Chapter 7

CONCEPTUAL STUDIES AND FORMULATION FOR HIPARSA REACTIVATION SCENARIOS

Data presented in Chapter 7 and 8 are based on the result which is investigated in the First Field Survey, and these data still have points to be reconfirmed and further investigated.

On the other hand, data used in Chapter 9 are based on the result which is obtained in the Second Field Survey, and these data are reconfirmed and brushed up for the further study.

Accordingly, in case there is discrepancy in data between Chapter 7 or 8 and Chapter 9, Chapter 9 is the final.

7.1 PRODUCT

In order to reactivate HIPARSA following 4 scenarios have been studied : -

Scenario - 1 : BF grade pellet will be produced by the existing process and will be supplied to the domestic BF plant (SIDERAR).

Scenario - 2 : DR grade pellet will be produced by the existing process and will be supplied to the domestic DR plant (ACINDAR/SIDERCA).

Scenario - 3 : Hot briquetted iron will be produced by the existing process and the additional gas based HBI plant and be supplied to the domestic and North/South American EAF plants.

Scenario - 4 : Hot briquetted iron will be produced by the existing mining, concentration and balling processes and the additional coal based HBI plant and be supplied to domestic and N/S American EAF plants.

However as mentioned in item 6.4 (2) due to lack of suitable coal for the coal based HBI plant in Argentina, Scenario-4 is not viable.

Product of Scenario-1,2 and Scenario-3 is BF grade pellet, DR grade pellet and HBI respectively. Expected quantity and quality of product for each scenario is shown in **Table-117**.

Table-117 Expected Quantity and Quality of Product

	Scenario - 1	Scenario - 2	Scenario - 3
Product	BF grade pellet	DR grade pellet	Hot Briquetted Iron
Quantity (kilo-t/year)	1,130	1,100	750
Quality			
Chemical (%)			
T.Fe	64.10	68.11	91 - 93
M.Fe	-	-	83 - 88
Metalization	-	-	92 - 95
SiO_2	2.3	1.3	3.3
Al_2O_3			
CaO	2.8	0.33	0.45
MgO	1.5	0.12	0.17
P	0.04	0.04	0.07
S			
C	-	-	1.0 - 1.5
Size and Shape	> 80% 9-16mm	> 80% 9-16mm	30 x 60 x 90 mm
	spherical	spherical	
Bulk density	2.0 - 2.3 t/m³	2.0 - 2.3 t/m³	2.6 - 2.7 t/m³
Aparent density			5.5 t/m³
Physical property			
CCS	ave. 250 kg	ave. 250 kg	-
	< 90 kg max 10%	< 90 kg max 10%	-
Tumbler str.	> 6.3mm min 92%	> 6.3mm min 92%	-
	< 0.5mm max 5.5%	< 0.5mm max 5.5%	-
Metal. property			
Reducibility	> 60%	> 60%	-
CSAR	> 50 kg	> 50 kg	-
Swelling	max 16%	max 16%	-
LTD	>6.3mm min 90%	>6.3mm min 90%	-
	< 0.5mm max 4%	< 0.5mm max 4%	-
Linder (760℃)	-	< 3.3mm < 3.0%	-
	-	CSAR > 50kg	-
	-	Metallization > 92%	-
SBRT	-	Tumbl >6.3mm90%	-
with Load (815℃)	-	Cluster None	-

7.2 PROCESS FLOW

Conceptual process flow are shown in **Fig.-61** and **Fig.-62** for scenario -1, 2 and -3.

Figure-61 Conceptual process flow

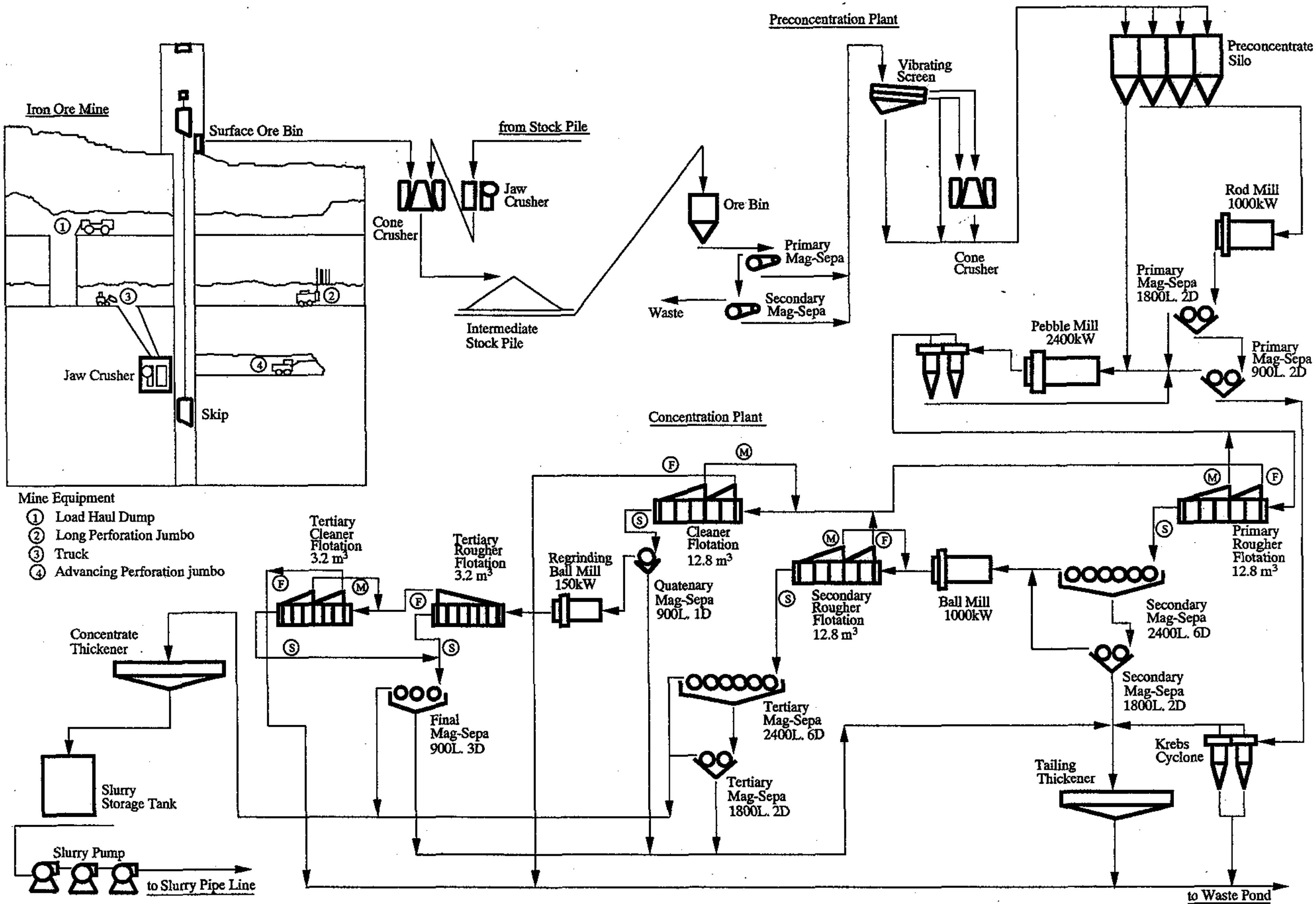
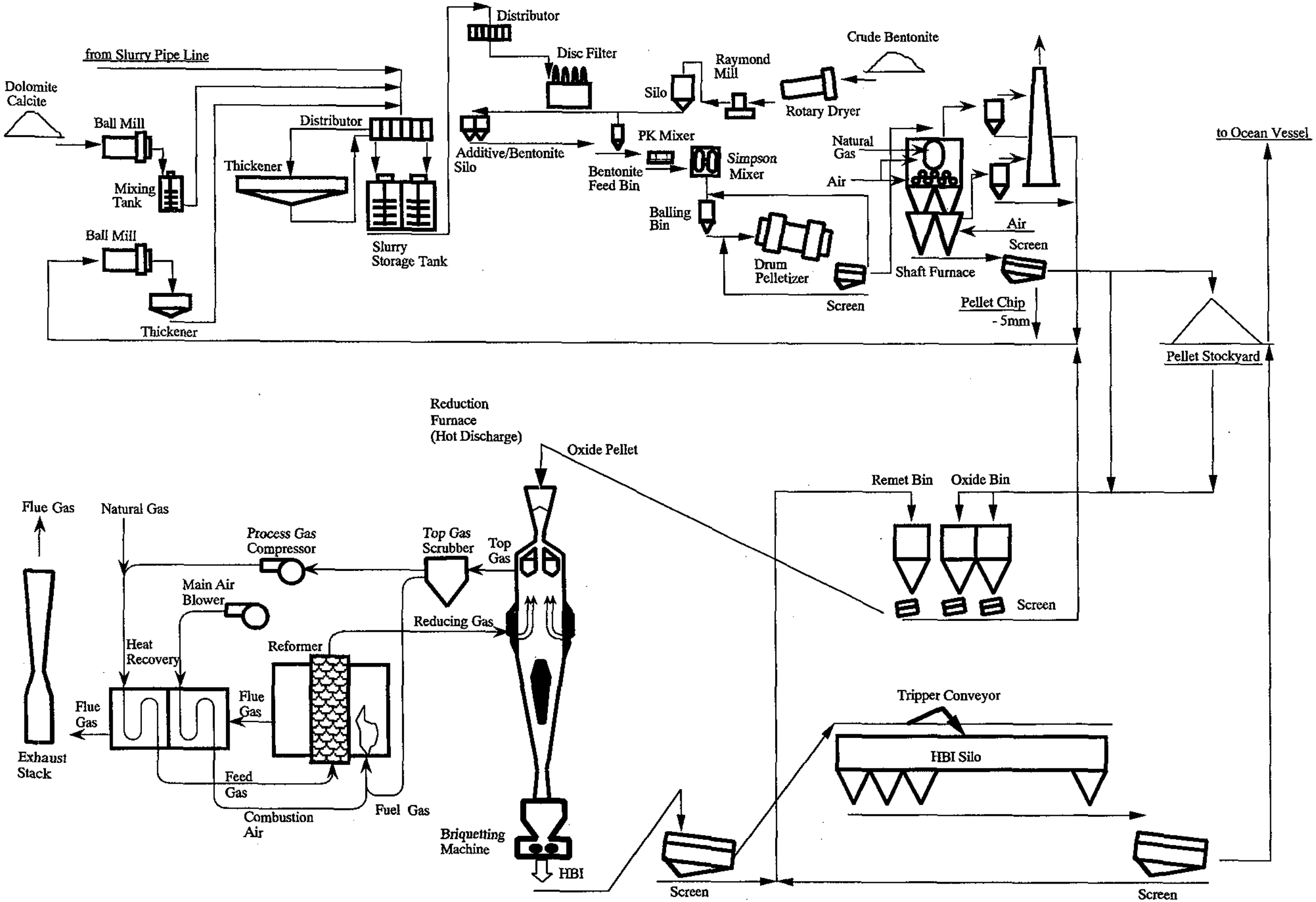


Figure-62 Conceptual process flow



7.3 MAJOR PRODUCTION FACILITIES

Major production facilities for each scenario are shown in **Table-118**.

Table-118 Major production facilities and nominal capacity

	Scenario - 1	Scenario - 2	Scenario - 3
Iron Ore Mine	2,600 kilo-t/year	2,600 kilo-t/year	2,600 kilo-t/year
Preconc. Plant	1,850 kilo-t/year	1,850 kilo-t/year	1,850 kilo-t/year
Conc. Plant	1,100 kilo-t/year	1,100 kilo-t/year	1,100 kilo-t/year
Slurry Pipe Line	2,000 solid-kilo-t/year	2,000 solid-kilo-t/year	2,000 solid-kilo-t/year
Pelletizing Plant	1,130 kilo-t/year	1,100 kilo-t/year	1,100 kilo-t/year
HBI Plant	—	—	750 kilo-t/year
Loading Facility	2000 t/h	2000 t/h	2000 t/h
Natural Gas Line			285×10^6 m^3/y
Transformer	25 MW×2	25 MW×2	25 MW×2
	16 MW×2	16 MW×2	16 MW×2
Water Line	112 liters/sec.	112 liters/sec.	275 liters/sec.

7.4 ADDITIONAL INVESTMENT COST ESTIMATION

Required investment cost for each scenario are approximately estimated as indicated in **Table-119**.

Investment in the iron ore mine is mainly for stope development up to 550m for mining 47,600,000 t of ore.

US$ 170-million for a new HBI plant based on turnkey cost and consists of engineering, equipment and material, training and advisory services, and civils. (based on a clear and level site), erection, project and construction management, commissioning and start-up.

Table-119 Additional investment cost estimation

(Unit: US$ million)

	Scenario - 1	Scenario - 2	Scenario - 3
Iron Ore Mine	142	142	142
Conc. Plant			
Pelletizing plant			
HBI Plant	—	—	170
Natural Gas Line	—	—	
Water Line	—	—	
Others			
Total			

7.5 PRODUCTION COST ESTIMATION

Production cost for each of the plants is approximately estimated as shown in **Table-120**.

Cost for administration and maintenance staff is charged on pellet cost and HBI cost respectively.

Pellet production cost and HBI production cost are estimated around US$ 31.4/t-p and around US$ 75.7/t-HBI including the cost of maintenance and administration staff.

Table-120-1 Production Cost Estimation (Iro Ore Mine)

2,600,000 t/year

Item		Unit	Price	Unit Consumption	Cost	Note
			US$	per ton	US$/t	
Variable	Electricity	kWh	0.040	14.81	0.593	
	Water	m^3	0.1	0.15	0.015	
	Consumable					
	Blasting				0.315	
	Drilling				0.051	
	Others (Vehicle etc)				0.061	
	Ope.cost (main equip.)					
	Dump tracks	7			0.307	
	Fan Drill Jumbos	5			0.147	
	LHD	9			0.252	
	Tyre shovel	4			0.035	
	Others				0.030	
	Other mainte. materials				0.321	
Total VC.					2.127	
Fixed	Manning cost	292	12,000		1.348	
	Management / Engineer					
	Labor					
	Depreciation				0.651	
	Interests etc.				0.186	
Total FC.					2.185	
	Stope development cost		114,816,000		2.412	Minable ore
						47,600,000 t
Total					6.724	

Table-120-2 Production Cost Estimation (Concentration Plant) 1,100,000 t/year

Item		Unit	Price	Unit Consumption	Cost	Note
			US$	per ton	US$/t	
Raw Material	Iron Ore	ton	6.724	2.364	15.90	
Variable	Electricity	kWh	0.040	63.5	2.54	
	Water	m^3	0.1	1.80	0.18	
	Consumable - 1					
	Steel ball					
	Steel rods					
	Mill liners					
	Screen plate					
	Total C-1					
	Consumable - 2					
	Chemicals					
	Lubricants					
	Total C-2					
	Other Consumable				0.7	Savage
Total VC.					3.42	
Fixed	Ope. Labor	52	12,000		0.57	
	Mainte. Labor					pooled
	Contractor	5	9,600		0.04	
	Spareparts					
	Depreciation					
	Interest					
	Other Finance Cost					
Total FC.					0.68	
Total					19.93	

Table-120-3 Production Cost Estimation (Pelletizing Plant) DR grade pellet 1,100,000 t/year

Item		Unit	Price	Unit Consumption	Cost	Note
			US$	per ton	US$/t	
Raw Material	Mag. Concentrate	ton	19.93	1	19.93	
	Limestone	ton				
	Dolomite	ton				
	Bentonite	kg	0.1	10	1.0	
	Others					
Total R.M.					20.93	
Variable	Electricity	kWh	0.04	73	2.92	
	Natural Gas	Nm^3	0.062	15	0.93	
	Coal	kg	0.04	6	0.24	
	Water	m^3	0.1	0.3	0.03	
	Cosumable - 1					
	Screen plate					
	Filter cloth					
	Total C - 1				1.0	
	Other Cosumable					
Total VC.					5.12	
Fixed	Ope. Labor	64	12,000		0.70	
	Mainte. Labor					pooled
	Contractors	15	9,600		0.13	
	Spareparts					
	Refractories				2.0	
	Depreciation					
	Interests etc.					
	Other Finance Cost					
Total FC.					2.83	
Total					28.88	
Common	Mainte/Admin/Labo staff	229	12,000		2.50	31.38

Table-120-4 Production Cost Estimation (HBI Plant) 750,000 t/year

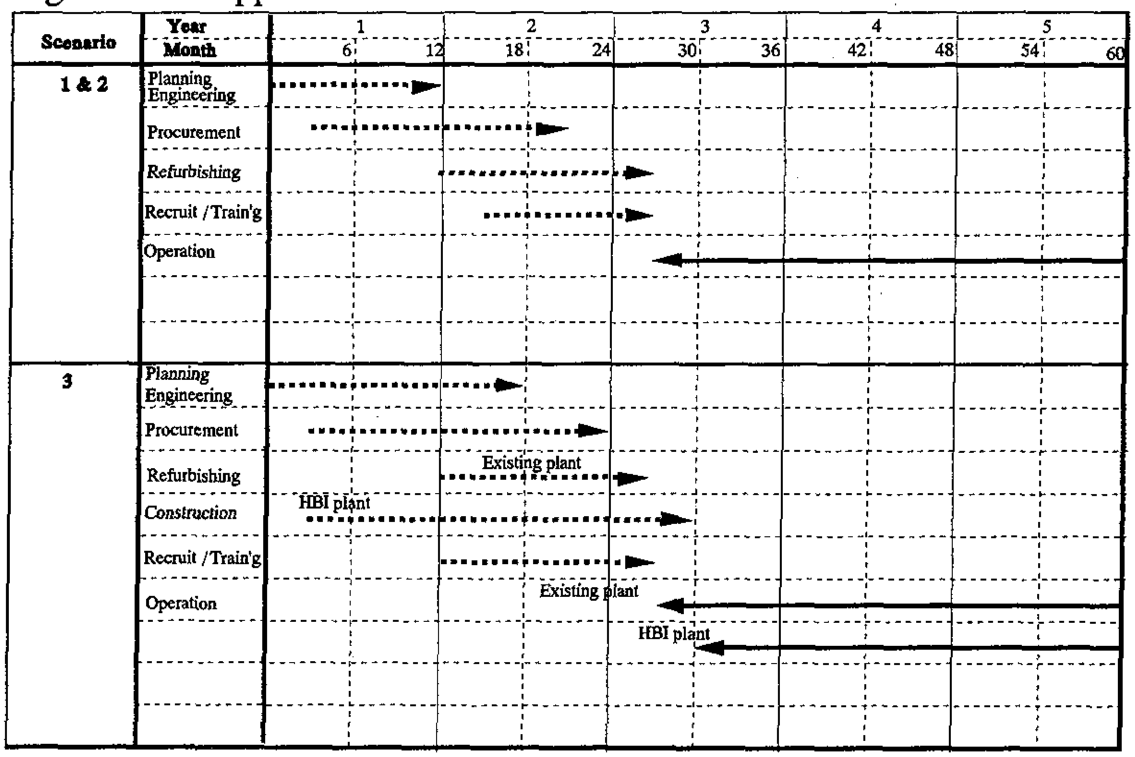
Item		Unit	Price	Unit Consumption	Cost	Note
			US$	per ton	US$/t	
Raw Material	Pellet	ton	31.38	1.45	45.50	
	Remet					
	Chips etc.					
Total RM.						
Variable	Electricity	kWh	0.04	130	5.20	
	Natural Gas	Nm^3	0.062	295	18.29	
	Coal	ton	—	—	—	
	Water	m^3	0.1	0.5	0.05	
	Consumable - 1					
	Screen plate					
	Liner					
	Total C - 1					
	Other Consumables					
Total VC.					23.54	
Fixed	Ope. Labor	70	12,000		1.12	
	Mainte. Labor					pooled
	Contractors	15	9,600		0.20	
	Spareparts					
	Refractories				4.0	
	Depreciation					
	Interests etc.					
	Other Finance Cost					
Total FC.					5.32	
Total					74.36	
Common	Mainte/Admin/Labo staff	85	12,000		1.36	75.72

7.6 APPROXIMATE REACTIVATION SCHEDULE

An approximate schedule for HIPARSA reactivation project is shown in **Fig.-63**.

