CHAPTER 9

ESTIMATION OF PRODUCTION COST

Summary of Chapter 9:

I. Preconditions of cost accounting

(1) Basic accounting assumption

1) Reference date : March, 1979
2) Currency : US$
3) Unit system : Metric system
4) Operation condition : Normal operation (Normal Year)
5) Taxation : Investment Incentive Act is not considered

(2) Cost accounting method and basis of cost calculation

1) Cost accounting method

Continuous process cost accounting method
Reciprocal distribution method .... Auxiliary division

2) Basis of cost calculation

① Full cost calculation basis → Profit and loss information by products type
② Variable cost calculation basis → Break-even point analysis
③ Element cost calculation basis → Sensitivity analysis

(3) Price and amount of main cost elements

Cost elements		Landed price	Requirement	Amount
Raw materials				
Iron ores & pellets	(Import)	27.5 $/t	2,022 thous. t	55.6 mil. $/y
Imported coal	(Import)	77.8 $/t	1,186 thous. t	92.3
Purchased scrap	(Import)	192.2 $/t	139 thous. t	26.7
Heavy oil	(Domestic)	135.0 $/t	66 thous. t	8.9
Limestone	(Domestic)	7.2 $/t	285 thous. t	2.1
Labor cost (including wellfare)				
Total labor cost of steelworks		1,840 $/person/y	3,901 person	7.2
(to workers only)		(1,372)	(2,712)	(3.7)
Expenditures				
Purchased electricity		0.018 $/KWH	43,450 thous. KWH	0.8
PSC sintering cost		16.0 $/t-sinter	1,486 thous. t	23.8

II. Results of accounting

(1) Production cost of clasified products

(Unit: $/t)

Products	Full cost	Variable cost
Sinter	41.9	38.4
Coke	127.2	98.5
Pig iron	157.0	114.5
Liquid steel	208.0	153.8
Slab	235.7	164.9
Bloom	240.0	159.3
Billet	286.9	172.0
Hot coil	292.5	181.0

(2) Utility production cost

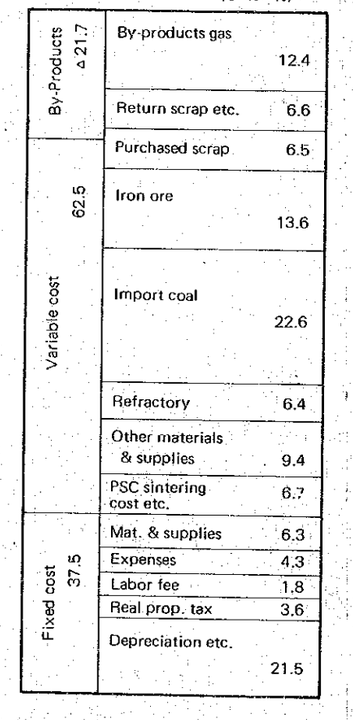
(Unit: $)

Utility	Cost	Remarks
Oxygen	0.074/Nm^3	
Electricity	0.066/KWH	Factory own production & purchasing average
Steam	8.764/t	
Sea-water	0.023/m^3	
Industrial water	0.111/m^3	
Potable water	0.227/m^3	Only complemental water

III. Analysis of results of accounting

(1) Cost structure diagram

(Unit: %)



(2) Sensitivity analysis

(Unit: $/t)

	Condition		Effects ($/t)	
	Items	Variation	Billet	Hot coil
Normal case	Operating cost	—	286.9	292.5
Cost changes	Capital expenditure cost (*1)	± 10%	± 8.5	± 8.4
	Iron ore price	± 10%	± 3.9	± 3.9
	Import coal price	± 10%	± 6.5	± 6.4
	Scrap price	± 10%	± 1.9	± 1.9
	Refractory price	± 10%	± 1.8	± 1.8
	Operation rate	— 10%	+ 12.8	+ 12.4
	"	+ 10%	— 10.4	— 10.1

(*1) Capital expenditure cost includes Depreciation, Real property tax & Maintenance repair parts.

CHAPTER 9 ESTIMATION OF PRODUCTION COST

In this chapter, an outline concerning the estimation of production cost is explained. The EDP calculation data which have been a base data for explanation of this chapter are so much and are separately listed on chapter 14 "Cost calculation detail". Therefore, refering to the data of the chapter 14 will give you a better comprehension of this chapter.

9-1 Basic philosophy of production cost accounting

9-1-1 Basic accounting conditions

(1) **Reference date:** March, 1979

(2) **Currency:** US$

(3) **Philippines peso exchange rate:** 1US$ = 7.39 Pesos

(4) **Unit system:** Metric system

(5) **Operation condition:** Normal operation condition

A normal operating condition in this study means a operating condition in regular years after the steelworks has been set on its way; that is, the equipment which has been designed to be capable of producing a crude cast steel of $1.5^{mil.t}$ per year (this is a basic precondition of this study) produces the crude cast steel of $1.5^{mil.t/y}$ as it is expected. Therefore, for other years such as the starting-up and blast furnace repairing periods, the cost accounting is corrected and stated separately in the finance estimation.

(6) **Taxes: Regular taxation condition**

A regular taxation condition is assumed to taxes to be applied to imported raw materials, such as customs duty, specific tax and advanced sales tax, which should be included into the operating cost. Therefore, tax reduction or exemption according to Investment Incentive Act or Presidential Decree is reflected later and the figures are corrected in the finance estimation.

9-1-2 Cost accounting method

(1) Type of cost accounting method

The cost accounting in this study depends upon "Continuous process cost accounting method" which is generally utilized by the steelworks field in advanced countries. Namely;

1) Total cost arising in each process (cost center) is estimated and allocated to subsequent processes according to the flows of semi-products or services, and then reflected to the final product cost.
2) The cost of auxiliary departments is estimated according to the reciprocal distribution method and finally allocated to the production department.

