Programming System Extended/370) generally known is used for solving the LP model. Matrix generator produces a matrix of the model by basic data and converts the matrix to MPS data format.

(2) MPSX/370

IBM Application program

(3) Report Generator

MPSX/370 produces the solution of the model by variable. In order to analyze the result easily, Report generator edits the solution and produces several types of table used for energy supply-demand analysis.

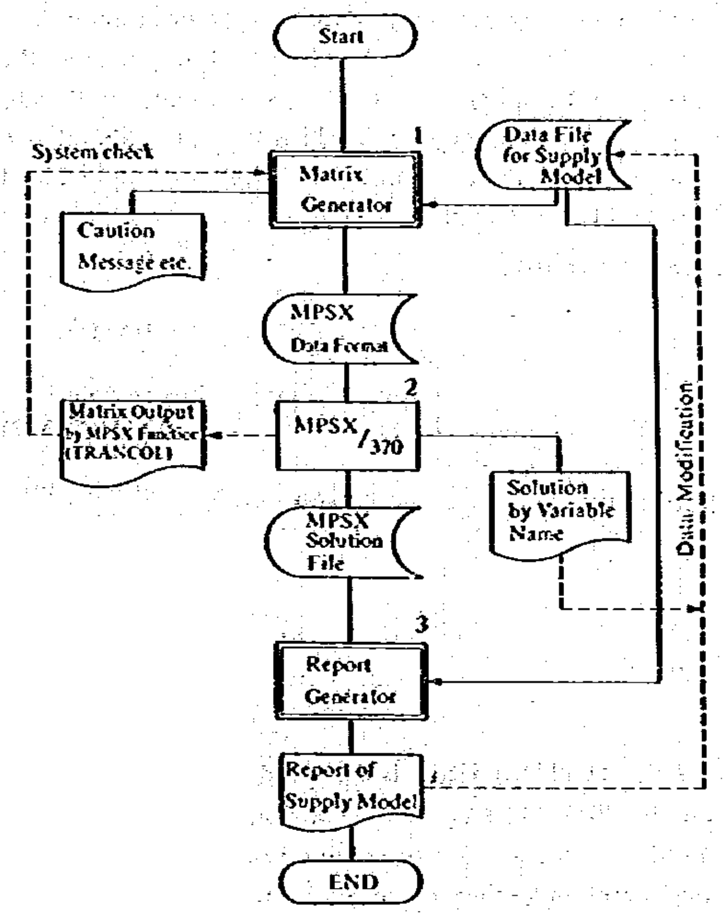


Fig. 3-1-5 Structure of the Supply Model System

3-2 Structure of the Model

3-2-1 Oil Refining

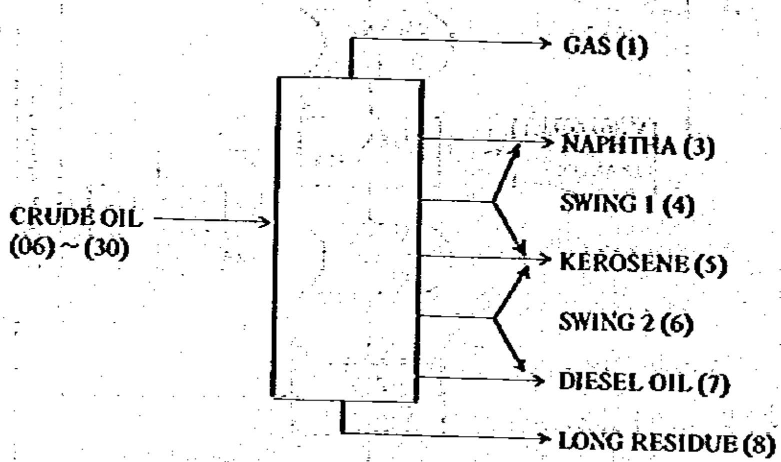
(1) Refining process

The refining process taken by this model can be categorized into the following three types considering the structure of the model. The first is the TOPPING UNIT which is the distillation equipment for crude oil. The second is the secondary equipment which cracks or reforms characteristics of intermediate products to convert them into other types of intermediate products. The third is the equipment that though its characteristics are similar to those of the secondary equipment, it performs unit conversion on the input and output of intermediate products. That is, the intermediate products which are input are on a volume basis, but those that are output are on a weight basis and its capacity and operation cost are taken as weight.

1) TOPPING UNIT

The TOPPING UNIT, as shown in the figure below, produces intermediate products such as gas and naphtha by processing various crude oils through constant-pressure distillation. As for naphtha, kerosene, diesel oil, and long residue, their characteristics vary depending on what types of crude oils are input, and therefore the process is performed for each type of crude oil. Which type of crude oil is taken as input for a certain intermediate product can be specified to the model by data (refer to the Table-3-2-1 of intermediate product codes).

TOPPING UNIT (01)



The matrix of the TOPPING UNIT is described below taking the example of Fig. 3-2-1. The variable PD06111 (As for the component elements of a variable, refer to Section 3-3) indicates the amount of crude oil (06) which was produced in Area I during the first period and then processed by the TOPPING UNIT in Area I. The equations in which this variable appears are the following.

(i) MC1: Price of crude oil

(ii) FR1: Freight rate for the distance from a crude oil (06) field to Refining Area 1

(iii) OV1: Operation cost of the TOPPING UNIT (variable cost)

(iv) DP0611: Upper limit of crude oil (06) production for the first period; It is included in the Equation 3-2-1 along with the crude oil export variable described later.

(v) PO0111: Operation restriction of the TOPPING UNIT (01) in Refining Area 1; It is included in the Equation 3-2-2 along with the equipment capacity variable described later.

(iv) IP*****: Yield of an intermediate product; Among the intermediate products, characteristics of gas (01) do not vary depending on crude oils, and hence the crude oil code (06) is not included.

Table 3-2-1 Intermediate Product Codes

Code		Name	Code	Name	
00		INTERMEDIATE PR		INTERMEDIATE PR	
01		GAS	23	MC.C.C.	
02		LPG	24	FO.C.C.	
03	1	NAPHTHA	25	MC.T.C.	
04	1	SWING 1	26	FC.T.C.	
05	1	KEROSENE	27	FC.VISB	
06	1	SWING 2	28	GREEN COKE	
07	1	DIESEL OIL	29	LUB	
08	1	LONG RESIDUE	30	FC.L.P.	
09		REF.FUEL GAS	31	ASP BASIS	
10		MC.SPRITTER	32	WAX	0.950
11		TR.NAPHTHA	33	FC.W.P.	
12		REFORMATE	34	COKE	0.960
13		REFORM.T.R.	35	DRY GAS	
14	1	HGO	36	KERO.H.C	
15		TREATED KERO	37	GAS OIL .H.C	
16		MC.EDELEANU	38	GAS OIL DHDS	
17		FC.EDELEANU	39	GAS OIL VISB	
18	1	LGO	40	ASPHALT	1.050
19		LUB FEED	41	POLY PROPYLENE	0.950
20	1	VAC BOTTOM	99		
21	1	MC.H.C.			
22		PROPYLENE			

1 Indicates the intermediate products specified by type of crude oil in the model

$\sum_{j=1}^{3} PD061j + EX0611 \leq$ (Production upper limit) . . . . . Equation 3-2-1

where j = refining area 1 through 3.

$\sum_{c1} PDC1i11 + \sum_{c2} IMC2i11 \leq PCO111$ . . . . . Equation 3-2-2

where C1 = domestic crude oil

C2 = imported crude oil

The second variable indicates the amount of exports of the crude oil (06) produced in Area 1 during the first period, and it is appeared in the following two equations.

(i) MC1: Export price (FOB); It is dealt as a negative cost.

(ii) DP0611: Production upper limit of crude oil (06) (refer to Equation 3-2-1)

The third through 6th variables are the matrix of the before mentioned SWING FRACTION.

Imported crude oils are handled in the manner similar to that for domestic crude oils except for the following two points.

(i) MC1: Import price (CIF)

(ii) DP2541: Upper limit of crude oil (25) imports for the first period; It is included in Equation 3-2-3

$\sum_{j=1}^{3} IM254j1 \leq$ (Import upper limit) . . . . . Equation 3-2-3

where j = refining area 1 through 3.

< Case of domestic crude oil >

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ACTIVITY	(1) PD06111	(2) EX0611	(3) SW430611	(4) SW450611	(5) SW650611	(6) SW670611	PD07111	EX0711	1....1 ACTIVITY
MC1	43.71001	43.71001-	.	.	.	.	40.00000	40.00000-	MC1
FR1	.20000-	.	.	.	.	.	.20000	.	FR1
OV1	.10400	.	.	.	.	.	.10400	.	OV1
OP0611	1.00000	1.00000	.	.	.	.	.	.	OP0611
PD0111	1.00000-	.	.	.	.	.	1.00000-	.	PD0111
IP10011	.06900-	.	.	.	.	.	.	.	IP10011
IP30611	.45900-	.	1.00000-	.	.	.	.	.	IP30611
IP40611	.	.	1.00000	1.00000	.	.	.	.	IP40611
IP50611	.35500-	.	.	1.00000-	1.00000-	.	.	.	IP50611
IP60611	.	.	.	.	1.00000	1.00000	.	.	IP60611
IP70611	.05400-	.	.	.	.	1.00000-	.	.	IP70611
IP80611	.06300-	.	.	.	.	.	.	.	IP80611
OP0711	.	.	.	.	.	.	1.00000	1.00000	OP0711
IP30711	.	.	.	.	.	.	.06900-	.	IP30711
IP50711	.	.	.	.	.	.	.21900-	.	IP50711
IP70711	.	.	.	.	.	.	.09700-	.	IP70711
IP80711	.	.	.	.	.	.	.59500-	.	IP80711

< Case of imported crude oil >

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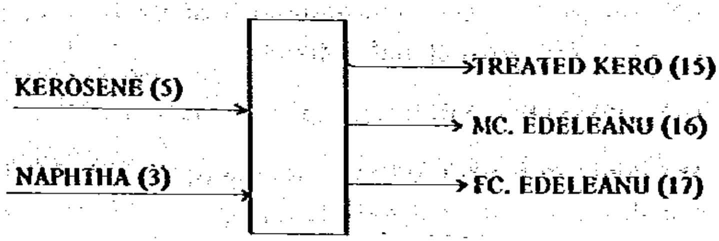
IM25411	SW432511	SW452511	8....1 ACTIVITY
37.95999	.	.	MC1
.	.	.	FR1
.10400	.	.	OV1
1.00000-	.	.	PD0111
.00400-	.	.	IP10011
.	.	.	OP1931
.	.	.	IP31911
.	.	.	IP41911
.	.	.	IP51911
.	.	.	IP61911
.	.	.	IP71911
.	.	.	IP81911
1.00000	.	.	OPZ541
.18500-	1.00000-	.	IP32511
.	1.00000	1.00000	IP42511
.29200-	.	1.00000-	IP52511
.09300-	.	.	IP72511
.12600-	.	.	IP82511

2) Volume-based secondary equipment

The volume-based secondary equipment is basically different from the TOPPING UNIT in the following two points. The one is that intermediate products are input instead of crude oils, and the second is that the material cost elements such as crude oil prices are not included since it is an intermediate process. The secondary equipment is described here taking the example of KEROSENE TREATER (EDELEANU) (refer to P.75).

KEROSENE TREATER (06)
[EDELEANU]



The first and the second variables, V5000611 and V300061 indicate the volumes of kerosene (5) and naphtha (3), respectively, which are processed by the kerosene treater (06) in Area 1 during the first period, and they are included in the following equations.

(i) OV1: Operation cost (variable one)

(ii) IP300011
IP500011: Equation showing the balance between the naphtha and kerosene produced in a refinery and those used here; While characteristics of naphtha and kenosene which are produced by the TOPPING UNIT are considered to vary depending on types of crude oil, they are considered here as having identical properties. Hence, balance is maintained with aggregated naphtha and kerosene. If naphtha is processed by this equipment and significant differences are observed in yield of output intermediate products depending on types of crude oils, input yield of naphtha for each type of crude oil. Then, the system automatically maintains balance with pre-aggregated naphtha.

```
05  THR.REFORMER R.GAS 92FM.TR13  HGO 14
03  NAPHTHA          11.4    73.5    15.1
99
06  EDELEANU     T.KER 15 MC.ED16 FC.ED17
05  KEROSENE         65.1     7.6    25.2
03  NAPHTHA                  95.0     5.0
09
07  DHDS         T.KER 15 D.O. 3B
18  LGO              90.     10.
99
 |
 +---- Crude oil code
```

(iii) PO0611: Operation restriction of the kerosene treater (EDELEANU, 06) in Refining Area 1

(iv) IP*****: Yield intermediate product

The third variable PC0611 indicates the equipment capacity in Area 1 for the first period, and it is included in the followings.

(i) OX1: Operation cost (fixed one)

(ii) PO0611: Operation restriction; The equipment is operated at the capacity less than its full capacity for the amounts of naphtha and kerosene to be processed.

(iii) PE0611: The equation used to obtain the capacity at a certain time by adding the capacity of new and additional facility to the existing one (refer to Equation 3-2-4).

The fourth variable PX0611, as shown in Equation 3-2-4, indicates the amount of new and additional facility, and it relates to the amount of investment in plant and equipment (IC1).

PC0611 ≦ (existing facility capacity) + PX0611 ...... Equation 3-2-4
↑ new and additional facility

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ACTIVITY	PX0511	(1) V5000611	(2) V3000611	(3) PC0611	(4) PX0611	VI000711	PC0711	PX0711	64....1 ACTIVITY
OX1	.	.	.	16.00000	.	.	.10300	.	OX1
OV1	.	10.66600	10.66600	.	.	.06800	.	.	OV1
IC1	118.00000	.	.	.	59.00000	.	.	14.75000	IC1
IP30011	.	.	1.00000	.	.	.	.	.	IP30011
IP50011	.	1.00000	.	.	.	.	.	.	IP50011
IPI0011	.	.	.	.	.	1.00000	.	.	IPI0011
PE0511	1.00000-	.	.	.	.	.	.	.	PE0511
PO0611	.	1.00000-	1.00000-	1.00000	.	.	.	.	PO0611
IPF0011	.	.65100-	.	.	.	.90000-	.	.	IPF0011
IPG0011	.	.07600-	.95000-	.	.	.	.	.	IPG0011
IPH0011	.	.25200-	.05000-	.	.	.	.	.	IPH0011
PE0611	.	.	.	1.00000	1.00000-	.	.	.	PE0611
PO0711	.	.	.	.	.	1.00000-	1.00000	.	PO0711
IP360011	.	.	.	.	.	.10000-	.	.	IP380011
PE0711	.	.	.	.	.	.	1.00000	1.00000-	PE0711

< Aggregation of kerosene(5) >

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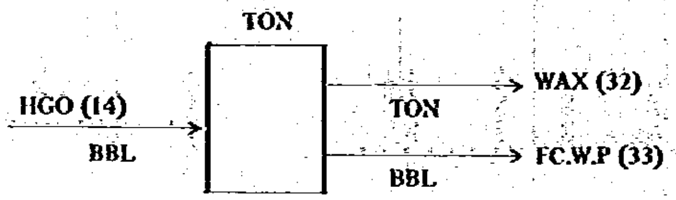
ACTIVITY	AG32611	AG50611	AG50711	AG50811	AG50911	AG51011	AG51211	AG51511	30....1 ACTIVITY
IP50611	.	1.00000	.	.	.	.	.	.	IP50611
IP50711	.	.	1.00000	.	.	.	.	.	IP50711
IP50811	.	.	.	1.00000	.	.	.	.	IP50811
IP50911	.	.	.	.	1.00000	.	.	.	IP50911
IP51011	.	.	.	.	.	1.00000	.	.	IP51011
IP51211	.	.	.	.	.	.	1.00000	.	IP51211
IP51511	.	.	.	.	.	.	.	1.00000	IP51511
IP32611	1.00000	.	.	.	.	.	.	.	IP32611
IP30011	1.00000-	.	.	.	.	.	.	.	IP30011
IP50011	.	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	IP50011

3) Secondary equipment requiring unit conversion

The matrix structure is described here by taking the example of Wax PLANT (16). Although HGO (14) which in fed to this equipment is on a volume basis (BBL) and the intermediate product of FC.W.P. (33) which is produced is also on a volume basis (BBL), WAX (32) must be counted on a weight basis (TON) and hence the operation cost and the equipment capacity are also processed on a basis of production amount of wax.

WAX PLANT



The first variable, VE001611 indicates the amount of HGO (14) to be fed, and naturally its unit is BBL. Meanwhile, the intermediate products of WAX (32) and FC.W.P. (33) are produced on a volume basis of yield. The second variable, MTW1611, indicates the amount of weight-based (TON) WAX (32) production. Conversion from BBL to TON is carried out using the equation of IPW9911, and the weight-based intermediate product. Wax is balanced using the equation of IPW0011 before linking it to its final product. In addition, since the main product of this equipment is wax and other intermediate products are considered as by-products, the operation cost (variable one) and the equipment capacity must be related to the amount of wax production. Consequently these elements are included in MTW1611.

On the other hand, in order for the system to form a matrix having such structure, there must be at least one intermediate product data having its specific gravity among the intermediate products to be produced.

BBL–TON Conversion: 1 TON = 6.29 x SPGR BBL
= 5.9775

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ACTIVITY	PX1411	VK251511	PC1511	PX1511	VE001611 (BBL)	MTW1611 (TON)	PC1611 (TON)	PX1611 (TON)	69----2 ACTIVITY
OX1			1.13400				12.29400		OX1
OV1		.75600				8.19600			OV1
IC1	125.00000			59.00000				29.50000	IC1
IPE0011					1.00000				IPE0011
IPK2511		1.00000							IPK2511
IPJ0011		.37000-							IPJ0011
PE1411	1.00000-								PE1411
PO1511		1.00000-	1.00000						PO1511
IPV0011		.62700-							IPV0011
PE1511			1.00000	1.00000-					PE1511
IPW9911					.28000-	5.97550			IPW9911
IPX0011					.73000-				IPX0011
IPW0011						1.00000-			IPW0011
PO1611						1.00000-	1.00000		PO1611
PE1611							1.00000	1.00000-	PE1611

E : 14 HGO
W : 32 WAX
X : 33 FC.W.P.

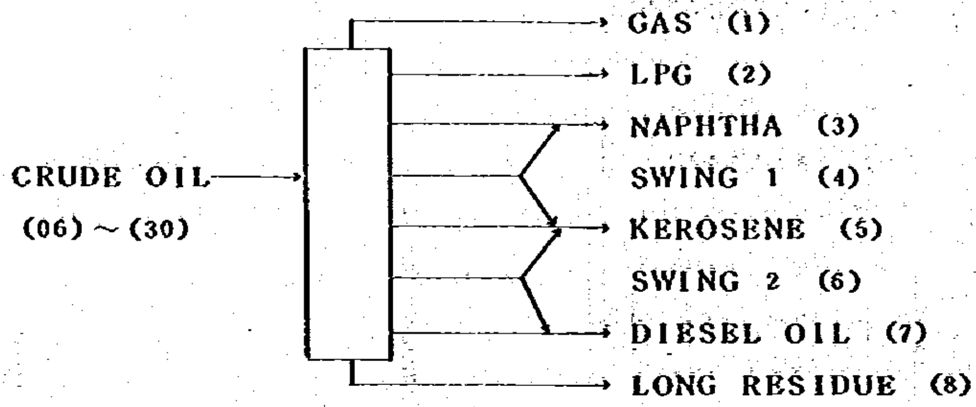
Table of Intermediate Product Code

		specific gravity
30	FC.L.P.	
31	ASP. BASIS	
32	WAX	0.950
33	FC.W.P.	
34	COKE	0.960
35	DRY GAS	
36	KERO.H.C	
37	GAS OIL .H.C	
38	GAS OIL DHDS	
39	GAS OIL VISB	
40	ASPHALT	1.050
41	POLY PROPYLENE	0.950
99		

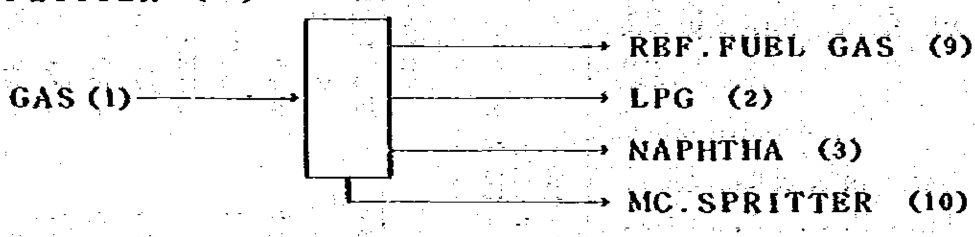
(2) Functions of Each Equipment

Figures in parenthesis indicate the intermediate product codes.