Pellet production and HBI production shall be able to start 27 months and 30 months after the project start.

Fig.-63 An approximate schedule for HIPARSA



Chapter 8

SELECTION OF A REACTIVATION PLAN OF HIPARSA

Data presented in Chapter 7 and 8 are based on the result which is investigated in the First Field Survey, and these data still have points to be reconfirmed and further investigated.

On the other hand, data used in Chapter 9 are based on the result which is obtained in the Second Field Survey, and these data are reconfirmed and brushed up for the further study.

Accordingly, in case there is discrepancy in data between Chapter 7 or 8 and Chapter 9, Chapter 9 is the final.

8.1 COMPARATIVE STUDY OF MAJOR AND ALTERNATIVE SCENARIOS

Comparison of the following factors in 4 scenarios is shown in **Table-121**.

Scenario - 1 (S-1)

: BF grade pellet will be produced by the existing process and be supplied to the domestic BF plant (Siderar).

Scenario - 2 (S-2)

: DR grade pellet will be produced by the existing process and be supplied to the domestic DR plant (Acindar/Siderca).

Scenario - 3 (S-3)

: Hot briquetted iron will be produced by the existing process and the additional gas based HBI plant and be supplied to domestic and North/South American EAF plants.

Scenario - 4 (S-4)

: Hot briquetted iron will be produced by existing mining, concentration and balling processes and the additional coal based HBI plant and be supplied to domestic and N/S American EAF plants.

Table-121 Comparison of Reactivation Scenarios

	Scenario - 1	Scenario - 2	Scenario - 3	Scenario - 4
Major facilities	Iron ore mine	Iron ore mine	Iron ore mine	Iron ore mine
	Conc.plant	Conc.plant	Conc.plant	Conc.plant
	Pellet plant	Pellet plant	Pellet plant	
			Gas base HBI plant	Coal base HBI plant
Product	BF grade pellet	DR grade pellet	HBI	HBI
	1,130 kilo-t/year	1,100 kilo-t/yearear	750 kilo-t/yearear	870 kilo-t/year
Market	SIDERAL	SIDERAL	ACINDAR 300 kilo-t/yearear	ACINDAR 300 kilo-t/yearear
		ACINDAR	Acerobrag 100 kilo-t/yearear	Acerobrag 100 kilo-t/yearear
		SIDERCA	Brazil 200 kilo-t/yearear	Brazil 200 kilo-t/yearear
Iron ore	Pellet feed	Pellet feed	Pellet feed - pellet	Pellet feed
	- Available	- Available	- Available	- Available
Reductants	(not necessary)	(not necessary)	Natural gas	Coal
			- Available	- Not acceptable
Initial investment	64 m$	64 m$	220 m$	
Production cost	31.4 $/t-pellet	31.4$/t-pellet	75.7 $/t-HBI	
Sales price (fob)	34.3 $/t-pellet *1	39.2 $/t-pellet *2	110 $/t-HBI	
Employee (Mine)	292 + ( )*3	292 + ( )	292 + ( )	
(Conc.)	52 + (5)	52 + (5)	52 + (5)	
(Pellet)	64 + (15)	64 + (15)	64 + (15)	
(Labo)	25	25	32	
(new HBI)	0	0	70 + (15)	
(Mainte)	132	132	192	
(Admin)	72 + ( )	72 + ( )	90 + ( )	
(Total)	637 + ( )	637 + ( )	792 + ( )	
Reactivation schedule	27 months	27 monts	30 months	

*1 : '98 Brazil to Europe fob price
53.56 ¢ /Fe x 64.10 %

*2 : BF pellet price x 1.075
53.56 x 67.2 x 1.075

*3 : Contractor

(1) Major facilities

Existing facilities are utilized with minor modification in S-1 and - 2. Gas based HBI plant in S-3 and coal based HBI plant in S-4 have to be newly installed respectively. In S-4, existing shaft furnace and related equipments will not be required.

(2) Product

In S-1 and -2, the product is oxide pellet. Acceptable Fe and P content of pellet in S-1 is not so critical than that of S-2.

Products of S-3 and -4 are HBI. Owing to ash in coal Fe content of HBI from S-4 will naturally be lower than that of S-3.

There is no bottleneck for each scenario on the product.

(3) Market of product

The market for BF grade pellet is rather slack and is not be expected expand in the future.

While the DR grade pellet market is tight at present, it is expected to expand in the future. Acindar and Siderca are a probable market and Sideral has shown interest in the DR grade pellet.

HBI has a bright market future and Acindar, Acerobrag, Siderca and the Brazilian EAF operator will be the probable market.

From the view point of product marketability, S-1 is difficult to sell out all product, and S-3, S-4 are preferable. So, S-1 has to be discounted from further study.

(4) Available iron ore source

Pellet feed is directly used for S-1, S-2 and S-4, but in S-3, pellet feed is agglomerated to pellet and fed to the furnace.

Concerning on iron ore source, each scenario does not have any problem.

(5) Available reductants (in S-3 and S-4)

Enough quantity and suitable quality natural gas is available with capacity up suppliability for S-3, houwever, due to high volatile matter and low fixed carbon contents, domestic (Rio Turbio) coal is not acceptable as reductant for S-4, coal based HBI process. Accordingly S-4 has to be omitted from any further study.

(6) Estimated initial investment

(7) Estimated production cost

US$ 31.4/t for pellet production cost is high comparedwith the estimated sales price (BF grade pellet 34.3 and DR grade pellet US$ 39.2/t FOB Puerto Colorada). US$ 75.7/t for HBI production cost is acceptable compared to the sales price.

From view points of production cost and sales price, S-3 is considered most preferable.

(8) Number of employee

Number of employee is roughly estimated 637+contractor for S-1,S-2 and 792+contractor sor S-3. In case of S-3, more than 155 jobs are created.

(9) Estimated Reactivation Program

In the case of S-1 and S-2 the plant will be able to start 27 months after the project starts, whilest in the case of S-3, HBI production will be able to commence 30 months after the project start.

8.2 SELECTION OF A REACTIVATION PLAN

In order to select the most suitable scenario, the result of comparative study for each scenario is schematically shown in **Table-122.**

Table-122 Result of comparative study of scenarios

	S-1	S-2	S-3	S-4
Applicability of existing facility and equipment	◎	◎	○	○
Product marketability	×	△	◎	◎
Iron ore appliability	○	○	△	○
Reductant availability	○	○	○	×
Initial investment	○	○	△	△
Margin (sales price - production cost)	×	△	◎	◎
Recovery of investment	×	○	○	○
Job creatibity	○	○	◎	○
Total evaluation	×	○	◎	×

Where mark ◎ shows "excellent", mark ○ shows "good", and mark △ shows "acceptable", while mark X shows "un-accceptable"

In conclusion to the study, S-3 shall be selected as the HIPARSA reactivation scenario which will be examined and developed further in the feasibility study.

Chapter 9

FORMULATION OF A REACTIVATION PLAN FOR HIPARSA

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9.1 REACTIVATION PLAN FOR HIPARSA

9.1.1 Mining

(1) General

The Basic principles of the reactivation plan for Sierra Grande iron ore mine is as follow:

① Promotion of mechanized mining methods
② Rationalized development of deeper deposits
③ New organization and man-power allocation

An annual crude ore production of 2,600 kilo-t will be possible and high productivity will continue for more than 20 years when the mining plan is prepared on the basis of the above mentioned basic principles as shown in **Table-123**.

Table-123 Operation conditions for 2,600 kilo-t per year production

Item	Condition
1. Annual operation days	250 days
2. Number of faces	Number in development : 12, Number in operation : 6
3. Monthly blasting number	Approximately 60/month
4. Production volume by blasting	2,900-3,000 t/face
5. Annual production volume	Face production : 2,100,000 t/year Drifting : 500,000 t/year Total : 2,600,000 t/year

(2) Promotion of mechanized mining methods

Replacement of present pneumatic fan drill jumbo, LHD and trucks past their productive life, etc., will create reliability of the mobile equipment and will create steady numbers of mineable faces and increased production volume from each face.

After replacement mobile equipment shall have the following features.

1) Oil-hydraulic fan cut drill
With sufficient drilling capacity (upward direction 40m, downward direction 50m) and various functions to enable one man operation.
Numbers to be introduced; 7 units

2) LHD and dump truck
Dimensions suitable for underground use with exhaust gas treatment.
LHD radio remote control system will increase mining recovery.
Number to be introduced; LHD 9 units and dump truck 10 units

(3) Rationalized development of deeper deposits

Development of -410 ML will be planned for possible mining to -620 ML with a possible recovery of 63,000,000 t. The following measures will be taken to decrease the investment and cost of reactivation.

Central shaft and skip station at -480 ML shall remain as it is. Crusher on the ground out of operation with same specification of existing one at -410ML shall be moved to -620 ML. Crushed ores will be transported to the skip station moved to -480 ML by belt conveyor.

Major work to be carried out for reactivation is as follows.

1) Expansion and extension of ventilation shafts
No.148, 275, 860, 314

2) Extension of incline
480 ML～620 ML 1,700m

3) Transfer of CR station and CR
Weight of CR 200 t area of CR station 6,000 m^3

4) Drift for belt conveyor
480 ML～620ML 800m length with BC of 1,000 mm

5) Drift at main level
Decrease of transportation drift by introduction of subtruck (approximately 3,000 m per level)

(4) New organization and man-power allocation

New organization of the mining department will be headed by a head of mining. Geologist and mining engineer will support him as staff engineers. Shift chief allocated 6 sections will direct people under the instructions of the head of mining. Total number was 225.

Waiting and rest place for workers and maintenance space for mobile equipment shall be studied for introduction in future underground to prevent the decrease actual working hours of the workers and of work ratio of mobile equipment which will occur by the deeper drilling level.

9.1.2 Iron ore concentration plant

(1) Outline of the Process

There is no need for increasing capacity of the concentration plant, however, there is a need for modification of process to decrease phosphorus content. The most promising measure would be the reduction of phosphorus by two stage processing. The effective decreasing of phosphorus content by two stage processing was confirmed by laboratory test to some extent although a plant test was not able to be carried out.

It is deemed to difficult to execute typical two stage processing at Sierra Grande by unifying two lines to one line. The justification to modify the existing secondary grinding mill to a ball mill is the pebble mill is too big to work as a ball mill.

Two stage processing is possible to apply to Sierra Grande is shown in **Fig.-22** in 6.2.6. Primary grinding after the rod mill will remain as it is, i.e.the pebble mill, and secondary grinding will be executed by converting a rod mill to a ball mill.

(2) Pre-concentration plant

There is no need for modification, however, there is always a need for maintenance and repair work as abrasion of the preconcentration plant is larger than other plants because of the treatment of coarse size iron ore. As there is a need for maintenance and repair work, 24 hours continuous running of the pre-concentration plant is not possible. Resumption of three line operation is considered necessary.

(3) Rod mill and primary magnetic separation

There is a need for two line operation out of three lines. There is almost no need for modification of the existing equipment and maintenance work to resume operations.

(4) First stage processing

The first stage treatment process by closed circuit grinding with pebble mill and cyclone and continuing magnetic separation and flotation will not change. There is a need for some modification. First is the modification of the relation of pebble mill and cyclone. The present closed circuit grinding is currently modified from the original standard type shown in **Fig.-4** to the reverse type shown in **Fig.-5**, therefore there is a need for modification to bring it back to the original style. Reverse type closed circuit grinding tends to dilute pulp density of the product.

Feed for the magnetic separator was not fed to the first drum in full due to diluted density and was distributed to first, second and third drum. This is unorthodox. The present magnetic separator which has 6 drums shall be modified to three drums each. There is a need to consider that the feed volume will be doubled at two stage processing.

Floatation was also changed to open circuit system not to repeat floatation froth when HIPARSA was in operation as shown in **Fig.-5**. This floatation shall be changed to the original circuit system shown in **Fig.-4**.

In order to obtain effective decrease of phosphorus content, floatator for cleaning is better used after the re-grinding of re-treatment circuit of flotation froth.

(5) Secondary stage processing

No.3 rod mill will be used as a ball mill for grinding at the secondary stage as the speed of the rod mill is low and suitable for a secondary grinding ball mill. There is a modification required to prevent ball run out from the mill as rod in the mill will be replaced to ball. It is preferable to replace the present liner to a rubber liner to extend the life at the time of renewal.

A Cyclone is used because of condensation at the secondary stage treatment and ball mill is used in open circuit. This has the purpose of avoiding heavy medium separation effect of closed circuit classification cyclone. More effectiveness could be expected if a closed circuit of sieve bend will be applied, however a demerit of a sieve bend is the need of more space. There maybe a problem as to whether or not a sieve bend can be applied to the existing plant which has a very compact design. This item should be studied in future.

Flotation comes first and magnetic separation comes after flotation at the secondary stage treatment. The residual amount of apatite becomes very small when magnetic separation comes first and effective floatation can not be expected. Elimination of fine particles difficult to remove at flotation and de-slimming is the role of magnetic separation here.

Hydraulic concentrator such as siphonsizer is more effective and economical for de-slime, however, de-slime effect by two stage processing is also large. Whether or not siphonsizer will be needed will be also the subject of future study.

(6) Re-treatment of flotation froth

Re-treatment of floatation froth in the past was re-grinding and magnetic separation. When floatation and magnetic separation will be repeated after re-grinding, the effect will increase. **Fig.-22** is an alternative. It would be difficult to get a clear answer by laboratory test only. This will also be a subject of discussion when the plant resumes operation.

(7) Tailing disposal

There is a need for re-assembling of thickener for tailing as it is disassembled- at present. There is also a need for re-installation of cyclone for treatment of primary magnetic separation tailing.

(8) Concentrate transport pipeline

It is reported that the pipeline is ready to resume operation. It is also reported that the flow rate can be lower than designed. It is one of the important future subject for discussion for lowering costs.

(9) Operation

Four (4) crew three (3) shift operation of pre-concentration plant, concentration plant and concentrate transport pipeline will be necessary. Operators of the pre-concentration plant shall have the ability to carry out daily maintenance work and parts of the repair work as there occurs larger abrasion as compared with other plants.

(10) Expected concentration operation performance

Expected concentration operation performance in compliance with the flow shown in **Fig.-22** is shown in **Table-98**.

9.1.3 Pelletizing plant

(1) General

The Basic requirements to restart the pellet plant are as follows:

① Utilizing the existing plant to minimize as much as possibleinvestment cost

② Improving and rectifying equipment which is informed as clearly defective

③ Producing DR grade pellets

(2) Quality

1) Chemical composition (refer to **Table-124**)

From the results of the beneficiation test, chemical composition is estimated. Based on this result, Chemical composition of pellets with 1.0% bentonite blend is estimated and this result shows that HBI made from these pellets will satisfy the specification of DRI.

Vanadium content, which is a catalytic poison against the DR process is high but it is considered that it does not have a serious affect because some pellets with almost the same content are used world wide without usage limitation.

2) Physical quality (Refer to 6.3.2)

Pot test results shows that it is possible to produce pellets with properties within specification for DR grade pellets when they are produced with the correct moisture of green ball (less than 10%), the correct bentonite blend (less than 1.0%) and with the correct heat pattern.

Table-124 Chemical composition concentrate and pellets

	T.Fe	FeO	SiO2	Al2O3	CaO	P	S	V	Na20	K2O	CO2	Igloss	C.W	TiO2	Cr	Ni	MgO	Zn
HIPASAM conc(analized)	69.14	30.12	1.47	1.46	0.30	0.134	0.100	0.080	0.10	0.03	0.04	-2.54	0.47					
HIPARASA No10 test	70.42	29.87	0.76	0.95	0.13	0.044	0.033	0.112	0.02	0.01		-2.82						
Concentarate*1(forecasted)	69.50	30.05	1.27	1.32	0.25	0.047	0.081	0.09	0.08	0.02	0.04	-2.62	0.47	0.137	0.038	0.026	0.10	0.011
Fiered pellets*2(Calc.)	67.20	0.14	1.80	1.40	0.27	0.045	0.005	0.09	0.10	0.02	0.04			0.13	0.038	0.026	0.12	0.011
Fiered pellets*3(Pot result)	67.11	6.15	2.12	1.62	0.32		0.001		0.06	0.04							0.10	

*1: This is forecasted for future quality based on this report.

*2:This is calcilated with premise that pellet is produced with the blend of 99% of concentration forecasted *1 and 1% of bentonite.

*3:This is produced through pot test using the blend of 99% of HIPASAM concentration and 1% of bentonite.