(2) Establishment of cost center

As a preparation of the continuous process cost accounting, the cost center is to be established in order to adequately grasp the arising costs and make the cost accountings. The cost center is decided in consideration of classification of facility control, organization and staff control, production (type of products) control, etc. In this study, they are established as shown in *Table 9-1-1.*

Table 9-1-1 Establishment of cost center

Division	Cost center	Code	Product	Code	Equipment	Equipment details
Production division	Sintering plant	XAO	Sinter	P01	–	Committed to Philippines Sinter Corp.
	Coke oven	XBO	Coke	P02	Coke oven, By-products plant	Coal blending bin, coke oven, Coke belt conveyor, Gas cooling device, Ammonia cracking, Light oil recovery equipment, Biological treatment facilities
	Calcining plant	XCO	Burnt-lime	P03	Burnt lime calcining plant	Limestone receptacle, Water-washing facility, Limestone storage silo, Calcining furnace, Product bunker
	Blast furnace	XDO	Pig iron	P04	Blast furnace	Blast furnace, Hot blast stove, Gas cleaning equipment, Iron ore bin, Coke bin, Slag treatment equipment, Pig casting machine, Torpedo car
	Basic oxygen furnace	XEO	Liquid steel	P05	Convertor (including desulphurizing machine and ingot making facility)	Convertor, Lance and Lance hoist rigs, Waste gas treatment, Sub-raw materials transportation facility, Hot metal charging ladle, Hot metal weighing car, Steel ladle, Steel ladle car, Slag ladle car, Crane
	Slab casting equipment	XFO	Slab	P06	Slab	Continuous slab caster, Cast slab delivery equipment, Crane, Hot metal handling equipment (Ladle turret, Tundish and Tundish car)
	Bloom casting equipment	XGO	Bloom	P07	Bloom	Continuous bloom caster, Cast bloom delivery equipment, Crane, Hot metal handling equipment (Ladle turret, Tundish and Tundish car)
	Billetting mill	XHO	Billet	P08	Billet mill	Reheating furnace, Rolling mill equipment, Shear, Cooling equipment, Crane
	Hot strip mill	XIO	Hot coil	P09	Continuous hot rolling mill equipment	Reheating furnace and its front and rear equipment, Rugher rolling mill equipment, Finished rolling mill equipment and Coiler, Complement facilities
Auxiliary division	Oxygen (N_2, Ar) plant	YAO	Oxygen (N_2, Argon)	4001	Oxygen generator	Air seperator, Compressed oxygen gas delivery equipment, Nitrogen gas compressor, Argon rectifier, Liquid oxygen equipment, Gas holder
	Power generation	YBO	Electricity	4002	Power receiving/distribution facilities, Power generator	Power receiving/transformer Power distributor Generator } (Common equipment) Boiler, Steam turbine, Pure water equipment, Pressure and temperature reducer
	BF blower	YCO	Hot air	4003	Blower	Blower
	Process steam gen.	YDO	Steam	4004	Low pressure steam generator	Low pressure boiler
	Sea-water	YEO	Sea-water	4005	Sea-water supply pipe arrangement	Sea-water receiving facilities, Pump, Supply and drain pipe
	Industrial-water	YFO	Industrial-water	4006	Industrial-water supply pipe arrangement, (recirculation facilities are dispersed to each factory)	Elevated tank, Industrial-water piping Potable water treatment equipment } (Common equipment) Water receiving pond, Water treatment equipment
	Potable-water	YGO	Potable-water	4007	Potable-water supply and piping equipment	
	Gas, oil distribution	YHO	Service	4010	Gas, oil distribution facilities Steam distribution facilities	BFG holder, Dispersion tower, COG holder, Dispersion tower, Heavy oil tank, Oil berth, BFG, COG, Oil, Oxygen, Steam, Blower piping
	Material handling	YIO	"	4020	Raw material berth, Port facilities Raw material handling facilities	Coal berth, Unloader, Transportation equipment (Trailer, truck etc. in yards), Ore yard, Sinter, Screened ore yard, Blending yard, Coke yard (Conveyor, Stacker, Reclaimer included)
	Iron-ore sizing	YJO	"	4030	Ore sizing equipment	Crushing and screening equipment
	Product handling	YKO	"	4040	Product berth, Port facilities	Product berth, Loader, Transportation equipment (Trailer etc. in the product yard)
	Intra-works transportation	YLO	"	4050	Intra-works transportation equipment	Railroad transportation equipment (Exclude cars, include rail and signal etc.) Road transportation equipment (Dump truck, Trailer, Bulldozer) (Facotry ~ yards)
	Test and inspection	YMO	"	4060	Test and analysis facilities	Raw materials testing center, Analytical center, Mechanical test center
	Maintenance shop	YNO	"	5000	Maintenance facility	Central office, Mechanical repair shop, Machine shop, Structural shop, Fundry shop, Forging shop, Electric & instrumentation repair shop, Civil/construction/waterworks repair shop, Car repair shop, Local maintenance shop, Warehouse
	Plant administration	YOO	"	5010	Office, Welfare, Common facilities in works	Main office, Welfare, Telecommunication facilities, Illumination facilities on road, Drainage cannal construction, Revetment
Head Office						

(3) Cost elements classification

It is important to summarize and readjust these cost elements from various expense elements, which are significant for the cost control and cost analysis. For the classification of the cost elements in this study, such as raw material cost, labor cost and expenditures, refer to the cost list of EDP output. Besides, the cost of iron ore, coal, steel alloy are naturally accounted with classification of the import source. However, they are too much to be inserted in the EDP cost list and the list of paticulars classified by import source is separately attached (*Table 14-2-1*).

(4) Classification of variable cost and fixed cost

On condition that a certain operation (which, in this study, is based on normal operation of $1.5^{mil.t}$) is performed, classifying the cost elements into variable cost and fixed cost is indispensable for conducting the management control through the cost analysis. In this study, a base of classification of the variable cost and the fixed cost is depended upon a characteristic of the integrated steelworks, that is especially an industry to be heavy equipped and to be continuously operated without stops. Namely, the equipment cost such as repairing cost and depreciation cost, and the labor cost which can hardly change due to the operation variation, are all included into the fixed cost.

(5) Sorts of cost accounting basis

After the above preparation has been made, the cost accounting is performed by the following three ways in accordance with purposes of cost analysis. Refer to the EDP output of full cost calculation basis listed on chapter 14 "Cost calculation detail". Other data are omitted.

1) Full cost calculation basis

As an estimation standard of product value, this is a base for data of profit and loss of classified products in relation to products estimate value and selling prices of the classified products.

2) Variable cost calculation basis

Being corresponded with the periodical fixed cost, the product cost, which has been calculated only with the variable cost elements, brings data that are reflected by a variation of the operation. That is, it gives us information such as profit and loss estimation in every year, break-even point analysis and marginal profit analysis of each product.