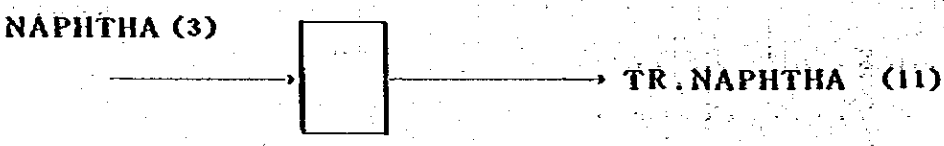
1. TOPPING UNIT (01)



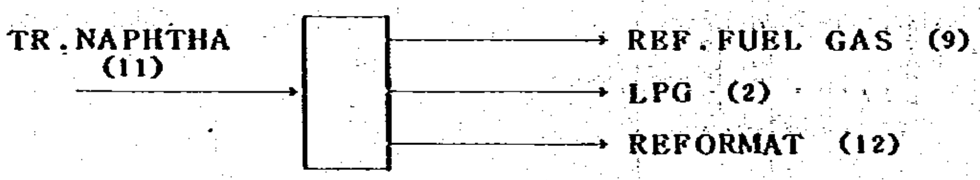
2. SPLITTER (02)



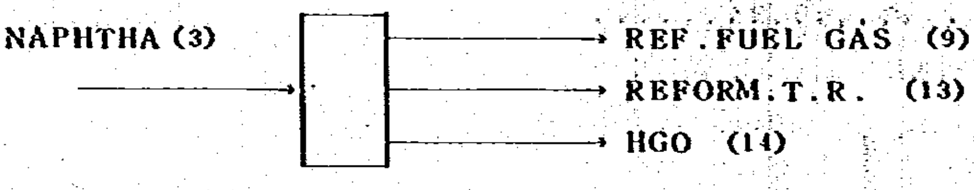
3. NHDT (03)



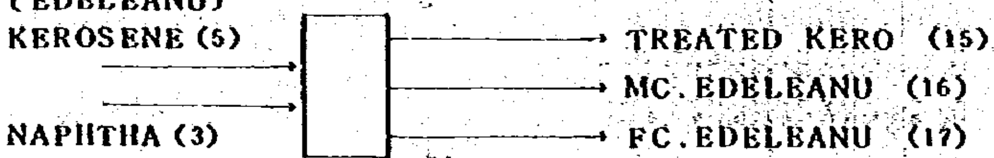
4. CAT.REFORMER (04)



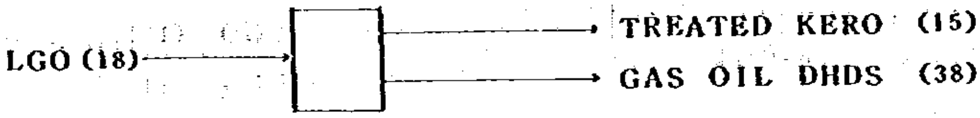
5. THERMAL REFORMER (05)



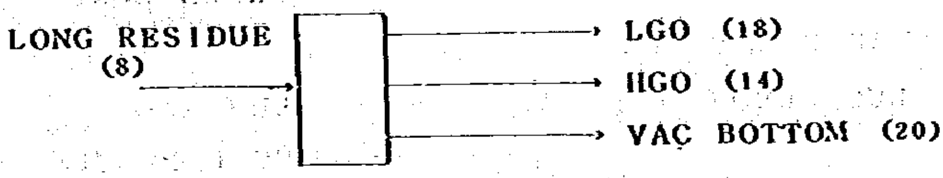
6. KEROSENE TREATER (06)
(EDELEANU)



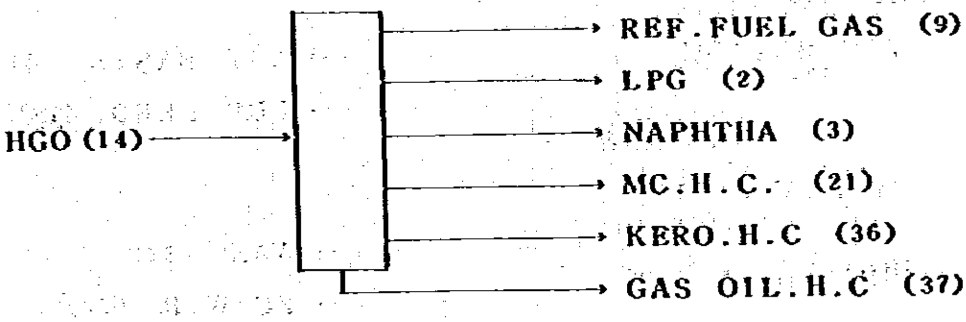
7. DHDS



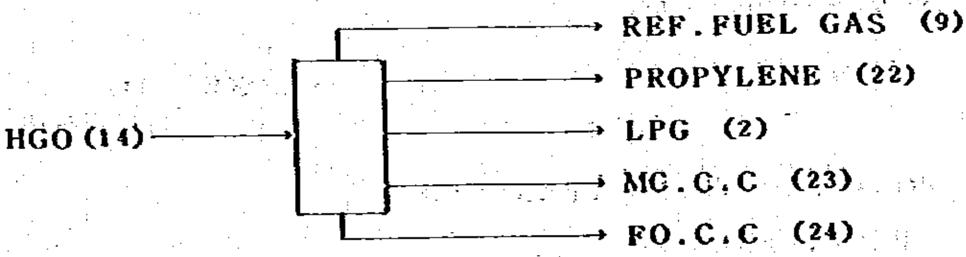
8. HVU (HIGH VACUUM UNIT) (08)



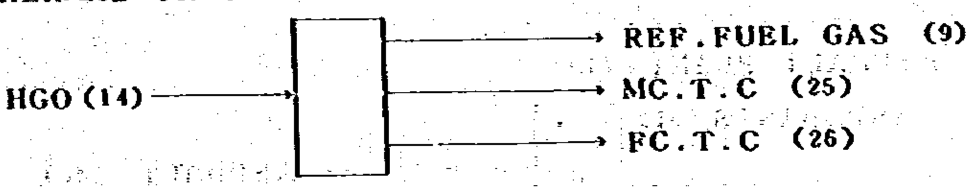
9. HYDRO CRACKER (09)



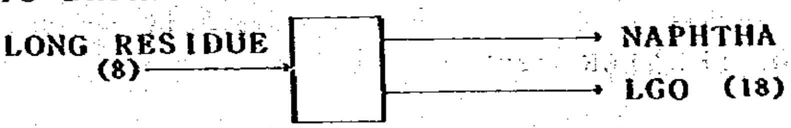
10. CATALYTIC CRACKER (10)



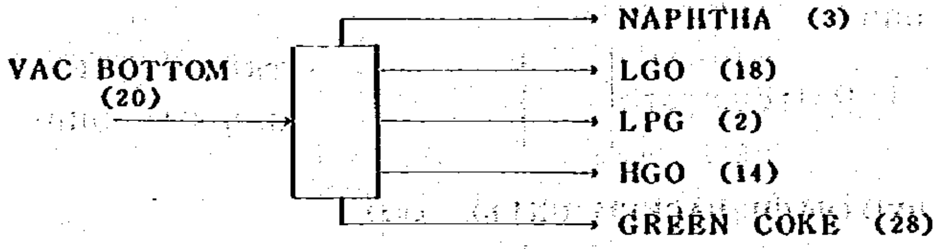
11. THERMAL CRACKER (11)



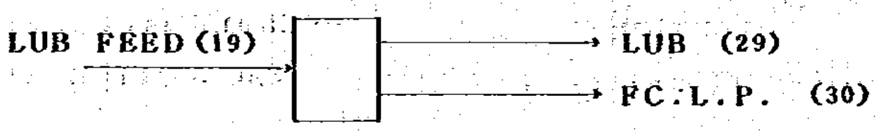
12. VIS-BREAKER (12)



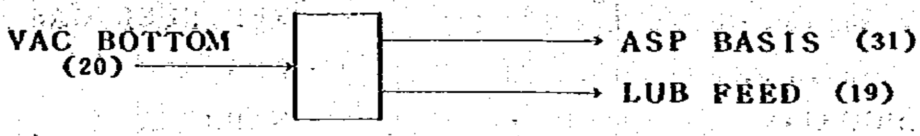
13. CO KER (13)



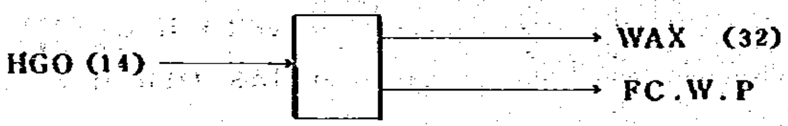
14. LUBE PLANT (14)



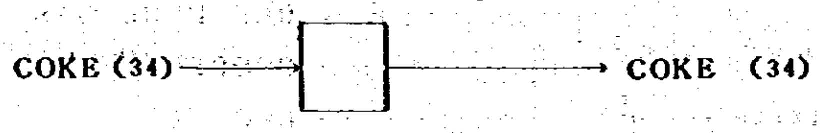
15. PDU (15)



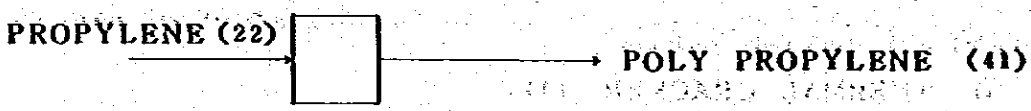
16. WAX PLANT (16)



17. CAL CINER (17)

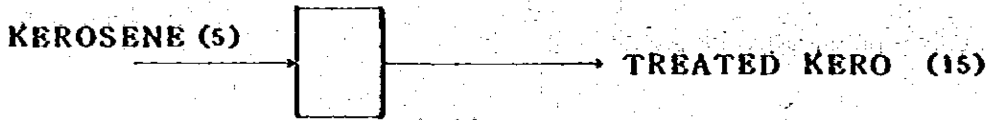


18. POLY PROPYLENE PLANT (18)



19. ASPHALT PLANT (19)

20. KEROSENE TREATER (20)



(3) Blending

Blending is the process in which final products are produced from the intermediate products through the refining process. This model introduces two types of blendings. The one is the blending in which an intermediate product is blended in such a way as to produce a final product having specified properties, and the other is the blending where the parcentage of an intermediate product to be contained in a final product is specified. This model calles these two types of blendings as SPEC. BLENDING and COEF. BLENDING, respectively.

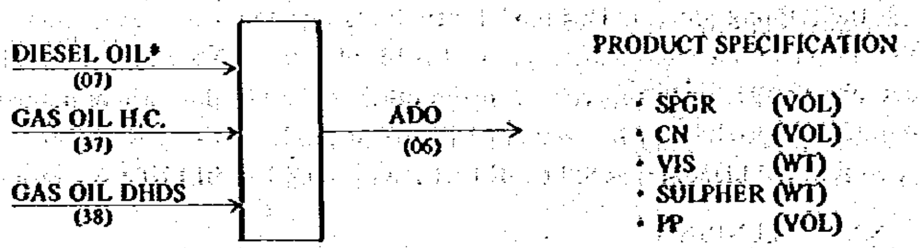
1) SPEC. BLENDING

Final products subject to this blending type are, as shown in Table 3-2-2, gasoline, kerosene, ADO, and fuel oil. Although jet fuel and IDO also posses product properties, they are included in COEF. BLENDING for the sake of simplicity.

Table 3-2-2 Estimated Product Specification (1990)

	Specification	Volume	Type of Blending
FUEL GAS	SG 60/60	–	% volume
MOGAS COMP	RVP	< 90	% volume
	ON clear	> 90	% volume
	TEL max 1,5 w.l.		
KERO	SG 60/60	< 0.835	% volume
	SM Point, mm	> 18	% volume
AUTOMOTIVE D.O	Cetane Number	> 45	Index detane % volume
	SG 60/60	< 0.87	% volume
		> 0.82	
	Kin. Viscosity 100°F, Cst.	> 1.6	Viscosity blending % wt index
		< 5.8	
INDUSTRIAL D.O.	SG 60/60	> 0.34	% volume
		< 0.92	
	Viscosity	> 1.6	Visc. blind, index % wt
		< 5.8	
FUEL OIL	SG 60/60	< 0.990	volume
	Kin. Viscosity, Cst.	> 100	Visc. blen. index % wt
		< 300	
	Sulfur %wt	2.5	% wt
JET FUEL	SG 60/60	< 0.803	
		> 0.775	
	Smoul Point	> 20	

The matrix structure of SPEC. BLENDING is illustrated here taking the example of ADO's blending.



* : By type of crude oil

CO NAME	SG	01 RVP	02 ON	03 SP	04 CN	05 VIS	06 S	07 FP	08 PP	99
0600A00 L	0.87				S 45.0	L 5.8	L 0.50		L 65.0	
0600A00 G	0.82					G 1.6				
37 H.C.	0.82				62.0	4.5			60.0	
38 DHDS	0.80				54.0	2.3			52.0	
0706A00	0.87				56.0	5.4	0.08		35.0	
0707A00	0.83				55.6	5.5	0.06		60.0	
0708A00	0.90				49.0	5.2	0.03		50.0	
0709A00	0.89				45.5	4.6	0.12		15.0	
0710A00	0.87				52.3	5.9	0.10		45.0	
0712A00	0.86				54.0	5.4	0.15		45.0	
0713A00	0.86				52.5	5.7	0.12		15.0	
0714A00	0.82				72.0	4.8	0.04		55.0	
0715A00	0.86				60.4	5.9	0.10		45.0	
0716A00	0.85				55.9	5.0	0.12		40.0	
0717A00	0.87				52.6	5.4	0.14		45.0	
0718A00	0.92				32.3	7.4	2.54		15.0	
0719A00	0.89				53.5	6.5	0.12		56.0	
0720A00	0.87				55.0	5.3	0.15		59.0	
0722A00	0.87				53.6	5.7	0.59		20.0	
0723A00	0.86				65.0	65.0	0.07		120.0	
0725A00	0.87				58.0	5.15	1.56		37.0	

The intermediate products used for the blending of ADO are diesel oil (07) from the TOPPING UNIT and gas oil (37 and 38) from DHDS and hydro cracker. Since diesel oil vary in its properties depending on types of crude oil, it has several types. Variables from 1 through 19 are for the blending materials. In order to balance those intermediate products produced from various equipment and those used for this blending, the IP equation is used to establish the relationships. The MB equation is the quantitative balance equation between the blending materials and the final products, and the PS equation is regarding product properties. Product properties of ADO, as mentioned earlier, have five types, of which properties of viscosity and sulpher are prescribed on a weight basis. Hence, they must be converted to a weight base and each of them is balanced by multiplying each property by its specific gravity (refer to Equation 4-2-5).

$$\underset{(WT)}{\underline{\Sigma \underset{(Bbl)}{B} \times SPGR_B \times SPEC_B}} \gtreqless \underset{(WT)}{\underline{\Sigma \underset{(Bbl)}{PR} \times SPGR_P \times \underset{(WT)}{SPEC_P}}} \ldots\ldots \text{Equation 4-2-5.}$$

The variables 20 and 21 indicate the amounts of the final product ADO which is produced by this blending. The reason why there are two variables for the final product is that there is some range in the product property. The one is given its upper limit, and the other for the lower limit. When there is no range in the property, an identical value is given to both variables. What must be noted here is that sign conditions of the two cases are different. Equation 3-2-6 illustrates the two different cases. The sum of the two variables is the amount of the final product, and it is the amount sent out to the market block by way of the FP equation.

1 Range in product property: $\Sigma \alpha B = \beta PR1 + \gamma PR2$ (equal sign)

2 No range in product property: $\Sigma \alpha B \lesseqgtr \beta PR1 + \gamma PR2$ (the sign depends on input) . . . . . Equation 3-2-6

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ACTIVITY	MU5411	(1) B3700611	(2) B3800611	(3) B706611	(4) B707611	(5) B708611	(6) B709611	(7) B710611	104....1 ACTIVITY
IP70611	.	.	.	1.00000	.	.	.	.	IP70611
IP70711	.	.	.	.	1.00000	.	.	.	IP70711
IP70811	.	.	.	.	.	1.00000	.	.	IP70811
IP70911	.	.	.	.	.	.	1.00000	.	IP70911
IP71011	.	.	.	.	.	.	.	1.00000	IP71011
IP380011	.	.	1.00000	.	.	.	.	.	IP380011
IP370011	.	1.00000	.	.	.	.	.	.	IP370011
FD411	1.00000	.	.	.	.	.	.	.	FD411
CN511	1.00000	.	.	.	.	.	.	.	CN511
RL5411	1.00000	.	.	.	.	.	.	.	RL5411
MB611	.	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	MB611
PS6111	.	.82000	.80000	.87000	.83000	.90000	.89000	.87000	PS6111
PS6511	.	62.00000	54.00000	56.00000	65.60001	49.00000	45.50000	53.30000	PS6511
PS6611	.	3.69000	1.84000	5.56800	4.56500	4.68000	7.65400	5.13300	PS6611
PS6711	.	.	.	.06960	.04980	.02700	.10680	.08700	PS6711
PS6911	.	60.00000	52.00000	35.00000	60.00000	50.00000	15.00000	45.00000	PS6911

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ACTIVITY	(8) B712611	(9) B713611	(10) B714611	(11) B715611	(12) B716611	(13) B717611	(14) B718611	(15) B719611	105....1 ACTIVITY
IP71211	1.00000	.	.	.	.	.	.	.	IP71211
IP71511	.	.	.	1.00000	.	.	.	.	IP71511
IP71611	.	.	.	.	1.00000	.	.	.	IP71611
IP71711	.	.	.	.	.	1.00000	.	.	IP71711
IP71811	.	.	.	.	.	.	1.00000	.	IP71811
IP71911	.	.	.	.	.	.	.	1.00000	IP71911
MB611	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	1.00000-	MB611
PS6111	.86000	.86000	.82000	.86000	.85000	.87000	.92000	.89000	PS6111
PS6511	56.00000	52.50000	72.00000	60.39999	55.89999	52.60001	32.30000	53.60001	PS6511
PS6611	4.64400	5.07400	3.93600	5.07400	5.10000	4.69800	8.64800	5.87400	PS6611
PS6711	.12900	.10320	.03280	.08600	.10200	.12180	2.33680	.10680	PS6711
PS6911	45.00000	15.00000	55.00000	45.00000	40.00000	45.00000	15.00000	50.00000	PS6911

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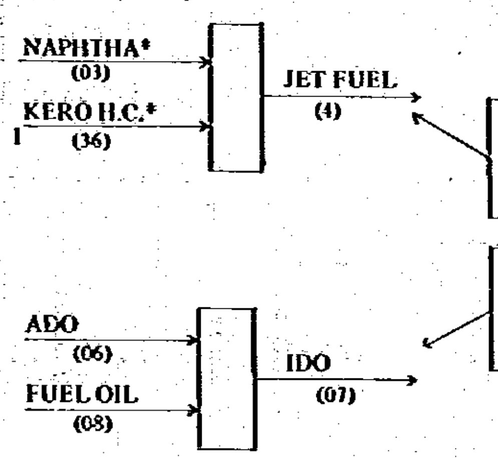
ACTIVITY	(16) B720611	(17) B722611	(18) B723611	(19) B725611	(20) PR620111	(21) PR620112	MO6111	MO6121	106....1 ACTIVITY
FR1	.	.	.	.	.	.	.	1.00000	FR1
IP72511	.	.	.	1.00000	.	.	.	.	IP72511
MB611	1.00000-	1.00000-	1.00000-	1.00000-	1.00000	1.00000	.	.	MB611
PS6111	.87000	.87000	.86000	.87000	.87000-	.82000-	.	.	PS6111
PS6511	55.00000	53.60001	86.00000	58.00000	45.00000-	45.00000-	.	.	PS6511
PS6611	6.96000	5.13300	73.09999	5.35050	5.04600-	1.31200-	.	.	PS6611
PS6711	.13050	.51330	.06020	1.44420	.43500-	.43500-	.	.	PS6711
PS6911	60.00000	30.00000	120.00000	37.00000	65.00000-	65.00000-	.	.	PS6911
FP60011	.	.	.	.	1.00000-	1.00000-	1.00000	1.00000	FP60011
CN611	.	.	.	.	.	.	1.00000-	.	CN611
CN621	.	.	.	.	.	.	.	1.00000-	CN621

2) COEF. BLENDING

There are two types in this COEF. BLENDING. The one is the blending in which intermediate products are used as blending materials, and the other is the one on which for the sake of convenience a final product is produced from other final products.

Type 1

Type 2




```
********** COFF. BLENDING
CD  NAME LOWER   UPPER
02  LPG
02  LPG
99
CD  NAME LOWER   UPPER
04  JET
03  NAPH    0.00    0.30
36  KERD    0.70    1.00
99
CD  NAME LOWER   UPPER
07  IDD
06  ADD     0.60    1.00
08  FO      0.00    0.40
99
```

with * mark: Intermediate product
Others: Final product

These two types of COEF. BLENDING are structually same, but they are different only in one point that the former balances with intermediate products as blending materials (IP equation) and the latter balances with final products (FP equation). The MB equation is the quantitative balance equation between blending materials and final products in the same token as the case of SPEC. BLENDING. The equations in which percentages of blending materials against a final product are the L and U equations.

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< JET FUEL >

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ACTIVITY	MD3121	MD3131	MU3211	MU3411	EX311	B300411	B3600411	PR42011	99....1 ACTIVITY
MC1					40.70000-				MC1
FR1	1.00000	1.26000							FR1
IP30011						1.00000			IP30011
IP360011							1.00000		IP360011
FP30011	1.00000	1.00000			1.00000				FP30011
CN311			1.00000	1.00000					CN311
CN321	1.00000-								CN321
CN331		1.00000-							CN331
FD211			1.00000						FD211
RL3211			1.00000						RL3211
FD411				1.00000					FD411
RL3411				1.00000					RL3411
MB411						1.00000-	1.00000-	1.00000	MB411
U300411						1.00000		.30000-	U300411
L3600411							1.00000	.70000-	L3600411
U3600411							1.00000	1.00000-	U3600411
FP40011								1.00000-	FP40011

< IDO >

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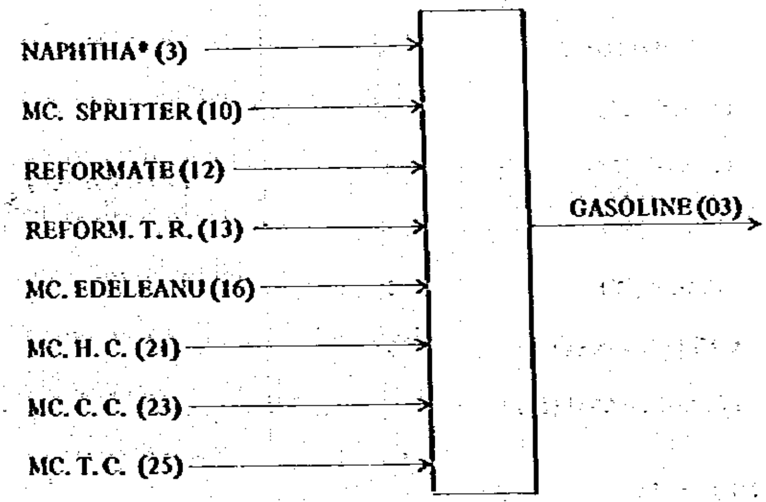
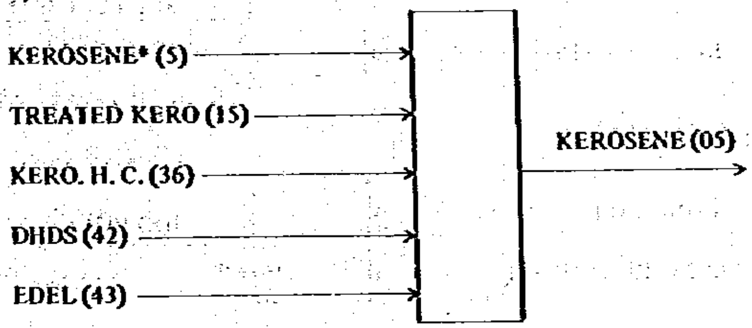
B600711	B800711	PR72011	MD7111	107....1 ACTIVITY
				FR1
				FD311
				FD211
				FD411
1.00000				FP60011
				CN611
				CN631
				RL6211
				RL6311
				RL6411
1.00000-	1.00000-	1.00000		MB711
1.00000		.60000-		L600711
1.00000		1.00000-		U600711
	1.00000	.40000-		U800711
		1.00000-	1.00000	FP70011
			1.00000-	CN711
	1.00000			FP80011

(4) Blending Flow

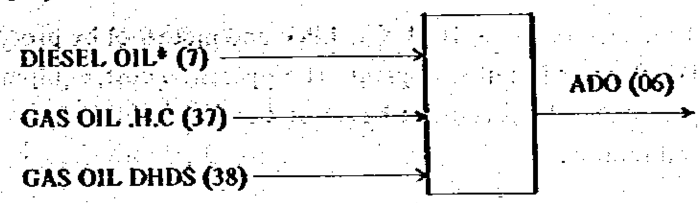
GASOLINE (03) Figures inparenthesis indicate product codes



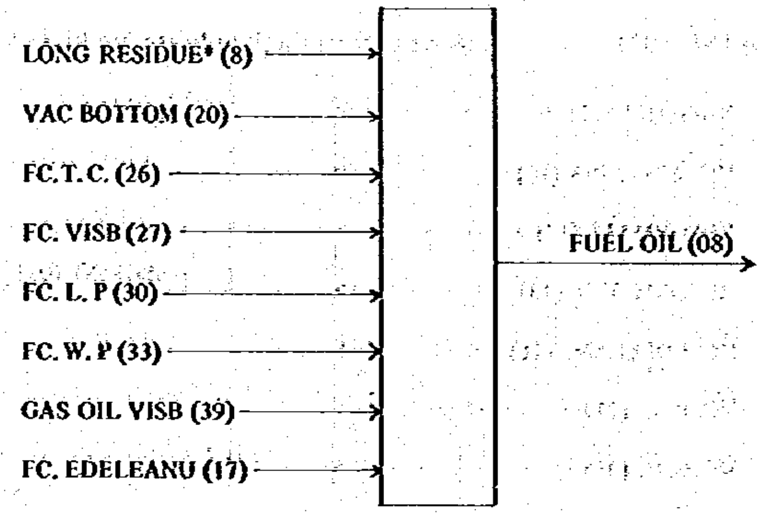
KEROSENE (05)



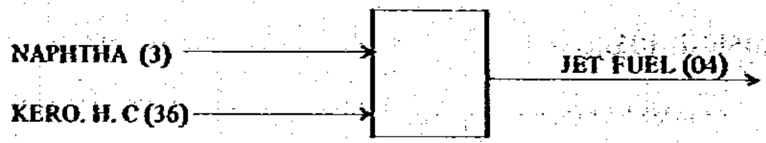
ADO (06)



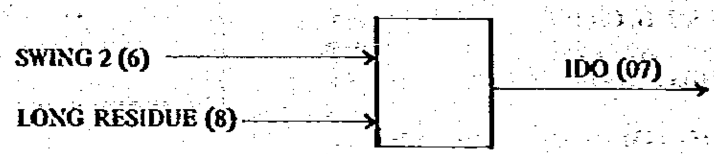
FUEL OIL (08)



JET FUEL (04)

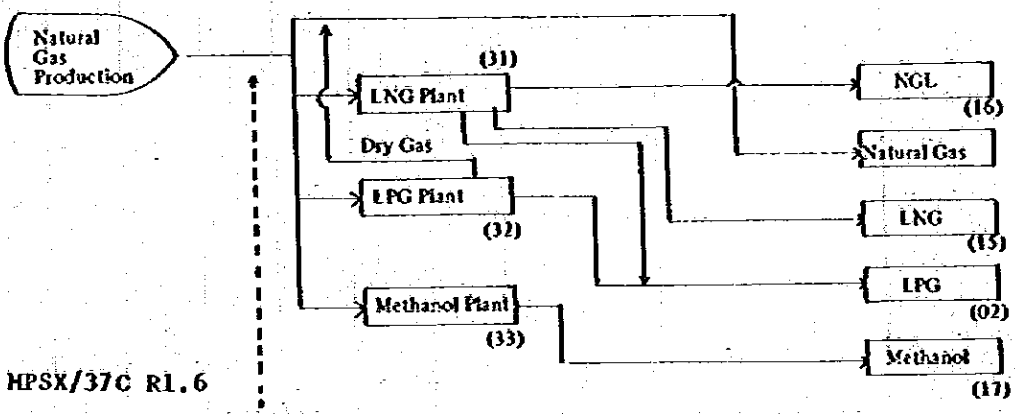


IDO (07)



3-2-2 Manufacturing of Gas

This is the process of manufacturing NGL, LNG, LPG, and methanol by processing natural gas at LNG plant, LPG plant and methanol plant. The operation cost, equipment capacity, etc. are dealt on a quantitative basis (output basis) of a main product produced, as in the case of wax plant for oil refining.