(3) Preparation for re-staring production techniques

1) Training

To establish the production organization, key personnel must be hired before the re-start. They will receive training at another plant with the same shaft pelletizing furnace. After obtaining experience, they must inspect the repairs, modifications and new construction work for re-starting the plant and they must get normal work practises (or work standard) and must give training to new comers.

2) Technical assistance

This must be commenced before the re-start to rectify equipment. Transfer of technical knowledge must be done through this technical assistance before and after the re-start.

(4) Premise for production

1) Plant performance

The Plant will be operated with 3 shift of 4 crew. Three furnaces to be operated simultaneously with 1 furnace on stand-by. One furnace is to be operated for a continuous 16 month period then a period 2 months for a small extent of repair of the fire brick and a standby period of 2 months. Overhaul of whole brick lining will be carried out every 8 years.

2) Availability

① Available hour for production----------	6077.8 h/year
② Break down stoppage-------------------	242.2 h/year
③ Scheduled shutdown--------------------	1056.0 h/year
④ Operation delay------------------------	384.0 h/year
⑤ Unforeseeable stoppage----------------	1000.0 h/year

3) Production rate------------------------------------- 62 t/h

4) Annual production-------------$62 \times 6077.8 \times 3 = 1.13$ million-t/year

(5) Unit consumption

1) From pot test result it is possible to produce DR grade pellets with the blend of bentonite only and limestone addition to improve the quality. This study is based on the blend of 1 percent of bentonite.

2) By substituting natural gas partially with solid fuel heat pattern will be expected to lead to the energy saving as explained in 6.3.4.

3) In this study, coke breeze (size=6.35~9.51mm) usage is premised because many sizes are available and there should be suitable size for this usage in the shaft furnace. Too smaller size breeze will be blown out from the furnace before combustion and too larger size breeze will melt down pellet particles during combustion of coke breeze. It is possible to obtain coke breeze from integrated steel plants equipped with blast furnaces where coke smaller than 1 inch is not used and this size of coke is always available for customer. When this coke is sold, coke is sieved to many size ranges for adjusting size against the request from each customer.

4) When the plant is operated with 3 furnaces at 62 t/h for each and with 6,078 h/year available for each furnace, electric power consumption would be estimated to be lower than 75 kWh/t-PP from the relation of electric unit consumption versus availability. There was no actual result for operation at a higher production rate and availability. On the other hand there is a designed figure for electric power consumption of 75 kWh/t-PP at nominal production on the DIAGRAMA GENERAL DE FLUJO. So, 75 kWh/t-PP is used for the study.

5) Repair of fire brick is assumed as following.

a) Minor repair is done every 16 month for each furnace.
1 third of brick to the upper part will be replaced.

(It is estimated that past record indicated 1 operational period was 16 month)

b) Whole brick replacement is carried out every 8 years.

Table-125 shows the unit consumption.

Table-125 Unit consumption

Concentration	965	kg/t-PP[*1]
Bentonite	10	kg/t-PP
Natural gas	15	Nm^3/t-PP
Coke breeze	6	kg/t-PP
Electric power	75	kWh/t-PP
Fire brick and heat resistance material	0.8	kg/t-PP

*1: Product pellet after screening at product screen

(6) Investment

The following is calculated from the hearing results concerning the unit construction cost in Argentina and general opinion for the shaft furnace.

1) Tuning and rectification of equipment (unpredictable items)
By using the premise that a new shaft furnace pelletizing plant for 2 million t/year production could be installed at the cost of US$100-million and it is generally considered that rectification after construction requires a cost of 6 % of investment cost. So, this cost is premised to be
---US$ 6-million

2) Replacement of equipment

a) Change of vibrating seed screen to roller screen
Weight of screen-----7t/screen
Number of screen----4
Cost of replacement (including modification of related equipment, installation and freight cost)
---US$ 1.9-million

b) Replacement of Index Feeder to an up-dated one
From investigation, it is estimated.
Cost of replacement (including engineering and PLC control)
---US$ 1.6 million

c) Change of product screen
Weight of screen-----15t/screen
Number of screen----2
Cost of replacement (including installation and freight cost)
---US$ 0.5-million

d) Change electrical circuit from relay to PLC
From study requested by HIPARSA to engineering company, it is estimated
---US$ 0.9-million

3) New installation

a) Belt weigher
It is attached to No 10 belt conveyor to measure green ball production.
Number of weigher----4
---US$ 0.3-million

b) Dry concentration addition (**Table-126**)

① Access slope to charge hopper

② Charge Hopper

③ Short conveyor from Charge hopper to storage bin

Horizontal length--------43.5m

Lift----------------------11.7m

Motor--------------------6kW

Capacity-----------------100t/h

④ Storage bin

⑤ Long conveyor to day bin

Horizontal length--------178.1m

Lift----------------------40m

Motor--------------------22kW

Capacity-----------------100t/h

⑥ Day bin

Table-126 Investment cost for dry conc. addition

	Steel structure and machine weight (t)	Reinforced concrete (m^3)	Investment cost (US$)
①		14	10,000
②	6	74	20,000
③	39	20	350,000
④	46	295	350,000
⑤	138		1,300,000
⑥	25		80,000
		Total	2,110,000

c) Coke addition

① Access slope to charge hopper

② Charge Hopper

③ Short conveyor from Charge hopper to storage bin

Horizontal length---------15m

Lift--------------------------2m

Motor---------------------1.5kW

Capacity------------------100t/h

④ Day bin

Table-127 Investment cost for coke addition

(US $)

	Steel structure and machine weight (t)	Reinforced concrete (m^3)	Investment cost
①		14	10,000
②	6		20,000
③	15	25	230,000
④	20		120,000
		Total	380,000

9.1.4 HBI plant

A new gas based HBI plant shall be constructed in Punta Colorada, adjacent to the existing pelletizing plant.

In compliance with the reactivation plan of existing plants, annual production capacity of HBI plant is set on 750 kilo-t/year. 750 kilo-t/year of HBI is produced from 1,100 kilo-t/year of pellet by using natural gas as reductants, and is mainly shipped to domestic and Brazilian consumers as described in Chapter 10.

The HBI plant is connected by the belt conveyor which transport oxide pellet from the pellet plant and/or from the pellet stockyard to new oxide bins, at the end of the existing stacking conveyor. HBI transport conveyor is connected to the end of the existing reclaiming conveyor by a newly installed conveyor.

The key plan of HBI plant is shown in **Fig.-64**.

(1) General specification of HBI plant

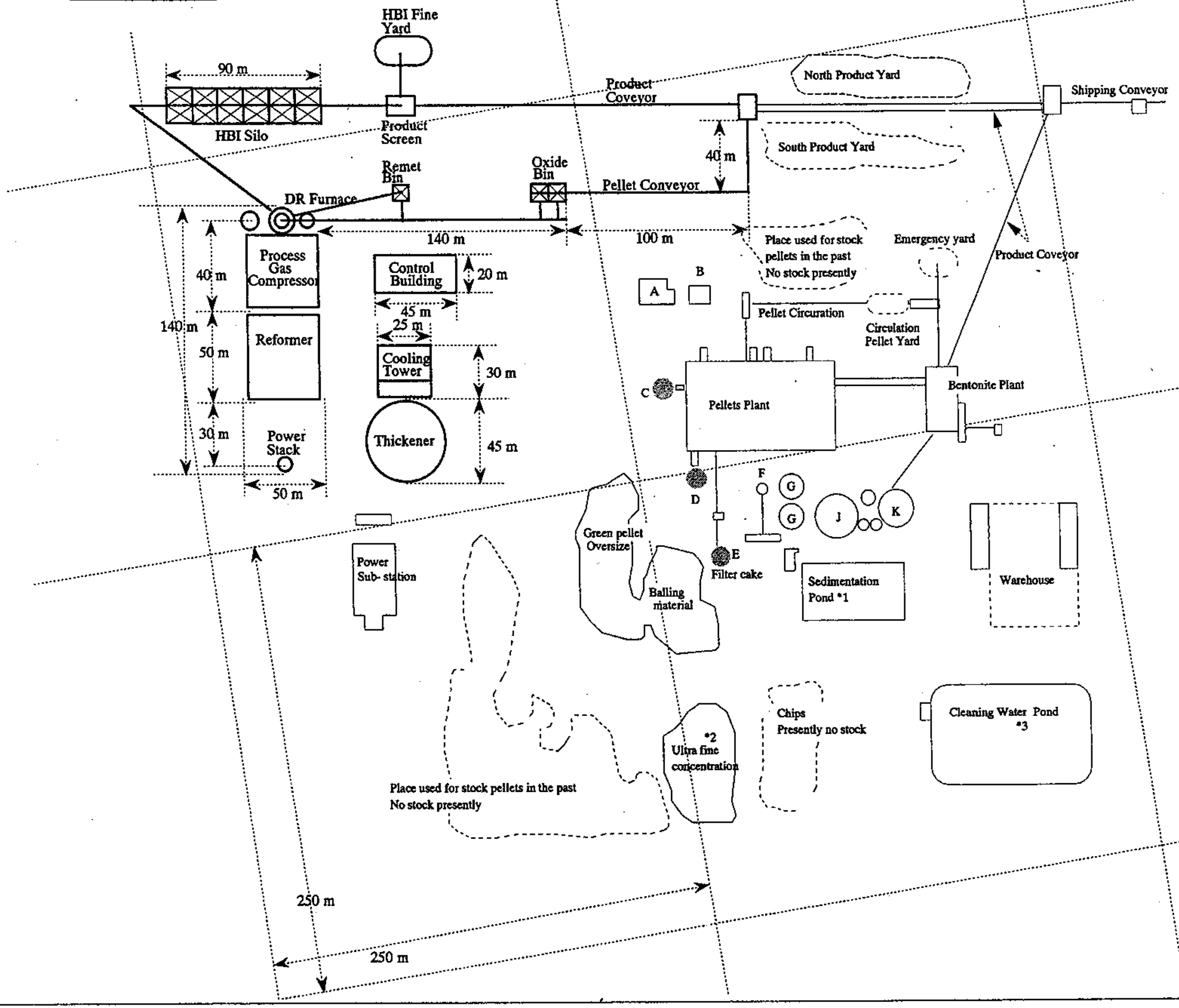
1) Annual production capacity --- 750 kilo-t/year
(62,500 t/month,100 t/h)
Plant operation hours --- 7,500 h/year

2) Iron oxide --- 100 % of iron ore pellet . (Expected specification of pellet is shown in **Table-128**)
Required quantity of iron ore pellet is around 1,100 kilo-t/year.

3) Reductant --- Natural gas, with 9,700 kcal/Nm^3 of high calorific value. (Specification of natural gas is shown in **Table-129**.)
Required quantity of natural gas is around $222 \times 10^6 Nm^3$/year.

4) Product --- Hot briquetted iron (HBI).(**Table-128.**)

Figure-64 750 HBI Plant



Note ;

A : Emergency Generator
B : Cooling Tower
C : Emergency Pile of Green Pellet Over Size
D : Emergency Pile of Balling Material
E : Filter Cake
F : Slurry Tank
G : Slurry Receiving Tank
J : Concentrate Thickener
K : Silica and Dolomite Thickener

Table-128 Expected Specification of Iron ore/Concentrate/Pellet/HBI

Item		unit	Iron ore	Concentrate	Pellet	HBI
Chemical analysis	T.Fe	%	53.2～56.4	69.5	67.2	91.5
	FeO	%	27	30	0.14	8.0
	SiO_2	%	5.15～6.75	1.3	1.8	2.4
	Al_2O_3	%	4.35～5.35	1.3	1.4	2.0
	P	%	1.37～1.49	0.047	0.045	0.061
	S	%	0.36～0.52	0.08	0.08	0.11
	CaO	%	2.91～3.63	0.3	0.3	0.37
	MgO	%	n.d.	0.1	0.1	0.16
	M.Fe	%	—	—	—	85.1
	Metallization	%	—	—	—	92～95
	C	%	—	—	—	1.3
Physical properties	Size distribution				(9-16 mm)	
		%			85	
		mm				30x60x90
	C.C.S Ave.	kg	—	—	250	—
	< 80 kg	%	—	—	5	—
	Tumbler	%	—	—	94 (6mm)	—
	<0.6mm	%	—	—	3	—
	Aprt. density	t/m³	—	—	2.1	5.5
Metallurgical properties	Linder (760℃)					
	Fine (<6.0mm)	%	—	—	3	—
	C.S.	kg	—	—	—	—
	Metallization	%	—	—	92	—
	Static bed reduction					
	with load (815℃)					
	Tumble (6.8mm)	%	—	—	—	—
	Clustering	%	—	—	30	—
	Metallization	%	—	—	92	—
	Static bed reduction					
	without road					
	Reducibility	%	—	—	95	—
	Metallization	%	—	—	92	—
	C.S. after R	kg	—	—	50	—

Table-129 Specification of Utilities

Natural gas			Coke			Water		
Item	Unit	Spec.	Item	Unit	Spec.	Item	Unit	Spec.
Composition	%		Coke.analysis	%		PH value		n.d.
CH_4		89.80-90.16	Ash		14	Total hardness	mg/l	128 - 170
		Ave.90.02	VM		0.6	Calcium hardness	mg/l	n.d.
C_2H_6		4.71-4.89	FC		85	Total alkalinity	mg/l	124 - 147
		Ave.4.81	Moisture	%	8 - 10	Suspended solids	mg/l	n.d.
C_3H_8		1.87-2.01	Size analysis			Dissolved solids	mg/l	n.d.
		Ave.1.91	6 - 9 mm	%	80 - 90	Sulfate	mg/l	66 - 94
C_4 and higher		1.11-1.29				Total Fe	mg/l	< 0.1
		Ave.1.20				Dissolved Fe	mg/l	n.d.
CO_2		0.13-0.20				Silica	mg/l	n.d.
		Ave.0.17	Ash analysis	%		Chloride	mg/l	35 - 50
N_2		1.80-1.96	Fe		12.9			
		Ave.1.90	SiO_2		43.4	Temperature	℃	n.d.
O_2		0	Al_2O_3		23.9	Pressure	kg/cm²	n.d.
H_2		0	CaO		6.4			
Calorific value	Kcal/Nm³	9,658-9,731	MgO		1.4			
Hh		Ave.9,692	P		0.3			
Calorific value	Kcal/Nm³	8,809-8,875	S		0.7			
Hl		Ave.8,843	Mn		0.3			
Pressure	kg/cm^2	5.5	Others					
			Calorific value	Kcal/kg	6800-7000			

(2) Major equipment

The battery limit of the new HBI plant is from the oxide pellet receiving conveyor at the terminal of the existing stacking conveyor to the HBI transport conveyor at the terminal of the existing reclaiming conveyor.

The new HBI plant consists of the following major equipment.

1) Oxide pellet handling equipment
- Oxide pellet conveyor
- Oxide pellet bin and remet bin
- Furnace feed conveyor

2) Reduction furnace

3) Hot briquetting system

4) Natural gas reformer

5) Water system

6) Dust collection system

7) HBI handling equipment
- HBI conveyor
- HBI storage silo
- HBI screen and HBI fine yard

8) Central control room
Laboratory and maintenance shop will use existing facilities.

9.1.5 Utilities

(1) Natural gas supply line

At the present stage, Natural gas, obtained from Pico Truncado in Santa Cruz Province, is sent to Buenos Aires through a pipeline (30 inches in diameter). In Sierra Grande, it branches to the town and to HIPARSA. The branch pipeline runs 47 km to the Pelletizing plant. The gas pressure is decreased in a valve station at the branch point and in a valve station near the entrance of the Pelletizing plant initially from 70 to 20-40 kg/cm^2 in each station, and the gas is sent to the entrance of the Pelletizing plant in a 6-inch pipeline, then its pressure is further decreased to 5.5 kg/cm^2 in the second stage.

Although the unit consumption of natural gas for Pelletizing plant was designed on total of 1.76 Nm^3/sec. and the 6 inch diameter of the existing piping was based on 2,000 kilo-t · pellet /year.

In the case of reactivation of HIPARSA, a total of 11.33Nm^3/sec.will be required for the HBI plant and the Pelletizing plant, which means about 6.5 times the design base of 1.76 Nm^3/sec.for the Pelletizing plant. As the result, it is very difficult to supply the natural gas after reactivation of plants by using the existing 6 inch size pipeline due to piping pressure resistance.

Therefore, erection of the new HBI plant needs an initial investment of US$ 8.8-million for the replacement of 47 km of existing pipeline and valve station. A 12 inch diameter pipeline will replace the 6 inch .

(2) Industrial water supply line

At the present time Industrial water is taken from two springs some distance from the plant and passed through pipelines, making use of the altitude difference of about 400 m. One spring is about 170 km away; about 120 km from HIPARSA in Sierra Grande to La Ventana and about 50 km beyond. The supply capacity is 135,826 m^3/month (52.40 liters/sec.). The other is about 150 km away; about 100 km from HIPARSA to Los Berros and then about 50 km beyond. The supply capacity is 154,154 m^3/month (59.47 liters/sec.).

A reservoir of 30,000 m^3 is currently installed at the mine. To prevent shortage of water due to piping repair work, etc., a natural reservoir (about 6 ha, 350,000m^3) is used.

The water supply capacity is as low as 112 liters/sec. in total.

However in the case of reactivation of HIPARSA the overall demand will be 275 liters/sec. Considering the desired increase in production and possible increase in water consumption in Sierra Grande, it is quite clear that the present water supply sources cannot meet the required future demand. For reactivation of HIPARSA, therefore, securing the necessary quantity of water is very important.

As other water sources, there is a possibility to utilize the canal that runs from Pomana in Rio Negro Province to near San Antonio de Oeste, about 120 km away from Sierra Grande. The water supply is 4,000 liters/sec. and this is sufficient.

(3) Power supply line

The power demand of the second industrial area will be 29.72MW in case of reactivation of HIPARSA. This will cause no problem because the capacity of the power receiving station is 32MW.

The power demand of the first industrial area is conventionally 25.08MW in case of reactivation of HIPARSA. This too will cause no problem because the capacity of the power receiving station is 50MW.

9.2 ROUGH INITIAL INVESTMENT COST ESTIMATION

Rough initial investment cost estimation. Initial investment cost for HIPARSA reactivation is roughly estimated as US$ 219.7-million as shown in **Table-130**. In the table, the cost for additional water supply line and replacement of gas line are included in the total amount, but the cost for environmental assessment and initial make up of chemical agent in concentration plant are not included. (These costs are accounted for in pre-operation cost).