3) Element cost calculation basis

A cost of product, which is obtained by retroactively reflecting the total cost of separate products to the first purchased element cost, brings information of effects caused by cost variation of paticular elements: that is, data of sensitivity analysis.

9-2 Estimation and method of element cost

For estimation method of unit prices and expenses, which are prerequisite to cost accounting, the followings are estimated with supplements of expertise and experiences of the mission based on the field survey and information presented by the counterpart so as to enable a domestic procurement in Philippines as much as possible.

9-2-1 Principal first purchased cost

(1) Unit price of purchasing raw materials, fuels and other materials

① On the presume that a regular taxation is applied, the landed price of imported materials is calculated by adding taxes related to import (customs duty, Specific tax and Advanced sales tax) and insurance cahrges etc. to the cost of C&F Philippines.

② The price of undersize (fine ore) is decided by an estimation of contained Fe % on basis of average unit price per Fe % of the purchased fine ore.

③ On the condition of this study, the source of raw materials is assumed for the most rational ore in considerable cases. Therefore, it is needless to say that this point should be examined more at the stage the project is virtually carried out.

④ In consideration of quantity and quality problems, in this study the refractories are decided to be imported. However, it may be possible in future that some of them be utilized with the domestic products.

⑤ It is assumed in this study that the new steelworks does not directly import the heavy oil but purchase it from domestic importors in the Philippines.

Table 9-2-1 Unit price of raw materials, fuels and other materials

(Unit: $/t)

Materials and sources		Import or domestic procurement	C&F price	Landed price	Remarks	
Iron ores					Lump ore price	Undersize price
Australia	(Unscreened)	Import	19.99	25.60	(26.75)	(24.20)
Brazil	(Unscreened)	Import	21.01	26.12	(27.21)	(24.79)
India	(Unscreened)	Import	22.31	28.12	(31.85)	(23.52)
Australia	(Fine ores)	Import	17.68	22.55		
Brazil	(Fine ores)	Import	20.32	25.23		
India	(Fine ores)	Import	17.05	21.35		
Pellets	(Australia)	Import	26.79	34.41	(34.97)	(23.82)
Ferromanganese ore		Import	34.65	43.25		
Iron sand		Domestic		11.18		
Dolomite		Domestic		8.54		
Silica		Domestic		8.39		
Coals						
U.S.A.	(L.V.)	Import	92.50	104.23		
U.S.A.	(M.V.)	Import	90.80	102.30		
Australia	(Hard coking)	Import	62.38	70.95		
Australia	(Semi-hard)	Import	62.74	71.23		
Australia	(Soft coking)	Import	58.28	66.10		
Limestone	(Lump)	Domestic		7.21		
Limestone	(Fines)	Domestic		6.50		
Fluorspar		Import	82.55	105.62		
Scrap		Import	151.00	192.24		
Fe Mn	(HC)	Domestic		493.14		
Fe Mn	(MC)	Domestic		463.14		
Fe Mn	(LC)	Domestic		1,050.14		
FeSi		Domestic		565.14		
SiMn		Domestic		480.14		
Bunder Al		Import	1,698.00	2,376.06		
Carbide		Domestic		520.69		
Heavy oil		Domestic		135.00/t	Purchase from domestic importer	
L.P.G.		Domestic		285.00/t	"	

Materials and sources	Import or domestic procurement	C&F price	Landed price	Remarks
Refractories				
BF trough refractory	Import	625.87	790.29	
BF mud	Import	1,251.77	1,579.50	
Converter brick	Import	742.72	937.63	
Converter ladle brick	Import	233.66	295.75	
Castable refractory	Import	267.05	339.27	
CC tundish brick	Import	602.64	760.99	
CC tundish nozzle	Import	2,472.08	3,118.22	
Torpedo car brick	Import	509.00	643.00	
Rolls	Import		1,965.65	Hot strip, Billet

Note: Landed price is that C & F price is added by Customs duty, Specific tax, Advanced sales tax, and insurance, etc.

(2) By-products

1) Estimation standard of by-products

① Estimation of by-products is principally based on market prices and depends on the selling price or purchasing price. (*Table 9-2-2*)

② Return scrap is estimated the same value as the purchased scrap. Other scraps are estimated by their contained Fe %.

③ For sinter fines and mill scales, the average price of purchased fine ores is used.

④ Gasses are assessed on the basis of heavy oil price and weighted by their calorific values.

2) Appropriation standard of by-products

According to the material flow of the production plan explained in chapter 4, the appropriation standard restricts the by-products to those which can be reclaimed inside the integrated steelworks or which can be sold outside; that is, those having economical value. Other generated materials are abolished and not appropriated as a by-product. The by-products sellable outside are to be sold at the same price as the cost and appropriated to non-operating profit and loss account. The reason why the sales of the by-products is not appropriated to sales account but to non-operating profit and loss account is that they are not main products of the steel works. The balance of the by-products are shown in *Table 9-2-3*.

Table 9-2-2 Unit price of by-products

(Unit: $)

Item	Unit	Unit price	Remarks
Scrap (Return)	t	192.24	
Pig iron scrap	"	173.02	
Roll scrap	"	180.71	
Mill scales	"	23.62	
BF dust	"	9.15	
COG	Nm^3	0.0588	4,500 Kcal/Nm^3
BFG	"	0.0094	800 "
LDG	"	0.0235	2,000 "
Light oil	t	106.00	
Coal tar	t	71.00	
Sinter undersize	t	23.62	
Coke breeze	t	50.60	
Limestone undersize	t	6.50	
Burnt lime undersize	t	6.50	

Table 9-2-3 Balance table of by products

(Unit: thous. Nm^3 / thous. t)

Items	Quantity of respective factory								Destination
	Sintering coke caldining	BF	BOF	Slabing	Blooming	Billetting	Hot strip	Total	
COG (thous. Nm^3)	379,300							379,300	reused
Tar & pitch oil	42							42	Sale
Light oil	11							11	〃
BFG (thous. Nm^3)		2,764,500						2,764,500	reused
LDG (〃)			109,800					109,800	〃
Steel scrap			32	51	17	3	15	118	→ BOF
Iron scrap		4						4	→ BOF
Mill scale				5	2	2	10	19	→ Sintering
BF dust		30						30	→ 〃
Sinter (fines)	119							119	→ 〃 return 1
Coke breeze	131							131	Sale (to PSC) 130
Lime st. (fines)	21							21	〃 (〃)
Burnt lime (f)	2							2	〃 (〃)
Dust	10	3						13	Abolish
Slag		430	49	12				479	〃
Sludge	6	18	19	3		1	2	49	〃
Refractory dust		4	6	3	1			14	〃

(3) Labor Cost

Based on the manning plan seen in chapter 7, personnel are to be classified by cost centers and job categories. Their wages and salaries, shown in *Table 9-2-4*, are based on the most part on the recent wage and salary data for the Philippines and also partly by estimation.

