6.3.4 Required improvement

(1) General

As mentioned in 6.3.1 required improvement can be summarized as followings.

1) Completion of rectifying equipment condition to decrease stoppage.

2) Reduction of green pellets moisture to prevent bursting and for good balling with low under size pellets and stable green pellets production to keep stock level constant.

3) Change of indurstion control to avoid bursting and chunk formation.

4) Modification of index conveyor to stack green pellets evenly for homogeneous indurating and to decrease stoppage due to the trouble of index conveyor.

5) Structure modification of hot gas duct to decrease long stoppage required for grout.

(2) Completion of rectifying equipment in proper condition

As mentioned in b-1) of (2)-2 in 4.2.3, there may be many faults which have to be completed before the start of commercial production. From what we have heard the following are existing faults.

- Side travel of belt conveyor
- Dosing system (hanging, flushing and dosing with large errors)

- Green pellets screen (seizing of ball bearing)
- Product screen (abnormal vibration)

With long term closure of the plant and fading memories it may be difficult to list up faults of equipment accurately and it may be possible to rectify within a short period (within one year) after re-start.

(3) Reduction of green ball moisture

As green pellets moisture was high, it is estimated that high moisture made the troubles of chute choking, side travel of belt and slip of belt and was one of cause of busting and chunk formation. Maximum moisture of green pellets sometimes was 11% (as shown in **Table-56**)(green pellets moisture on 17th in October in Number 1 furnace shows 10.6 ± 0.4) (designed moisture = 9.3 ± 0.3). In order to decrease moisture contents of filter cake in concentration plant, slime content in concentrate must be decreased.

In order to decrease moisture contents in the pellet plant, following is some counter measures possible, "to keep control valve, Which is a part of disc filter, in good condition", "to use high quality of filter cloth", "to increase the temperature of slurry for lower viscosity of water", "to introduce new dewatering machine, like as filter press with high dewatering capacity".

Considering that it is better in the pellet side to have the counter method to decrease moisture content in balling material even if the moisture is high., following counter is taken into consideration.
To achieve the above, it is required to blend low moisture concentrate dried by sunlight to excess moisture filter cake.

- Excess quantity of filter cake during major shut down or in theperiod with low production rate is discharged onto the ground

- For drying filter, newly discharged filter is to be kept o out side for some period (3 to 4 month)

- Stocked place for drying, dried filter is charged on to production line and blended with excess moisture filter cake.

This has the effect not only to decrease moisture in balling material not also to have emergency stock in pellet plant when concentration plant and/or slurry pipe line transportation is stopped. The following is the concept of dried concentrate mix.

Past results

Production rate of pellets 62 t/h × 3=186

Average green pellets moisture =10.1% in October, 1989

Average filter cake moisture =10.3% in October, 1989

Premise

Average filter cake moisture =10.3%

Average green pellets moisture =10.2% with new blending

Production rate of pellets 62 t/h × 3=186 and 1,165 kilo-t/year

Dried concentrate shall have 3% moisture.

Balance of dried concentrate

Annual requirement of dried concentrate to reduce green pellet moisture 10.2% to 9.3% is 139,800 t (11,650 t/month). Average monthly stoppage hour is about 185 hours and half of this hour may be possible to produce excess filter cake. 133 t/h × 185 × 0.5=12,300 t/month.

Also during major shut down with 20 stoppage, 64,000t of excess filter cake can be discharged onto ground. It is possible and a requirement to keep filter 48,000 t of cake equivalent to 4 months usage.

Capacity of mixing rate

Maximum moisture content of filter cake is estimated to 11.2% when maximum moisture content was 11%.

Premise

Moisture of dried filter = 3.0 %

Moisture of newly dewatered filter = 11.2 %

Required filter cake charge rate = 182 t/h

Required mixing rate of dried filter is 45.2 t/h (dry base) against the 141 t/h(dry base) rate of newly dewatered filter.

Required facilities (refer to **Fig.-51**)