Table-130-1 Initial Investment Cost (1)

Area	Item		Quantity	Unit Cost	Cost	Note
					x 10^6 us$	
Iron ore mine	Mining equipments	(1) Fan drilling jumbo	7	620 x10^3US$	4.3	HL 1000
		(2) L.H.D	9	400 x10^3US$	3.6	4.0 m^3
		(3) Track	10	420 x10^3US$	4.2	20 m^3
		(4) Face drilling jumbo	2	440 x10^3US$	0.9	
		(5) Scaler	3	220 x10^3US$	0.7	
		(6) ANFO charger	3	140 x10^3US$	0.4	
		(7) Multi-carrier	6	130 x10^3US$	0.8	
		(8) Others			0.3	
Total					15.2	
Conc. plant	Pre-conc. plant	Rectification			0.3	
	Conc. plant	(1) Mill modification			1.5	
		(2) Rectification			0.8	
	Pipe line	Rectification			0.1	
Total					2.7	Initial make up of chemical agent
						(0.16 m$ is included in pre-ope.cost)
Pellet plant	Conc. stock yard				2.1	
	Coke addition system				0.4	
	Green pellet circuit				3.6	Roller Screen (2.5), Weigher etc (1.1)
	Index conveyor				1.6	
	Plant rectification				6.0	
Total					13.7	

Table-130-2 Initial Investment Cost (2)

Area	Item		Quantity	Unit Cost	Cost	Note
					x 10^6 us$	
HBI plant	750,000 tpy	C&F + SV			105.0	
		Civil / Erection			36.0	
		Others			6.0	
Total					147.0	FTK base
Natural gas line	Exist. 1.76Nm³/s →11.33Nm³/s		12" ϕ x 47 km	13 $/in-m	7.3	Replace for exist. 6" ϕ pipe
	Others				1.5	
Total					8.8	
Water line	Exist. 112 l/s → 275 l/s		16" ϕ x120 km	14 $/in-m	26.9	
	Others				5.4	
Total					32.3	
						Enviromental assessment cost
						(0.16 m$) is included in pre-ope.cost
G.Total					**219.7**	

9.2.1 Iron ore mine

The main items of initial investment in the iron ore mine are renewal of some mining equipment.

Stope development cost is accounted for in the operation cost, except the initial three years expense, during which HBI production has not started. This is accounted for in pre-operation cost.

9.2.2 Concentration plant

In order to decrease phosphorous content in the magnetite concentrate, the existing process flow shall be modified.

Initial investment in the concentration plant is mainly process modification and equipment replacement cost.

9.2.3 Pelletizing plant

Main items of initial investment in the pelletizing plant are as followings.

(1) Installation of concentrate stockyards

In order to decrease moisture content of balling feed by mixing of stocked concentrate, which has less moisture content, with direct feed and also to reduce pellet plant stoppage due to the shortage of concentrate, concentrate stockyards (capacity 48 kilo-t) shall be newly installed.

(2) Green pellet weigher and roller screen

In order to control furnace operation by the green pellet production rate substitute for concentrate feed rate to the disc, green pellet weighers and related control systems shall be newly installed.

As index conveyors are severely deteriorated, conveyors shall be renewed and the drive system and control system shall be modified.

Further more, to improve green pellet properties, existing vibrating screens shall be replaced to roller screens.

(3) Coke addition system

In order to reduce the input heat rate from the combustion chamber in order to avoid rapid heating of green pellet in the furnace, around 0.5% of sized coke (6 mm～9 mm under size of blast furnaces coke) shall be charged into the furnace mixed with green pellet. The coke addition system shall be newly installed.

(4) Improvement of hot gas ducts

In order to avoid damage of hot gas ducts due to hot gas flowing behind refractories, the structures shall be modified.

9.2.4 HBI plant

Initial investment cost in the HBI plant is estimated on a turnkey cost based on the complete plant in the battery limit, of which production capacity is 750 kilo-t/year, including a control room building.

The cost also includes spare parts and consumable for two years operation. The cost consists of engineering, equipment and materials, training and advisory services, civils works based on a clear and level site, erection, project and construction management, commissioning and start-up.

9.2.5 Utilities

(1) Natural gas supply line

In order to satisfy the required quantity of natural gas (11.33 Nm^3/sec.), a 12" $\phi \times 47$ km gas supply line shall replaced the existing 6" ϕ line.

(2) Industrial water supply line

In order to satisfy the required quantity of water (275 liters/sec.), a 16" $\phi \times 120$ km water supply line shall be newly installed.

9.3 PRODUCTION COST ESTIMATION

Production cost for the rated operation are roughly estimated as **Table-131**.

In this estimation, financial cost (tax, depreciation, interest) is not included.

9.3.1 Iron ore

2,600,000 t/year of iron ore will be produced at Sierra Grande south deposit with 225 employees for 250 days/year (20.8 days/month) operation by 3 shifts per day by 3 crews.

Stope development cost excluding the first three years is accounted for in the operating cost in the manner that total investment after commissioning is evenly spread over the total mineable ore (63 million-t). Namely, total required cost for development after commissioning :

Total cost --- US kilo$ 164,220
Before HBI plant commissioning --- US kilo$ 11,212
(164,220 - 11,212)= US kilo$153,008
Total mineable ore : 63,000 kilo-t
Development cost : 153,008/63,000=US$ 2.429/t

Operating cost in the mine for the rated operation is around US$ 5.88/t including stope development cost (US$ 2.43/t).

Stope development schedule is shown in **Fig.-65**.

9.3.2 Concentrate

1,100,000 t/year of concentrate will be produced from approx. 2,600,000 t/year of iron ore with 61 employees and 7,500 h/year operation by 3 shifts per day by 4 crews.

The production cost of concentrate for the rated operation is around US$ 19.94/t.

9.3.3 Pellet

1,100,000 t/year of pellet will be produced from approx. 1,060,000 t/year of concentrate with 80 employees and 7,500 h/year operation by 3 shifts per day by 4 crews.

The production cost of pellet for the rated operation is around US$ 28.10/t, and this figure is around US$ 6/t higher than the representative production costs in Latin America (excluding financial cost : US$ 21.5/t) mainly due to higher pellet feed cost.

9.3.4 HBI

750,000 t/year of HBI will be produced from approx.1,100,000 t/year of pellet with 85 employees and 7,500 h/year operation by 3 shifts per day by 4 crews.

The production cost of HBI in the rated operation is around US$ 67.58/t. By adding US$ 6.42/t of manpower cost for indirect departments (Administration, Maintenance, Laboratory) HBI production cost is around US$ 74/t.

Table-131-1 Production Cost Estimation-1 (Mining Section) 2,600,000 t/year

Item		Unit	Price	Unit Consump.	Cost	Note
			US$	per ton	US$/t	
Variable	Electricity	kWh	0.033	14.81	0.49	
	Water	m^3	0.21	0.15	0.03	
	Consumable					
	Blasting				0.32	ANFO etc.
	Drilling				0.11	Drill rod,Drill bit, Drill coupling
	Sub total				0.43	
	Ope.cost (main equip.)					
	Movile equipment				0.90	LHD, Track, Jumbo,ANFO charger etc
	Other materials				0.29	
	Stationary equipment				0.11	
	Sub total				1.30	
	Mining tax					(Excluding from the table)
Total VC					2.25	
Fixed	Manning cost	225	12,982		1.12	Average per head cost 12,982 $/y
	Others				0.08	Lease fee, Insurance
	Depreciation					(Excluding from the table)
	Interests etc.					(Excluding from the table)
Total FC.					1.20	
	Stope development cost		153,008,000		2.43	
Total					5.88	

Table-131-2 Production Cost Estimation-2 (Concentration Section) 1,100,000 t/year

Item		Unit	Price	Unit Consump.	Cost	Note
			US$	per ton	US$/t	
Raw Material	Iron Ore	ton	5.88	2.364	13.90	
Variable	Electricity	kWh	0.033	63.5	2.10	Preconc. 1.94, Conc.55.51,Pipe 6.20
	Water	m^3	0.21	1.80	0.38	Preconc. 0.02, Conc. 1.10, Pipe 0.68
	Consumable - 1					
	Steel ball (150 kW)	kg	0.90	0.052	0.05	
	Steel ball (1000 kW)	kg	0.90	0.555	0.50	
	Steel rods	kg	0.80	0.670	0.54	
	Total C-1					
	Consumable - 2					Sodium Carbonate, Sodium Silicate
	Chemicals	kg	0.29	2.05	0.59	Tall Oil, Gas Oil, Sodium Hydro Oxide
	Lubricants	l	1.27	0.033	0.04	Floculanto,Sodium Sulfide
	Greese	l	19.46	0.003	0.06	
	Total C-2					
Total VC.					4.25	
Fixed	Manning cost	61	14,245		0.79	Average per head cost 14,245 $/y
	Spareparts				1.00	
	Depreciation					(Excluding from the table)
	Interest					(Excluding from the table)
	Other Finance Cost					
Total FC.					1.79	
Total					19.94	

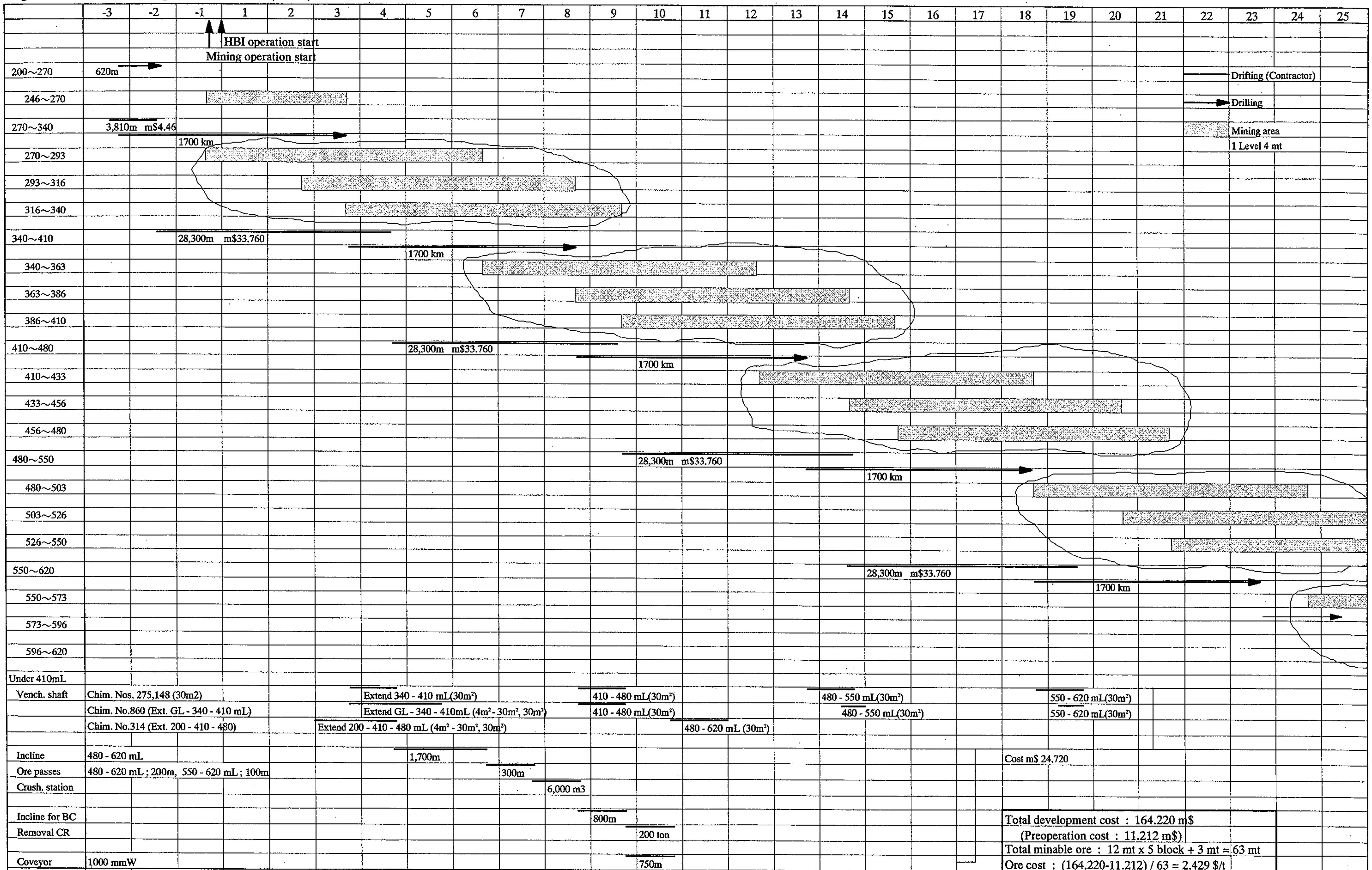
Table-131-3 Production Cost Estimation-3 (Pelletizing Section) 1,100,000 t/year

Item		Unit	Price	Unit Consump.	Cost	Note
			US$	per ton	US$/t	
Raw Material	Mag. Concentrate	ton	19.94	0.965	19.24	
	Limestone	ton				
	Dolomite	ton				
	Bentonite	kg	0.048	10	0.48	
	Others					
Total R.M.					19.72	
Variable	Electricity	kWh	0.033	73	2.41	
	Natural Gas	Nm^3	0.0497	15	0.75	
	Coke breeze	kg	0.08	6	0.48	
	Water	m^3	0.21	0.3	0.06	
	Cosumable - 1					
	Screen plate					
	Filter cloth					
	Total C - 1				1.00	
	Other Cosumable				0.50	
Total VC.					5.20	
Fixed	Manning cost	80	13,061.3		0.95	Average per head cost 13,061.3 $/y
	Maintenance				2.00	
	Refractories				0.23	
	Depreciation					(Excluding from the table)
	Interests etc.					(Excluding from the table)
	Other Finance Cost					
Total FC.					3.18	
Total					28.10	
Common	Mainte/Admin/Labo staff					

Table-131-4 Production Cost Estimation-4 (HBI Section) 750,000 t/year

Item		Unit	Price	Unit Consump.	Cost	Note
			US$	per ton	US$/t	
Raw Material	Pellet	ton	28.10	1.45	40.75	
	Remet					
	Chips etc.					
Total RM.					40.75	
Variable	Electricity	kWh	0.033	130	4.29	
	Natural Gas	Nm^3	0.0497	295	14.66	
	Coal	ton				
	Water	m^3	0.21	0.5	0.11	
	Consumable				2.30	Segment, Screen plate etc.
Total VC.					21.36	
Fixed	Manning cost	85	13,006.0		1.47	Average per head cost 13,006.0 $/y
	Spareparts					
	Refractories				4.0	
	Depreciation					(Excluding from the table)
	Interests etc.					(Excluding from the table)
Total FC.					5.47	
Total					67.58	
Common	Mainte/Admin/Labo staff	305	15,793		6.42	
	Water line --- Depre.					(Excluding from the table)
	--- Finance					(Excluding from the table)
	Gas line --- Depre.					(Excluding from the table)
	--- Finance					(Excluding from the table)
HBI Cost					74.00	

Figure-65 Mine development schedule (Final)



Cost (m$)	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 (Total)
	Preoperation cost			Ore cost																								Total
Drifting	2.230	2.230	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752	6.752						139.500
410 mL under	0	0	0	0	0	0.780	3.410	3.065	1.975	0.570	2.420	2.810	6.010	0.640	0.320	0	1.360	0	0	0	0	1.360						24.720
Total	2.230	2.230	6.752	6.752	6.752	7.532	10.162	9.817	8.727	7.322	9.172	9.562	12.762	7.392	7.072	6.752	8.112	6.752	6.752	6.752	6.752	8.112						164.220

9.4 REACTIVATION SCHEDULE

An approximate schedule (program) for HIPARSA reactivation project is shown in **Fig-66**.

In the figure, the HBI plant commissioning year is shown as the 1st year. Production of HBI shall be able to start from 31 months after the contract becomes effective.

Considering the pellet storage capacity and the learning curve of the plants, pellet plant operation shall be started 3 months before HBI plant commissioning.

Mine and concentration plant shall commence operation 1 month and half a month before the pellet plant commissioning respectively. Each plant will reach rated capacity production in 13 months after the HBI plant commissioning.

Stock of iron ore, concentrate and pellet are around 90 kilo-t, 50 kilo-t and 70 kilo-t respectively in a normal operation condition.