Welfare costs have also been based on information available and estimation so as to be entered into the calculation.

(4) PSC Related Cost

Closer relationship with PSC (Philippine Sinter Corporation) which is located in close proximity to the new steelworks should be used in order to aid in the reduction of capital investment for facilities in the Stage I. The following information for utilization of PSC facilities is shown in the following categories. Prices are based upon what is envisaged as costs for March 1979.

1) Sintering cost (Subcontracted basis)

Production of sintered ores for use by the steelworks is to be subcontracted by PSC. The new steelworks is to supply major raw materials of sinter such as iron ores, for

sintering operations. It is considered that subcontracting costs for the supply of sinter will be about $16.00 per ton. In this price coke breeze, undersized lime fines is included along with operation and administration costs.

2) Rental charge of PSC's sea-berth

Of the raw materials used by the new steelworks, unscreened iron ore, purchased fine ores and pellet, are disembarked using PSC's sea-berth at a rental cost of $1.15 per ton. The handling volume at the PSC sea-berth is supposed to reach 2,095$^{thous.t/y}$.

Table 9-2-4 Labor cost and other main expenses

Item	Unit cost	Remarks
Wages & alaries (Paid basis)		(Employee within the works)
General superintendent	13,052 $/man·y	1 men
Deputy general superintendent	9,789	1
General manager	9,259	9
Manager	7,492	28
Assistant manager	3,768	90
Engineering staff member	2,910	349
Clerical staff member	1,497	98
Foreman	2,252	126
Assistant foreman	1,597	487
Skilled worker	1,207	2,712
Semi-skilled worker	936	
Unskilled worker	846	
		(Total 3,901 men)
P.S.C. sintering sub-contracting cost	16.00 /t	Cost per ton of sinter ore before sizing
P.S.C. sea-berth rental cost	1.15 /t	Based on Stage I period
Electric power (Purchase)	0.0180 /kwH	

9-2-2 Depreciation & amortization etc.

(1) Depreciation of tangible fixed assets

We settled the depreciation year by classification of assets according to the results of the field investigation. Thereafter, depreciation is accounted on the basis of the fixed assets aquisition costs which have been explained at 8-3-1, 2.

Depreciation of Tangible Fixed Assets

(Unit: mil. $)

Classification of assets	Aquisition cost of fixed assets	Depreciation period	Annual depreciation	Residual value
Buildings & structures	445.3	25 years	17.8	0
Machinery & equipment	850.4	15	56.7	0
Vehicles				
Railway	14.3	15	0.9	0
Trucks	5.9	5	1.2	0
Total	1,315.5		76.6	

(2) Amortization of deferred assets

The training & education cost and operation guidance fee before and after the start of operation are amortized as deferred assets over a period of 10 years. The costs incurred in the amortization is allocated for convenience of accounting calculation to the cost of plant administration department.

Amortization of deferred assets

(Unit: mil. $)

Classification of deferred assets	Amount of deferred assets	Amortization period	Annual amortization
Education and training cost, Operation guidance fee	36.8	10 year	3.7
Initial organization expenses	11.2	10	1.1
Total	48.0		4.8

(3) Provision for blast furnace relining

After normal operation, the blast furnace requires major repairs coincided with relining of most refractories at several year intervals. Because the cost of this repair work will amount to a huge sum, it is normal procedure to set aside funds each year for such requirements. In this study, as usual case, and with our experience an estimation has been made as follows. However, it should be taken care that the situation varies fairly by various conditions.

Plan for blast furnace relining maintenance

(Unit: mil. $)

Categories	Direct construction cost	Relining maintenance cost	Relining plan	Annual provision for relining cost
Blast furnace related facilities	63.7	31.8	7th year, 14th year } 5 months	5.3
Hot stove related facilities	28.4	14.2	14th year 5 months	1.2
Total	92.1	7th year 31.8 14th year 46.0		6.5

Note: From experience, the cost required for relining maintenance is 50% of direct construction costs.

9-2-3 Auxiliary Department Cost

The following will briefly explain the content and area described as auxiliary departments.

(1) Cost of maintenance and repair shop

The new steelworks has an independant maintenance and repair department equiped and manned sufficiently for carrying out ordinary repairs. The maintenance facilities will consist of central maintenance station and local maintenance shops. Though the central maintenance station will be basically of a scale that will permit it to perform ordinary maintenance work, it will be so equiped that it can handle a complete range of jobs necessary for the manufacture of parts and repair of equipment including casting, forging, machining and steel fabrication, etc. Besides, direct repair materials are not assessed for the cost center of maintenance shop but individual cost center according to quantities required by them and included in their cost.

(2) Electric Power

The by-product gas of the BFG, LDG and COG generated in the plant is almost reused completely; therefore, adequate supply of fuel for the furnace of each factory intra-works and fuel for generating electric power is available. Under normal conditions, 100% of electric power can not be only supplied for production operations, but also some surplus electricity is sold outside. As for demand and supply, purchase of electric power is necessary from outside during scheduled maintenance of generators. From the convenience of this study, the sales price of electricity sold is estimated as the same price as electricity purchased.

The purchasing price of electricity from outside, calculated at rates as of March 1979, are likely to experience a sharp rise in the near future and care should be taken.

Electric Power Balance

Category	Power	Unit price	Amount
Generated power within the works	488,740 thous. KWH	0.066 $/KWH	32,069 thous. $
Purchased power from outside (during scheduled maintenance)	43,450	0.018	782
Power sold to outside (normal operation time)	Δ51,714	0.018	Δ931
Distributed power within the works	480,676	0.066	31,920

(3) Plant administration department cost

The plant administration cost covers such cost as accruing to the general superintendent office, safety and security, production scheduling, quality control, purchasing, order entry control, welfare and other administrative departments. For the convenience of this study, the amortization cost before mentioned and real property tax is to be gathered firstly by this department. The detailed explanation of real property tax are given in chapter 10.