HPSX/37C R1.6

ACTIVITY	PD31111
MC1	3.48000
FR1	.15000
OX1	.
FP23111	.
FP23211	.
PO3211	.
DP0331	.
DP0481	.
DB0431	.
DP3111	1.00000
DB3111	1.00000-
FPF3111	.
FPG3111	.
PE3111	.
FPG3211	.
IPZ0011	.
PE3211	.
PO3111	.

Natural gas taken from a gas well is used for a number of purposes including not only gas manufacturing, but also manufacturing of town gas, power generation, etc. Therefore, the equation regarding domestic distribution which was not considered for crude oil is used. In other words, the variable PD31111 indicates the amount of natural gas which is used in Area 1 out of that produced in Area 1 during the first period. Although the structure of the matrix regarding gas price, freight rate, production upper limit, etc. is the same as that of crude oil, DB3111 (the balance equation of the amount of natural gas used in Area 1 during the first period) is used for its distribution for different purposes.

As illustrated below, the matrix basically describes the process where natural gas is processed at each plant and various gas products are manufactured. What must be noted here is that natural gas is on a volume basis (SCF), where as final products are on a weight basis (TON), and hence unit conversion is required. In addition, LPG produced at LNG and LPG plants and LPG obtained by oil refining are combined and then sent out to the market block together.

		LNG, LPG, Methanol Plant. (MMSCF) to LNG P.	(MMSCF) to LPG P.	(MMSCF) to MET.P.	(MMSCF) Dry Gas Return to Nat. Gas	(10^3 ton) PR LNG from LNG P.	(10^3 ton) PR NGL from LNG P.	(10^3 ton) PR MET from MET P.	(10^3 ton) PR LPG from LNG P.	(10^3 ton) PR LPG from LPG P.	(10^3 ton) PR LPG from Ref.
Balanced on a volume basis (MMSCF)	DB	1.0	1.0	1.0	−1.0						
	FP LNG from LNG P.	−Y 1				α					
	FP NGL from LNG P.	−Y 2					β				
	FP LPG from LNG P.	−Y 3							δ		
	FP LPG from LPG P.		−Y 4							δ	
	IP Dry Gas		−Y 5		1.0						
	FP Meth. from MET P.			−Y 6				γ			
	*FP LNG					−1.0					
	*FP NGL						−1.0				
	*FP Methanol							−1.0			
Balanced on a volume basis (10^3 BBL)	IP LPG										ε
	*FP LPG								−1.0	−1.0	−1.0

* indicates balance on a weight basis (10^3 ton)

	PR LNG from LNG P.	PR NGL from LNG P.	PR MET from MET P	PR LPG from LNG P.	PR LPG from LPG P.	PR LPG from Ref.	PC LNG P. (10³ ton)	PC LPG P. (10³ ton)	PC Metha. P. (10³ ton)
PO LNG P.	−1.0						1.0		
PO LPG P.					−1.0			1.0	
PO Met.P.			−1.0						1.0
OV	US$/ton		US$/ton		US$/ton				
OX							US$/ton	US$/ton	US$/ton

00 FINAL PRODUCTS
01 COAL
02 LPG 17.09 δ MSCF(LPG)/TON(LPG)
03 GASOLINE
04 JET FUEL
05 KEROSENE
06 ADO
07 IDO
08 FUEL OIL
09 POLY PROPYLENE
10 LUB
11 WAX
12 ASPHALT
13 COKE
14 NAPHTHA
15 LNG 43.18 α MSCF(LNG)/TON(LNG)
16 NGL 10.57 β MSCF(NGL)/TON(NGL)
17 METHANOL 21.70 γ MSCF(MET)/TON(MET)
18 ETHANOL
19 TOWN GAS
20 ELECTRICITY
21 NAT. GAS
22 WOOD

ε ; 3.45950 (= 6.29 Bbl/kℓ × SPGR OF LPG : 0.55)

3-2-3 Distribution of Coal

Since coal, similar to natural gas, is also used for a number of purposes, the equation concerning domestic distribution is introduced. The formation of the matrix regarding coal price, freight rate, and production upper limit is done in the same manner as in the cases of crude oil and natural gas, and imports and exports are handled similarly to the case of crude oil. Therefore, they will not be discussed here.

< Distribution of Coal >

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ACTIVITY	MOE321	MOE331	MUE531	PD01111	EX0111	PD02111	EX0211	PD03311	162.....1 ACTIVITY
MC1	.	.	.	29.50000	29.50000-	30.14000	30.14000-	29.50000	MC1
FR1	.	.	.	1.00000	.	10.00000	.	11.00000	FR1
CNE21	1.00000-	.	.	.	.	.	.	.	CNE21
CNE31	.	1.00000-	1.00000	.	.	.	.	.	CNE31
FD531	.	.	1.00000	.	.	.	.	.	FD531
FPE0031	1.00000	1.00000	.	.	.	.	.	.	FPE0031
DP0111	.	.	.	1.00000	1.00000	.	.	.	DP0111
DB0111	.	.	.	1.00000-	.	.	.	.	DB0111
DP0211	.	.	.	.	.	1.00000	1.00000	.	DP0211
DB0211	.	.	.	.	.	1.00000-	.	.	DB0211
DP0331	.	.	.	.	.	.	.	1.00000	DP0331
DB0311	.	.	.	.	.	.	.	1.00000-	DB0311

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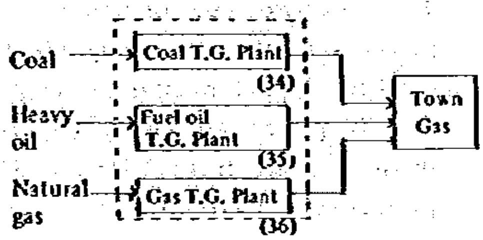
ACTIVITY	IM04811	PD01121	PD02121	PD03321	IM04821	PD01131	PD02131	PD03331	163.....1 ACTIVITY
MC1	59.71001	29.50000	30.14000	29.50000	58.71001	29.50000	30.14000	29.50000	MC1
FR1	.	10.00000	1.00000	10.00000	.	11.00000	10.00000	1.00000	FR1
DP0111	.	1.00000	.	.	.	1.00000	.	.	DP0111
DP0211	.	.	1.00000	.	.	.	1.00000	.	DP0211
DP0331	.	.	.	1.00000	.	.	.	1.00000	DP0331
DP0481	1.00000	.	.	.	1.00000	.	.	.	DP0481
DB0411	1.00000-	.	.	.	.	.	.	.	DB0411
DB0121	.	1.00000-	.	.	.	.	.	.	DB0121
DB0221	.	.	1.00000-	.	.	.	.	.	DB0221
DB0321	.	.	.	1.00000-	.	.	.	.	DB0321
DB0421	.	.	.	.	1.00000-	.	.	.	DB0421
DB0131	.	.	.	.	.	1.00000-	.	.	DB0131
DB0231	.	.	.	.	.	.	1.00000-	.	DB0231
DB0331	.	.	.	.	.	.	.	1.00000-	DB0331

3-2-4 Manufacturing of Town Gas

Raw materials of town gas handled by this model are coal, natural gas, and heavy oil. The unit used to count town gas is SCF, whereas these three raw materials have their own unique unit (TON, BBL, and SCF, respectively). Consequently the conversion factor which also takes account of manufacturing efficiency is introduced here.



	(MMSCF) V	(MMSCF) PR
DB: Coal Natural Gas (FP): Fuel Oil	α	
OV	US$/MSCF	
FP: Town Gas with plant code	−1.0	1.0
FP: Town Gas		−1.0

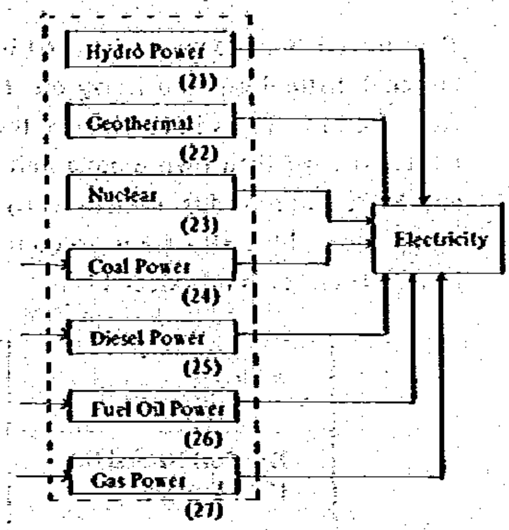
α: Needed volume to produce 1 MMSCF Town Gas

1) Natural Gas 0.4505 MMSCF
2) Coal 0.0158 10^3 ton
3) Fuel Oil 0.0790 10^3 Bbl

CD PLANT NAME	VARIABLE	FIXED	INVEST	PLT UFE	EFFICIENCY
34TG FR COAL	1.319	1.759	7000	20	0.0158 MSCF/ION
35TG FR FUEL	1.319	1.759	7000	20	0.0790 MSCF/BBL
36TG FR GAS	1.319	1.759	7000	20	0.4505 MSCF/MSCF

3-2-5 Electricity

There are two types of power generation. One is power generation requiring no fuel (hydraulic, geothermal, and nuclear power generation), and one is power generation requiring fuel (coal thermal, diesel thermal, heavy oil thermal, and gas thermal generation).



The structure of the matrix is similar to that of town gas, but the element of working hour (1 year) is introduced to incorporate an amount of power generation and a capacity of generation facility.

(1) Power generation requiring fuel

	(MWH) V	(MWH) PR	(MWH) PC
DB: Coal Natural Gas (FP): Fuel Oil	α		
OV		US$/KWH	
FP: Electricity with plant code	−10	1.0	
PO		−1.0 (−h/100)	h (+h/100)
FP: Electricity		−1.0	

α: Needed volume to produce 1MWH Electricity

1)	Fuel oil	0.0022	10^3 Bbl
2)	Diesel oil	0.0029	10^3 Bbl
3)	Coal	0.0004	10^3 ton
4)	Natural gas	3.54	MM SCF (10^6)

h: Working hours/year

1) Hydro : 4000
2) Geothermal : 4000
3) Nuclear : 4000
4) Coal power : 4500
5) Diesel : 2450
6) Fuel oil : 4500
7) Gas power : 2800

CD PLANT NAME	VARIABLE	FIXED	INVEST	PLT UFE	EFFICIENCY
21HYDRO POWER	0.50	31.50	1.15	20	
22GEOTHERMAL	2.00	12.00	0.77	20	
23NUCLEAR	6.00	20.00	1.07	20	
24COAL POWER	18.26	0.90	0.40	15	0.0004 KWH/TON
25DIESEL POWER	111.13	1.71	0.30	10	0.0029 KWH/BBL
26FO POWER	73.08	1.72	0.32	15	0.0022 KWH/BBL
27GAS POWER	116.98	0.76	0.16	15	3.5400 KWH/MSCF
	US$/MWH		US$/KWH		

(2) Power generation requiring no fuel

	(MWH) PR	(MWH) PC
OV	US$/KWH	
FP: Electricity with plant code	1.0	
PO	–1.0 (–h/100)	h (+h/100)
FP: Electricity	–1.0	

3-2-6 Other Energies

(1) Direct consumption of coal and natural gas in the final demand sectors

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Y0019911	Y0029911	207.....1 ACTIVITY
.	.	
.	.	OX1
.	.	IC1
.	.	FD131
.	.	FD331
.	.	FD631
1.00000	.	080111
.	1.00000	080211
.	.	FPK0031
.	.	PO2731
.	.	PE2731
.	.	CKK31
1.00000-	1.00000-	FP10011

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ACTIVITY	Y0039911	Y0049911
	.	.
FR1	.	.
FD111	.	.
FD311	.	.
FD211	.	.
080311	1.00000	.
080411	.	1.00000
083111	.	.
FP10011	1.00000-	1.00000-
CN111	.	.
CN121	.	.
RL1111	.	.
RL1211	.	.
RL1311	.	.
FPL0011	.	.

Matrix for the case of coal

(2) Biomass and Biogas

1) Biomass (ethanol)

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PR13711	PC3711	PX3711	MOI111	MOI121	213.....1
.	.	.	.	.	ACTIVITY
.	.	.	.	.12000	FR1
.	1.75900	.	.	.	OX1
1.31900	.	.	.	.	OV1
.	.	70.00000	.	.	IC1
.	.	.	.	.	FO111
.	.	.	.	.	FO311
.	.	.	.	.	FPR0011
.	.	.	.	.	CNR11
.	.	.	.	.	CNR31
.	.	.	.	.	RLR111
1.00000-	.	.	1.00000	1.00000	FPI0011
1.00000-	1.00000	.	.	.	PO3711
.	1.00000	1.00000-	.	.	PE3711
.	.	.	3.33000-	.	CNI11
.	.	.	.	3.33000-	CNI21

2) Biogas

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PR03811	PC3811	PX3811	MOO111	MOO121	214.....1
.	.	.	.	.	ACTIVITY
.	.	.	.	.	FR1
.	10.00000	.	.	.	OX1
10.00000	.	.	.	.	OV1
.	.	70.00000	.	.	IC1
.	.	.	.	.	FO311
.	.	.	.	.	FO211
.	.	.	.	.	FPI0011
.	.	.	.	.	CNI11
.	.	.	.	.	CNI31
.	.	.	.	.	REI211
.	.	.	.	.	RLI311
1.00000-	.	.	1.00000	1.00000	FPO0011
1.00000-	1.00000	.	.	.	PO3811
.	1.00000	1.00000-	.	.	PE3811
.	.	.	.16000-	.	CNO11
.	.	.	.	.18000-	CNO21

(3) Gasification of coal and manufacturing of briquettes

	(10^3 ton) V	(10^3 ton) PC	(10^3 ton) PX
DB coal	α		
OV	US$/ton		
FP without plant code	−1.0		
PO	−1.0	1.0	
PE		1.0	−1.0

α : Needed volums to produce 10^3 ton briquet or symthetic gas

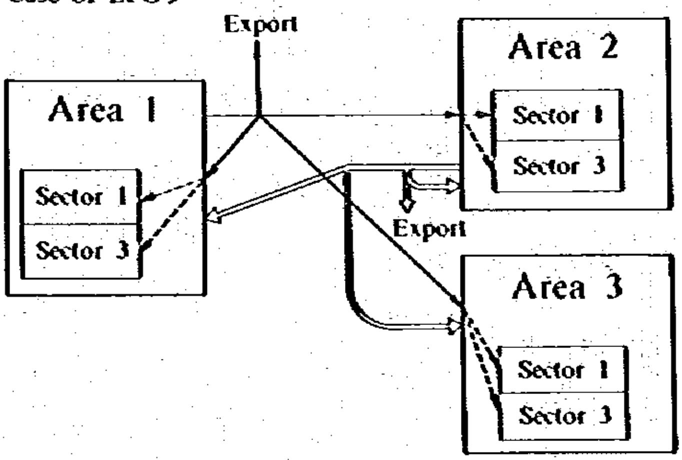
(4) Coal liquefaction

	(10^3Bbl) V	(10^3Bbl) PC	(10^3Bbl) PX	
DB coal	α			
OV	US$/Bbl			
DP26	−1.0			Treated as a crude oil in refinery
PO	−1.0	1.0		
PE		1.0	−1.0	

α : Needed volume to produce 10^3 Bbl synthetic oil

3-2-7 Domestic Transportation of Final Energy Products and Linkage to the Final Demand Sectors

< Case of LPG >



This is illustrated in taking the example of LPG. LPG produced in Area 1 can meet not only the demand in Area 1, but also the demands in Areas 2 and 3 after transported there with a certain freight rate.

In addition, if there still exist some surplus, it may be exported. For LPG produced in Areas 2 and 3, the same can be applied. LPG transported to each area satisfies the demands of the final demand sectors of 1 and 3 (the residencial/commercial and industrial sectors). At this stage, the unit unique to LPG, i.e., TON, is converted to the common unit of BOE.

Let's look at a matrix, specifically. The first through third variables indicate domestic transportation of LPG from Areas 1 → 1, Areas 1 → 2, and Areas 1 → 3, respectively, and their unit is TON. Each variable is balanced with LPG as a final energy product produced in Area 1. The fourth and fifth variables indicate the amount of LPG consumed in the final demand sectors of 1 and 3, respectively, and their unit is BOE. Unit conversion is carried out using the CN equation.

< Case of LPG >

ACTIVITY	PX1931	VS002031	PC2031	PX2031	PR22011	PR23111	PR23211	MO2111 (1)	94....1 ACTIVITY
OX1	.	.	.00800	.	.	.	.	.	OX1
OV1	.	.00600	.	.	.	.	.60400	.	OV1
IC1	29.50000	.	.	59.00000	.	.	.	.	IC1
IP20011	.	.	.	.	3.45950	.	.	.	IP20011
IP50031	.	1.00000	.	.	.	.	.	.	IP50031
IPF0031	.	.90000-	.	.	.	.	.	.	IPF0031
PE1931	1.00000-	.	.	.	.	.	.	.	PE1931
PO2031	.	1.00000-	1.00000	.	.	.	.	.	PO2031
PE2031	.	.	1.00000	1.00000-	.	.	.	.	PE2031
FP20011	.	.	.	.	1.00000-	1.00000-	1.00000-	1.00000	FP20011
FP23111	.	.	.	.	.	17.09000	.	.	FP23111
FP23211	.	.	.	.	.	.	17.09000	.	FP23211
PO3211	.	.	.	.	.	.	1.00000-	.	PO3211
CN211	.	.	.	.	.	.	.	8.52000-	CN211

ACTIVITY	MO2121 (2)	MO2131 (3)	MU2111 (4)	MU2311 (5)	EX211 (6)	BA00311	BC00311	BD00311	95....1 ACTIVITY
MC1	.	.	.	.	38.50000-	.	.	.	MC1
FR1	.18000	.21000	.	.	.	.	.	.	FR1
IPA0011	.	.	.	.	.	1.00000	.	.	IPA0011
IPC0011	.	.	.	.	.	.	1.00000	.	IPC0011
IPD0011	.	.	.	.	.	.	.	1.00000	IPD0011
FP20011	1.00000	1.00000	.	.	1.00000	.	.	.	FP20011
CN211	.	.	1.00000	1.00000	.	.	.	.	CN211
CN221	8.52000-	.	.	.	.	.	.	.	CN221
CN231	.	8.52000-	.	.	.	.	.	.	CN231
FD111	.	.	1.00000	.	.	.	.	.	FD111
RL2111	.	.	1.00000	.	.	.	.	.	RL2111
FD311	.	.	.	1.00000	.	.	.	.	FD311
RL2311	.	.	.	1.00000	.	.	.	.	RL2311
MB311	.	.	.	.	.	1.00000-	1.00000-	1.00000-	MB311
PS3211	.	.	.	.	.	10.00000	12.00000	10.00000	PS3211
PS3311	.	.	.	.	.	59.80000	90.00000	61.00000	PS3311

3-2-8 Expansion of Energy Production Facility

Facility which are added to the existing one by means of equipment and plant investment carried out at a certain period is naturally used continually from that time on. However, each facility has its durable years and hence any facility cannot continue operating forever. For this reason, this model obtains a depreciation rate from a number of durable years of a facility and expresses its effect.

ACTIVITY	V3000631	PC0631	PX0631	VI000731	PC0731	PX0731	V0250831	ACTIVITY
	.	.	.	.	.	.	.	
OX1	.	16.00000	.	.	.10300	.	.	OX1
OV1	10.66600	.	.	.06800	.	.	.29100	OV1
IC1	.	.	59.00000	.	.	14.75000	.	IC1
IP82531	.	.	.	.	.	.	1.00000	IP82531
IP30031	1.00000	.	.	.	.	.	.	IP30031
IPI0031	.	.	.	1.00000	.	.	.	IPI0031
PO0631	1.00000-	1.00000	.	.	.	.	.	PO0631
IPF0031	.	.	.	.90000-	.	.	.	IPF0031
IPG0031	.95000-	.	.	.	.	.	.	IPG0031
IPH0031	.05000-	.	.	.	.	.	.	IPH0031
PE0631	.	1.00000	1.00000-	.	.	.	.	PE0631
PO0731	.	.	.	1.00000-	1.00000	.	.	PO0731
IP380031	.	.	.	.10000-	.	.	.	IP380031
PE0731	.	.	.	.	1.00000	1.00000-	.	PE0731
PO0831	.	.	.	.	.	.	1.00000-	PO0831
IPI2531	.	.	.	.	.	.	.21200-	IPI2531
IPE2531	.	.	.	.	.	.	.34200-	IPE2531
IPK2531	.	.	.	.	.	.	.44600-	IPK2531
PE0632	.	.	.77378-	.	.	.	.	PE0632
PE0732	.	.	.	.	.	.77378-	.	PE0732

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ACTIVITY	PC0732	PX0732
	.	.
OX2	.10300	.
OV2	.	.
IC2	.	14.75000
IP80732	.	.
IP81232	.	.
IP81532	.	.
IP81632	.	.
IP82532	.	.
PO0732	1.00000	.
PE0732	1.00000	1.00000-

3-2-9 Objective Function

All costs of each period are aggregated in an objective function (OF), but all the costs are evaluated based on present value using the discount rate.