Figure-66 Reactivation Schedule (1/2)

General (Year -4 to Year 4, by month)

Spec.definition	Year -4, month 7 – Year -3, month 1
Fund and tender approval	Year -3, month 1 – month 7
Effective date	Year -3, month 7
Mine development start	Year -3, month 7
Rectification and modification	Year -3, month 11 – Year -1, month 7
HBI plant construction start	Year -3, month 7
Training start	Year -1, month 3
Mining operation start	Year -1, month 9
Conc. operation start	Year -1, month 9
Pellet operation start	Year -1, month 9
HBI operation start	Year 1, month 1

Production (kt/m)

	Y-1 M9	Y-1 M11	Y1 M1	Y1 M3	Y1 M5	Y1 M7	Y1 M9	Y2 M1	Y2 M5	Y3 M5	Y4 M3
Iron ore mine	115				130	145	180	216			
Yearly production	460 kt/y				1,695 kt/y				2,600 kt/y	2,600 kt/y	2,600 kt/y
Conc. plant	25	45			55	62	77	92			
Yearly production	160 kt/y				707 kt/y				1,100 kt/y	1,100 kt/y	1,100 kt/y
Pellet plant	31	39	47	55		62	77	92			
Yearly production	101 kt/y				715 kt/y				1,100 kt/y	1,100 kt/y	1,100 kt/y
HBI plant			26.5	37.5		47.5	58.5	62.5			
Yearly production					510 kt/y				750 kt/y	750 kt/y	750 kt/y

Recruiting Schedule

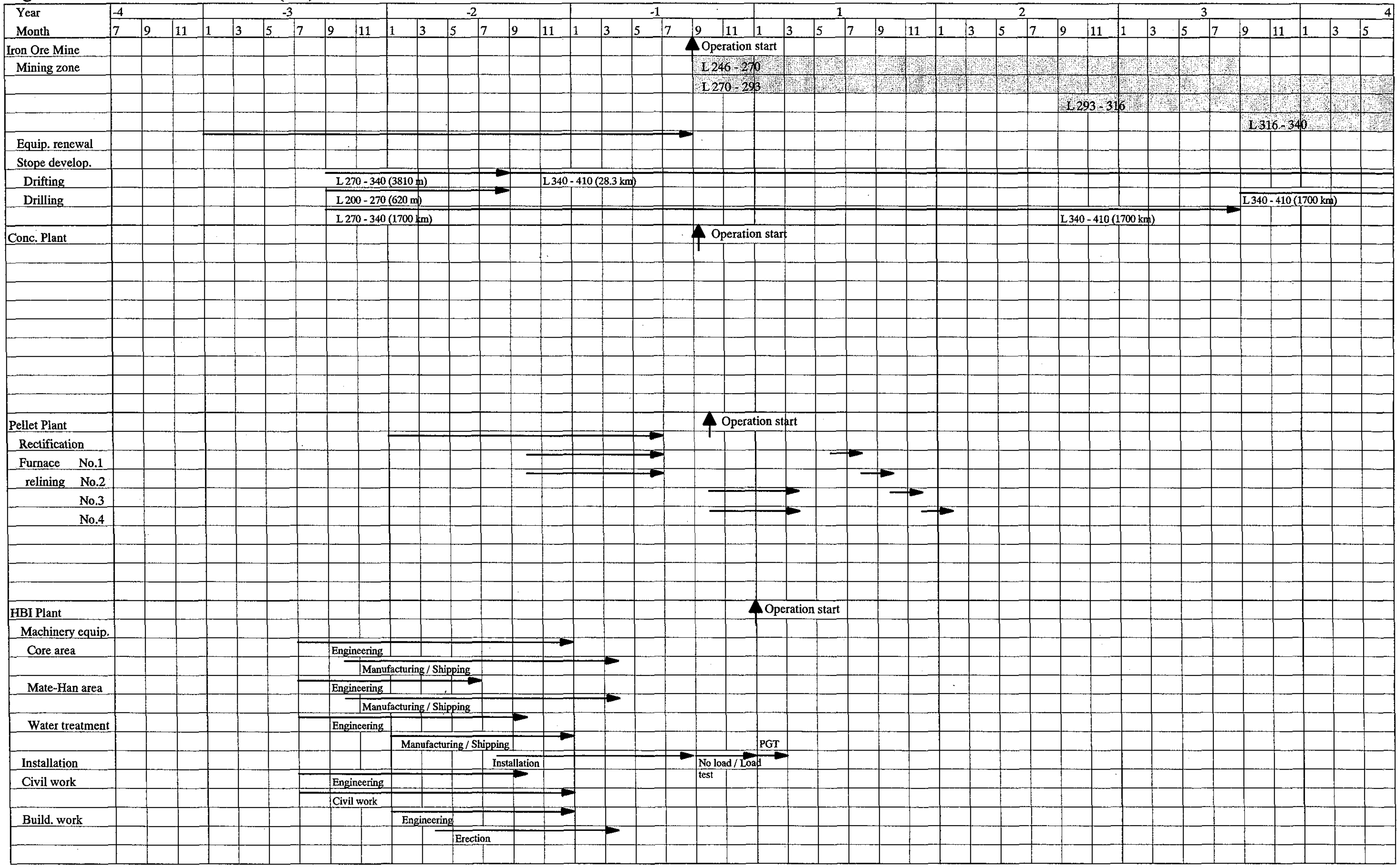
Note:Excluding of stope development contractor and system operation contractor

	Y-4 M7 (Planning staff)	Y-3 M7 (Construction staff)	Y-1 M1 (Trainer/Core staff)	Y-1 M3–M5	Y-1 M7	Y-1 M9	Y1 M1
Iron ore mine	9	15	5		196	0	0
(Cumulative)	9	24	29		225	225	225
Conc. plant	3	5	3		45	5	0
(Cumulative)	3	8	11		56	61	61
Pellet plant	3	4	9	Tr'g at a plant	49	15	0
(Cumulative)	3	7	16		65	80	80
HBI plant	2	6	9	Tr'g at a plant	33	20	15
(Cumulative)	2	8	17		50	70	85
Labo.	0	3	6		10	11	0
(Cumulative)	0	3	9		19	30	30
Mecha. mainte	2	10	1		26	56	0
(Cumulative)	2	12	13		39	95	95
E / I mainte.	1	7	5		22	56	0
(Cumulative)	1	8	13		35	18	53
Planning.	4	18	0		7	0	0
(Cumulative)	4	22	22		29	29	29
Administration	3	20	2		35	17	13
(Cumulative)	3	23	25		60	77	90
Management	6	0	0		2	0	0
(Cumulative)	6	6	6		8	8	8
Total	33	88	40		425	180	28
(Cumulative)	33	121	161		586	693	756

Utility

Water line	Construction: Year -2, month 5 – Year -1, month 7
Gas line	Construction: Year -1, month 5 – month 11

Figure-66 Reactivation Schedule (2/2)



9.4.1 Annual requirement and costs for raw materials and utilities

Based on the reactivation schedule (program) shown in **Fig.-66**, annual requirement and costs for raw materials and utilities is shown in **Table-132**.

Table-132 Annual Requirement for Raw Materials and Utilities

Year		Iron ore mine				Conc.plant				Pellet plant						HBI				Total							
		Raw mate.	Utilities			Raw mate.	Utilities			Raw mate.			Utilities			Raw mate.	Utilities			Raw materials					Utilities		
			Elec.	N.Gas	Water	Ore	Elec.	N.Gas	Water	Conc.	Coke	Bento.	Elec.	N.Gas	Water	Pellet	Elec.	N.Gas	Water	Ore	Conc.	Pellet	Coke	Bento.	Elec.	N.Gas	Water
			kWh	Nm³	m³	ton	kWh	Nm³	m³	ton	kg	kg	kWh	Nm³	m³	ton	kWh	Nm³	m³	ton	ton	ton	kg	kg	kWh	Nm³	m³
-1	Production (kilo-t)	460				160				101						0											
	Unit consump. (U/t)		14.81	—	0.15	2.364	63.5	—	1.80	0.97	6	10	73	15	0.3	1.45	130	295	0.5	—	—	—	—	—	—	—	—
	Yearly consump. (x10^3 U/year)		6,813	—	69	378	10,160	—	288	98.0	606	1,010	7,373	1,515	30.3	0	0	0	0	378	98.0	0.0	606	1,010	24,346	1,515	387
	Unit cost (us$/U)		0.033	0.0497	0.21	7.880	0.033	0.0497	0.21	23.59	0.08	0.048	0.033	0.0497	0.21		0.033	0.0497	0.21				0.08	0.048	0.033	0.0497	0.21
	Cost (x10^3 US$/year)		225	—	14.5	2,981	335	—	60.5	2,311	48.5	48.5	243	75	6.4		0	0	0				48.5	48.5	803.4	75.3	81.3
1	Production (kilo-t)	1,695				707				715						510											
	Unit consump. (U/t)		14.81	—	0.15	2.364	63.5	—	1.80	0.97	6	10	73	15	0.3	1.45	130	295	0.5	—	—	—	—	—	—	—	—
	Yearly consump. (x10^3 U/year)		25,103	—	254	1,671	44,895	—	1,273	693.6	4,290	7,150	52,195	10,725	215	740	66,300	150,450	255	1,671	693.6	740	4,290	7,150	188,492	161,175	1,996
	Unit cost (us$/U)		0.033	0.0497	0.21		0.033	0.0497	0.21		0.08	0.048	0.033	0.0497	0.21		0.033	0.0497	0.21				0.08	0.048	0.033	0.0497	0.21
	Cost (x10^3 US$/year)		828	—	53.4		1,482	—	267.2		343.2	343.2	1,722	533	45.0		2,188	7,477	53.6				343.2	343.2	6,220.3	8,010.4	419.2
2 & On	Production (kt)	2,600				1,100				1,100						750											
	Unit consump. (U/t)		14.81	—	0.15	2.364	63.5	—	1.80	0.97	6	10	73	15	0.3	1.45	130	295	0.5	—	—	—	—	—	—	—	—
	Yearly consump. (x10^3 U/year)		38,506	—	390	2,600	69,850	—	1,980	1,067	6,600	11,000	80,300	16,500	330	1,088	97,500	221,250	375	2,600	1,067	1,088	6,600	11,000	285,156	237,750	3,075
	Unit cost (us$/U)		0.033	0.0497	0.21		0.033	0.0497	0.21		0.08	0.048	0.033	0.0497	0.21		0.033	0.0497	0.21				0.08	0.048	0.033	0.0497	0.21
	Cost (x10^3 US$/year)		1,271	—	81.9		2,305	—	415.8		528.0	528.0	2,650	820	69.3		3,218	10,996	78.8				528.0	528.0	9,443.1	11,816.2	645.8

9.4.2 Manpower requirement for operation

(1) Manpower allocation

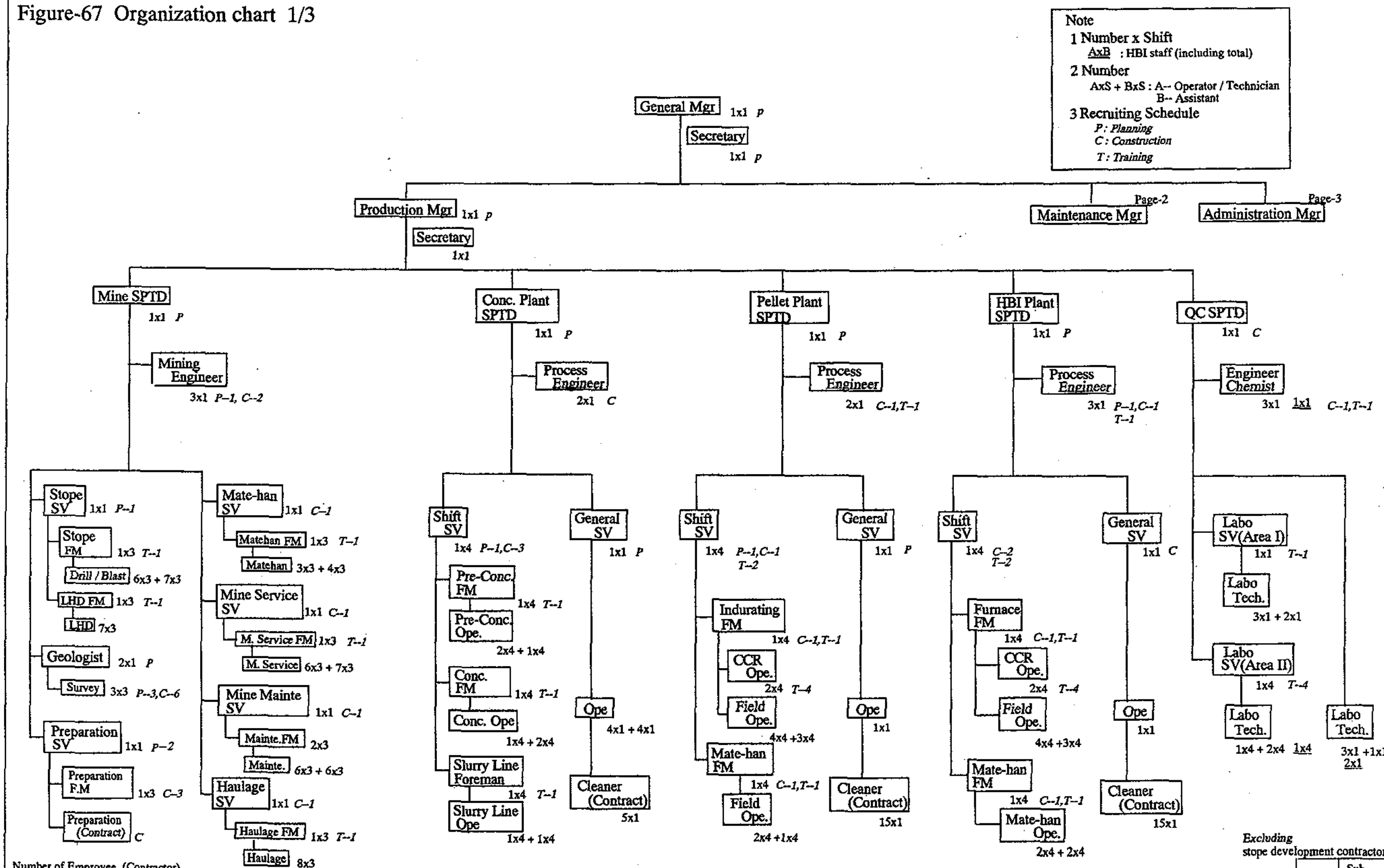
The organization and manpower allocation is shown in **Fig.-67** and **Table-133**.

Total employee, excluding stope development contractor in mining section and system operating contractor in the company, is 756.

Stope development in iron ore mine, system operation of the company, cleaning in the pellet plant, HBI plant and main office shall be carried out by contractors.

Maintenance work of the plant is centralized in the maintenance department except in the iron ore mine which has a maintenance group.

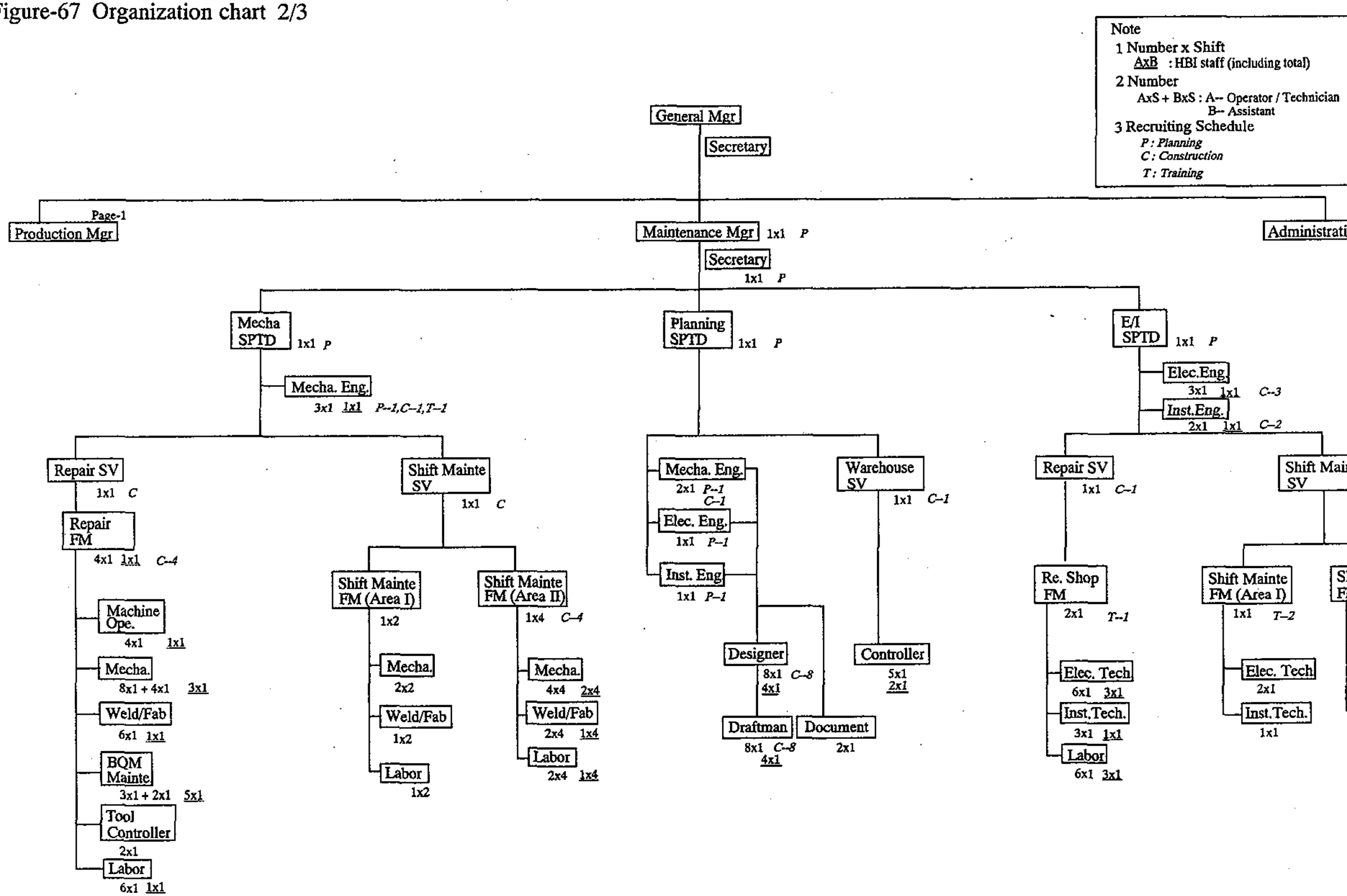
Figure-67 Organization chart 1/3



Number of Empoyee (Contractor)

						Others	Sub Total
Exist. Plant	71x3 12x1 225+ (Development)	12x4 12x1 60 + (5)	15 x 4 5x1 65 + (15)		3 x 4 11x 1 23	4	377 (20)
HBI Plant				16 x 4 6 x 1 70 + (15)	1 x 4 3 x 1 7		77+ (15)
Total	225 + (Development)	60 + (5)	65 + (15)	70 + (15)	30	4	454+ (35)