(4) Water

The raw water taken from a nearby river is assumed free of charge; however, the equipment necessary such as water collecting facility and piping to works is also assumed governmental infrastructure. Each factory has individual water circulation facility; therefore, industrial water newly used is equivalent to additional quantity of water supply volume.

9-3 Results of production cost calculations

In this paragraph, based upon the calculations and primises of the former paragraph a summary of the calculations for the production cost can be realized. Analysis and assessment of costs are explained in 9-4 and EDP output is shown in chapter 14.

9-3-1 Cost center flow (full cost basis)

The figures that the operating cost of products is formed through the operating process flow are illustrated for an easy understanding in the cost center flow of *Fig. 9-3-1.* Production cost of liquid steel is about 208.0$^{\$/t}$. The price of scrap is 192.2$^{\$/t}$ therefore it is recognized that we can enjoy the scale-merit of integrated steel making method through BF—BOF process in comparison with electric furnace steel making process using scrap.

The liquid steel cost of 208.0$^{\$/t}$ is finally changed to hot stripped coil cost of 292.5$^{\$/t}$, billet cost of 286.9$^{\$/t}$ and unfinished products.

There are no consideration about ingot making in the production plan, on normal operational conditions.

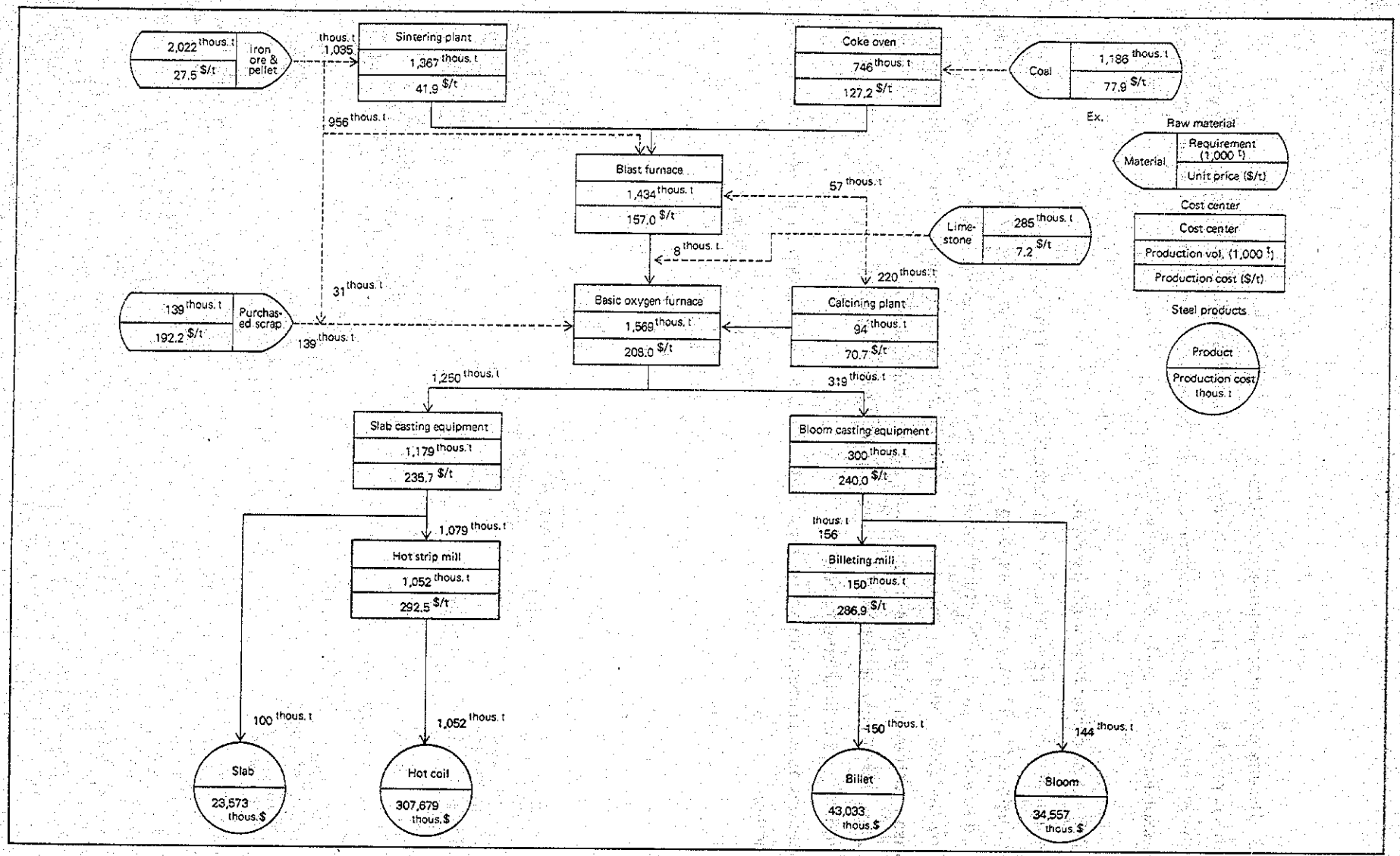


Fig. 9-3-1 Cost center flow (full cost basis)

9-3-2 The summerized table of the operating cost per ton in main factories

In this study, following the purpose of operating cost analysis, we have accounted the operating cost with three basis of cost calculations explained in 9-2-1.

① Full cost calculation basis
② Variable cost calculation basis
③ Element cost calculation basis

Concerning the full cost calculation basis, the EDP output is shown in chapter 14.

The output of the other two calculation basis have been omitted, however analysis using these output is explained in this chapter. The summerized table of the operating cost in main factories is shown in *Table 9-3-1*.

According to the explanations given in 9-1-2 (5), the following characteristics arising from difference of cost calculation basis should be understood.

①The operating cost total for both the full cost calculation basis and the element cost calculation is the same.

②The operating cost total of the variable cost calculation basis and the variable cost total of the element cost calculation basis are the same. And these two costs will be so called as marginal cost by products type.

③The variable cost upon the full cost calculation basis are different from the variable cost on the other two cost calculation basis.

In the former full cost calculation basis, the complex cost of the process products cost are recognized as variable cost.

Because the standard of division between variable cost and fixed cost are applied to not only element cost but also complex cost. On the contrary, in the latter two cost calculation basis, only one part of the process products cost are recognized as variable cost. Because the standard of division between variable cost and fixed cost are applied to element cost only.