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ACTIVITY	M00322	M00332	MU0132	XM1	XF1
	.	.	.	.	.
MC1	.	.	.	1.00000-	.
FR1	.	.	.	.	1.00000-
OX1	.	.	.	.	.
OY1	.	.	.	.	.
FO132	.	.	1.00000	.	.
CN022	.18000-	.	.	.	.
CN032	.	.18000-	1.00000	.	.
FP00032	1.00000	1.00000	.	.	.
OF	.	.	.	.78353	.78353

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532....1

XX1	XY1	ACTIVITY
.	.	
.	.	MC1
.	.	FR1
1.00000-	.	OX1
.	1.00000-	OY1
.	.	FO132
.	.	CN022
.	.	CN032
.	.	FP00032
.78353	.78353	OF

3-3 Component Elements of Variable Names

3-3-1 ROWS

(1)	Domestic Production Capacity	[D , P , [c] , i , t , ,]
(2)	Distribution of Primary Energy	[D , B , [c] , j , t , ,]
(3)	Intermediate Product	[I , P , m , [c] , j , t ,]
(4)	Plant Expansion	[P , E , [p] , j , t , ,]
(5)	Plant Operation	[P , O , [p] , j , t , ,]
(6)	Material Balance of Oil Blending	[M , B , f , j , t , , ,]
(7)	Blending Ratio (Lower)	[L , m , [c] , f , j , t ,]
(8)	Blending Ratio (Upper)	[U , m , [c] , f , j , t ,]
(9)	Product Specification	[P , S , f , l , j , t , ,]
(10)	Final Product	[F , P , f , [p] , j , t ,]
(11)	Unit Conversion	[C , N , f , j , t , , ,]
(12)	Final Demand	[F , D , k , j , t , , ,]
(13)	Material Cost	[M , C , t , , , , ,]
(14)	Freight	[F , R , t , , , , ,]
(15)	Operation Cost (Fixed)	[O , X , t , , , , ,]
(16)	Operation Cost (Variable)	[O , V , t , , , , ,]
(17)	Investment Cost	[I , C , t , , , , ,]
(18)	Objective Function	[O , F , , , , , ,]
(19)	Product Raitio in Sector (Upper)	[R , U , f , k , j , t , ,]
(20)	Product Raitio in Sector (Lower)	[R , L , f , k , j , t , ,]

3-3-2 COLUMNS

(1)	Primary Energy Supply to Domestic Market	[P , D , [c] , i , j , t ,]
(2)	Export	[E , X , [c] , i , t , ,] E X f i t
(3)	Import	[I , M , [c] , i , j , t ,] I M f i j t
(4)	Feed Volume to Plant	[V , m , [c] [b] , j , t]
(5)	Plant Capacity	[P , C , [p] , j , t , ,]
(6)	Plant Expansion	[P , X , [p] , j , t , ,]
(7)	Blending Component	[B , m , [c] , f , j , t ,]

(8)	Final Product	[P, R, f, p, j, t,]
(9)	Domestic Supply of Final Product (Original Unit)	[M, O, f, i, j, t, ,]
(10)	Domestic Supply of Final Product (Universal Unit)	[M, U, f, k, j, t, ,]
(11)	Sector Demand (Universal Unit)	[S, D, k, j, t, , ,]
(12)	Material Cost	[X, M, t, , , , ,]
(13)	Freight (Internal Movement)	[X, F, t, , , , ,]
(14)	Operation Cost (Fixed)	[X, X, t, , , , ,]
(15)	Operation Cost (Variable)	[X, V, t, , , , ,]
(16)	Investment Cost	[X, I, t, , , , ,]
(17)	Swing Fraction m′ : Swing Fraction m″ : Intermediate Product	[S, W, m′, m″, c, j, t]
(18)	Aggregation of Intermediate Product	[A, G, m, c, j, t,]
(19)	Intermediate Product in Weight	[M, T, m, p, j, t,]

3-4 Correspondence Table of Codes

(1) COAL

CD		NAME	CD		NAME
01	01	STEAM COAL	03	03	STEAM COAL
02	01	ANTRACIT	04	08	
			99	99	

(2) CRUDE OIL

CD		NAME	CD		NAME
06	01	RANTAU	17	03	HANDIL
07	01	SLC/MINTS	18	03	BULA
08	01	TAP/LIRIK	19	03	SEPINGGAN
09	01	PEDADA	20	03	BADAK
10	01	SPALEMBANG	21	03	SANGASANGA
11	01	ARUN	22	03	WALIO
12	02	ARJUNA/ARB	23	02	CINTA
13	02	JATIBARANG	24	03	MIXED CRUD
14	03	UDANG	25	04	ARABLIGHT
15	03	ATTAKA	26		COAL LIQ.
16	03	BEKAPAI			
			99	99	

(3) NATURAL GAS

CD		NAME	CD		NAME
31	01	ASSOCYATED	34	02	NON A GAS
32	01	NON A GAS	35	03	ASSOCYATED
33	02	ASSOCYATED	36	03	NON A GAS

(4) INTERMEDIATE PRODUCTS

01		GAS	M22	PROPYLENE	
02		LPG	N23	MC.C.C.	
03	1	NAPHTHA	O24	FO.C.C.	
04	1	SWING 1	P25	MC.T.C.	
05	1	KEROSENE	Q26	FC.T.C.	
06	1	SWING 2	R27	FC.VISB	
07	1	DIESEL OIL	S28	GREEN COKE	
08	1	LONG RESIDUE	T29	LUB	
09		REF.FUEL GAS	U30	FC.L.P.	
A10		MC.SPRITTER	V31	ASP BASIS	
B11		TR.NAPHTHA	W32	WAX	0.950
C12		REFORMATE	X33	FC.W.P.	
D13		REFORM.T.R.	Y34	COKE	0.960
E14	1	HGO	Z35	DRY GAS	
F15		TREATED KERO	36	KERO.H.C	
G16		MC.EDELEANU	37	GAS OIL .H.C	
H17		FC.EDELEANU	38	GAS OIL DHDS	
I18	1	LGO	39	GAS OIL VISB	
J19		LUB FEED	40	ASPHALT	1.050
K20	1	VAC BOTTOM	41	POLY PROPYLENE	0.950
L21		MC.H.C.			

(5) FINAL PRODUCTS

01	COAL		
02	LPG	46.176	MSCF (LPG) / TON (LPG)
03	GASOLINE		
04	JET FUEL		
05	KEROSENE		
06	ADO		
07	IDO		
08	FUEL OIL		
09	POLY PROPYLENE		
A10	LUB		
B11	WAX		
C12	ASPHALT		
D13	COKE		
E14	NAPHTHA		
F15	LNG	46.176	MSCF (LNG) / TON (LNG)
G16	NGL	46.176	MSCF (NGL) / TON (NGL)
H17	METHANOL	47.973	MSCF (MET) / TON (MET)
I18	ETHANOL		
J19	TOWN GAS		
K20	ELECTRICITY		
L21	NAT.GAS		
M22	WOOD		
N23	AGRI.WASTES		
O24	BIOGAS		
P25	GAS FR COAL		
Q26	COAL LIQUID		
R27	BRIQUET		

(6) PLANT CODE

01	TOPPING UNIT	21	HYDRO POWER
02	SPLITTER	22	GEOTHERMAL
03	NHDT	23	NUCLEAR
04	CAT.REFORMER	24	COAL POWER
05	THERMAL REF.	25	DIESEL POWER
06	EDELEANU	26	FO POWER
07	DHDS	27	GAS POWER
08	HVU		
09	HYDRO CRACK	31	LNG PLANT
10	CAT.CRACKER	32	LPG PLANT
11	THERMAL CRAC	33	METHANOL
12	VIS-BREAKER	34	COAL TG
13	COKER	35	FO TG PLANT
14	LUB PLANT	36	GAS TG PLANT
15	PDU	37	ETHANOL
16	WAX PLANT	38	BIOGAS
17	CALCINER	39	DISTRIBUTION
18	POLY PROP PL	40	COAL LIQFI.
19	ASPHALT PL	41	COAL GASFIC.
20	KER TREATER	42	BRIQUET

(7) PRODUCT SPECIFICATION

01	SPECIFIC GRA
02	RVP
03	C N CLEAR
04	SMOKE POINT
05	CETANE NUM.
06	VISCOSITY KI
07	SULFUR %WT
08	FLASH POINT
09	POUR POINT

(8) DEMAND SECTOR

01	RES.& COMM.
02	TRANSPORTATI
03	INDUSTRIAL
04	GOVERNMENT
05	NON ENERGY

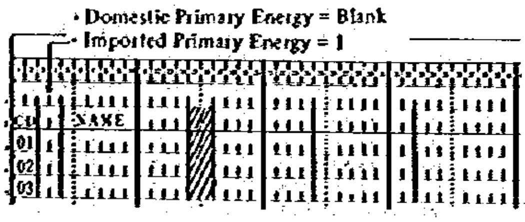
(9) AREA CODE

01	SUMATRA
02	JAWA
03	KAL+EAST IND

3-5 List of Input Data and Data Formats

TEST RUN OF LONG TERM ENERGY SUPPLY MODEL.

1965	1	5	5.0

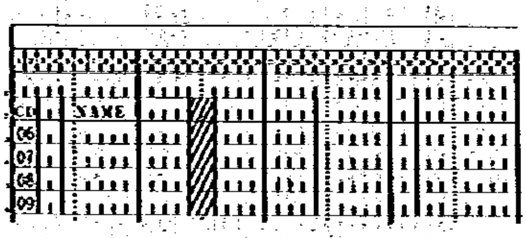


********** COAL PRODUCTION

CO NAME	1980	1985	1990
0101STEAM COAL	400	2500	6000
0201ANTRACIT	50	110	110
0303STEAM COAL			12000
0408		500	
9999			

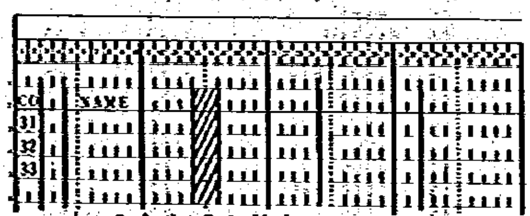
********** CRUDE OIL PRODUCTION

CO NAME	1980	1981	1982	1983	1984	1985	1990	1995
0601RANTAU	6447	6531	6652	6795	6931	7070	7805	8617
0701SLC/MINAS	278495	282115	287757	293512	299322	305370	337125	372169
0801TAP/LIRIK	11531	11681	11915	12153	12396	12644	13959	15411
0901PEDADA	435	442	451	460	469	478	528	583
1001SPALEMBANG	8205	8313	8479	8649	8822	8998	9934	10967
1101ARUN	24432	24750	25245	25791	26307	25833	29524	32705
1202ARJUNA/ARB	47082	47694	48646	49621	50613	51625	56994	62921
1302JATIBARANG	8058	8163	8326	8492	8662	8835	9754	10768
1403UDANG	6755	6844	6981	7121	7263	7408	8178	9029
1502ATTAKA	33687	34125	34803	35594	35214	35938	40720	45021
1603BEKAPAI	12965	13133	13396	13664	13937	14216	15694	17326
1703HANDIL	59809	60587	61799	63035	64256	65532	72403	79933
1803BULA	313	317	323	329	336	343	379	413
1903SEPINGGAN	3605	3653	3726	3800	3875	3954	4365	4819
2003BADAK	8532	8643	8816	8992	9172	9355	10328	11402
2103SANGASANGA	1560	1580	1611	1643	1676	1709	1837	2093
2203WALIO	19864	20122	20524	20934	21353	21780	24045	25546
2302CINTA	30079	30470	31079	31700	32334	32981	36411	40198
2403MIXED CRUD	14462	14650	14943	15242	15542	15858	17507	19320
2504ARABLIGHT	22375	22375	22375	22375	22375	22375	22375	22375
26 COAL LIQ.								
9999								



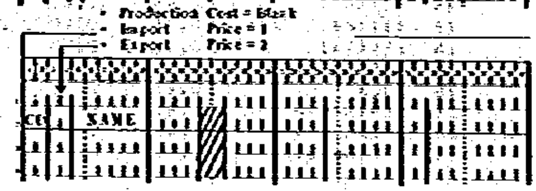
********** NATURAL GAS PRODUCTION

CO NAME	1980	1985	1990	1995
3101ASSOCYATED	82832	91446	103956	111455
3201NON A GAS	205486	226856	250449	276495
3302ASSOCYATED	15320	16913	18672	20614
3402NON A GAS	39758	43893	48458	53493
3503ASSOCYATED	92721	102364	113010	124873
3603NON A GAS	105852	116851	129014	142431
9999				



**********COAL PRICE

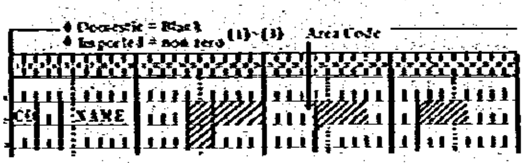
CO NAME	1980	1985	1990
01 STEAM COAL	25.00	29.50	34.20
02 ANTRACITE	26.00	30.14	34.94
03 STEAM COAL	25.00	29.50	34.20
04 1STEAM COAL		44.71	50.67
01 2STEAM COAL	25.00	29.50	34.20
02 2ANTRACITE	26.00	30.14	34.94



**********CRUDE OIL PRICE

CO NAME	1980	1985	1990
06 RANTAU	43.71	43.71	51.40
07 SLC/MINAS	35.00	40.00	47.04
08 TAP/LIRIK	35.0	40.00	47.04
09 PEPEDA	35.00	40.00	47.04
10 SPD	35.00	40.00	47.04
11 ARUN	33.25	43.71	51.40
12 ARJUNA	36.45	41.56	49.00
13 JATIBARANG	34.10	39.00	45.86
14 UDANG	34.60	39.54	46.50
15 ATTAKA	37.75	43.14	50.73
16 BEKAPAI	37.75	43.14	50.73
17 HANDIL	35.30	40.34	47.44
18 BULA	35.00	40.00	47.04
19 SEPINSSAN	35.30	40.34	47.44
20 BADAK	37.75	43.14	50.73

```
21  SANGASANGA       34.80   39.77   46.77
22  WALIO            35.00   40.00   40.04
23  CINTA            34.50   39.43   45.44
24  MIXED CRUD       34.80   39.77   46.77
06 2RANTAU           43.71   43.71   51.40
07 2SLC/MINAS        35.00   40.00   47.04
08 2TAP/LIRIK        35.0    40.00   47.04
09 2PEPEDA           35.00   40.00   47.04
10 2SPD              35.00   40.00   47.04
11 2ARUN             38.25   43.71   51.40
12 2ARJUNA           35.45   41.66   49.00
13 2JATIBARANG       34.10   39.00   45.56
14 2UDANG            34.60   39.54   46.50
15 2ATTAKA           37.75   43.14   50.73
16 2BEKAPAI          37.75   43.14   50.73
17 2HANDIL           35.30   40.34   47.44
18 2BULA             35.00   40.00   47.04
19 2SEPINGGAN        35.30   40.34   47.44
20 2BADAK            37.75   43.14   50.73
21 2SANGASANGA       34.80   39.77   46.77
22 2WALIO            35.00   40.00   40.04
23 2CINTA            34.50   39.43   46.45
24 2MIXED CRUD       34.80   39.77   46.77
25 1ALC              32.00   37.10   43.00
9999
***********NATURAL GAS PRICE
CO   NAME            1980    1985    1990
31   ASS GAS-1        3.00    3.48    4.03
32   NONASS GAS-1     3.00    3.45    4.03
33   ASS GAS-2        3.00    3.48    4.03
34   NONASS GAS-2     3.00    3.46    4.03
35   ASS GAS-3        3.00    3.48    4.03
36   NONASS GAS-3     3.00    3.43    4.03
9999
***********COAL TRANSPORTATION COST
CO   NAME               1       2       3
01   STEAM COAL       1.00   10.00   11.00
02   STEAM COAL      10.00    1.00   10.00
03   STEAM COAL      11.00   10.00    1.00
04 1STEAM COAL       15.00   14.00   15.00
99
***********CRUDE OIL TRANSPORTATION COST
CO   NAME               1       2       3
06   RANTAU           0.20    0.40    0.45
07   SLC              0.20    0.40    0.45
08   TAP/LIRIK        0.20    0.40    0.45
09   PEDADA           0.20    0.40    0.45
10   SPD              0.20    0.40    0.45
11   ARUN             0.20    0.40    0.45
12   ARJUNA           0.40    0.20    0.40
13   JATIBARANE       0.40    0.20    0.40
14   UDANG            0.45    0.40    0.20
15   ATTAKA           0.45    0.40    0.20
16   BEKAPAI          0.45    0.40    0.20
17   HANDIL           0.45    0.40    0.20
18   BULA             0.45    0.40    0.20
19   SEPINGGAN        0.45    0.40    0.20
20   BADAK            0.45    0.40    0.20
21   SANGASANGA       0.45    0.40    0.20
22   WALIO            0.45    0.40    0.20
23
24
25 1ALC               0.86    1.00    1.10
9999
```



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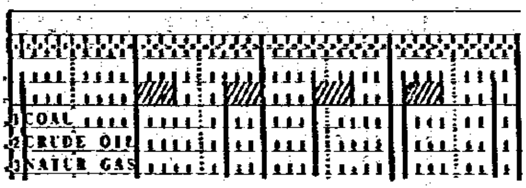
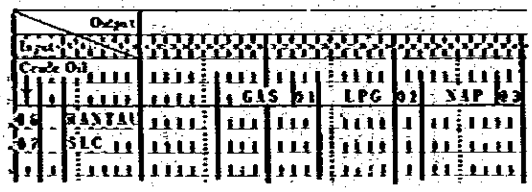
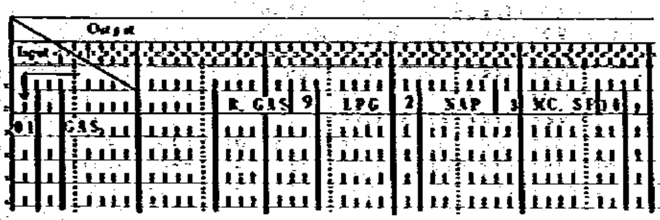
##########NATURAL GAS TRANSPORTATION COST
CO   NAME                 1        2        3
31   ASSOCIATED        0.15    10.00    10.00
32
33   ASSOCIATED       10.00     0.15    10.00
34
35   ASSOCIATED       10.00     0.15    10.00
36
99
###########MODIFICATION FACTOR OF FREIGHT
                1980    1985    1990
1COAL            1.0     1.0     1.0
2CRUDE OIL       1.0     1.0     1.0
3NATUR GAS       1.0     1.0     1.0
9
```



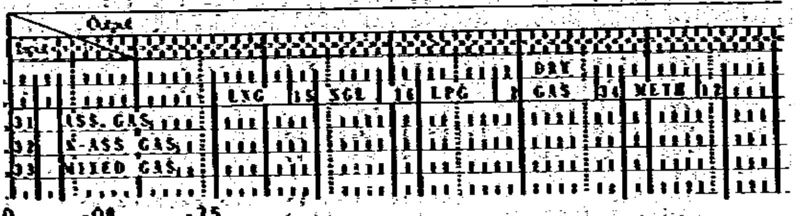

```
########## REFINERY PROCESSING FLOW
01   TOPPING UNIT   GAS 01  LPG 02  NAP 03   SW1 04   KER 05   SW2 06 D.O. 07  L.R. 08
25   ARABIAN L.T       0.4             18.5             29.2              9.3     12.6
07   MINAS             0.0              5.9             21.7              9.7     59.5
12   ARJUNA            2.7             24.6             32.5              9.2     31.0
15   ATTAKA            2.2             31.7             46.7              8.9     12.5
16   BEKAPAI           1.9             25.7             19.7              9.0     13.7
18   BULA               0               4.3             34.3             15.5     45.6
17   HANDIL            0.6             12.4             27.7             14.1     45.2
09   PEDADA            0.1             12.0             25.7              6.9     54.3
19   SEPINGGAN         0.7             16.4             41.1             15.5     26.0
10   S.P.O             0.8             10.3             23.9             12.6     47.5
06   RANTAU            6.9             45.9             35.5              5.4      6.3
08   T.A.P.            2.1             23.4             30.2              9.2     35.0
26   COAL LIC.         5.0             20.0             30.0             10.0     30.0
99
```




```
02   SPLITTER       R.GAS 9  LPG  2  NAP  3 MC.SP10
01   GAS                7.7     1.7     71    19.6
99
03   NHDT           T.NAP 11
03   NAPHTHA           99.0
99
04   CAT.REFORMER R.GAS 9 LPG    2RFM.CR12
11   TR.NAPHTHA         1.5    16.5    81.0
99
05   THR.REFORMER R.GAS 9RFM.TR13  HGO 14
03   NAPTHA            11.4    73.5    15.1
99
06   EDELEANU       T.KER 15 MC.ED15 FC.ED17
05   KEROSENE          65.1     7.5    25.2
03   NAPHTHA                   55.0     5.0
99
07   DHDS           T.KER 15 D.O. 33
18   LGO                90.      10.
99
08   HVU             LGO 18  HGO 14   VB 20LB.FS 19
 825L.R.ARAB.LT        21.2    34.2    44.6
 807      MINAS        14.4    33.2    52.4
 812      ARJUNA       23.5    33.8    42.6
 815      ATTAKA       31.2    68.8
 816      BEKAPAI      27.1    40.4    32.9
 818      BULA         21.4    32.0    46.6
 817      HANDIL       25.8    38.4    35.8
 809      PEDADA       12.4    18.5    39.6
 819      SEPINGGA     25.8    38.7    35.5
 810      SPO          23.0    39.6    42.4
 806      RANTAU      100.0
 808      TAP          11.8    17.7    70.5
```



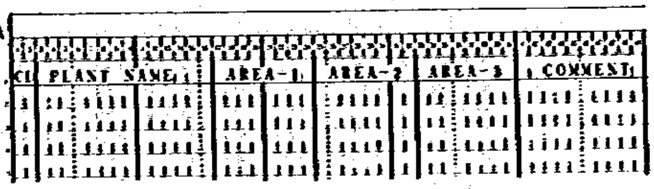
```
826     **COAL**     100.0
99
09  HYD.CRACKER R.GAS  9  LPG  2  NAP  3 MC.HC21  KER 36 O.O. 37
14  HGO                2.0      4.0     13.0      8.0     50.0     26.0
99
10  CAT.CRACKER R.GAS  9 PRPL 22  LPG  2 MC.CC23 FC.CC24
14  HGO               14.2      5.3     13.6     31.4     34.5
99
11  THE.CRACKER R.GAS  9MC.TC 25FC.TC 26
14  HGO               16.9     17.2     48.9
99
12  VIS-BREAKER     NAP. 3  LGO 39FC.VB 27
8                      7.5     24.0     66.0
99
13  COKER           NAP  3  LGO 38  LPS  2  HGO 14G.COKE28
20  VB                14.4     35.0     10.3     31.0        3
99
14  LUB PLANT       LUB 29FC.LP 30
19  LUB FEED STK      42.2     57.8
99
15  PDU             ASP 31LE.FS 19
2025VB                62.7     37.0
99
16  WAX PLANT       WAX 32FC.WP 33
14  HGO                 26       73
99
17  CALCINER       COKE 34
28  GREEN COKE          72
99
18  POLY PROP PL POLY 41
22  PRPL              85.0
99
19  ASP PLANT      ASPH 40
31  ASP BASE          85.0
2007MINAS             95.0
2012ARJUNA            95.0
2015ATTAKA            95.0
2016BEKAPAI           95.0
2018BULA              95.0
2017HANDIL            95.0
2009PEDADA            95.0
2019SEPINGGA          95.0
2010SPD               95.0
2006RANTAU            95.0
2008T.A.P.            95.0
99
20  KER TEATER     TR.KR15
05  KERO              90.0
9999
***********GAS YIELD
                    LNG  15 NGL   16 LPG  02 GAS   35 METH.17
31  LNG PLANT         0.80        .02       .05
```