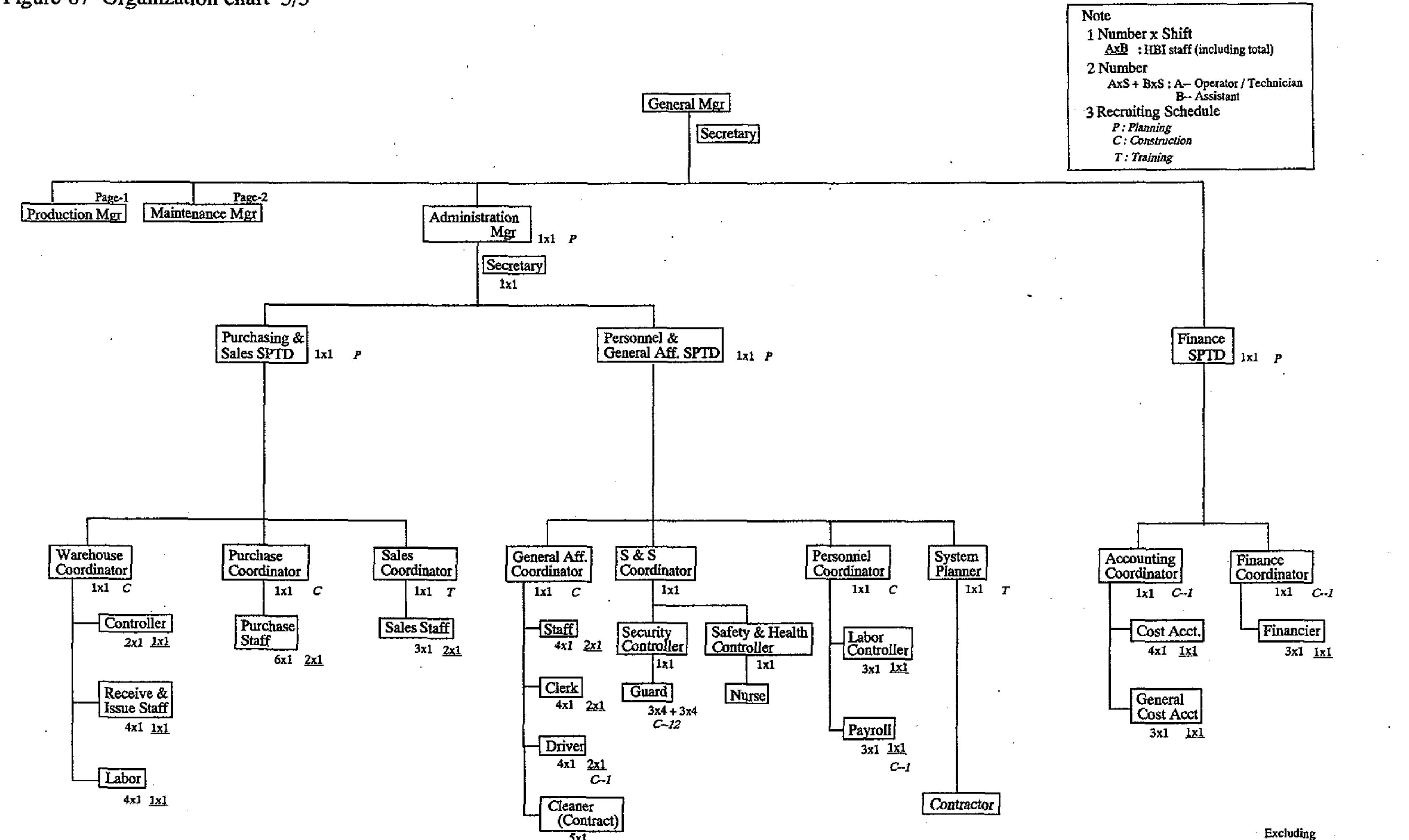
Figure-67 Organization chart 2/3



Number of Emproyee (Contractor)

				Others	Sub Total
Exist. Plant	5x4 + 5x2 32 x 1 62	19 x 1 19	3 x 4 20 x 1 32	2	115
HBI Plant	4 x 4 13 x 1 29	10 x 1 10	3 x 4 9 x 1 21		60
Total	91	29	53	2	175

Figure-67 Organization chart 3/3



Excluding
- stope development contractor
- system operation contractor

Number of Employee (Contractor)

									Others	Sub Total	Total
Exist. Plant	16 x 1	16	6 x 4 17x 1	41 + (5)	10 x 1	10	2	67+ (5)	561+(25)
HBI Plant	7 x 1	7	8 x 1	8	3 x 1	3		18	155+ (15)
Total		23		49 + ( )		13	2	85+ (5)	716+(40)

Table-133 Manpower Allocation

	Senior Manager	Manager	Super Intendent	Engineer	Super visor	Foreman	Operator Tech'n	Assistant	Senior Secretary	Secretary	Cleaner (Contractor)	Driver	Total
General	1								1				2
Admin.dept.													
Management		1								1			2
Personel &			1		3	6	19	16			5	4	54
General Affairs sect.													
Purchase &			1		3		15	4					23
Sales sect.													
Financial sect.			1		2		10						13
Admin.dept. Total		1	3		8	6	44	20		1	5	4	92
Production dept.													
Management		1								1			2
Mining sect.			1	5	6	24	117	72					225
Concentration sect.			1	2	5	12	20	20			5		65
Pelletizing sect.			1	2	5	8	33	16			15		80
HBI sect.			1	3	5	8	33	20			15		85
Labo. sect.			1	3	5		10	11					30
Product. dept. Total		1	5	15	26	52	213	139		1	35		487
Maintenance dept.													
Management		1								1			2
Mecha. mainte.sect.			1	3	2	10	53	22					91
E/I mainte.sect.			1	5	2	7	32	6					53
Planning sect			1	4	9		15						29
Mainte. dept. Total		1	3	12	13	17	100	28		1			175
Grand Total	1	3	11	27	47	75	357	187	1	3	40	4	756

Note: Excluding of stope development contractor and system operation contractor.

(2) Recruitment schedule

A recruitment schedule is also shown in **Fig.-66**. In order to consider the recruitment schedule, all staff is roughly divided into planning staff, construction staff, trainer/core staff, operator/technician and assistant staff, and each staffing is planned to recruit at the most effective time.

Core operators of the pellet plant and HBI plant will be recommended to a have training period in an operating plant for 2 to 3 months.

At least 4 CCR operators and 4 furnace operators in the pellet plant, and 4 CCR operators, 4 furnace operators and 4 reformer operators in the HBI plant shall have to take this outside training course.

(3) Annual man-power cost for operating years

Table-134 shows annual man-power cost for operating years. The per head cost is estimated as follows;-

① Senior manager -- US$ 100,000 /year
② Manager -- US$ 75,100 /year (Category "G")
③ Superintendent -- US$ 48,000 /year (Category "J") Engineer,
④ Supervisor -- US$ 26,200 /year (Category "S1+S2+S3")
⑤ Foreman -- US$ 19,500 /year
⑥ Operator, Technician -- US$ 12,800 /year (Category"I +C + OE")
⑦ Assistant staff -- US$ 8,600 /year (Category "O+O/2+A")
⑧ Cleaner -- US$ 6,500 /year

* Category is suggested by JICA Minutes of Meeting dated July 31,1998

Labour cost is estimated at US$ 13,067,600 for 4 years of preparation periods and US$ 10,760,500 /year for a normal operation year.

Table-134 Annual Manpower Cost (1/3)

Year		-4		-3				-2				-1								1	
Month		7	12	1	6	7	12	1	6	7	12	1	3	4	6	7	9	10	12	1	12
	U.cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/6M)	Num -ber	Cost (k$/6M)	Num -ber	Cost (k$/6M)	Num -ber	Cost (k$/6M)	Num -ber	Cost (k$/3M)	Num -ber	Cost (k$/3M)	Num -ber	Cost (k$/3M)	Num -ber	Cost (k$/3M)	Num -ber	Cost (k$/year)
Production dept.																					
Mining sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	5	65.5	5	65.5	11	144.1	11	144.1	11	144.1	11	72.1	11	72.1	11	72.1	11	72.1	11	288.2
FM	19.5	0	0	0	0	3	29.3	3	29.3	3	29.3	8	39.0	8	39.0	24	117.0	24	117.0	24	468.0
Ope. Tech.	12.8	3	38.4	3	19	9	57.6	9	57.6	9	57.6	9	28.8	9	28.8	117	374.4	117	374.4	117	1,497.6
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72	154.8	72	154.8	72	619.2
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		9	127.9	9	108.7	24	255.0	24	255.0	24	255.0	29	151.9	29	151.9	225	730.3	225	730.3	225	2,921.0
Concentration sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	2	26.2	2	26.2	7	91.7	7	91.7	7	91.7	7	45.9	7	45.9	7	45.9	7	45.9	7	183.4
FM	19.5	0	0	0	0	0	0	0	0	0	0	3	14.6	3	14.6	12	58.5	12	58.5	12	234.0
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	64.0	20	64.0	20	256.0
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	43.0	20	43.0	20	172.0
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5	8.1	5	32.5
Total		3	50.2	3	50.2	8	115.7	8	115.7	8	115.7	11	72.5	11	72.5	60	223.4	65	231.5	65	925.9
Pelletizing sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	2	26.2	2	26.2	4	52.4	4	52.4	4	52.4	7	45.9	7	45.9	7	45.9	7	45.9	7	183.4
FM	19.5	0	0	0	0	2	19.5	2	19.5	2	19.5	8	39.0	8	39.0	8	39.0	8	39.0	8	156.0
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	33	105.6	33	105.6	33	422.4
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	16	34.4	16	34.4	16	137.6
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	24.4	15	97.5
Total		3	50.2	3	50.2	7	95.9	7	95.9	7	95.9	16	96.9	16	96.9	65	236.9	80	261.2	80	1,044.9
HBI sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	1	26.2	1	13.1	5	65.5	5	65.5	5	65.5	8	52.4	8	52.4	8	52.4	8	52.4	8	209.6
FM	19.5	0	0	0	0.0	2	19.5	2	19.5	2	19.5	4	19.5	4	19.5	8	39.0	8	39.0	8	156.0
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	4	12.8	4	12.8	33	105.6	33	105.6	33	422.4
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	20	43.0	20	172.0
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	15	97.5
Total		2	50.2	2	37.1	8	109.0	8	109.0	8	109.0	17	96.7	17	96.7	50	209.0	70	252.0	85	1,105.5
Labo. sect.																					
SPTD	48.0	0	0	0	0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	0	0	0	0	2	26.2	2	26.2	2	26.2	8	52.4	8	52.4	8	52.4	8	52.4	8	209.6
FM	19.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	10	32.0	10	32.0	10	128.0
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	11	23.7	11	94.6
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	3	50.2	3	50.2	3	50.2	9	64.4	9	64.4	19	96.4	30	120.1	30	480.2
Production MGR	75.1	1	37.6	1	37.6	1	37.6	1	37.6	1	37.6	1	18.8	1	18.8	1	18.8	1	18.8	1	75.1
Secretary	11.4	0	0	0	0	0	0	0	0	0	0	1	2.9	1	2.9	1	2.9	1	2.9	1	11.4
Product. dept.TTL		18	316.1	18	283.8	51	663.3	51	663.3	51	663.3	84	0,503.9	84	0,503.9	421	1,517.5	472	1,616.6	487	6,564.0

Table-134 Annual Manpower Cost (2/3)

Year		-4		-3				-2				-1								1	
Month		7	12	1	6	7	12	1	6	7	12	1	3	4	6	7	9	10	12	1	12
	U.cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)	Num -ber	Cost (k$/year)
Maintenance dept.																					
Mecha.mainte.sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	1	26.2	1	13	3	39.3	3	39.3	3	39.3	4	26.2	4	26.2	5	32.8	5	32.8	5	131.0
FM	19.5	0	0	0	0	8	78.0	8	78.0	8	78.0	8	39.0	8	39.0	8	39.0	10	48.8	10	195.0
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	25	80.0	53	169.6	53	678.4
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	22	47.3	22	189.2
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		2	50.2	2	37.1	12	141.3	12	141.3	12	141.3	13	77.2	13	77.2	39	163.8	91	310.4	91	1,241.6
E/I mainte.sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	0	0	0	0.0	7	91.7	7	91.7	7	91.7	7	45.9	7	45.9	7	45.9	7	45.9	7	183.4
FM	19.5	0	0	0	0	0	0	0	0.0	0	0.0	5	24.4	5	24.4	7	34.1	7	34.1	7	136.5
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	20	64.0	32	102.4	32	409.6
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	12.9	6	51.6
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total		1	24.0	1	24.0	8	115.7	8	115.7	8	115.7	13	82.2	13	82.2	35	156.0	53	207.3	53	0,829.1
Planning sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	3	78.6	3	39.3	13	170.3	13	170.3	13	170.3	13	85.2	13	85.2	13	85.2	13	85.2	13	340.6
FM	19.5	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ope. Tech.	12.8	0	0	0	0	8	51.2	8	51.2	8	51.2	8	25.6	8	25.6	15	48.0	15	48.0	15	192.0
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total		4	102.6	4	63.3	22	245.5	22	245.5	22	245.5	22	122.8	22	122.8	29	145.2	29	145.2	29	580.6
Mainte.dept.MGR	75.1	1	37.6	1	37.6	1	37.6	1	37.6	1	37.6	1	18.8	1	18.8	1	18.8	1	18.8	1	75.1
Secretary	11.4	1	5.7	1	5.7	1	5.7	1	5.7	1	5.7	1	2.9	1	2.9	1	2.9	1	2.9	1	11.4
Mainte. dept. TTL		9	220.1	9	167.7	44	545.8	44	545.75	44	545.8	50	303.8	50	303.8	105	486.5	175	684.45	175	2,737.8

Table-134 Annual Manpower Cost (3/3)

Year		-4		-3				-2				-1								1	
Month		7	12	1	6	7	12	1	6	7	12	1	3	4	6	7	9	10	12	1	12
	U.cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)	Num -ber	Cost (k$/y)
Administration dept.																					
Pers.&Gen.af. sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	0	0	2	26.2	2	26.2	2	26.2	2	26.2	3	19.65	3	19.65	3	19.65	3	19.7	3	78.6
FM	19.5	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	6	29.3	6	29.3	6	117.0
Ope. Tech.	12.8	0	0	13	83.2	13	83.2	13	83.2	13	83.2	13	41.6	13	41.6	19	60.8	19	60.8	19	243.2
Assist.	8.6	0	0	1	4.3	1	4.3	1	4.3	1	4.3	1	2.2	1	2.2	1	2.15	10	21.5	20	172.0
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total		1	24.0	17	137.7	17	137.7	17	137.7	17	137.7	18	75.4	18	75.4	30	123.9	39	143.2	49	658.8
P'chase.& Sales sect.																					
SPTD.	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	0	0	2	26.2	2	26.2	2	26.2	2	26.2	3	19.7	3	19.7	3	19.7	3	19.7	3	78.6
FM	19.5	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	8	25.6	15	48.0	15	192.0
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4	34.4
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total		1	24.0	3	50.2	3	50.2	3	50.2	3	50.2	4	31.7	4	31.65	12	57.3	19	79.7	23	353.0
Financial sect.																					
SPTD	48.0	1	24.0	1	24.0	1	24.0	1	24.0	1	24.0	1	12.0	1	12.0	1	12.0	1	12.0	1	48.0
SV / Engineer	26.2	0	0	2	26.2	2	26.2	2	26.2	2	26.2	2	13.1	2	13.1	2	13.1	2	13.1	2	52.4
FM	19.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Ope. Tech.	12.8	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	10	32.0	10	32.0	10	128.0
Assist.	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Cleaner(Contractor	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total		1	24.0	3	50.2	3	50.2	3	50.2	3	50.2	3	25.1	3	25.1	13	57.1	13	57.1	13	228.4
Admin.dept.MGR	75.1	1	37.6	1	37.6	1	37.6	1	37.6	1	37.6	1	18.8	1	18.8	1	18.8	1	18.8	1	75.1
Secretary	11.4	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	1	2.9	1	2.9	1	11.4
Cleaner(Contractor)	6.5	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.0	5	8.1	5	8.1	5	32.5
Admin. dept. TTL		4	109.6	24	275.7	24	275.7	24	275.7	24	275.65	26	150.9	26	150.9	62	268.0	78	309.7	92	1,359.2
General Manager	100.0	1	50.0	1	50.0	1	50.0	1	50.0	1	50.0	1	25.0	1	25.0	1	25.0	1	25.0	1	100.0
Senior secretary	16.3	1	8.2	1	8.2	1	8.2	1	8.2	1	8.2	1	4.1	1	4.1	1	4.1	1	4.1	1	16.3
Grand Total		33	703.8	53	785.2	121	1,542.9	121	1,542.9	121	1,542.9	162	0,987.7	162	0,987.7	590	2,301.0	727	2,639.9	756	10,777.3
Areawise average																					
Mining																		225	2,921.0		12,982.2
Conc.plant																		65	925.9		14,244.6
Pellet plant																		80	1,044.9		13,061.3
HBI plant																		85	1,105.5		13,005.9
Labo.																		30	480.2		
Maintenance																		179	2,774.7		
Administration																		92	1,359.2		
GM/Prod.manage.																		4	202.8		
Common total																	Common	305	4,816.9		15,793.1

9.5 ENVIRONMENTAL IMPACT ASSESSMENT

Environmental maintenance in the mining andproduction industry activities has speed up in Argentina, and the applicable law with regard to it is being enforced. The mining and production industry activities on this project are restricted by the environmental law (No. 24,585) for mining.

At the time of re-activation of this project, HIPARSA only has to submit an investigation report "Environmental Impact Assessment" combining the the newly constructed factory (HBI) and the three existing plant and equipment (mine, mineral dressing and slurry transportation, and pellet).

Legal controls of the environmental standards for atmosphere, industrial waste, and the noise, etc. is not established but water quality and drainage do have environmental standards which are maintained in Rio Negro Province. Therefore, it will be necessary to refer to an average world standard value for items for which a standard value is not yet enacted.

9.5.1 Conditions for the investigation concerning the Environmental Impact Assessment

(1) On his project, it is necessary to submit an Environmental Impact Assessment's investigation report. Moreover, the report can be collectively submitted covering every process of the factory.

(2) The investigation of the Environmental Impact Assessment should be carried out individually for the next three steps.

-Phase 1

The existing environment is investigated and analyzed.

-Phase 2

Investigation and analyses of the soil and the water quality, etc. and environmental measures to be taken into consideration is executed.

-Phase 3

Investigation of environmental impact assessment after operation restarts is considered.

When the investigation of Phase 1 and Phase 2 have been completed, the cost and time required to make Environmental impact assessment's investigation report are outlined below;

① cost: Max. US$ 160,000.

② days: Max. 120 day.

(3) The follow up improvement investigation Phase 3 after the operation of factories re-starts is not included at this stage.