The column of project total shows the average cost of shipment, which are calculated dividing total amount of operating cost shown in *Table 9-3-3* by total quantity of of shipment equivalent to $1{,}446^{\text{thous. t}}$.

Table 9-3-1 Summerized operating cost table per ton of main factories by calculation basis

1. Full cost calculation basis

(Unit: $/t)

Cost center	Blast furnace	Basic oxigen furnace	Slab casting equipment	Bloom casting equipment	Billetting mill	Hot strip mill	Project total
Production (1,000 ton)	1,434	1,569	1,179	300	150	1,052	1,446 (Shipment)
Raw materials	21.5	40.8	–	–	–	–	151.8
Process products	106.2	147.8	220.5	221.2	249.6	241.8	–
Raw material total	127.7	188.6	220.5	221.2	249.6	241.8	151.8
(Less) By-products	△ 18.8	△ 5.5	△ 8.4	△ 11.1	△ 4.2	△ 3.0	△ 61.3
Fuel gas	6.3	0.1	0.4	0.4	5.2	5.5	35.2
Materials & supplies	11.4	8.1	7.9	4.7	1.5	3.6	32.1
Expenses	0.1	0.1	–	0.1	0.1	0.4	19.0
Variable cost total	126.7	191.4	220.4	215.3	252.2	248.3	176.8
Materials & supplies	1.8	1.5	2.3	4.0	4.8	6.2	17.8
Labor fee	0.2	0.3	0.4	0.7	2.0	0.6	5.0
Expenses	0.3	0.1	0.2	0.3	0.6	0.5	22.4
Depreciation etc.	10.0	4.2	5.0	10.0	11.3	16.1	60.7
Aux. div. costs	18.0	10.5	7.4	9.7	16.0	20.8	–
Fixed cost total	30.3	16.6	15.3	24.7	34.7	44.2	105.9
Operating cost total	157.0	208.0	235.7	240.0	286.9	292.5	282.7

2. Variable cost calculation basis

Raw materials	21.5	40.9	–	–	–	–	151.8
Process products	87.9	107.0	163.1	163.6	165.7	169.2	–
Raw material total	109.4	147.9	163.1	163.6	165.7	169.2	151.8
(Less) By-products	△ 18.8	△ 5.6	△ 8.4	△ 11.1	△ 4.2	△ 3.0	△ 61.3
Fuel gas	6.3	0.1	0.4	0.4	5.2	5.5	35.2
Materials & supplies	11.4	8.1	7.9	4.7	1.5	3.6	32.1
Expenses	0.1	0.1	–	0.1	0.1	0.4	19.0
Variable cost total	17.8	8.3	163.0	157.7	168.3	175.7	176.8
Aux. div. (variable basis)	6.1	3.2	1.9	1.6	3.7	5.3	–
Operating cost total	114.5	153.8	164.9	159.3	172.0	181.0	176.8

3. Element cost calculation basis

Raw materials	107.2	139.9	148.3	148.7	154.7	152.1	151.8
Fuel gas	20.3	22.9	26.3	26.1	35.6	37.1	35.2
Material & supplies	12.4	19.6	29.0	25.8	28.7	33.8	32.1
Expenses	18.4	17.1	18.2	18.3	19.2	19.3	19.0
(Less) By-products	△ 43.8	△ 45.7	△ 56.9	△ 59.6	△ 66.2	△ 61.3	△ 61.3
Variable cost total	114.5	153.8	164.9	159.3	172.0	181.0	176.8
Supplies	6.2	8.2	11.4	13.2	19.2	18.8	17.8
Labor fee	1.7	2.3	3.2	3.7	6.8	5.0	5.0
Expenses	8.4	11.2	14.7	16.9	24.4	23.7	22.4
Depreciation etc.	26.2	32.5	41.5	46.9	64.5	64.0	60.7
Fixed cost total	42.5	54.2	70.8	80.7	114.9	111.5	105.9
Operating cost total	157.0	208.0	235.7	240.0	286.9	292.5	282.7

9-3-3 Utility production cost

Each utility production cost generated within the works is shown in *Table 9-3-2.*

Table 9-3-2 Utility production cost

(Unit: $)

Utility	Production cost	Remarks
Oxigen	0.074/Nm^3	Oxygen, Nitrogen, Argon are all the same price
Electricity	0.066/KwH	Average of both in-plant production and purchasing
Steam	8.764/t	
Sea-water	0.023/m^3	
Industrial water	0.111/m^3	Cost corresponding to only additional water (Circulating water is excluded)
Potable water	0.227/m^3	

9-3-4 Operating cost summerized sheet (full cost basis)

Table 9-3-3 will give a operating cost summerized sheet which is accounted according to collect the whole operating cost by each cost elements. The cost element can also be known in relation to the size of the total expenditure that will be necessary. The scale of the total operating costs is $409^{mil.\$}$. The average cost of products for sale to outside customers is about $283^{\$/t}$.

In it, variable costs is $256^{mil.\$}$. (Tonnage rate is $177^{\$/t}$)

Fixed cost is $153^{mil.\$}$ (Tonnage rate is $106^{\$/t}$)

Table 9-3-3 Cost summerized sheet (general)