```
32  LPG PLANT                     .10       .08       .75
33  METHANOL                                          .80
99
```

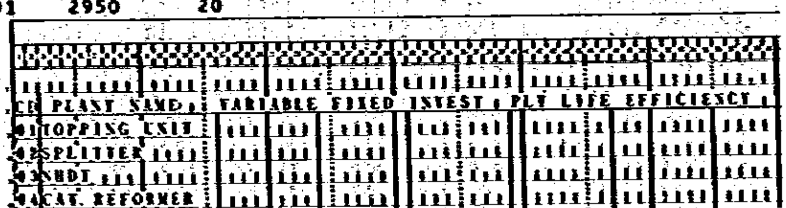
########## INITIAL CAPACITY

CO	PLANT NAME	AREA-1	AREA-2	AREA-3	COMMENT
01	TOPPING UNIT	340.00	300.00	270.00	PLANT CAPA
02	SPLITTER	23.00	23.00		
03	NAPHTHA HDT	10.10	40.00	20.00	CITY IN
04	CAT.REFORMER	15.10	34.20	20.00	000 BPCD
05	THERMAL REFORM	7.00			OTHERWISE
06	EDELEANU	3.00			SPECIFIED
07	DHDS		20.00		
08	VACUUM UNIT	186.60	35.75	94.00	
09	HYDRO CRACKER	55.80		55.00	
10	CAT.CRACKER	18.00			
11	THERM.CRACKER	7.50			
12	VISBREAKER		55.00		
13	COKER	35.20			
14	LUB PLANT		21.00		FURFUR+MEK
15	PROPANE DEASP		8.00		
16	WAX PLANT	49.50		51.00	000 TPA
17	CALCINER	350.79			000 TPA
18	POLY PROPYLENE	11.00			000 TPA
19	ASPHALT PLANT	75.90			000 TPA
20	KER TREATER		25.70		
21	HYDRO POWER	46.20	462.00	190.00	MW
22	GEOTHERMAL				
23	NUCLEAR				
24	COAL POWER				
25	DIESEL POWER	953.00	1573.00	489.00	MW
26	FO POWER	25.00	706.00	25.00	MW
27	GAS POWER	147.00	735.00	14.00	MW
31	LNG PLANT	182.00		122.00	000 TPA
32	LPG PLANT	3.87	8.28	6.68	
33	METHANOL			7.20	000 TPA
99					



########## PLANT INFORMATUON

CO	PLANT NAME	VARIABLE	FIXED	INVEST	PLT LIFE	EFFICIENCY		COMMENT
01	TOPPING UNIT	0.104	0.156	2950	20			COST AND AREA 1
02	SPLITTER	0.408	0.611	2950	20			INVESTMENT REA 1
03	NHDT	0.040	0.060	1475	20			US$/BBL
04	CAT.REFORMER	0.605	0.908	11800	20			
05	THERMAL REFORM	0.392	0.588	11800	20			PLANT LIFE
06	EDELEANU	10.666	16.000	5900	20			ALL 20 YRS
07	DHDS	0.069	0.103	1475	20			
08	VACUUM UNIT	0.116	0.171	2950	20			
09	HYDRO CRACKER	0.652	0.997	14750	20			
10	CAT CRACKER	0.652	0.977	5900	20			
11	THERM.CRACKER	0.993	1.489	11800	20			
12	VISBREAKER	0.652	0.997	4425	20			
13	COKER	1.568	2.352	2950	20			
14	LUB PLANT	0.400	0.600	11800	20			
15	PROPANE DEASP	0.756	1.134	5900	20			
16	WAX PLANT	8.196	12.294	2950	20			
17	CALCINER	1.568	2.352	2950	20			
18	POLY PROPYLENE	3.200	4.800	17700	20			
19	ASPHALT PLANT	6.461	9.691	2950	20			
20	KER TRATER	0.006	0.008	5900	20			
21	HYDRO POWER	0.50	31.50	1.15	20			WE
22	GEOTHERMAL	2.00	12.00	0.77	20			MWE
23	NUCLEAR	6.00	20.00	1.07	20			
24	COAL POWER	18.26	0.90	0.40	15	0.0004	KWH/TON	SED ON
25	DIESEL POWER	111.13	1.71	0.30	10	0.0029	KWH/BBL	
26	FO POWER	73.08	1.72	0.32	15	0.0022	KWH/BBL	IS
27	GAS POWER	116.98	0.76	0.16	15	3.5600	KWH/MSCF	
31	LNG PLANT	0.604	11.43	15.84	20			
32	LPG PLANT	0.379	0.569	2950	20			
34	TG FR COAL	1.319	1.759	7000	20	0.0158	MSCF/TON	
35	TG FR FUEL	1.319	1.759	7000	20	0.0790	MSCF/BBL	
36	TG FR GAS	1.319	1.759	7000	20	0.4505	MSCF/MSCF	
37	ETHANOL	10.00	10.00	7000	20		*****	
38	BIOGAS	10.00	10.00	7000	20		*****	
40	COAL LIQ.	10.00	10.00	7000	20	0.77	*****	
41	COAL GAS.	10.00	10.00	7000	20	0.77	*****	
42	BRIQUET	10.00	10.00	7000	20	0.77	*****	
99								



CO PLANT NAME	VARIABLE	FIXED	INVEST	PLT LIFE	EFFICIENCY	COMMENT
01TOPPING UNIT	0.092	0.137	2950	20		COST AND AREA 2
02SPLITTER	0.408	0.611	2950	20		INVESTMENT REA 2
03NHOT	0.040	0.060	1475	20		US$/BBL
04CAT.REFORMER	0.252	0.378	11800	20		
05THERMAL REFORM	0.392	0.588	11800	20		PLANT LIFE
06EDELEANU	10.666	16.000	5900	20		ALL 20 YRS
07DHOS	0.068	0.103	1475	20		
08VACUUM UNIT	0.267	0.401	2950	20		
09HYDRO CRACKER	0.652	0.977	14750	20		
10CAT CRACKER	0.652	0.977	5900	20		
11THERM.CRACKER	0.993	1.489	11800	20		
12VISBREAKER	0.652	0.977	4425	20		
13COKER	1.568	2.352	2950	20		
14LUB PLANT	0.400	0.600	11800	20		
15PROPANE DEASP	0.756	1.134	5900	20		
16WAX PLANT	8.196	12.294	2950	20		
17CALCINER	1.568	2.352	2950	20		
18POLY PROPYLENE	3.200	4.800	17700	20		
19ASPHALT PLANT	6.461	9.691	2950	20		
20KER TREATER	0.006	0.008	5900	20		
21HYDRO POWER	0.50	31.50	1.15	20		WE
22GEOTHERMAL	2.00	12.00	0.77	20		MWE
23NUCLEAR	6.00	20.00	1.07	20		
24COAL POWER	18.26	0.90	0.40	15	0.0004 KWH/TON	SEO GN
25DIESEL POWER	111.13	1.71	0.30	10	0.0029 KWH/BBL	
26FO POWER	73.09	1.72	0.32	15	0.0022 KWH/BBL	IS
27GAS POWER	116.93	0.76	0.16	15	3.5400 KWH/MSCF	
32LPG PLANT	0.379	0.569	2950	20		
34TG FR COAL	1.319	1.759	7000	20	0.0158 MSCF/TON	
35TG FR FUEL	1.319	1.759	7000	20	0.0790 MSCF/BBL	
36TG FR GAS	1.319	1.759	7000	20	0.4505 MSCF/MSCF	
37ETHANOL	10.00	10.00	7000	20	*****	
38BIOGAS	10.00	10.00	7000	20	*****	
40COAL LIQ.	10.00	10.00	7000	20	0.77 *****	
41COAL GAS.	10.00	10.00	7000	20	0.77 *****	
42BRIQUET	10.00	10.00	7000	20	0.77 *****	

99

CO PLANT NAME	VARIABLE	FIXED	INVEST	PLT LIFE	EFFICIENCY	COMMENT
01TOPPING UNIT	0.287	0.431	2950	20		COST AND AREA 3
02SPLITTER	0.408	0.611	2950	20		INVESTMENT REA 3
03NHOT	0.040	0.060	1475	20		US$/BBL
04CAT.REFORMER	0.252	0.378	11800	20		
05THERMAL REFORM	0.392	0.588	11800	20		PLANT LIFE
06EDELEANU	10.665	16.000	5900	20		
07DHOS	0.068	0.103	1475	20		
08VACUUM UNIT	0.291	0.437	2950	20		
09HYDRO CRACKER	0.652	0.977	14750	20		
10CAT CRACKER	0.652	0.977	5900	20		
11THERM.CRACKER	0.993	1.489	11800	20		
12VISBREAKER	0.652	0.997	4425	20		
13COKER	1.568	2.352	2950	20		
14LUB PLANT	0.400	0.600	11800	20		
15PROPANE DEASP	0.756	1.134	5900	20		
16WAX PLANT	9.594	14.391	2950	20		
17CALCINER	1.568	2.352	2950	20		
18POLY PROPYLENE	3.200	4.600	17700	20		
19ASPHALT PLANT	6.461	9.691	2950	20		
20KER TREATER	0.006	0.008	5900	20		
21HYDRO POWER	0.50	31.50	1.15	20		WE
22GEOTHERMAL	2.00	12.00	0.77	20		MWE
23NUCLEAR	6.00	20.00	1.07	20		
24COAL POWER	18.26	0.90	0.40	15	0.0004 KWH/TON	SEO ON
25DIESEL POWER	111.13	1.71	0.30	10	0.0029 KWH/BBL	
26FO POWER	73.09	1.72	0.32	15	0.0022 KWH/BBL	IS
27GAS POWER	116.93	0.76	0.16	15	3.5400 KWH/MSCF	
32LPG PLANT	0.379	0.569	2950	20		
34TG FR COAL	1.319	1.759	7000	20	0.0158 MSCF/TON	
35TG FR FUEL	1.319	1.759	7000	20	0.0790 MSCF/BBL	
36TG FR GAS	1.319	1.759	7000	20	0.4505 MSCF/MSCF	
37ETHANOL	10.00	10.00	7000	20	*****	
38BIOGAS	10.00	10.00	7000	20	*****	
40COAL LIQ.	10.00	10.00	7000	20	0.77 *****	
41COAL GAS.	10.00	10.00	7000	20	0.77 *****	
42BRIQUET	10.00	10.00	7000	20	0.77 *****	

99

########## MODIFICATION FACTOR OF PLANT COST

CO PLANT NAME	1980	1985	1990
01TOPPING UNIT	1.0	1.0	1.0
02SPLITTER	1.0	1.0	1.0
03NHDT	1.0	1.0	1.0
04CAT4REFORMER	1.0	1.0	1.0
05THERMAL REFORM	1.0	1.0	1.0
06EDELEANU	1.0	1.0	1.0
07DHDS	1.0	1.0	1.0
08VACUUM UNIT	1.0	1.0	1.0
09HYDRO CRACKER	1.0	1.0	1.0
10CAT CRACKER	1.0	1.0	1.0
11THERM.CRACKER	1.0	1.0	1.0
12VISBREAKER	1.0	1.0	1.0
13COKER	1.0	1.0	1.0
14LUB PLANT	1.0	1.0	1.0
15PROPANE DEASP	1.0	1.0	1.0
16WAX PLANT	1.0	1.0	1.0
17CALCINER	1.0	1.0	1.0
18POLY PROPYLENE	1.0	1.0	1.0
19ASPHALT PLANT	1.0	1.0	1.0
20KER TREATER	1.0	1.0	1.0
21HYDRO POWER	1.0	1.0	1.0
22GEOTHERMAL	1.0	1.0	1.0
23NUCLEAR	1.0	1.0	1.0
24COAL POWER	1.0	1.0	1.0
25DIESEL POWER	1.0	1.0	1.0
26FO POWER	1.0	1.0	1.0
27GAS POWER	1.0	1.0	1.0
31LNG PLANT	1.0	1.0	1.0
32LPG PLANT	1.0	1.0	1.0
33METHANOL	1.0	1.0	1.0
34TG FR COAL	1.0	1.0	1.0
35TG FR FUEL	1.0	1.0	1.0
36TG FR GAS	1.0	1.0	1.0
37ETHANOL	1.0	1.0	1.0
38BIOGAS	1.0	1.0	1.0
40COAL LIQ.	1.0	1.0	1.0
41COAL GAS.	1.0	1.0	1.0
42BRIQUET	1.0	1.0	1.0
9999			

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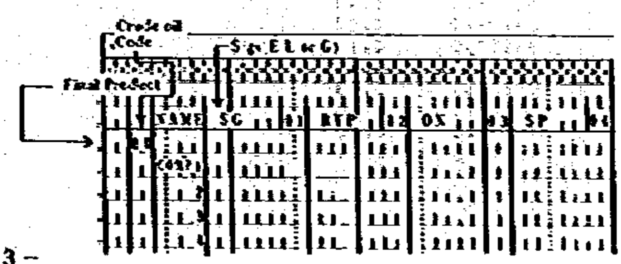
########## SPEC. BLENDING

CO NAME SG	01 RVP	02 ON	03 SP	04 CN	05 VIS	06 SUF	07 FP	08 PP	09
0300GASO	L	9.05	60.5			L 0.02			
0300GASO									
10 SPLT		10.0	59.8			0.02			
12 R(C)		12.0	99.6			0.02			
13 R(T)		10.0	61.0			0.02			
16 EDEL		8.0	60.0			0.02			
21 H.C.		10.0	90.0			0.02			
23 C.C.		10.0	90.0			0.02			
25 T.C.		10.0	57.5			0.02			
0306NAPH		7.7	57.5			0.02			
0307NAPH		6.0	55.9			0.02			
0308NAPH		9.7	60.5			0.02			
0309NAPH		5.0	54.4			0.02			
0310NAPH		5.3	59.6			0.02			
0312NAPH		7.4	61.0			0.02			
0313NAPH		6.5	61.0			0.02			
0314NAPH		5.4	52.4			0.01			
0315NAPH		5.7	60.5			0.02			
0316NAPH		6.4	60.0			0.02			
0317NAPH		6.4	65.5			0.01			
0318NAPH		4.2	59.6			0.03			
0319NAPH		5.2	63.3			0.03			
0320NAPH		3.2	54.4			0.01			
0322NAPH		6.2	56.0			0.02			
0323NAPH		4.4	59.6			0.01			
0325NAPH		13.5	59.6			0.04			
99									

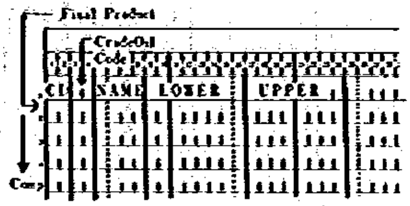


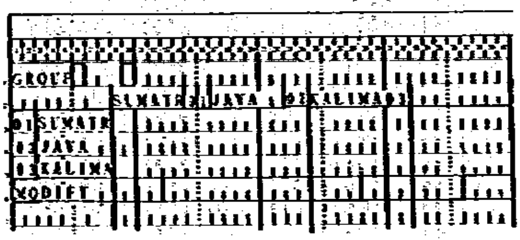
CO NAME	SG	01 RVP	02 ON	03 SP	04 CN	05 VIS	06 S	07 FP	08 PP	09
0500KEROL	0.83			L 4.76			L 0.20	G160.0		
0500KERO										
15 T.KR	0.77			4.55			0.05	108.0		
36 H.C	0.79			3.45			0.04	110.0		
42 OHDS	0.81			6.25			0.04	115.0		
43 EDEL	0.77			4.76			0.03	120.0		
0506KERO	0.81			5.88			0.03	137.0		
0507KERO	0.80			4.17			0.03	141.0		
0508KERO	0.81			5.26			0.03	126.0		
0509KERO	0.84			6.25			0.04	148.0		
0510KERO	0.86			10.00			0.04	155.0		
0512KERO	0.84			8.33			0.05	143.0		
0513KERO	0.85			9.09			0.05	148.0		
0514KERO	0.79			6.54			0.02	159.0		
0515KERO	0.83			6.67			0.05	142.0		
0516KERO	0.83			5.88			0.08	139.0		
0517KERO	0.87			10.00			0.06	152.0		
0518KERO	0.86			7.69			0.89	157.0		
0519KERO	0.88			9.09			0.04	159.0		
0520KERO	0.85			6.25			0.03	145.0		
0522KERO	0.82			4.55			0.21	135.0		
0523KERO	0.80			3.13			0.03	136.0		
0525KERO	0.84			4.55			0.55	160.0		
99										

CO NAME	SG	01 RVP	02 ON	03 SP	04 CN	05 VIS	06 S	07 FP	08 PP	99
0600ADO L	0.87				S 45.0	L 5.8	L 0.50		L 65.0	
0600ADO G	0.82					G 1.6				
37 H.C.	0.82				62.0	4.5			60.0	
38 OHDS	0.80				54.0	2.3			52.0	
0706ADO	0.87				56.0	6.4	0.08		35.0	
0707ADO	0.83				65.6	5.5	0.06		60.0	
0708ADO	0.90				49.0	5.2	0.03		50.0	
0709ADO	0.89				45.5	8.6	0.12		15.0	
0710ADO	0.87				53.3	5.9	0.10		45.0	
0712ADO	0.86				54.0	5.4	0.15		45.0	
0713ADO	0.86				52.5	5.9	0.12		15.0	
0714ADO	0.82				72.0	4.8	0.04		55.0	
0715ADO	0.86				60.4	5.9	0.10		45.0	
0716ADO	0.85				55.9	6.0	0.12		40.0	
0717ADO	0.87				52.6	5.4	0.14		45.0	
0718ADO	0.92				32.3	9.4	2.54		15.0	
0719ADO	0.89				53.6	6.5	0.12		50.0	
0720ADO	0.87				55.0	8.0	0.15		60.0	
0722ADO	0.87				53.6	5.9	0.59		30.0	
0723ADO	0.86				86.0	85.0	0.07		120.0	
0725ADO	0.87				58.0	6.15	1.66		37.0	
99										

CO NAME	SG	01 RVP	02 ON	03 SP	04 CN	05 VIS	06 S	07 FP	08 PP	09
0800F.O L	0.99					L312.0	L 3.50			
0800F.O						G100.0				
20 V.BT	0.90					35.2	0.20			
26 T.C.	1.03					34.0	0.21			
27 VISB	1.06					34.2	0.26			
30 LUBP	1.00					34.2	4.10			
33 WAXP	0.95					33.2	0.02			
39 G.O.	0.97					33.2	0.90			
17 EDEL	0.89					30.4	0.17			
0806F.O	0.94					118.0	0.24			
0807F.O	0.89					370.0	0.11			
0808F.O	0.93					62.0	0.07			
0809F.O	0.91					230.0	0.13			
0810F.O	0.94					232.0	0.17			
0812F.O	0.92					235.0	0.17			
0813F.O	0.91					85.0	0.16			
0814F.O	0.88					237.0	0.08			
0815F.O	0.92					280.0	0.18			
0816F.O	0.93					240.0	0.20			
0817F.O	0.90					54.0	0.17			
0818F.O	0.99					242.0	3.83			
0819F.O	0.93					82.0	0.18			
0820F.O	0.93					245.0	0.24			
0822F.O	1.30					247.0	1.30			
0823F.O	0.22					248.0	0.22			
0825F.O	3.00					250.0	3.00			
9999										

```
**********COEF.BLENDING
CO  NAME LOWER    UPPER
02  LPG
02  LPG
99
CO  NAME LOWER    UPPER
04  JET
03  NAPH    0.00     0.30
36  KERO    0.70     1.00
99
CO  NAME LOWER    UPPER
07  IDO
06  ADO     0.60     1.00
08  FO      0.00     0.40
99
CO  NAME LOWER    UPPER
10  LUB
29  LUB
99
CO  NAME LOWER    UPPER
11  WAX
32  WAX
99
CO  NAME LOWER    UPPER
12  ASPH
40  ASPH
99
CO  NAME LOWER    UPPER
13  COKE
34  COKE
99
CO  NAME LOWER    UPPER
14  NAPH
03  NAPH
99
CO  NAME LOWER    UPPER
09  POLY
41  POLY
9999
************TRANSPORTATION COST OF FINAL PRODUCTS
GROUP2    7        JETFUL04GASOLN03KEROSN05DIESEL06FULOIL07NAPTHA12LISCOL26
          SUMATR01JAVA  02KARIMA03
01SUMATR           0.500    0.630
02JAVA    0.500             0.500
03KALIMA 0.630     0.500
MODIFY        1980      1985     1990
03            1.00      2.00     3.00
04            1.00      2.00     3.00
05            1.00      2.00     3.00
06            1.00      2.00     3.00
07            1.00      2.00     3.00
13            1.00      2.00     3.00
26            1.00      2.00     3.00
GROUP1    2        COAL   01PRICE127
          SUMATR01JAVA  02KALIMA03
01SUMATR           0.250    0.300
02JAVA    0.250             0.250
03KALIMA 0.300     0.250
MODIFY        1980      1965     1990
01            1.00      2.00     3.00
27            1.00      2.00     3.00
GROUP3    5        LNG    15NGL   16MEINCL17ETHNCL13LPG    02
          SUMATR01JAVA  02KALIMA03
01SUMATR            0.120    0.140
02JAVA     0.120             0.120
03KALIMA   0.150    0.120
MODIFY        1980      1965     1990
15             1.0       1.0      1.0
16             1.0       1.0      1.0
17             1.0       1.0      1.0
18             1.0       1.0      1.0
02             1.0       1.5      2.0
```





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**********CONTROL FOR DOMESTIC TRANS. OF F.P.
01 COAL          1 1985 1-3 2-3
20 ELECTRICITY 0 1985
99
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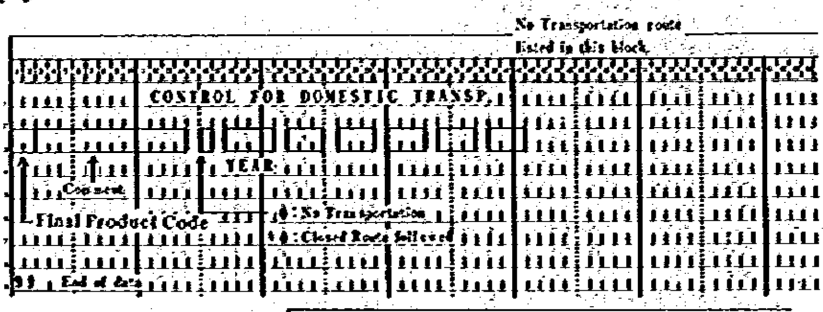


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**********IMPORT PRICE OF FINAL PRODUCT
CO  NAME              1980    1985    1990
9999
```
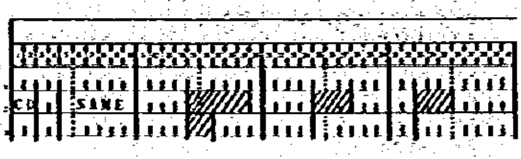
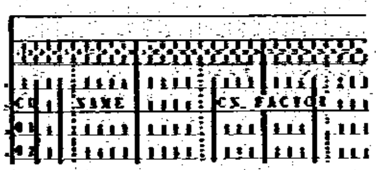


```
**********EXPORT PRICE OF FINAL PRODUCT
CO   NAME             1980    1985    1990
02  LPG              35.00   38.50   42.35
03  NAPHTHA          37.00   40.70   44.77
11  WAX              89.00   97.90  107.69
15  LNG              23.54   30.04   38.34
17  METHANOL         21.19   27.04   34.52
9999
```




```
**********CONVERSION FACTOR
CO  NAME          CN.FACTOR    COMMENT
01  COAL             5.00   BOE/T
02  LPG              8.52   BOE/T
03  GASOLINE         1.00   BOE/BBL
04  JET FUEL         1.00   BOE/BBL
05  KEROSENE         1.00   BOE/BBL
06  ADO              1.00   BOE/BBL
07  IDO              1.00   BOE/BBL
08  FUEL OIL         1.00   BOE/BBL
09  POLY PROP        1.00
10  LUB              1.07   BOE/BBL
11  WAX              5.71   BOE/TON
12  ASPHALT          6.31   BOE/TON
13  COKE             8.28   BOE/TON
14  NAPHTHA          1.00   BOE/BBL
15  LNG              7.14   BOE/T
16  NGL              7.14   BOE/T
17  METHANOL         3.84   BOE/T
18  ETHANOL          3.33   BOE/T
19  TOWN GAS         .178   BOE/MSCF
20  ELECTRICITY   0.00062   BOE/KWH
21  NAT.GAS          .178   BOE/MSCF
24  BIOGAS           .160   BOE/TON
25  GAS COAL         .182   BOE/MSCF
27  BRIQUET          5.00   BOE/T
99
```