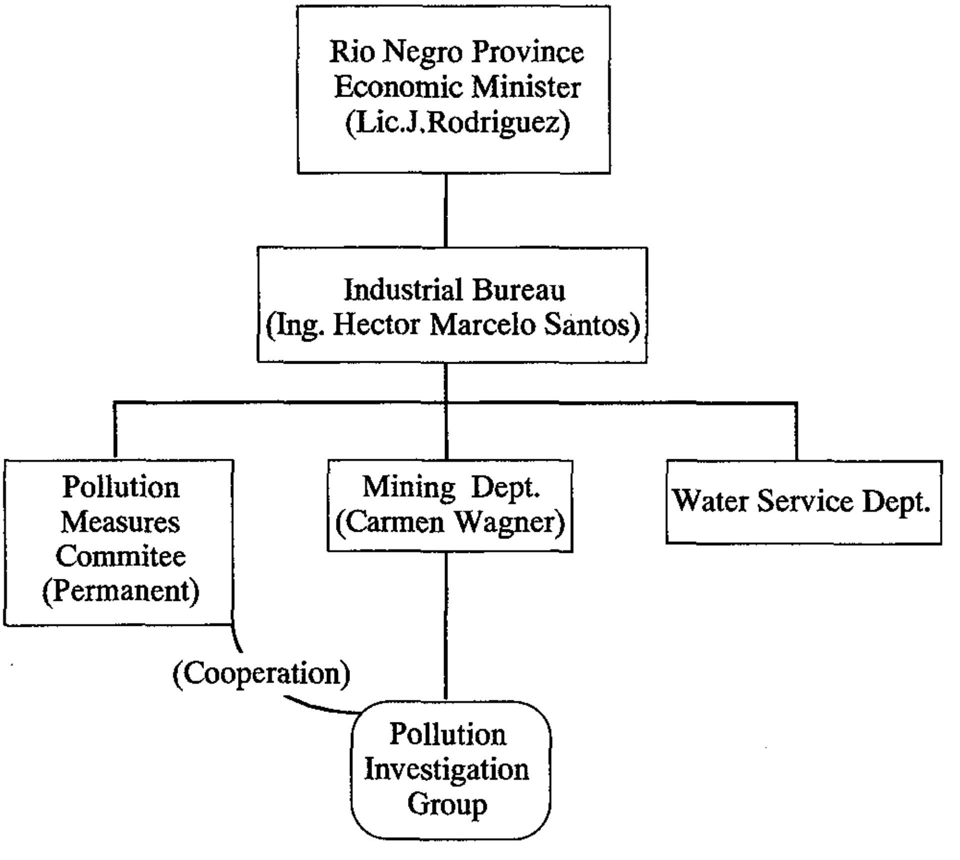
9.5.2 Conditions related to environmental protection

When JICA was fully investigated in 1984 (The phosphoric acid fertilizer plan investigation of Argentina: report August, 1984), Feasibility Study (F/S) in which phosphoric acid mineral was concentrated from non-magnetic tails floatation tails and phosphoric acid fertilizerproduced was executed. The possibility of the effective use for the solid waste was shown as a result.

9.5.3 Jurisdiction governing Environmental Impact Assessments

The industrial bureau mining part of Rio Negro Provincial Government has jurisdiction over the Environmental impact assessments. The organization is shown in **Fig.-68**.

Fig.-68 Organization which governs environmental issues of Rio Negro Provincial Government



9.5.4 Use of environmental data for assessment of this case

After HIPASAM had shutdown, they carried out an investigation of the Environmental Impact Assessment for the first time.

The data measured after HIPASAM had shut down sets an environmental standard for the investigation of EIA in the future.

The evaluation of the water quality is the most important point in the EIA investigation of Area I and Area II where the factory of HIPARSA exists judging from the following natural features.

① In this region, it is always windy, and there are a lot of dust.
② The solid waste is of an abolition stone nature.
③ Drainage in Area I remains in Laguna Blanca and is of the closed system. Moreover, housing does not exist in the vicinity.
④ In Area Ⅱ, the drainage of dehydrated slurry is saved in the pond, and the clarified liquid is discharged into the sea.

(1) Water quality

It is confirmed that the measurement value for Area I, and is more or less the Maximum Permissible Limit (This numerical value is very severe for Area I) which the Federation Government imposes.

Dehydrated water and its drainage is saved in the pond in Area II where the pellet factory exists. Moreover, some of the clear liquid is discharged into the sea. Therefore, it is necessary to clarify the Maximum Permissible Limit of "To rain conduit or water course" which is a severer standard in this case. Additionally, it is necessary to pay attention to the heavy metal ion, pH of the liquid, and phenol.

(2) Tailing disposal

Tailing separated by mineral processing the abolition stone, which is the natural rock excavated from Area I, piled up in Laguna Negro. Their solids do not go out outside because Laguna Negro is a closed system.

Therefore, it is thought that the numerical value measured when HIPASAM is closed is an environmental standard, and is sufficient enough to evaluate the EIA.

(3) Air pollution.

Data concerning air pollution does not exist at all. In Area II, NOx, SOx, and CO gas exhausted when burning should give the combustion method and the gas processing which should not exceed the standard value.

The distinction with flying sand is not pounded easily from the particulate matter (PM) because this region is very windy.

Chapter 10

SALES PROGRAM

10.1 MARKET AND VOLUME OF HBI SALES

The estimation of the annual HIPARSA HBI sales are planned as **Table-142**.

Table-142 Annual HBI sales plan

(kilo-t)

Domestic market		
ACINADAR	250	
ACERO BRAGADO	120	
ACERO ZAPLA	25	
SIDERCA	100	
SIDERAR	50	
Total Argentina		545
Export market		
Brazil	205	
Total Brazil		205
Grand Total		750

First priority for sales is the domestic market at 545,000 t/year and the balance to be for export (for Brazil), because net income for the domestic market is better than for export at FOB Punta Colorada (not considered Patagonia export rebate system).

HBI is consumed as;

① substitute for scrap at EAF
:ACINDAR, ZAPLA, ACERO BRAGADO, SIDERCA, Brazilian mills
② substitute for pig iron:ZAPLA, Brazilian mills
③ new demand (higher productivity at BOF):SIDERAR, Brazilian mills

Due to the limitation of charcoal pig iron supply in Brazil in the future, the Brazilian market will have sufficient capacity to absorb any quantity of HIPARSA HBI.

At present the Brazilian market is more feasible than the USA market in incentives for import tax and payment terms, as long as the Mercosur Agreement exists.

10.2 SELLING PRICE OF HBI

(1) Forecast average HBI price

Considering HBI market price in USA for this year, average of HIPARSA HBI sales price (CIF or delivered) is forecast as US$ 138/t.

(2) Freight from Punta Colorada to each client

Table-144 shows freight cost from Punta Colorada to each client.

Table-144 Estimated freight

Clients	CIF/Delivered	Freight	FOB Punta Colorada
ACINDAR	138/t	11/t by sea	US$ 127 /t
ACERO BRAGADO	144/t	17/t by truck	US$ 127 /t
ACERO ZAPLA	144/t	17/t by sea/railway	US$ 127 /t
SIDERAR	138/t	11/t by sea	US$ 127 /t
SIDERCA	138/t	11/t by sea	US$ 127 /t
Brazil	138/t	12/t by sea	US$ 126 /t
USA(Gulf)	138/t	20/t by sea	US$ 118 /t

- Due to inland truck transportation (BRAGADO) and vessel/railway combined transportation (ZAPLA), HBI sales price for both companies have been based on FOB Punta Colorada US$ 127/t.
- If it is available to consider Mercosur tax incentive, selling price of HBI for Brazil it may be able to apply 5% higher than the market price, of which import cost is equivalent to it from outside of Mercosur.
- Ocean freight from Punta Colorada to USA(Gulf) is approx. US$ 20 /t.

(3) Total annual sales amount of HIPARSA HBI (FOB Punta Colorada)

Table-145 Estimated annual sales

Domestic market	545 kilo-t×US$ 127/t	= US$ 69,215,000
Export market	205 kilo-t×US$ 126/t	= US$ 25,830,000
	750 kilo-t	= US$ 95,045,000

(average US$ 126.73/t)

10.3 ANNUAL SALES AMOUNT OF HIPARSA HBI

Table-146 Yearly estimated sales

Year	Production	Sales quantity (kilo-t) (domestic/export/stock)	Sales amount (FOB Punta Colorada)
1st year	510,000 t	430/0/80	US$ 54,610,000
2nd year	750,000 t	545/205/0	US$ 95,045,000
3rd year	750,000 t	545/205/0	US$ 95,045,000

Production for the first year is 510,000 t/year and first quarter production a quantity 80,000t is reserved as stock therefore first year sales is commenced from the second quarter onwards, of which the quantity is 430,000t.

Chapter 11

FINANCIAL ANALYSIS

11.1 BASES OF FINANCIAL CALCULATION

In this excercise for FIRR calculation, the price was set as of the end of 1998, and no escalation/inflation was considered. Manpower cost, Operation cost, investment, and pre-operation cost are based on the data mainly in Chapter 9. Sales quantities and prices are taken from Chapter 10.

(1) Investment

In this calculation, the transfer value of HISPARSAs existing assets is set at zero(0).

The rehabilitation and renovation of the existing mine, plant and facilities, plus construction of the new plant and facilities are estimated to take four(4) years from award of the contracts to the commencement of commercial production of HBI, which is the starting point of year 1.

Investment cost for renovation of the existing facilities of HIPARSA and new facilities such as the HBI plant, Water Pipeline and Natural Gas Pipeline is estimated for each year as follows.

Table-147 Yearly investment cost

(Unit: $1,000)

Year	-4	-3	-2	-1	Total
Mine Equipment/Facilities	0	6,080	6,080	3,040	15,200
Concentration Plant	0	0	1,800	900	2,700
Pellet Plant	0	0	6,850	6,850	13,700
HBI Plant	0	29,400	58,800	58,800	147,000
Water Pipeline	0	0	16,150	16,150	32,300
Natural Gas Pipeline	0	0	0	8,800	8,800
Total	0	35,400	89,680	94,540	219,700

(2) Pre-operation Cost

Pre-operation Cost includes all cost and expenses incurred prior to the start of commercial operation; Manpower Cost, Salary and Wages for staff and labour hired, Variable and Fixed Cost for the preparatory operation of the mine, concentration and pelletizing plants and facilities. It also includes costs for environmental tests and protection, training, administration expenses for the new company's construction supervision. These expenses are not individually estimated at this stage, and $ 2-million per year was allocated in the lump sum. Fixed cost for the year-1 corresponds to start-up period of mining, concentration, pelletizing, utilities and common facilities in the year-1, being 1/4 of the annual fixed cost. It also includes Mining Tax of $920,000 for 460,000 t of Iron Ore mined in the year-1.

Table-148 Yearly pre-operation cost

(Unit: $1,000)

	-4	-3	-2	-1	Total
Manpower Cost	704.0	2,328.4	3,085.9	6,899.3	13,017.6
Variable Cost	0	0	0	3,406.5	3,406.5
Fixed Cost	0	0	0	1,860.3	1,860.3
Sales/Adm./Other Cost	2,000.0	2,000.0	2,000.0	2,000.0	8,000.0
Total	2,704.0	4,328.4	5,085.9	14,166.1	26,284.4

(3) Production volume and sales

The production of iron ore, concentrate, pellet starts in the year -1 to prepare enough stock of raw material for the production of HBI, which starts in the year 1. The production figures are shown in **Table-149.**

Table-149 Production volume

(Unit: kilo-t)

	-1	1	2 onward
Iron Ore	460	1,695	2,600
Concentrate	160	707	1,100
Pellet	101	715	1,100
HBI	0	510	750

HBI is sold in the domestic and export markets. In the first year, a part of the initial production is used to build up the stock. The sales amount is shown in the following **Table-150**.

Table-150 HBI production and sales

	Year 1		Year 2 onward	
	HBI Tonnage (1,000 t)	HBI Sale ($1,000)	HBI Tonnage (1,000 t)	HBI Sale ($1,000)
Stock Building	80,000	0	0	0
Domestic Sales	430,000	54,610	545,000	69,215
Export Sales	0	0	205,000	25,830
Total	510,000	54,610	750,000	95,045

(4) Production cost

Production cost consists of Salary and Wages, Utilities, Auxiliary and Consumable Materials, and Maintenance, spare parts and repair costs. Details are as shown in Chapter 9.

Stope development and drilling cost down to the level ML-620 is summarized, and distributed to ore mined. ($2.43/t)

(5) Depreciation and amortization

Depreciation and amortization are the cost items without cash outflow. They are included in cost items to be deducted from gross income to calculate the gross profit, which is the basis for calculation of Income Tax. For IRR calculation, cashflow is obtained by adding depreciation and amortization, and interest paid, to the Profit after Tax.

1) Depreciation

Depreciation is taken over 20 years, straight line, salvage value 0.

2) Amortization

Amortization of Pre-production Cost and Intangible Assets is to be taken in 5 years, straight line, residual value 0.

There is a scheme to accelerate depreciation and amortization for the mining industry in Argentina. This project, having a lower profit prospect, is considered unable to enjoy the privilege due to lower cash flow in early years, and the calculation is made on 20 years depreciation and 5 years amortization.

(6) Taxes and Rebates

1) Taxes

In this exercise, Provincial Mining Tax, Provincial Gross Income Tax, and Federal Income Tax were taken into consideration. Export and Import duties are not applicable to this project, and not taken into account.

Provincial Mining Tax

Provincial Mining Tax is levied at the rate of $2 per ton of Iron Ore mined.

Provincial Gross Income Tax

Provincial Gross Income Tax rate is 3% of industrial product sales; in this project, sales amount of HBI.

National Income Tax

National Income Tax rate is currently 33%, and expected to be 35% of the Gross Profit. In this exercise, the rate was taken at 35%, applicable when cumulative loss disappears.

There are other taxes and charges on the Federal, Provincial and Municipal levels. IVA is basically imposed on consumption of goods in Argentina, and can be considered neutral to profit/loss of the project. IVA is, therefore, not included in the calculation in connection with sales and profit/loss.

The only case IVA may affect the project IRR is the plant cost. IVA is imposed, but Argentina has a provision for early refunding, and therefore IVA is not included in this evaluation.

Another federal tax is the one levied on foreign exchange transactions, the rate of which is maximum 0.3% of the transaction, and could be small compared with other taxes separately handled.

Provincial taxes other than Mineral Tax and Gross Income Tax are, Real Estate Tax, Vehicle Tax and Stamp Tax. All of these taxes are less significant in amount, and considered covered by Sales and Administration Cost.

Municipal taxes in Sierra Grande are Household Tax and Safety Tax. Both are relatively small in amount, it was supposed to be absorbed by Sales and Administration Cost.

2) Patagonia Export Rebate System

There is an incentive system to promote Patagonia export. The system is to give rebate to the products exported from ports in Patagonia. The rate of rebate given are shown in **Table-151.**

Table-151 Patagonia Export Rebate Rate Schedule

Year	Rate of rebate
1999	7% of exported value
2000	6
2001	5
2002	4
2003	3
2004	2
2005	1
2006 on	nil

This rebate system has no significant impact on the project, due to the small percentage of export and the low rebate rate when the project comes on-stream in the year 2003 when everything goes smoothly.

Due to relatively small and temporary impact on the IRR, the rebate on the export from Patagonian Ports were not considered. If everything goes smoothly, the year *1999* would be the year -4. The present rebate system gives rebates for the export of 2nd year, 2%, and 3rd year, 1%.

If the present scheme of the rebate system is changed to give more incentives to new projects in Patagonia, for instance, to grant rebates to exports from Patagonian Ports starting from the year of the commencement of the export, with gradually decreasing percentage like the present system, the positive impact would be much more effective.

The present sales program plans to export 205,000t of HBI at $126, and sell in the domestic market 545,000t at $127. Rebate may induce the change of the sales program to export the whole quantity of HBI produced.

(7) Sales and administration cost

General expenses are set at $2,000,000 per year, inclusive of contingencies and small cost items such as Municipal/vehicle taxes, general office expenses. This cost was considered to incur from the year -4, considering the need for engineering, supervision, environmental costs, testing, training, technical assistance, various minor taxes and levies, jetty and port charges etc. which may incur during preparation and construction stages.

(8) Loan and Interest

In this exercise, the financial structure was supposed to be 30% of the investment to be covered by equity, the rest by long term loan.

1) Equity

Equity is taken as 30% of Fixed Investment.

2) Long Term Loan

Long Term Loan is taken as 70% of Fixed Investment.

Interest: OECD current US dollar rate plus 1%=7.66%

Interest during Construction: added to the principal at the start of operation

Repayment: in 15 equal yearly installment

3) Working Capital

6 months of full scale production cost is taken as working capital.

4) Short Term Loan

Working Capital plus shortage of net cash flow after repayment and interest payment of long term loan.

Interest: 12%

Repayment: to be made as cash flow allows

(9) Profit and Cash Flow

1) Gross Profit

Gross Profit (Profit before Tax) is calculated by subtracting Production Cost, Mining and Sales Taxes, Depreciation and Amortization, and Interests from Revenue; in this project, Sales revenue.

2) Federal Income Tax

Income Tax is levied on the Gross Profit. The current rate is 33%, and there is a plan to increase the rate to 35% in the near future. In this exercise, the rate was taken as 35%.

3) Profit after Tax

Profit after Tax is obtained by subtracting Income Tax from Gross Profit, and shows the basis for dividends and other accounting transactions. The cash flow is obtained by adding depreciation and amortization to the Profit after Tax. To calculate IRR, interest is also to be added to show the real cash on hand, to compare with external interest for loan financing.

4) IRR

All the cash outflow as Investment cost and Pre-operation Cost and the net cash flow as calculated above are sorted in the corresponding year of outflow and inflow, and IRR is calculated by finding the discount rate to equate all the discounted cash outflow and in flow.

5) Financial IRR

Financial IRR (FIRR) analysis evaluates a project on the standpoint of a private company, and it indicates basically a profit rate in case of covering all the necessary equity, loans and working capital by own money. Depreciation items which do not require outflow of cash are added to the profit after tax, and loans and interests are also added to calcualte the inflow of cash. However, taxes are treated as outflow of cash because FIRR is the evaluation of profit rate on the basis of the private company.

Table-154 shows three cases, the base case and two cases with improved frameworks. Bases for the three cases are shown in **Table-152.**

Table-152 FIRR calculation for 3 cases

	Base Case	Case A	Case B
HBI Price	$126.7/t	$126.7/t	$126.7/t
Mining/Sales Taxes	Levied	Exempted	
Water/Gas Pipelines	By the project	By third party	
Income Tax	Levied	Levied	Exempted
FIRR	7.4%	12.56%	13.71%

In this project, the IRR is 7.4% for the base case. This rate is lower than the prevailing interest rates in Argentina, and the project may be unattractive to any commercial entity. Cases A and B shows the IRR above the interest rates, and could be attractive to some potential investors.

In Chapter 12, some recommendations for further improvement is made regarding governmental incentives/actions to improve IRR and attract more attention of potential investors.