THE PHILIPPINES INTEGRATED STEEL MILL PROJECT (FINAL-F/S)
COST SUMMARIZED SHEET (GENERAL)
JUL-04-1979
PAGE 0027

COST ELEMENT (UNIT) CODE		REQUIREMENT 1000QUANT	UNIT PRICE US.D/QUANT	AMOUNT 1000US.D
IRON ORE (M.T)	1001	2,022	27.498	55,600
LIME STONE (M.T)	1002	285	7.211	2,055
DOLOMITE (M.T)	1003	69	8.536	589
FERRO MANGANESE (M.T)	1004	26	43.154	1,122
SILICA (M.T)	1005	45	8.400	378
IMPORT COAL (M.T)	1006	1,186	77.847	92,327
STL SCRAP-PURCH (M.T)	1021	139	192.237	26,721
IRON SAND (M.T)	1031	72	11.181	805
	*	3,844	46.721	179,597
SCALE-RETURN (M.T)	1101	19	23.632	449
BF DUST-RETURN (M.T)	1102	30	9.133	274
STL SCRAP-RET. (M.T)	1103	118	192.237	22,684
IRN SCRAP RET. (M.T)	1104	4	173.000	692
SINTER(FINES) (M.T)	1105	119	23.622	2,811
COKE BREEZE (M.T)	1106	1	51.000	51
	*	291	92.649	26,961
FERROALLOYS (KG)	1201	10,700	.572	6,121
ALUMINUM (KG)	1202	2,200	2.376	5,227
CALCIUM CARBIDE (KG)	1203	2,000	.521	1,041
FLOURSPAR (KG)	1204	5,000	.106	528
	*	19,900	.649	12,917
COG (NM3)	1901	379,300-	.059	22,303-
TAR & PITCH OIL (M.T)	1902	42-	71.000	2,982-
LIGHT OIL (M.T)	1903	11-	106.000	1,166-
BFG (NM3)	1904	2,764,500-	.009	25,986-
LDG (NM3)	1905	109,800-	.023	2,580-
STEEL SCRAP (M.T)	1906	118-	192.246	22,685-
IRN SCRAP (M.T)	1907	4-	173.000	692-
MILL SCALE (M.T)	1908	19-	23.579	448-
BF DUST (M.T)	1909	30-	9.133	274-
SINTER(FINES) (M.T)	1910	119-	23.622	2,811-
COKE BREEZE (M.T)	1911	131-	50.603	6,629-
LIME ST.(FINES) (M.T)	1912	21-	6.476	136-
BURNT LIME(F.) (M.T)	1913	2-	6.500	13-
	*	3,254,097-	.027	88,705-
COG (NM3)	2001	379,300	.059	22,303
BFG (NM3)	2002	2,764,500	.009	25,987
LDG (NM3)	2003	109,800	.023	2,580
HEAVY OIL (KG)	2004	65,680	.135	8,893
LPG (KG)	2005	1,750	.285	498
LIGHT OIL (KG)	2006	4,721	.106	500
	*			60,761
ROLL (KG)	2012	1,325	1.966	2,605
REFRACTORY (KG)	2013	35,905	.725	26,042
OTHER VAR. SUPPLIES	2014			7,922
	*			36,569
ELECTRIC-PURCH.(KWH)	2020	43,450	.018	782
PSC SINTERING COST	2040	1,486	16.000	23,776
PSC SEA-BERTH LENTAL	2050	2,095	1.150	2,409
OTHER VARIABLE EXP.	2060			1,504
	*			28,471
MISCELLANEOUS INCOME	2090	51,714-	.018	931-
	*			931-
MAINTE.REPAIR SUPPL.	3001			23,540
OTHER FIXED SUPPLIES	3002			2,129
	*			25,669
LABOR FEE	3010			7,176
	*			7,176
PROV.FOR BF RELINING	3020			6,490
DEPRECIATION	3030			76,640
AMORTIZATION	3040			4,800
REAL PROPERTY TAX	3050			14,630
OTHER FIXED EXPENSES	3060			17,782
	*			120,342
MATERIAL COST TOTAL	**	3,230,062-	.040	130,770
VARIABLE COST TOTAL	**			124,870
FIXED COST TOTAL	**			153,187
GRAND COST TOTAL	***			408,827

9-4 Operating cost analysis and assessment

In this section an analysis of operating cost itself is made. It is needless to say, the relative relation between operating cost and sales price proves to decide the level of profit and loss. The analysis of these relative relation (that is break-even point analysis and profit & loss analysis by products type) is shown in chapter 10.

9-4-1 Cost structure analysis

As the former operating cost summerized sheet is used as a base, *Fig. 9-4-1* illustrates cost structure diagram according to group by main cost elements. The overall structure is shown in the following.

Overall structure		
Gross input cost	497.5 mil. $	(121.7%)
(less) Reused by-products gas & return scrap	△77.9	(△19.0)
Net input cost	419.6	(102.7)
(less) By-products sold	△10.8	(△2.7)
Total operating cost	408.8	(100.0)
{ Variable cost	255.6	(62.5)
{ Fixed cost	153.2	(37.5)