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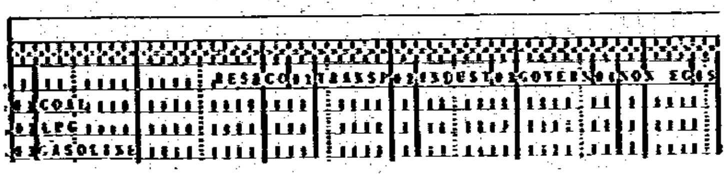
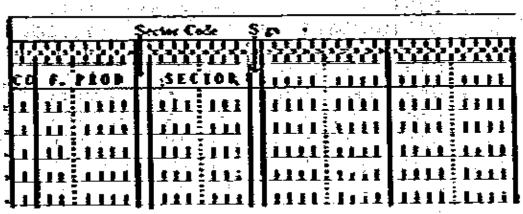
**********PRODUCTS FLOW TO SECTOR
                  RESECOO1TRANSPO2INDUSTO3GOVERNO4NON EGGS
01COAL              1      1      1      0
02LPG               1      0      1      0
03GASOLINE          0      1      0      1
04TETFUEL           0      1      0      1
05KEROSEN           1      0      0      1
06ADO               0      1      1      1
07IDO               0      1      1      0
08FUELOIL           0      1      1      1
09POLY PROP         0      0      0      0      1
10LUB               0      0      0      0      1
11WAX               0      0      0      0      1
12ASPHALT           0      0      0      0      1
13COKE              0      0      0      0      1
14NAPHTHA           0      0      0      0      1
18ETHANOL           0      1      1      0
17METHANOL          0      1      1      0
16NGL               0      1      0      0
19TOWN GAS          1      0      1      0
20ELECTRIC          1      0      1      1
21NAT.GAS           0      0      1      0
22WOOD              1      0      0      0
24GIOGAS            1      0      0      0
25GAS FR COAL       0      0      1      0      1
27BRIQUET           1      0      1      0
99
```




```
**********PRODUCTS RATIO IN SECTOR
CO F.PROD    SECTOR      1980 1985 1990
01COAL      1RESECOMML   .001 .050 .075
01COAL      2TRANSPORL   .001 .020 .030
01COAL      3INDUSTRYL   .002 .160 .250
02LPG       1RESECOMML   .020 .075 .100
02LPG       2TRANSPORL   .001 .002 .005
02LPG       3INDUSTRYL   .002 .010 .050
02LPG       4GOVERNMTL   .010 .020 .050
03GASOLINE1RESECOMML     .001 .002 .005
03GASOLINE2TRANSPORL     .400 .450 .500
03GASOLINE3INDUSTRYL     .020 .010 .005
03GASOLINE4GOVERNMTL     .350 .400 .450
04JET FUEL1RESECOMME     .000 .000 .000
04JET FUEL2TRANSPORL     .050 .075 .100
04JET FUEL3INDUSTRYE     .000 .000 .000
04JET FUEL4GOVERNMTL     .100 .150 .200
05KEROSINE1RESECOMML     .800 .700 .650
05KEROSINE3INDUSTRYL     .150 .120 .100
05KEROSINE4GOVERNMTL     .150 .200 .250
06ADO       1RESECOMML   .001 .002 .005
06ADO       2TRANSPORL   .250 .270 .300
```



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06A00      3INDUSTRYL .170 .150 .100
06A00      4GOVERNMTL .100 .125 .150
07I00      1RES&COMML .000 .000 .000
07I00      2TRANSPORL .050 .080 .100
07I00      3INDUSTRYL .280 .275 .275
07I00      4GOVERNMTL .100 .125 .150
08FUEL OIL2TRANSPORL .300 .350 .400
08FUEL OIL3INDUSTRYL .300 .275 .225
08FUEL OIL4GOVERNMTL .100 .125 .150
16NGL      2TRANSPORL .001 .010 .050
16NGL      3INDUSTRYE0.0000.0000.000
16NGL      4GOVERNMTL0.0010.0200.050
17METHANOL2TRANSPORE0.0000.0010.002
17METHANOL3INDUSTRYL0.0010.0020.005
17METHANOL4GOVERNMTL0.0010.0020.005
18ETHANOL 2TRANSPORE0.0000.0010.002
18ETHANOL 3INDUSTRYL0.0010.0020.005
18ETHANOL 4GOVERNMTL0.0010.0020.005
19TOWN GAS1RES&COMML0.0750.1000.125
19TOWN GAS3INDUSTRYL0.0010.0020.005
19TOWN GAS4GOVERNMTL0.0010.0100.050
21NAT.GAS 3INDUSTRYL0.1000.1500.200
21NAT.GAS 4GOVERNMTL0.0500.0750.100
25GAS COAL1RES&COMME0.0000.0000.001
25GAS COAL3INDUSTRYL0.0010.0020.005
25GAS COAL4GOVERNMTL0.0010.0100.020
27BRIQUET 1RES&COMML0.0010.0020.005
27BRIQUET 4GOVERNMTL0.0010.0100.020
99

*********** SECTOR DEMAND
CD  COMMENT             1980     1985     1990
0101RSDTL&COMC         43745    63607    89321
0102                  616704   547232   444632
0103                   29179    41762    60352
0201TRANSPORT           9121    15530    27636
0202                   34022    57921   102330
0203                    6164    10493    18538
0301INDUSTRY           10385    16606    24018
0302                   38735    61935    89582
0303                    7017    12483    16229
0401GOVERNMENT           494     1044     2198
0402                    1840     3895     8197
0403                     333      706     1485
0501NON ENERGY           610     1278     2141
0502                    2278     4021     7937
0503                     412      729     1447
9999
03 2STEAM COAL         25.00    29.50    34.20
9999
```
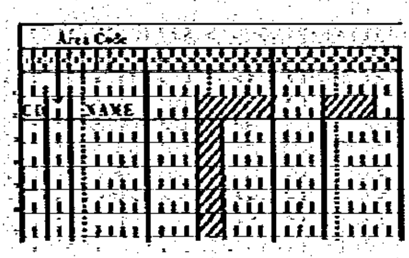



3-6 Outputs from the Report Generator

ENERGY ACTIVITY

Million BOE

ACTIVITY (MBOE REQUIRED TO MEET THE DEMAND	CODE	1985	1990	1995	2000
1. Oil					
2. Gas					
3. Coal					
4. Geothermal					
5. Hydro					
6. Nuclear					

TOTAL COST TO MEET THE ENERGY DEMAND

Million US dollar 1980

COST ITEM	CODE	1985	1990	1995	2000
Total Cost					
Investment					
Operating					

SHADOW PRICES OF ENERGY

US$/BOE

ITEM	CODE	1985	1990	1995	2000
1. Crude Oil At Refinery Gate					
2. Petroleum Products At Consumers Point by Area					
2.1 Avgas					
2.2 Avtur					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8 Fuel Oil					
3. Other energy					

ENERGY EXPORT/IMPORT

MM BOE

ENERGY SOURCE	CODE	1985	1990	1995	2000
1. Crude Oil					
1.1 Production					
1.2 Export					
1.3 Import					
1.4 Refined					
2. Coal					
1.1 Production					
1.2 Export					
1.3 Import					
1.4 Internal Use					
3. Petroleum Product					

TOTAL REFINING CAPACITY REQUIRED

MBSD

UNIT	CODE	1985	1990	1995	2000
1. Crude Distilling Unit					
2. Reformer					
3. Vacum Unit					
4. Hydro Cracking					
5.					
6.					

TOTAL UNUSED REFINING CAPACITY

MBSD

UNIT	CODE	1985	1990	1995	2000
1. Crude Distilling Unit					
2. Reformer					
3. Vacum Unit					
4. Hydro Cracking					
5.					
6.					

ELECTRICITY GENERATION CAPACITY

IN MW

UNIT	CODE	1985	1990	1995	2000
1. Thermal					
1.1 Oil Fired Steam Plant					
1.2 Diesel / Gas Turbine					
1.3 Coal Fired Steam Plant					
2. Geothermal					
3. Hydro					
4. Nuclear					

4 COST/TECHNOLOGY DATA BANK SYSTEM

Among various data on energy, a group of cost and technological data is as important at the group of energy supply-demand data. Cost data cover investment cost as well as operation cost required for primary energy production and transformation into secondary energy, the former involving oil fields, gas fields, coal fields, geothermal energy sources, hydro power sources, etc., while the latter involving oil refineries, LNG plants, LPG plants, town gas plants, etc. Technological data include such factors as capacity, yield, rate of operation, thermal efficiency and in-plant fuel consumption rate at individual sources of primary energy production and secondary energy transformation plants. These cost and technological data become critically important as basic data when an energy supply model of the type discussed in Chapter 3, whereby optimal solutions are obtained by minimizing costs, is employed. To review changes in investment and operation costs in a time series and make comparisons from various aspects, accumulated data on cost and technology are also essential. In this chapter, the cost/technology data bank system, originally developed to store cost and technological data, is detailed.

4-1 Classification of Cost and Technological Data

As shown in Table 4-1-1, cost and technological data can be roughly classified into five items including data category, field, company, period and characters of data.

Table 4-1-1 Classification of Data

1. Data Category
2. Field
3. Company
4. Period
5. Characters of Data

Codes are common to both cost and technological data when they are classified into the items 2 ~ 4. On the other hand, classification of the items 1 and 5 requires different codes between cost and technological data.

4-1-1 Data Category

Cost data: Due to the limit of data collection methods, investment and operation costs in the field of primary energy production can not be separated. Accordingly, these two factors combined are treated as "expenditure" (EXP), which forms a data category. On the other hand, investment and operation costs related to secondary energy transformation plants can be easily separated. They are classified into two data categories, "investment cost" (IVC) and "operation cost" (OPC).

Technological data: Data categories of technological data include "capacity" (CAP), "yield" (YLD), "operation rate" (OPR) and "thermal efficiency" (TME). Summarized in Table 4-1-2 are data categories, of which definitions have been established.

Table 4-1-2 Data Categories

Code	Name
(1) Cost Data	
EXP	Expenditure
INV	Investment Cost
OPC	Operation Cost
(2) Technological Data	
CAP	Capacity
YLD	Yield
OPR	Operation Rate
TME	Thermal Efficiency
LFP	Loss Factor of Plant (In-plant consumption)
TRL	Transmission Loss

4-1-2 Field

The concept of field is employed to classify production sites of primary energy and secondary energy transformation plants. Groups of primary energy classification include "working area" (WA), whereby oil and gas fields combined are classified into areas, "coal mine" (CMN), "geothermal source" (GEO) and "hydro source" (HYD). Groups of secondary energy classification include "refinary" (REF) and "LNG plant" (LNG). Table 4-1-3 shows codes given to individual production sites of primary energy and individual types of secondary energy transformation plants as well as their classification into smaller groups.

Table 4-1-3 Classification of Fields

Code Number	Name	Code Number	Name
(1)	Working Area	37	BUNYU & MHKAM
1	ACEH	38	SEL.MAKASAR
2	N.SUMATERA	39	BAWEAN
3	C.SUMATERA	40	PASE
4	S.SUMATERA	41	SINGKARAK
5	SEL.MALAKA	42	LANGSA
6	JAWA SEA	43	ASAHAN
7	WEST JAWA	44	BANGGAI
8	S.E.SUMATERA	45	KARIMUN
9	EAST JAWA	46	SEPASU
10	E.KALIMANTAN	47	MAMBERAMO
11	C.KALIMANTAN	48	NAUKA
12	N.E.KAL	49	WAIPONA
13	S.KALIMANTAN	50	KAMURA
14	N.W.JAWA	51	PANAI
15	C.SULAWESI	52	SIMENGGARIS
16	NATUNA SEA	53	JAMBI
17	NATUNA BL.A	54	KEP.BURUNG
18	NATUNA BL.B	55	TEWEH BLOK
19	NATUNA BL.D1	56	BINTUNI BLOK
20	NATUNA BL.D2	57	RIMAU BLOK
21	NATUNA BL.C	58	PAKANBARU
22	NATUNA BL.D&	59	TELUK BERAU
23	NATUNA BL.D3	60	OTHR P.AREAS
24	AMBON CERAM	61	NON-P.AREAS
25	IRIAN JAYA	(2)	Geothermal Source
26	S.LAMPUNG	1	G.SALAK
27	JAMBI A	2	KAMOJANG
28	S.JAMBI B	3	DIENG
29	N.E.JAMBI B	4	PASAMAN
30	N.E.MADURA	5	DERAJAT
31	W.MADURA	6	LAHENDONG
32	KANGEAN	(3)	Coal Mine
33	N.SAKALA	1	BUKIT ASAM
34	BLOK BEE	2	OMBILIN
35	MANGUNJAYA	(4)	Hydro Source
36	RIAU	1	SAGULING STI

Code Number	Name
2	SAGULING ST2
3	CIRATA
4	MRICA
5	MAUNG
6	KESAMBEN
7	MANINJAU
8	SINGKARAK
9	TES
10	BDG AGN ST1
11	BDG AGN ST2
12	BATU TEGI
13	PAD KMBAYUNG
14	RIAM KIWA
15	TENGGARI ST1
16	TENGGARI ST2
17	SAWANGAN
18	BAKARU
19	SENTANI
20	LARONA
21	ASAHAN
22	JATILUHUR
23	PAR KONDANG
24	LARONA
25	KARANG KATES
26	RAWA PENING
(5)	Refinary
1	P BRANDAN
2	DUMAI

Code Number	Name
3	SEI PAKNING
4	SEI GERONG
5	PLAJU
6	BALIKPAPAN
7	CILACAP
8	WONOKROMO
9	CEPU
(6)	LNG Plant
1	ARUN
2	BONTANG
(7)	LPG Plant
1	RANTAU
2	ARJUNA
3	MUNDU
4	SANTAN
5	SEI GERONG
(8)	Town Gas Plant
1	MEDAN
2	PADANG
3	PALEMBANG
4	JAKARTA
5	BOGOR
6	BANDUNG
7	CERIBON
8	SEMARANG
9	SURABAYA
10	U.PANDANG

4-1-3 Company

Cost and technological data can also be classified into companies. The concept of company is described by a classification code of CMP standing for "company." Table 4-1-4 contains code numbers given to individual companies.

Table 4-1-4 Classification of Companies

Code Number	Code Name	Code Number	Code Name
1	PERT EP I	25	BP PETQ DEV
2	PERT EP II	29	SHELL
3	PERT EP III	30	TREND ENERGY
4	PERT EP IV	31	HUSKY OIL
5	PERT EP V	32	CHEVRON & TEX
6	LEMIGAS	34	WHITE SHIELD
7	PT CPI	35	CXOCO INT
8	C&T	36	TEIKOKU OIL
9	CONOCO	37	DEMINEX
10	PTSI	38	JAPEX
11	IIAPCO	39	TEXACO
12	ARCO	40	KATY & UNION
13	UNION OIL	41	AMOCO
14	HUFFCO	42	ESSO
15	TOTAL IND	43	INPEX
16	PETR TREND	44	REDCO
17	ASAMERA OIL	45	INCA
18	TESORO	46	PAN OCEAN
19	AAR	47	LOUISIANA
20	PHILLIPS	48	UNION TEXAS
21	MARATHON PET	49	CITCO IND
22	MOBIL OIL	50	MONCRIEF PEX
23	CITY SERV	51	KERR-MC GEE
24	AGIP SPA	52	OTHR COMPANY

4-1-4 Period

The cost/technology data bank system employs three different periods for data classification. They are on a monthly basis (M: Monthly), on a quaterly basis (Q: Quaterly) and on an annual basis (CA: Calendar Annual, FA: Fiscal Annual). As shown in the parenthesis, they are given different codes, including M, Q, CA and FA. Table 4-1-5 shows codes of years, quaters and months which have been already registered.

Table 4-1-5 Classification of Periods

Code Number	Period Name
(1) Calender Annual	
1979	1979
1980	1980
1981	1981
(2) Fiscal Annual	
1979	1979/1980
1980	1980/1981
1981	1981/1982
(3) Quarter	
197901	1ST Q.1979
197902	2ND Q.1979
197903	3RD Q.1979
197904	4TH Q.1979
198001	1ST Q.1980
198002	2ND Q.1980
198003	3RD Q.1980
198004	4TH Q.1980
(4) Month	
197901	JAN.1979
197902	FEB.1979
197903	MAR.1979
197904	APR.1979
197905	MAY 1979
197906	JUN.1979
197907	JUL.1979
197908	AUG.1979
197909	SEP.1979
197910	OCT.1979
197912	DEC.1979

4-1-5 Characters of Data

A characteristic of cost data is that they are consisting of a number of cost elements which form a tree structure with total investment cost and/or total operation cost on the top of the structure. Fig. 4-1-1 shows a general tree structure of total expenditure involved in primary energy production. Fig. 4-1-2 and Fig. 4-1-3 show general tree structures of investment cost and operation cost required for energy transformation plants, respectively. Individual cost elements are given codes consisting of three alphabetic letters, which are specified in Table 4-1-6. Because individual costs thus consist of various elements which can be described by a tree structure, it becomes necessary to introduce the concept of characters of data, based on which cost data should be classified. An outstanding feature of cost data is that numerical values of cost elements appearing in the upper part of a tree structure can be obtained by adding up numerical values of elements appearing in the lower part which are derived from them.

Though limited within such data on capacity, yield, operation rate and loss factor of plant (in-plant fuel consumption), technological data can also be described by a tree structure when they are collected by production site or transformation plant. However, differing from the case of cost data, numerical values of technological data appearing in the upper part of a tree structure do not always accord with the sum total of numerical values of those appearing in the lower part which are derived from them.