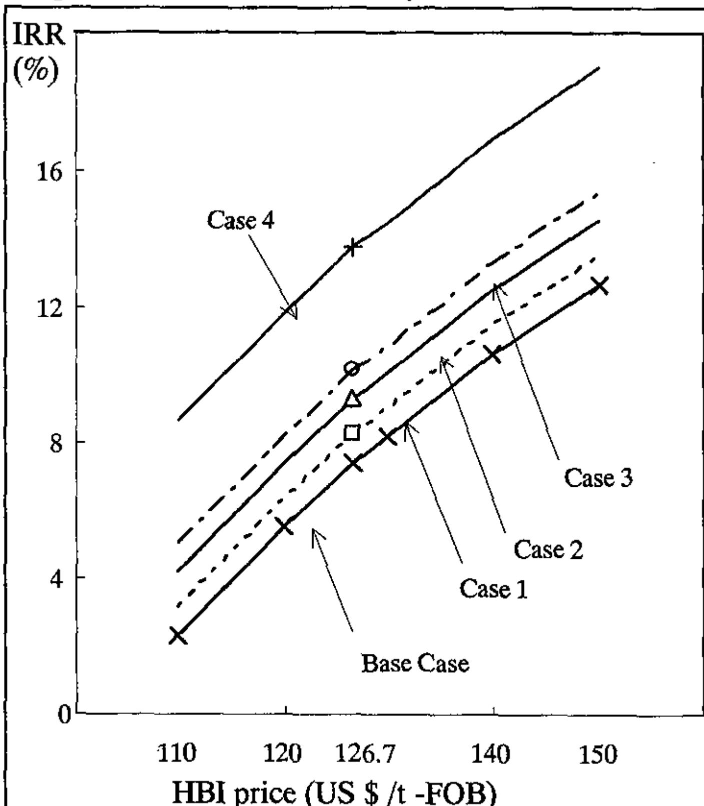
6) Sensitivity

Sensitivities of IRR for changes of Sales Price, Investment Cost (Water and Natural Gas Pipeline) and Mining/Sales/Income Taxes were calculated and shown in **Table-153**. The percentage under the IRR of each case shows the change of IRR from that of the base case.

Table-153 FIRR sensitivity chart

HBI price	$120	$126.7	$130	$140	$150
IRR	5.47%	7.4%	8.13%	10.57%	12.65%
	-1.93%	0	+0.73%	+3.17%	+5.25%
Mining/Sales Taxes	Fully levied			Exempted	
IRR	7.4%			10.10%	
-Case 3				+2.7%	
Income Tax	Fully levied			Exempted for 20 years	
	7.4%			8.26%	
-Case 1				+0.86%	
Water/Gas Pipelines	Included			Excluded	
	7.4%			9.28%	
-Case 2				+1.88%	

Graph-21 FIRR sensitivity chart



Base Case: No incentives
Case 1 : Income Tax exempted
Case 2 : Water/Gas Pipelines detached
Case 3 : Mining/Sales Tax exempted
Case 4 : All incentive included

Table-154-1 FIRR Calculation for Base Case
Base Case FIRR = 7.4%
1 Investment=$219,700,000
2 HBI Price-$126.7/t

(Unit: $1,000)

Calculation sheet for Base Case FIRR=7.4%			Project year																								
Items (variable name)	Code	Reference	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Plant & Equipment	a	sum of a = 219,700		-35,480	-89,680	-94,540																					-219,700
Pre-operation Cost	b	sum of b = 26,284	-2,704	-4,328	-5,086	-14,166																					-26,284
Sales	c						54,610	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	1,860,465
Rebate	c'							517	258																		
Production Cost	d						-43,414	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-999,000
Depreciation	e	1 to 3yr a/3 each					-73,233	-73,233	-73,233																		-219,700
Amortization	f	100% of b in 1st yr					-26,284																				-26,284
Interest	g						-14,708	-13,727	-12,747	-11,766	-10,788	-9,805	-8,825	-7,844	-6,864	-5,883	-4,903	-3,922	-2,942	-1,961	-981						-117,665
Taxes																											
Mining Tax	h	$2/ton of ore mined					-3,390	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-5,200	-102,190
Gross Income Tax	j	3% of HBI Sales					-1,638	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-2,851	-55,814
Sales/Administration Expenses	k						-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-40,000
Profit before Tax	m=c-(d~k)						-110,058	-56,950	-56,228	17,728	18,706	19,688	20,669	21,649	22,630	23,610	24,591	25,572	26,552	27,533	28,513	29,494	29,494	29,494	29,494	29,494	201,673
Cumulative Profit before Tax								-167,008	-223,236	-205,509	-186,803	-167,115	-146,446	-124,796	-102,166	-78,556	-53,965	-28,393	-1,841	25,691	54,205	83,698	113,192	142,685	172,179	201,673	
Income Tax	n=m*0.33	33% on m																		-9,086	-9,409	-9,733	-9,733	-9,733	-9,733	-9,733	-67,160
Profit after Tax	p=m-n						-110,058	-56,950	-56,228	17,728	18,706	19,688	20,669	21,649	22,630	23,610	24,591	25,572	26,552	18,447	19,104	19,761	19,761	19,761	19,761	19,761	134,513
Depreciation adjustment	+e	1 to 3yr a/3 each					73,233	73,233	73,233																		219,700
Amortization adjustment	+f	100% of b in 1st yr					26,284																				26,284
Interest adjustment	+g						14,708	13,727	12,747	11,766	10,788	9,805	8,825	7,844	6,864	5,883	4,903	3,922	2,942	1,961	981						117,665
Adjusted Cash Flow	q=p+e+f+g		-2,704	-39,808	-94,766	-108,706	4,168	30,010	29,752	29,494	29,494	29,494	29,494	29,494	29,494	29,494	29,494	29,494	29,494	20,408	20,084	19,761	19,761	19,761	19,761	19,761	498,163

Table-154-2 FIRR Calculation for Case A
Case A FIRR = 12.6%
1 Investment=$178,600,000
2 HBI Price-$126.7/t
3 Water/Gas Pipelines invested by third party
4 Mining/Gross Income Taxes exempted

(Unit: $1,000)

Calculation sheet for Case A FIRR=12.6%			Project year																								
Items (variable name)	Code	Reference	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Plant & Equipment	a	sum of a = 178,600		-35,480	-73,530	-69,590																					-178,600
Pre-operation Cost	b	sum of b = 26,284	-2,704	-4,328	-5,086	-14,166																					-26,284
Sales	c						54,610	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	1,860,465
Rebate	c'							517	258																		
Production Cost	d						-43,414	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-999,000
Depreciation	e	1 to 3yr a/3 each					-73,233	-73,233	-73,233																		-219,700
Amortization	f	100% of b in 1st yr					-26,284																				-26,284
Interest	g						-14,708	-13,727	-12,747	-11,766	-10,788	-9,805	-8,825	-7,844	-6,864	-5,883	-4,903	-3,922	-2,942	-1,961	-981						-117,665
Taxes																											
Mining Tax	h	exempted																									0
Gross Income Tax	j	exempted																									0
Sales/Administration Expenses	k						-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-40,000
Profit before Tax	m=c-(d~k)						-105,029	-48,899	-48,177	25,779	26,757	27,740	28,720	29,701	30,681	31,662	32,642	33,623	34,603	35,584	36,564	37,545	37,545	37,545	37,545	37,545	359,677
Cumulative								-153,928	-202,105	-176,326	-149,569	-121,829	-93,109	-63,408	-32,727	-1,065	31,577	65,200	99,803	135,387	171,952	209,497	247,042	284,587	322,132	359,677	
Income Tax	n=m*0.33	33% on m															-10,772	-11,096	-11,419	-11,743	-12,066	-12,390	-12,390	-12,390	-12,390	-12,390	-119,045
Profit after Tax	p=m-n						-105,029	-48,899	-48,177	25,779	26,757	27,740	28,720	29,701	30,681	31,662	21,870	22,527	23,184	23,841	24,498	25,155	25,155	25,155	25,155	25,155	240,632
Depreciation adjustment	+e	1 to 3yr a/3 each					73,233	73,233	73,233																		219,700
Amortization adjustment	+f	100% of b in 1st yr					26,284																				26,284
Interest adjustment	+g						14,708	13,727	12,747	11,766	10,788	9,805	8,825	7,844	6,864	5,883	4,903	3,922	2,942	1,961	981						117,665
Adjusted Cash Flow	q=p+e+f+g		-2,704	-39,808	-78,616	-83,756	9,196	38,062	37,803	37,545	37,545	37,545	37,545	37,545	37,545	37,545	26,773	26,449	26,126	25,802	25,479	25,155	25,155	25,155	25,155	25,155	604,281

Table-154-3 FIRR Calculation for Case B
Case B FIRR = 13.7%
1 Investment=$178,600,000
2 HBI Price-$126.7/t
3 Water/Gas Pipelines invested by third party
4 Mining/Gross Income Taxes exempted
5 Federal Income Tax exempted

(Unit: $1,000)

Calculation sheet for Case B FIRR=13.7%

Items (variable name)	Code	Reference	Project year -4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Plant & Equipment	a	sum of a = 178,600		-35,480	-73,530	-69,590																					-178,600
Pre-operation Cost	b	sum of b = 26,284	-2,704	-4,328	-5,086	-14,166																					-26,284
Sales	c						54,610	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	1,860,465
Rebate	c'							517	258																		
Production Cost	d						-43,414	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-999,000
Depreciation	e	1 to 3yr a/3 each					-73,233	-73,233	-73,233																		-219,700
Amortization	f	100% of b in 1st yr					-26,284																				-26,284
Interest	g						-14,708	-13,727	-12,747	-11,766	-10,788	-9,805	-8,825	-7,844	-6,864	-5,883	-4,903	-3,922	-2,942	-1,961	-981						-117,665
Taxes																											
Mining Tax	h	exempted																									0
Gross Income Tax	j	exempted																									0
Sales/Administration Expenses	k						-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-40,000
Profit before Tax	m=c-(d~k)						-105,029	-48,899	-48,177	25,779	26,757	27,740	28,720	29,701	30,681	31,662	32,642	33,623	34,603	35,584	36,564	37,545	37,545	37,545	37,545	37,545	359,677
Cumulative								-153,928	-202,105	-176,326	-149,569	-121,829	-93,109	-63,408	-32,727	-1,065	31,577	65,200	99,803	135,387	171,952	209,497	247,042	284,587	322,132	359,677	
Income Tax	n=m*0	0% on m																									0
Profit after Tax	p=m-n						-105,029	-48,899	-48,177	25,779	26,757	27,740	28,720	29,701	30,681	31,662	32,642	33,623	34,603	35,584	36,564	37,545	37,545	37,545	37,545	37,545	359,677
Depreciation adjustment	+e	1 to 3yr a/3 each					73,233	73,233	73,233																		219,700
Amortization adjustment	+f	100% of b in 1st yr					26,284																				26,284
Interest adjustment	+g						14,708	13,727	12,747	11,766	10,788	9,805	8,825	7,844	6,864	5,883	4,903	3,922	2,942	1,961	981						117,665
Adjusted Cash Flow	q=p+e+f+g		-2,704	-39,808	-78,616	-83,756	9,196	38,062	37,803	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	37,545	723,326

11.2 ECONOMIC IRR CALCULATION

Argentina peso ($) is linked to U.S.Dollar (US$), and there is no need to adjust the actual exchange rate to shadow exchange rate.

Argentina is a member country of Mercosur, with basically free trade environment. Considering the free market policy of the government, it is considered that the adjustment by shadow price is not necessary and the trial may not worth bringing about considerable differences.

In view of the relatively high unemployment rate, consideration on the employment impact of the project is important. Calculation of marginal productivity and wage of unskilled labour was considered of little worth in the presence of the high unemployment rate (more than 10%). Considering the high unemployment rate is affecting skilled and staff/engineer level, shadow wage of skilled labour level was set at zero, in addition to unskilled labour.

Skilled/Unskilled labour cost of the project is $ 7,968,400 per year and this amount was offset from production cost to obtain EIRR for the base case. Also Mining, Sales and Income Taxes were offset. Water/Natural Gas Pipeline investment is included in investment as the national economy requires this infrastructure investment whether it is done by a third party or the project itself. **Table-155** shows the yearly spread sheet for EIRR calculation.

EIRR calculated is 16.1% for the base case. This rate is above the prevailing interest rates, and justifies further steps of more detailed studies to improve the project performance. Present maintenance cost of $ 2,400,000 per year for HIPARSA, possible wastage of the existing assets of HIPARSA, and various hidden cost by the closure of HIPARSA for Rio Negro Province and Sierra Grande should also be taken into account when making a decision.

Table-155 EIRR Calculation
EIRR=16.1%
1 Investment=219700
2 Sales Price=$126.7
3 Taxes adjusted
4 Labor Cost Adjusted

(Unit:$1,000)

			Project Year																								
Items (variable name)	Code of Items	Reference	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Plant & Equipment	a	sum of a=219,700		-35,480	-89,680	-94,540																					-219,700
Pre-operation Cost	b	sum of b= 26,284	-2,704	-4,328	-5,086	-14,166																					-26,284
Sales	c						54,610	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	95,045	1,860,465
Rebate	c'							517	258																		
Production Cost	d						-43,414	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-55,500	-999,000
Salary/Wage adjustment			704	2,328	3,086	6,916	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	10,777	
Depreciation	e	a/3years					-73,233	-73,233	-73,233																		-219,700
Amortization	f	b/1year					-26,284																				-26,284
Interest	g						-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1						-15
Taxes																											
Mining Tax	h																										0
Gross Income Tax	j																										0
Sales/Administration Expenses	k						-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000	-40,000
Profit before Tax	m=c+c'-Σ(d..k)						-79,545	-24,395	-24,654	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,322	48,322	48,322	48,322	48,322	692,873
Cumulative								-103,941	-128,594	-80,273	-31,952	16,370	64,691	113,012	161,334	209,655	257,976	306,297	354,619	402,940	451,261	499,584	547,906	596,228	644,551	692,873	
Income Tax	n=m*0.33	33% on Profit before Tax																									0
Profit after Tax	p=m-n						-79,545	-24,395	-24,654	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,321	48,322	48,322	48,322	48,322	48,322	692,873
Depreciation adjustment	+e	1 to 3yr 1/3 each					73,233	73,233	73,233																		219,700
Amortization adjustment	+f	100% 1st yr					26,284																				26,284
Interest adjustment	+g						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						15
Adjusted Cash Flow	q=p+e+f+g		-2,000	-37,480	-91,680	-101,790	19,974	48,839	48,581	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	48,322	938,872

Chapter 12

PROPOSAL

ON VARIOUS INCENTIVE ACTIONS AND RULES OF FEDERAL AND PROVINCIAL GOVERNMENT

Free market system through price mechanism may, after all, be the only practical system, however inefficient, to realize economic solution of the distribution of resources. However, the invisible hands may bring about a situation which needs adjustment to realize better welfare of the society, or policy target of the government.

To realize a target in the given situation, Government guidance and incentive would be indispensable. On the other hand, incentives such as subsidy without limit could, in the long period, invite irresponsibility, inefficiency and other side effects to the parties concerned. In this study, the major target is to achieve sustainable growth by inducing industries and providing employment opportunities in Rio Negro Province through the reactivation of HIPARSA.

The project in the present study brings a rather low IRR prospect for the base case. There are many existing incentives already taken into consideration in the calculation of IRR. To increase IRR further to make the project more attractive, there are several measures the Government could take as mentioned in Chapter 11, in addition to the existing incentives.

12.1 ACTIONS BY PROVINCIAL GOVERNMENT

Provincial Government of Rio Negro is responsible to Rio Negro Province citizens including Sierra Grande inhabitants, who would be the beneficiary of the reactivation of HIPARSA through employment and various repercussion effects through commercial transactions.

In view of the state of industrialization in Rio Negro Province, it is advisable to initiate a measure to induce industries to the Province, in comparison with other provinces. Level of Mining Tax seems high if we consider \$ 2/t tax is actually \$ 4.56/t for 1t of Pellet, the price level of which is around \$ 30/t. More than 10% of the sale price could be considered excessive when industries are to come into the Province.

The Provincial Government may choose to exempt Mining and Gross Income Taxes for the life of the present project, and enjoy employment and repercussion effects of the project through increase of trade and resulting economic prosperity, which will eventually result in the increase in revenue.

(1) Exemption of Mining Tax and Gross Income Tax for 20 years

Our recommendation is to exempt Mining Tax and Gross Income Tax for at least 20 years from the start of commercial operation. After this 20 years exemption, the Taxes may be reactivated, but the rate to be carefully negotiated on a realistic level. If the Mining Law's fiscal stability guarantee is for 30 years, the exemption period is better to be the same.

(2) Investment of Water Pipeline and Natural Gas Pipeline for future industries in Sierra Grande area including reactivated HIPARSA

Our recommendation is that Provincial Government or other party bears the responsibility for the investment of Water Pipeline and Natural Gas Pipeline of the project. The project is to share the burden of depreciation and operating cost.

There is a plan to establish a Zona Franca in Puta Colorada area. To induce industries to the area, utilities such as water, electricity, natural gas are to be ready for the area. Provincial government or other party would construct supply lines of those utilities. Combination of those utilities and the utilities required for the project would bring considerable savings in capital and operating cost.

12.2 ACTIONS BY FEDERAL GOVERNMENT

(1) Exemption of Income Tax

Our recommendation is the exemption of Federal Income Tax for 10 to 20 years. In many countries, the exemption of Income Tax for a limited period is a popular measure to induce industries to certain area. Since the basic IRR is not so high, loss in the initial years could result. The exemption is to start and effective for 10 to 20 years after the cumulative loss is wiped out.

(2) Patagonia Port Export Rebate

Existing rebate system is set to start in 1999. Our recommendation is to alter the system to start from the year of the start of commercial production or the year of the start of export sale.

(3) Other possible measures

Any expenditure or incentive would be helpful to further increase IRR. In this project, considering the importance in employment effect, the expenditure on training, salary during pre-operation/construction period could be more convincing to tax payers. In this connection, the Federal and Provincial Governments could consider subsidy. In this case, subsidy would not bring in adversary effect because the period is clearly limited.

Production of HBI consumes large quantity of natural gas as reductant. Natural gas price applied to this Final Report is $ 1.32/million BTU. This price is almost two times higher than that in Venezuela or in Trinidad Tobago. It is necessary to make natural gas price less than $ 1/million BTU by giving "Favoured price to large quantity consumer" if it does already exist, or establish such system if it does not exist at present, in order to give competitiveness of HBI of HIPARSA at reactivation.

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