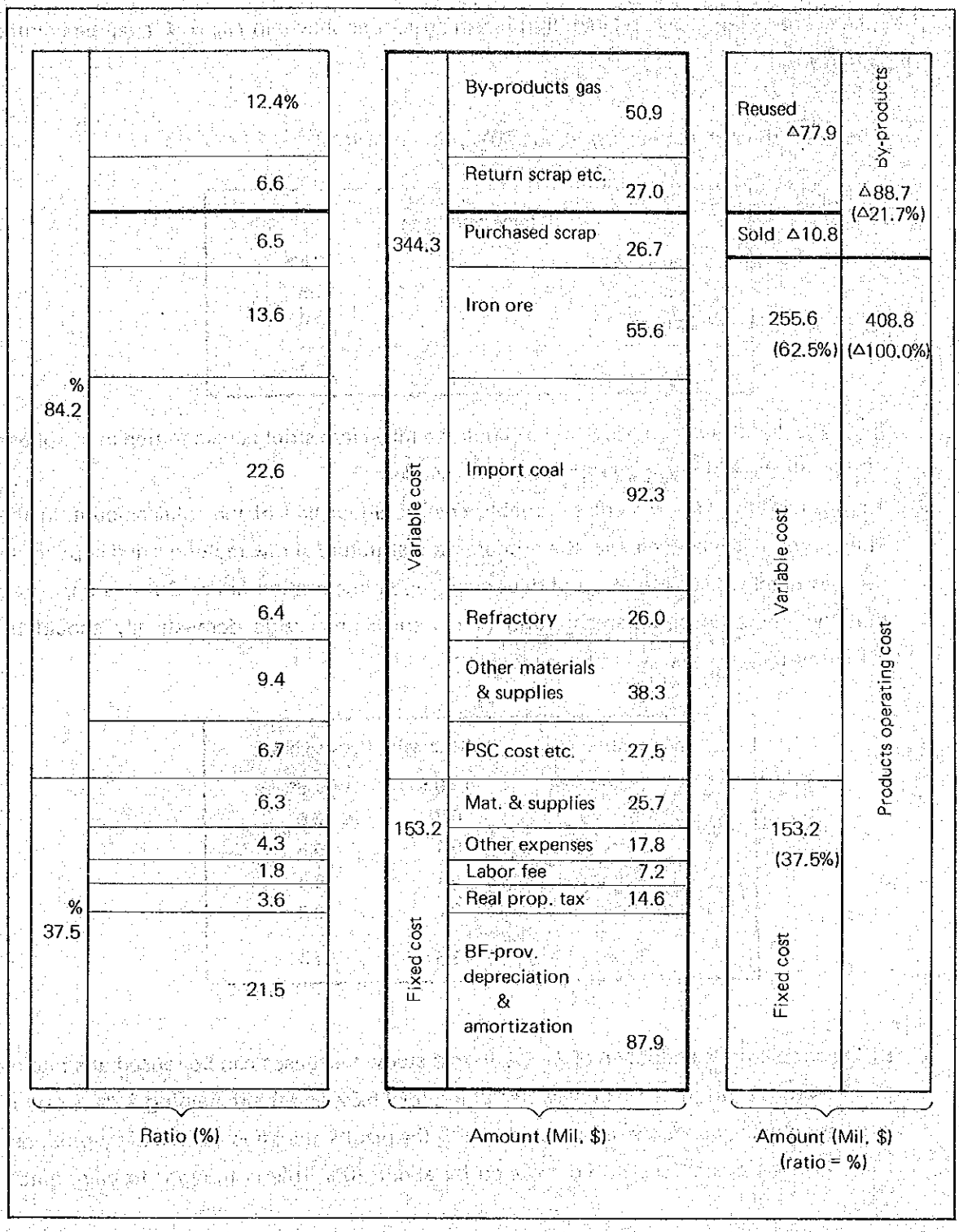


Fig. 9-4-1 Cost structure diagram

The special characteristics in relation to the cost structures shown in *Fig. 9-4-1* can be pointed out as follows.

① The main three items occupy about 60% portion of total.

3 Important items	
Import coal	22.6%
Depreciation etc.	21.5
Iron ore	13.6
Total	57.7

It goes without saying, these 3 items should be taken into strict consideration in the phase of making the executive plan for new steel works.

② The cost of imported materials (variable cost) is about half of the total amount. In the Philippines, it is inevitable that the procurement structure of raw materials and supplies in the new steel works is the type of depending upon importation firstly. But it is important that the domestic procurement ratio of materials procurable domestically should be increased step by step.

Import portion	(C&F base)	(Landed base)
Import coal	19.9 %	22.6%
Iron ore	10.7	13.6
Purchased scrap	5.1	6.5
Refractory	5.1	6.4
Others	1.7	2.3
Total	42.5	51.4

③ By-products form a deduction of 21.7%. In this study, fuel gases can be reused at a rate of 12.4%, return scrap, etc. can be recycled at a rate of 6.6% and the remaining 2.7% is calculated as valuable goods for sales outside. With the results, the effective use of by-products will allow the overall cost to be reduced by about 20%. This is thought to have much weight.

Therefore, the new steelworks should enoughly take care of recovering by-products and effective reuse.

④ Within the operating cost taxation figures, in relation to the normal tax bases, the tax percentages amount to about 10% and are considered to be a large figure.

Taxation weight in relation to operating cost

Customs duty, specific tax & advanced sales tax	28.9 mil. $	6.0%
Real property tax	14.6	3.6
Total	43.5	9.6
(Per ton of crude cast steel	29.0 $/t)	

Chapter 10 contains information relating to imported material taxation and reduced tax exemption.

⑤ Variable and fixed cost rates are set at 62.5, 37.5% respectively. Labor costs, in relation to the overall cost is about 2% and is fairly small, therefore, this also means that it enables to lower the whole fixed cost rate.

⑥ Information concerning the steelworks workers have been explained in chapter 7.; The productivity level is reasonable in relation to the first integrated steelworks in the developping country. Therefore it is considered that the labor equipment rate is proper.

1) Labor productivity

$$\frac{\text{Crude cast steel production volume}}{\text{Total number of employees}} = \frac{1{,}500 \text{ thous. t}}{4{,}065 \text{ men}} = 369 \text{ t/man} \cdot \text{y}$$

2) Labor equipment rate

$$\frac{\text{Tangible depreciable fixed assets}}{\text{Steelworks employees}} = \frac{1{,}315.9 \text{ mil. \$}}{3{,}901 \text{ men}} = 337 \text{ thous. \$/man}$$

Besides, break-even point analysis used division of variable and fixed cost will be explained in chapter 10.

9-4-2 Sensitivity analysis (Effect to operating cost)

It is estimated and showed in *Table 9-4-2*, that the operating costs of each sale product are effected to how extent in relation to normal cost at normal operating year as a precondition of this study, if major cost elements vary. Capital expenditure cost includes depreciation, real preperty tax and maintenance & repair supplies. The effect of operating rate change is calculated in correspondence to the change of the total fixed cost per ton of sales products.

The caracteristics of sensitivity analysis are shown below,

① Within the various conditions of 10% variations, the variation in operation rate will cause the largest effect of about $10 per ton of steel. (that is to say, in chapter 10 the operation level effect is analyzed through break-even point analysis.)

② If capital expenditure costs vary 10%, the effect of hot coil cost at $8.4 increase is considered to be large. For instance as it have been seen in 8-1 (3), if the price level of construction cost are to rise 10% every year, in five years the construction costs from the first will be up 61%. Following, the production cost of hot coil calculated through the assumption of these construction cost will raise about 51$/t. It causes to rise the hot coil cost of 292.5$/t by 17.4%.

③ Coal prices, iron ore prices variences are expected to have very large effects on overall costs. As the Philippines must to a large degree depend upon major raw materials to be imported, care should be taken in planning.

Table 9-4-2 Sensitivity analysis (Effect to operating cost)

(Unit: $/t)

	Condition		Effects			
	Items	Variation	Slab	Bloom	Billet	Hot coil
Normal case	Operating cost	—	235.7	240.0	286.9	292.5
Cost changes	Capital expenditure cost	± 10%	± 5.2	± 6.0	± 8.5	± 8.4
	Iron ore price	± 10%	± 3.8	± 3.8	± 3.9	± 3.9
	Import coal price	± 10%	± 6.2	± 6.3	± 6.5	± 6.4
	Scrap price	± 10%	± 1.8	± 1.8	± 1.9	± 1.9
	Refractory price	± 10%	± 1.8	± 1.8	± 1.8	± 1.8
	Operation rate	− 10%	+ 7.9	+ 9.0	+12.8	+12.4
	"	+ 10%	− 6.4	− 7.3	−10.4	−10.1