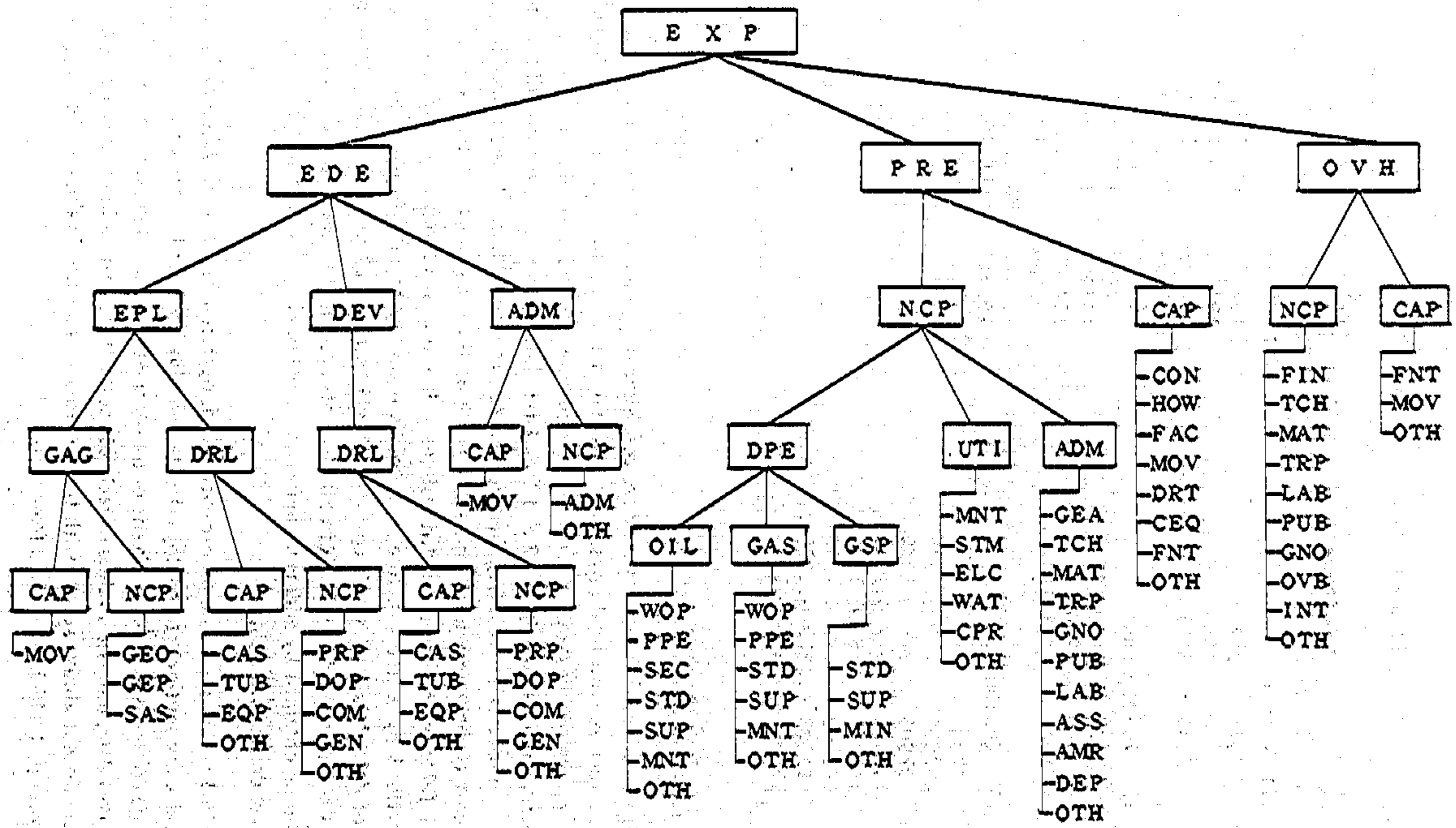


Fig. 4-1-1 Tree Structure of Expenditure (Primary Energy)

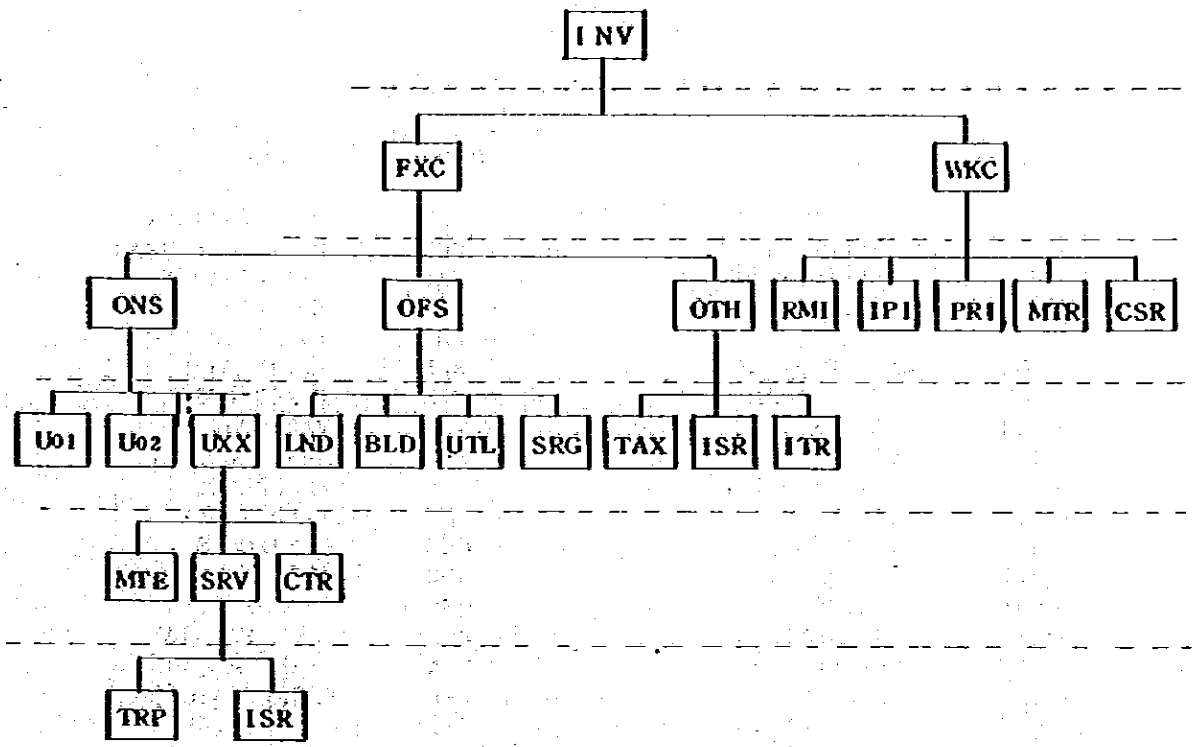


Fig. 4-1-2 Tree Structure of Investment Cost (Secondary Energy)

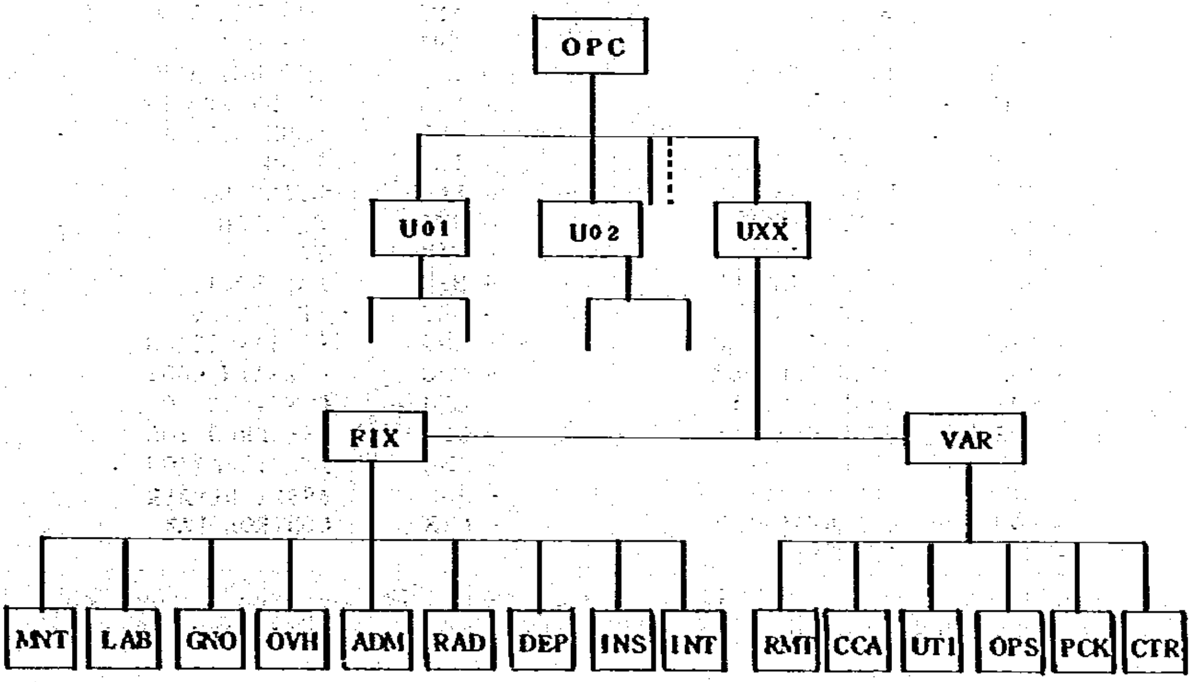


Fig. 4-1-3 Tree Structure of Operation Cost (Secondary Energy)

Table 4-1-6 Tree Name Codes

Code	Name	Code	Name
– EXP	EXPENDITURE	– CON	CONS UTI&AUX
– EPL	EXPLORATION	– HOW	HOUSING & WFAR
– DEV	DEVELOPMENT	– FAC	PR FACILITY
– EDE	EPI&DEV EXP	– MOV	MOVEBLE
– CAP	CAPITAL	– FNT	FURNITURE&EQ
– NCP	NON CAPITAL	– REF	REFINERY
– GEO	GEOLOGICAL	– FIX	FIXED COST
– GEP	GEOPHYSICAL	– VAR	VAR COST
– SAS	SEISMIC&SVY	– RAD	RESEARCH&DEV
– DRL	DRILLING EXP	– INS	INSURANCE
– CAS	CASING	– RMT	FEED STOCK
– TUB	TUBINGG	– CHC	CHEMICALS
– EQP	EQUIPMENT	– ADD	ADDITIVES
– OTH	OTHERS	– OPS	OP SUPPLIES
– PRP	PREPARATION	– PCK	PACK MATRIAL
– DOP	DRILLING OP	– CCA	CHEM&CAT&ADD
– GEN	GENERAL	– CAT	CATALISATOR
– COM	COMPLETION	– GAG	G&G SURVEYS
– ADM	ADM EXPENSE	– CTR	CONTROL LAB
– PRE	PRODUCT EXP	– INV	INVESTMENT
– DPE	DIRECT EXP	– FXG	FIXED CAPTL
– WOP	WELL OP	– WKC	WORKING CAP
– PPS	PROCESSING	– ONS	ONSITE
– SEC	SEC REC OP	– OFS	OFFSITE
– STD	STORAGE ETC	– RMI	RAW MAT INV
– SUP	SUPERVITION	– IPI	INPROC INV
– MNT	MAINTENANCE	– RPI	PRODUCT INV
– UTI	UTILITIES	– M7R	MAINT REPAIR
– STM	STEAM SER	– CSR	CASH RESERVE
– ELC	ELECTRICITY	– LND	LAND
– WAT	WATER SER	– BLD	BUILDING
– CPR	COMPRESSOR	– SRG	STORAGE
– GEA	GENERAL ADM	– TAX	TAX
– DEP	DEPRECIATION	– MTE	MAT EQUIP
– FIN	FINANCE&ADM	– SRV	SERVICING
– TCH	TECHNICL SER	– CNS	CONSTRUCTION
– MAT	MATERIAL SER	– OPC	OPERATN COST
– TRP	TRANSP COST	– CEQ	CONSTRUC EQ
– LAB	PERSONNEL EX	– DRT	DRL PROD TOL
– PUB	PUBLIC REL	– AMR	AMORTISATION
– GNO	GEN OFFICE	– ASS	ASSET REFAIR
– OVH	OVERHEAD ABR	– CTR	CONTROL LAB
– INT	INTEREST		

4-2 Filing Structure of the Cost/Technology Data Bank

Discussed in this section are kinds and structure of files required for systematic classification of cost and technological data, which is detailed in the preceding section. Software of the cost/technology data bank system was developed based on the filing structure discussed in this section. There are five kinds of dictionary table files, which are used for inquiry purposes when cost and technological data input are processed. They are master table, name table, tree name table, level name table and unit table. To store data, there are two kinds of files, element header file and element data file. To improve efficiency of retrieving function, two kinds of files, main retrieve file and retrieve index file, are also incorporated into the data bank.

4-2-1 Master Table

The master table is a file designed to register master codes. The master code is a general term given to alphabetic codes belonging to medium classification which is subsequent to major classification into data category, field, company, period and characters of data. For example, master codes related to data category are EXP (total expenditure), IVC (investment cost) and OPC (operation cost), while those related to field include WA (working area), REF (refinery) and LNG (LNG plant). In relation to major classification into company, there is the only one master code, CMP. Major classification into period has four master codes, including M (month), Q (quarter), CA (calendar annual) and FA (fiscal annual). Major classification into characters of data, described by a tree structure, has eight master codes, LEV1 ~ LEV8, each representing given level of the eight-tired tree structure.

Fig. 4-2-1 shows an example of structure of the master table. The master table employs seven words/28 bytes to describe a datum and is capable of filing up to 100 data. As shown in Fig. 4-2-1, the first of the seven words is used to show an item number of major classification, data category (1), field (2), company (3), period (4) and level of a tree structure (5), to which given master code belongs. The second word is used to register a master code consisting of three alphabetic letters, which is 'REF␣' in the example shown in Fig. 4-2-1. The third, fourth and fifth words are used to show an official name of given master code. The sixth word shows the starting points registered in individual types of tables of name codes or level name codes to which given master code belongs. Likewise, the seventh word shows the ending points. Name codes and level name codes are explained later. Though detailed later, related data can be output one after another once their starting points registered in the name table or the level name table are retrieved by the master table.

1	02	Item Number 1. Data Category 2. Working Area or Plant 3. Company 4. Period 5. Level
2	REF	Master Code
3	REFI	Master Name
4	NARY	
5		
6	101	Name Table or Level Name Table Head
7	536	Name Table or Level Name Table Tail

Fig. 4-2-1 Element of Master Table

4-2-2 Name Table

The name table is a file designed to register name codes. The name code is a general term given to codes consisting of numeric characters which belong to minor classification and are located immediately below master codes. In relation to data category, there is only one name code, which is represented by a numeric character of "1". Name codes related to field include given numbers of working area or refinery. In case of company, company numbers serve as name codes. In terms of period, numeric codes representing given month (ex. 198101: January, 1981), given quarter (ex. 198101: the first quarter of 1981) and given year (ex. 1981: the year of 1981) serve as name codes. Codes representing levels of a tree structure are given special processing with the use of tree name codes and level name codes, which is discussed below.

Fig. 4-2-2 shows the structure of the name table. The name table employs 11 words/44 bytes to describe a datum. It is a direct access file. As shown in Fig. 4-2-2, the first of the 11 words is to show an address registered in the master table of a master code in which given name code is included. The second word is to register given name code. The third, fourth and fifth words are to register an official name of given name code. The sixth and seventh words show addresses registered in the name table of name codes belonging to the same master code as given name code and located before and after given name code. Thus it is possible to extract name codes one after another which are located before and after given name code and belong to the same master code. The eighth and ninth words show the starting and ending points registered in the element header file of data related to given name code. The tenth and eleventh words show the starting and ending points registered in the element data file. The element header file and the element data file are detailed later.

1	12	Master Table Address
2	2	Name Code
3	DUMA	Name of Name Code
4	I	
5		
6	101	Link Address Before
7	103	After
8	35	Element Header Address Head
9	43	Tail
10	3064	Element Data Address Head
11	4016	Tail

Fig. 4-2-2 Element of Name Table

4-2-3 Tree Name Table

The item of characters of data involves two-stage classification, first medium classification of data into levels of a tree structure, then minor classification of data belonging to each level. The two-stage classification can not be completed simply by classifying name codes and requires classification of two additional kinds of codes, tree name codes and level name codes, the latter detailed in the following section. The tree name code is a general term given to the three-letter alphabetic codes appearing in Fig. 4-1-1, Fig. 4-1-2 and Table 4-1-6, which also serve as abbreviation of general names given to cost elements.

Fig. 4-2-3 shows the structure of the tree name table.

1	MAT	Tree Name Code
2	MATE	Name of Tree Name Code
3	RIAL	
4		

Fig. 4-2-3 Element of Tree Name Table

The tree name table employs four words/16 bytes to describe a datum, which are written in a file of sequential organization. Level name codes, explained in the following section, use addresses of tree name codes as they are, thereby the maximum level 8 of a tree structure is described by two-word level name codes. In other words, an area which can be used for registration of a code of a level is 8 bits out of 64 bits of two words. This means that 256 tree name codes can be registered at maximum. The first of the four words is to register a tree name code consisting of three-letter alphabetic code and the second, third and fourth words are to register an official name of given tree name code.

4-2-4 Level Name Table

The level name table is a file designed to register level name codes. To recognize an exact location of a level of a tree structure, a code given to the level should include all the information belonging to levels located above the level. Accordingly, an area consisting of two words/ eight bytes is prepared to file a level name code. A byte is designed to describe information related to a level. Thus, an area consisting of eight bytes is capable of describing eight levels at maximum. As mentioned before, the information to be written in a byte are addresses of tree name codes registered in the file. Taking Fig. 4-1-1 as an example, the lowest level leftmost is 'MCV.' When information belonging to other levels located above the level are included, the level is described as 'EXP EDE EPL CAG CAP MCV.' Because these three-letter codes are registered in the tree name table, each of their addresses registered in the tree name table is written in each of six bytes out of eight bytes, thereby the remaining two are left blank. A level name code consisting of two words/eight bytes is thus prepared. Because level name codes thus contain information belonging to upper levels, it becomes possible to obtain various information of a tree structure by decomposing and comparing level name codes.

Fig. 4-2-4 shows the structure of the level name table. The level name table employs 12 words/48 bytes to describe a datum, which are written in a file of direct organization. The first of the 12 words is used to show an address of a master code registered in the master table to which given level name belongs. The second word is used to show location of the lowest level of given level name code among the eight levels. The third and fourth words are to register a level name code consisting of two words/eight bytes. The fifth and sixth words show addresses, registered in the level name table, of level name codes belonging to the same master code as given level name code and located before and after given level name code. This enables extraction of level name codes belonging to the same level and located before and after given level name code one after another. The seventh and eighth words are to register addresses, filed in the level name table, of level name codes belonging to the same tree structure as given level name code and located before and after given level name code. This is to link given level name code with others belonging to the same tree structure.

As shown in Fig. 4-2-5, a code located uppermost of a line situated leftmost of a tree structure is given the youngest number. The next number is given to a code immediately below the first code of the same line. Thus, codes are numbered from left to right among lines and from top to bottom of a line to decide the order of positions of individual codes belonging to a tree structure. Codes are registered in the level name table in accordance with the order of their positions in a tree structure, thereby the seventh and eighth words register the linkage among codes without destroying the order established among codes. The ninth and tenth words show the starting and ending points registered in the element header file of data contained in given level name code. Similarly, the eleventh and twelveth words show the starting and ending points registered in the element data file of data contained

1	56	Master Index
2	5	Level Number
3	01 02 03 0A	
4	1A 00 00 00	
5	111	Level Link Address Before
6	115	After
7	0	Tree Link Address Before
8	41	After
9	51	Element Hedder Address Head
10	61	Tail
11	4051	Element Data Address Head
12	5071	Tail

Fig. 4-2-4 Element of Level Name Table

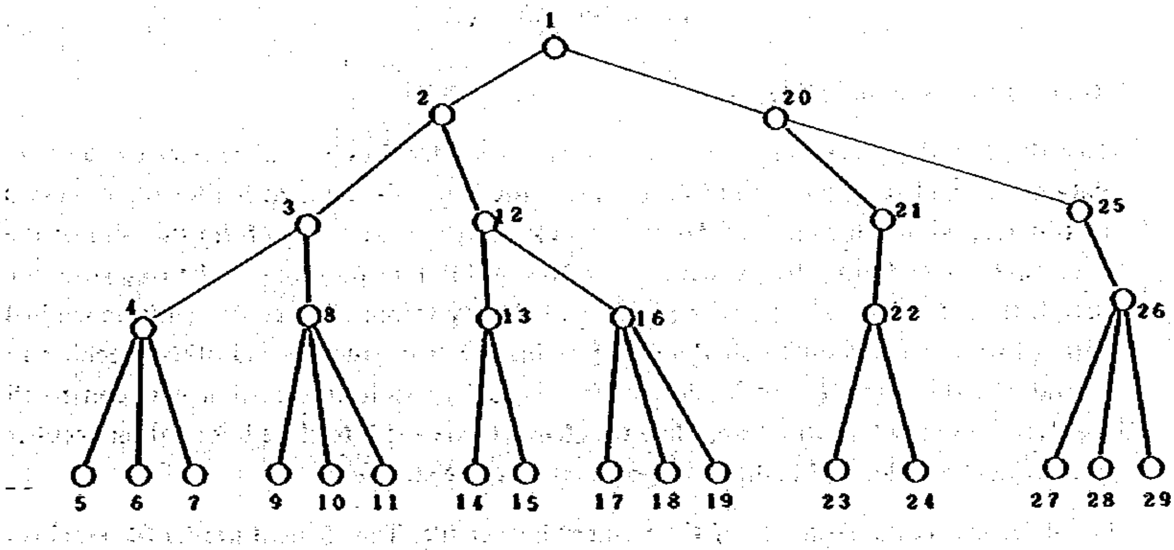


Fig. 4-2-5 Order of Tree Position

in given level name code.

4-2-5 Unit Table

The unit table is a file designed to store units of numerical values registered in the data bank. The table is also designed to register conversion factor matrix to deal with convertible units. As noted from an example shown in Fig. 4-2-6, data can be input and stored in a time series to deal with such subjects as exchange rates.

... UNIT TABLE ...

NO	UNIT CODE	NAME OF UNIT CODE
1	1	RP
2	2	US$

... EXCHANGE RATE ...

NO	YEAR	1	2
1	1979	620.00	1.00
2	1980	620.00	1.00
3	1981	620.00	1.00

Fig. 4-2-6 Unit Table

4-2-6 Element Header File

Explained in the preceding sections are dictionary table files, which are referred to when data are exploded in the data bank. On the other hand, the element header file discussed in this section and the element data file detailed in the next section form the core of the data bank. Data form a tree structure and data in different positions in the tree structure have different values. Hence, it is possible to classify information contained in individual data into those common to all the data forming the tree structure and others peculiar to individual data. The element header file is designed to store information common to all the data forming a tree structure, while the element data file is to store information peculiar to individual data located in different positions of a tree structure.

Fig. 4-2-7 shows the structure of the element header file. The element header file employs 18 words/72 bytes to describe a datum, which are written in a file of direct organization. The first and second of the 18 words are to register the starting and ending points registered in the element data file of information about given tree structure. The third word is to register the original unit of data used in given tree structure, while the fourth word is to register the value of 'K' when an operation of '10**K' is required for handling given data on the same unit as used in given tree structure. For example, data on investment cost are divided into investment made by Indonesian sources and investment by overseas sources. In this case, the third word is used to register the original unit of Indonesian investment and the fourth word registers a scale factor of the power of 10. Likewise, the fifth and sixth words are used to register the original unit of investment made by overseas sources and a scale factor of the power of 10, respectively. The words from the seventh to the eighteenth are used to register information about data category, field, company and period which are included in given tree structure. For example, the seventh word, to show the name code of data category included in given tree structure, registers the address of the name code filed in the name table. The eighth and ninth words register addresses, filed in the element header table, of tree structures having the same name code and located before and after given tree structure. Likewise, addresses of name codes of field, company and period as well as link addresses registered in the element header file are registered in the words from the tenth to the eighteenth, respectively.

1	Element Data File Head	
2	Tail	
3	Local Currency Unit	
4	Scale factor	
5	Foreign Currency Unit	
6	Scale factor	
7	Name Table Address	
8	Link Address Before	Item 1
9	After	
10	Name Table Address	
11	Link Address Before	Item 2
12	After	
13	Name Table Address	
14	Link Address Before	Item 3
15	After	
16	Name Table Address	
17	Link Address Before	Item 4
18	After	

Fig. 4-2-7 Element of Element Header File

4-2-7 Element Data File

As mentioned before, the element data file is designed to register numerical data located in different positions in given tree structure. Fig. 4-2-8 shows the structure of the element data file. The element data file employs 8 words/32 bytes to describe a datum. The first word contains the address registered in the element header file of the tree structure to which given numerical data belong. The second word contains the address registered in the level name table of the level name code which shows the position of given numerical data in the tree structure. The third and fourth words contain addresses registered in the element data file of numerical data located before and after given numerical data and having the same level name code as given numerical data in the element data file. The fifth and soxth words are to link individual numerical data belonging to the same tree structure, which is done by using their addresses registered in the element data file. The seventh word is to register numerical data in real terms. As mentioned before, data on investment are divided into investment by Indonesian sources and investment by overseas sources. Accordingly, the seventh word is used to register numerical data on Indonesian investment and the eighth word to register numerical data on investment made by overseas sources.

1	Element Hedder Address
2	Level Name Code Address
3	Link Address Before
4	After
5	Value Link Address Before
6	After
7	Local Currency Value
8	Foreign Currency Value

Fig 4-2-8 Element of Element Data File

4-2-8 Main Retrieve File

Though it is possible to retrieve data by using the six kinds of files discussed in the preceding sections, this requires a series of references to link addresses registered in individual files and the retrieving speed turns to be extremely slow. The main retrieve file and the retrieve index file discussed in the next section were prepared to improve the retrieving speed.

Fig. 4-2-9 shows the structure of the main retrieve file. The main retrieve file stores master items resulting from major classification, each classified into smaller groups by name code or level name code using addresses registered in the element data file of numerical data having the same name code or level name code. Length of a record of the main retrieve file is 1,000 words/4,000 bytes, which is proved to assure the best efficiency in the input/output oper-

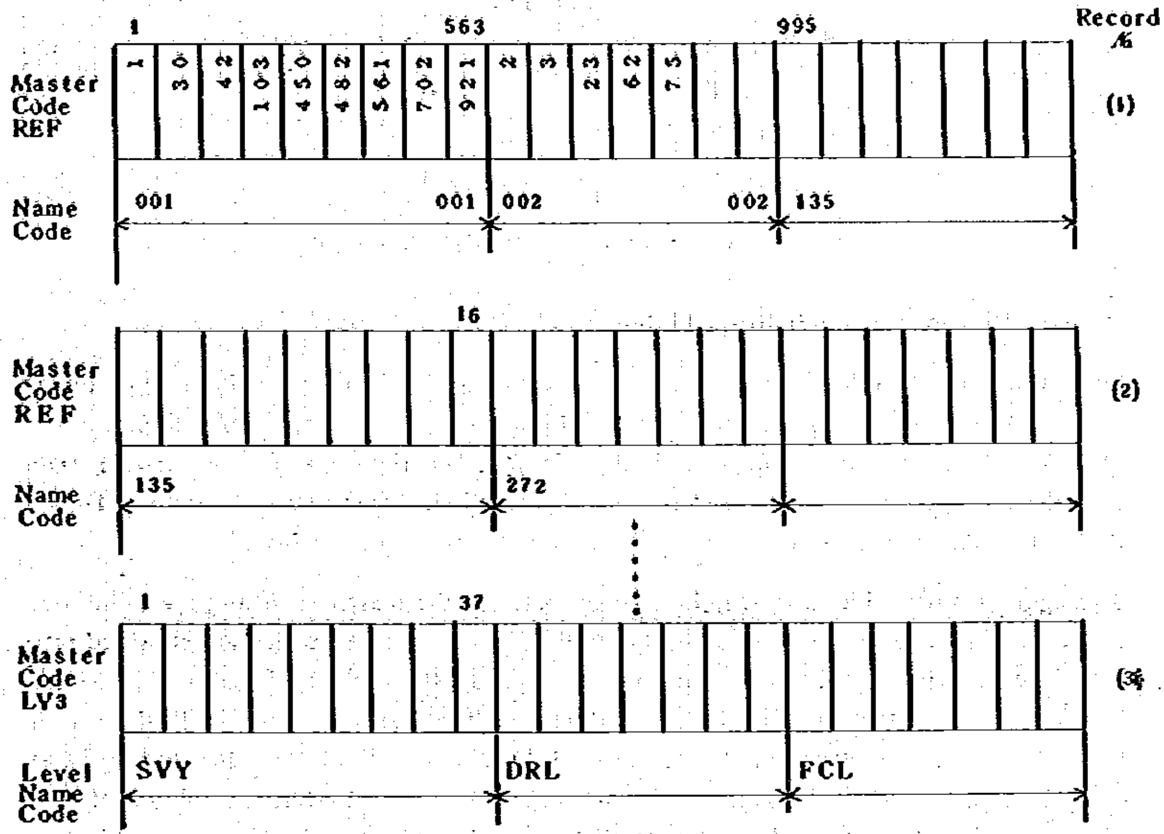


Fig. 4-2-9 Structure of Main Retrieve File

ations. This means that a record contains a row of 1,000 addresses registered in the element data file.

4-2-9 Retrieve Index File

The retrieve index file is a kind of dictionary file, which indicates from what position of what number of record in the main retrieve file the address of a name code or a level name code starts and to what position of what number of record the address continues. The structure of the retrieve index file is shown in Fig. 4-2-10. Referring to both Fig. 4-2-10 and Fig. 4-2-9, it is clearly known that the address data of REF001 starts from the first position of the first record in the main retrieve file and ends at the 563rd position of the first record. Accordingly, in the retrieve index file where a datum consists of 4 words/16 bytes, REF001 is registered as follows; the first word registeres start record number 1, the second word start position 1, the third word end record number 1 and the fourth word end position 563.

Thus, the main retrieve file and the retrieve index file enable to extract required addresses registered in the element data file much more efficiently than the method to refer to link addresses registered in six different files.

REF 001		REF 135	LV3SVY
1	St Rec No.	1	31
1	St Word No.	995	1
1	En Rec No.	2	31
563	En Word No.	16	37

Fig. 4-2-10 Structure of Retrieve Index File

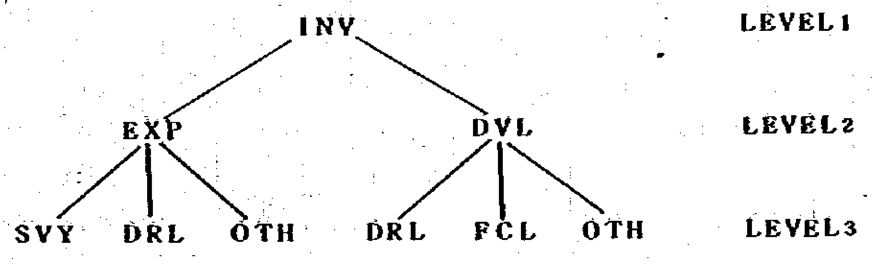
4-2-10 Relations among Individual Files

In this section, the relations among individual files explained so far are discussed by taking some examples of tree structures. Fig. 4-2-11 shows three examples of tree structures. Data 1 deal with investment cost in 1980 made in an oil field 001 of a company 01. Data 2 deal with operation cost in 1981 required by an oil field 002 of a company 02. Data 3 deal with investment cost in 1980 made in an oil field 003 of a company 03.

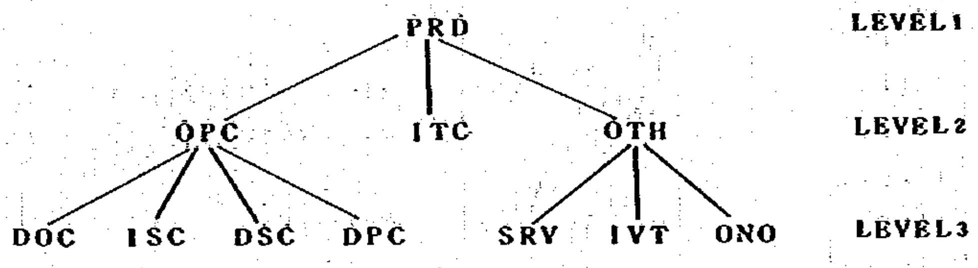
To begin with, Fig. 4-2-12 shows the relation between the master table and the name code table. Because INV (investment cost) and OPC (operation cost), which are classified into data category (item 1), have the only one name code, 01, each, 1, the address registered in the name code table, is placed in the columns of 'head' and 'tail' of INV in the master table. Likewise, 2 is placed in the columns of 'head' and 'tail' of OPC. Because no name codes belonging to the same master code are located before and after, the column of 'link address' in the name code table is left 0. CRF (oil field), which is classified into field (item 2), starts from the fourth position in the name code table and lasts till the 138th position. This means that 'head' and 'tail' of CRF, registered fourth in the master table with the item number 2, have values of 4 and 138, respectively. Because the codes numbered from 001 to 135 of CRF belong to the same master code, addresses of codes located before and after each code are linked in the form of link adresses registered in the name code table. In case of 001, the preceding link address is 0 because no codes belonging to REF are located before it, while the following link address is 5 which represents the address of 002. In case of 002 preceded by 001 and followed by 003, link addresses before and after it are 4 and 6, respectively. As shown in Fig. 4-2-12, codes of company and period are processed exactly in the same manner as those of data category and field.

Listed in Table 4-2-1 are tree name codes included in the three tree structures shown in Fig. 4-2-11. The tree name codes are given numbers from top to bottom as shown in the column of 'decimal.' These numbers are used as components when level name codes are prepared. The table also contains hexadecimal notation because hexadecimal digits are more articulate. As mentioned in the section explaining the level name table, a method to indicate positions of individual levels in a tree structure is to employ tree name codes in which information belonging to upper levels are also contained. In case of Data 1 shown in Fig. 4-1-1, individual positions in the tree structure can be described by tree name codes presented in Table 4-2-2. The table also presents hexadecimal notation of the same tree

Data 1 INV
CRF001
CMP 01
CA 1980



Data 2 OPC
CRF002
CMP 02
CA 1980



Data 3 INV
CRF003
CMP 01
CA 1980

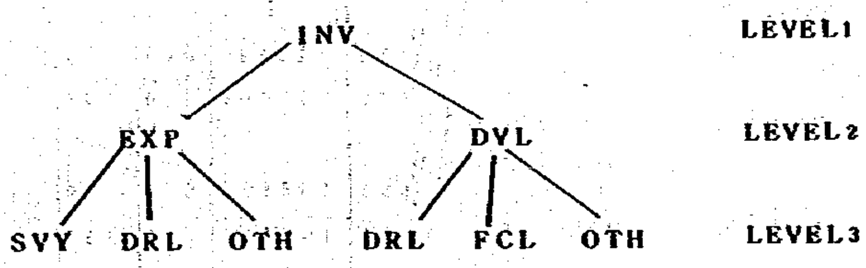


Fig. 4-2-11 Case Examples of Cost Data

Master Table

			Head	Tail
1	1	INV	1	1
2	1	OPC	2	2
3	1	T D	3	3
4	2	CRF	4	138
5	2	NGF	139	273
6	2	:		
7	2	REF		
8	2	:		
9	3	CMP	501	550
10	4	C A	551	562
11	4	F A	563	574
12	4	Q	575	650
13	4	M	651	750
14	5	LEV1		
15	5	LEV2		
16	5	LEV3		
17	5	LEV4		
18	5	LEV5		
19	5	LEV6		
20	5	LEV7		
21	5	LEV8		

Name Code Table

	Sub Code	Link		El.Hd.File		El.Da.File	
		Before	After	Head	Tail	Head	Tail
1	01	0	0	1	3	1	29
2	01	0	0	2	2	10	20
3	01	0	0				
4	001	0	5	1	1	1	9
5	002	4	6	2	2	10	20
6	003	5	7	3	3	21	29
:	:						
138	135	137	0				
139	001	0	140				
	:						
273	135	272	0				
	.						
	:						
	:						
501	01	0	502	1	3	1	29
	02	503	503	2	2	10	20
	:						
550	50	549	0				
551	1970	0	552				
	1971						
	:						
	1980	560	562	1	3	1	29
562	1981	561	0	2	2	10	20
563	1970	0	564				
	1971	563	565				
	:						
574	1981	573	0				
575	197001	0	576				
	:						
650	198104	649	0				
651	197001	0	652				
	:						
	:						
750	198112	749	0				

Fig. 4-2-12 Relation between Master Table and Name Table

name codes. It should be noted that values of level name codes stored in computers or files are those described by hexadecimal notation. A level capable of describing a tree structure of 8 levels at maximum without involving any tree name codes is cleared, thus resulting in 0. Table 4-2-13 was prepared based on the data shown in Fig. 4-2-11 to indicate the relations between the level name table consisting of level name codes and the master table.

Table 4-2-1 List of Tree Name Code

Code	Decimal	Hexa decimal	Code	Decimal	Hexa decimal
INV	1	01	ITC	12	0C
EXP	2	02	DOC	14	0E
DVL	3	03	ISC	15	0F
SVY	4	04	DSC	16	10
DRL	5	05	DPC	17	11
OTH	6	06	SRV	18	12
FCL	8	08	IVT	19	13
PRD	10	0A	ONO	20	14
OPC	11	0B			

Table 4-2-2 Example of Level Name Codes

Tree Name Code	Hexadecimal
INV	01 00 00 00 00 00 00 00
INV EXP	01 02 00 00 00 00 00 00
INV EXP SVY	01 02 04 00 00 00 00 00
INV EXP DRL	01 02 05 00 00 00 00 00
INV EXP OTH	01 02 06 00 00 00 00 00
INV DVL	01 03 00 00 00 00 00 00
INV DVL DRL	01 03 05 00 00 00 00 00
INV DVL FCL	01 03 08 00 00 00 00 00
INV DVL OTH	01 03 06 00 00 00 00 00

Because two kinds of level name codes, '01 00 00 00 00 00 00 00' and '0A 00 00 00 00 00 00 00,' exist in relation to a master code LEV1, 1 and 2, addresses registered in the level name table, are registered in 'head' and 'tail' of LEV1, respectively. Link of addresses in the level name table is also deduced from the relation between the two level name codes. As known from Fig. 4-2-13, conditions of LEV2 and LEV3 are exactly same as LEV1.

Fig. 4-2-14 shows the relations between the element header file and other tables. In case of Data 1 shown in Fig. 4-2-11, data category is IVC, thereby the name code of item 1 has an address of 1. Because filed is CRF001, the name code of item 2 has an address of 4. Item 3, which is CMP01, turns to be 501 and item 4, which is CA1980, turns to

Master Table

		Head	Tail
1	IVC	1	1
1	OPC	2	2
1	TD	3	3
2	CRF	4	138
2	GSF	139	273
2	:		
2	REF		
2	:		
3	CMP	501	550
4	CA	551	562
4	FA	563	574
4	Q	575	650
4	M	651	750
5	LEV1	1	2
5	LEV2	3	7
5	LEV3	8	20
5	LEV4		
5	LEV5		
5	LEV6		
5	LEV7		
5	LEV8		

Level Name Table

	Level Name / Table Code	Link		El. Hd.		El. Da	
		B	A	H	T	H	T
1	01 00 00 00 00 00 00 00	0	2	1	3	1	21
2	0A 00 00 00 00 00 00 00	1	0	2	2	10	10
3	01 02 00 00 00 00 00 00	0	4	1	3	2	22
4	01 03 00 00 00 00 00 00	3	5	1	3	3	23
5	0A 0B 00 00 00 00 00 00	4	6	2	2	11	11
6	0A 0C 00 00 00 00 00 00	5	7	2	2	12	12
7	0A 06 00 00 00 00 00 00	6	0	2	2	13	13
8	01 02 04 00 00 00 00 00	0	9	1	3	4	24
9	01 02 05 00 00 00 00 00	8	10	1	3	5	25
10	01 02 06 00 00 00 00 00	9	11	1	3	6	26
11	01 03 05 00 00 00 00 00	10	12	1	3	7	27
12	01 03 08 00 00 00 00 00	11	13	1	3	8	28
13	01 03 06 00 00 00 00 00	12	14	1	3	9	29
14	0A 0B 0E 00 00 00 00 00	13	15	2	2	14	14
15	0A 0B 0F 00 00 00 00 00	14	16	2	2	15	15
16	0A 0B 10 00 00 00 00 00	15	17	2	2	16	16
17	0A 0B 11 00 00 00 00 00	16	18	2	2	17	17
18	0A 06 12 00 00 00 00 00	17	19	2	2	18	18
19	0A 06 13 00 00 00 00 00	18	20	2	2	19	19
20	0A 06 14 00 00 00 00 00	19	0	2	2	20	20

Fig. 4-2-13 Relations between Master Table and Level Name Table

	El Da File		Item 1			Item 2			Item 3			Item 4		
	H	T	AD	B	A	AD	B	A	AD	B	A	AD	B	A
Data 1	1	9	1	0	3	4	0	0	501	0	3	561	0	3
Data 2	10	20	2	0	0	5	0	0	502	0	0	562	0	0
Data 3	21	29	1	1	0	6	0	0	501	1	0	561	1	0

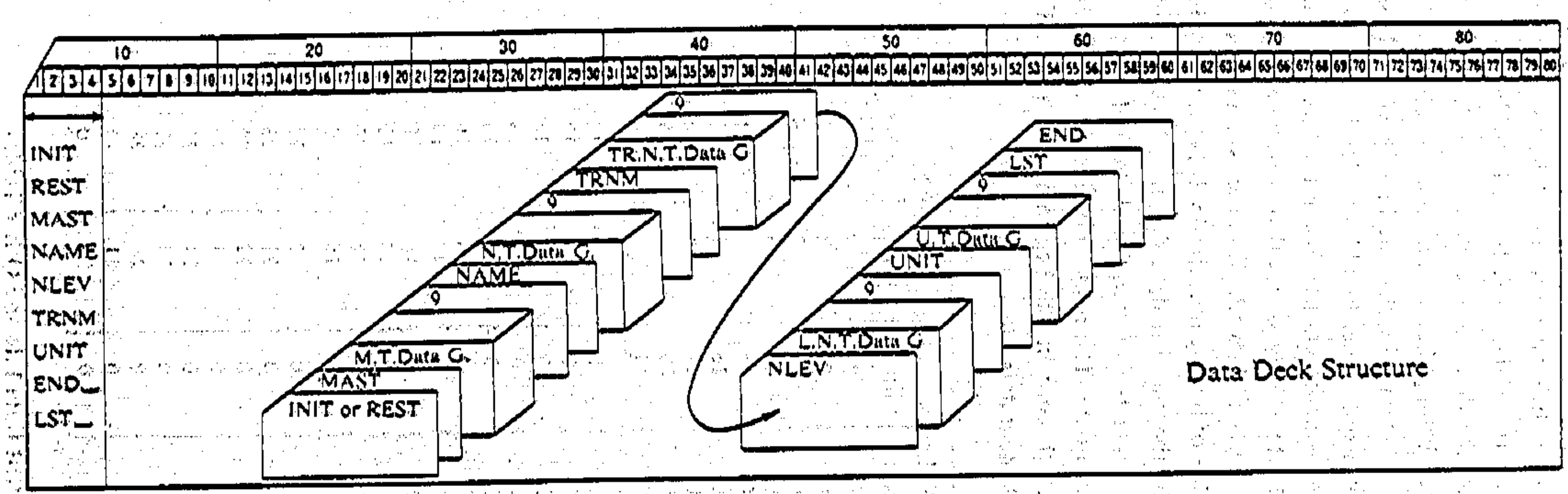
Fig. 4-2-14 Relations among Element Header File and Other Tables

be 561. Data 2 and Data 3 can be processed in the same manner, of which results are also shown in Fig. 4-2-14. In case of item 1, the preceding and following link addresses are 0 and 3, respectively, because 1VC also appears in Data 3. The preceding and following link addresses related to item 1 of Data 3 are 1 and 0, respectively. As for item 2 without involving same name codes, link addresses from Data 1 to Data 3 are left cleared, or 0. As for item 3 and item 4, conditions are exactly same as item 1. As shown in Fig. 4-2-12, the name table stores addresses of 'head' and 'tail' registered in the element header file which contain the same name codes. Fig. 4-2-13 shows that the level name table also stores 'head' and 'tail' registered in the element header file.

Fig. 4-2-15 shows the relations between the element data file and other tables. Data 1 has 9 numerical data which represent values of individual positions in the tree structure. Likewise, Data 2 and Data 3 have 11 and 9 numerical data, respectively. Individual numerical data also contain addresses of related codes registered in the element header file, thus showing a tree structure of data to which they belong. Level name codes related to individual numerical values are also shown by inputting into the element data file the addresses of the level name codes registered in the level name table. In addition, level name codes belonging to the same group are linked in the element data file. While the tree structures of Data 1 and Data 3 are exactly same, Fig. 4-2-15 clearly shows that corresponding positions of these tree structures are linked in the element data file from the aspect of 'before' and 'after.' The element data file is also capable of linking numerical values belonging to a tree structure of the same data. In relation to the element data file, the element header file stores addresses registered in the element data file of 'head' and 'tail' of numerical values belonging to a tree structure of the same data. The name code table and the level name code table also have 'head' and 'tail' which contain the beginning and the end of addresses of individual codes registered in the element data file.

		El. Hd. Address	LEVEL			LINK	
			Address	Before	After	Before	After
Data 1	1	1	1	0	21	0	2
	2	1	3	0	22	1	3
	3	1	4	0	23	2	4
	4	1	8	0	24	3	5
	5	1	9	0	25	4	6
	6	1	10	0	26	5	7
	7	1	11	0	27	6	8
	8	1	12	0	28	7	9
	9	1	13	0	29	8	0
Data 2	10	2	2	0	0	0	11
	11	2	5	0	0	10	12
	12	2	6	0	0	11	13
	13	2	7	0	0	12	14
	14	2	14	0	0	13	15
	15	2	15	0	0	14	16
	16	2	16	0	0	15	17
	17	2	17	0	0	16	18
	18	2	18	0	0	17	19
	19	2	19	0	0	18	20
	20	2	20	0	0	19	0
Data 3	21	3	1	1	0	0	22
	22	3	3	2	0	21	23
	23	3	4	3	0	22	24
	24	3	8	4	0	23	25
	25	3	9	5	0	24	26
	26	3	10	6	0	25	27
	27	3	11	7	0	26	28
	28	3	12	8	0	27	29
	29	3	13	9	0	28	0

Fig. 4-2-15 Relations among Element Data File and Other Tables



INIT : Initialization of Table File

REST : Addition, Change or Delete of Table Data

MAST : Master Table is treated

NAME : Name Table is treated

TRNM : Tree Name Table is treated

NLEV : Level Name Table is treated

UNIT : Unit Table is treated

END␣ : End of All Table operation

LST␣ : Table Listing

Fig. 4-3-1 Input Format of Control Data for Table Making

Explanations about the main retrieve file and the retrieve index file are omitted here because the relations between these files and other tables have been referred to in the preceeding sections.

4-3 Input Formats of Cost and Technological Data

Two kinds of data, cost data such as investment cost and operation cost, and technological data such as capacity, yield and operation rate, are input into the cost/technology data bank. As explained in the sections of 4-1 and 4-2, these data are classified into major items, each given a key code, from different aspects including data category, field, company, period and characters of data. Accordingly, explosion of data in the data bank requires not only an input format to encode information, based on which numerical values of data and their characters are determined, but also another input format to register beforehand key codes for the classification in the table files of the data bank system.

4-3-1 Input Formats of the Key Code Table

As mentioned in the section of 4-2, the cost/technology data bank system requires dictionary table files such as the master table, the name table, the tree name table, the level name table and the unit table. These dictionary table files should be prepared before explosion of cost and technological data in the data bank. Discussed in this section are input formats of data required for the preparation of the dictionary tables which function as compu... files.

Because there are various kinds of dictionary tables as mentioned before, control data are needed to identify to which dictionary tables individual data to be input are belonging. Fig. 4-3-1 shows the input format of control data. Input data should be preceded by either card of 'INIT' or 'REST'. 'INIT' means that all the dictionary tables should be newly prepared. On the other hand, 'REST' means that some of existing dictionary tables are left as they are though the preparation of new dictionary tables and addition and revision of data are also required. To specify a dictionary table to which given data blong, given data should be preceded by control cards, such as 'MAST' (master table), 'TRNM' (tree name table), 'NLEV' (level name table), 'UNIT' (unit table). Then, control cards of 'LST' are used to list the contents of dictionary tables prepared, while control cards of 'END' are used to complete the preparation of dictionary tables. Fig. 4-3-1 also shows the structure of data deck. Either card of 'INIT' or 'REST' is put at the beginning, which is followed by data contained in individual dictionary tables, and a card of 'BED' is put at the end.

Fig. 4-3-2 shows the input format of master table data. Four master codes at maximum can be input into a single data card. Twenty (20) columns are used to deal with a single master code, thereby the item number to which given master code belongs (I1), master code (A4) and the official name of the master code (3A4) are coded in that order. The item numbers are 1 for data category, 2 for field, 3 for company, 4 for period and 5 for given level of a tree structure. A master code should consist of less than four letters. Likewise, an official name should be described by less than 12 letters. No data error is marked even if part of the card is left blank. When data of the master table come to the end, processing of master table data can be completed by setting 9 at the location of given item number.