Three stock yards with 18,000 t stock for each

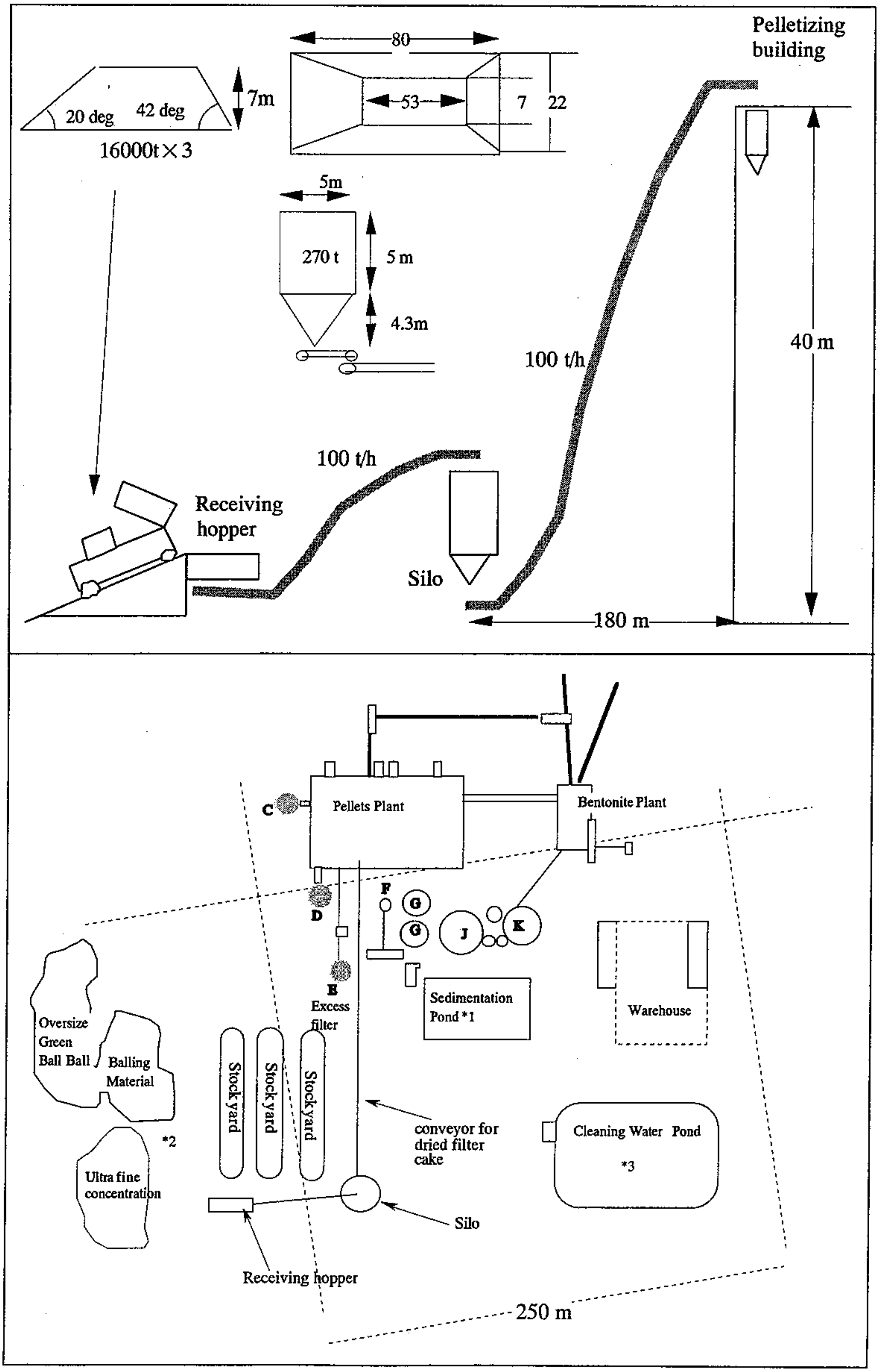
Receiving hopper with access road for trucks

Conveyor to silo

Silo for stock

Conveyor to day bin

Fig.-51 Dried filter cake addition



(4) Change of induration control circuit

Induration control should be done based on green pellets production rate not balling material charge rate. Refer to **Fig.-10** of (3)-2)-b) in 4.2.3, and **Attachment-13.**

For this purpose, installation of 4 weighers, 4 PLC's, 4 level detectors and 4 cameras with capacity to measure temperature of stock level are required.

(5) Change of heat pattern

In this plant, bursting occurred frequently to form chunk and stopped production for many hours.

As shown in **Table-59-7**, firing temperature (maximum temperature) level existed in shallow level and exhausted gas temperature was high.

This condition made green pellets burst with rapid heating.

So it is required to deepen the level of firing and it is required to reduce gas ascending or increase descending speed of burden for deepening firing level, in other words it is required to decrease A/D as shown in **Table-59-11**.

Induration comparison is as shown in **Table-105**. Design base shows 112.1 cm/sec. of ascending speed and speed higher than 100 cm/sec. is used in many pelletizing speed to supply heat homogeneously. A/D is higher than plant A.

A/D is not changed even if product rate is changed if hot gas temperature is fixed and unit consumption of fuel is constant. To reduce A/D, process air volume (air to cuba) must be changed but this lowers heat recovery.

The only way to change A/D with constant air volume to cuba is to change the kind of fuels.

Table-106 shows the results of fuel change (partial replace to carbon). (refer to **Fig.-52-2**). Replacement of 6 kg carbon with 5.7m3 of natural gas lowers A/D with value 2. In shaft furnace, hot gas is injected from side wall and near tuyere gas speed (refer to **Fig.-52-1**) is more rapid than the other area. It is easily imagined that heat is not homogeneous in strict sense (W2 area and vicinity of side wall as shown in **Fig.-52-2**)

Carbon addition reduces this tendency as shown in **Fig.-52-3** as carbon is distributed homogeneously on plane and fuels from tuyere is reduced.

For this improvement;

- 4 hoppers installation under No.25 belt conveyor
- some modification on No.24 belt conveyors with carbon stock silo

For homogeneous induration there is one measure to reduce the width of furnace but in this study it is not considered as the modification may be easy and can be conducted during the repair of refractory.

Table-105 Induration comparison

	HIPASAM actual	HIPASAM design	A
Production rate (t/h)	57	67	78
Energy			
N.Gas (m^3/t-p)	27	19.1	0
Carbon (kg/t-p)	0	0	6
Heavy oil (l/t-p)	0	0	12
Firing level (cm)	20		40
Descending speed (cm/min.)	4.7	5.5	9.0
Ascending speed (cm/sec)	96.3	112.1	132.8
A/D	20.54	20.34	14.83
Waste gas (m^3/h)	49152	57223	50834
Area of furnace entrance(m^2)	14.2	14.2	10.6

Table-106 The results of fuel change

	HIPASAM actual	HIPASAM change	A
Production rate (t/h)	57	57	78
Energy			
N.Gas (m^3/t-p)	27	18.0	0
Carbon (kg/t-p)	0	6.0	6
Heavy oil (l/t-p)	0	0	12
Firing level (cm)	20		40
Descending speed (cm/min.)	4.7	4.7	9.0
Ascending speed (cm/sec)	96.3	87.5	132.8
A/D	20.54	18.7	14.83
Waste gas (m^3/h)	49152	44654	50834
Area of furnace entrance(m^2)	14.2	14.2	10.6

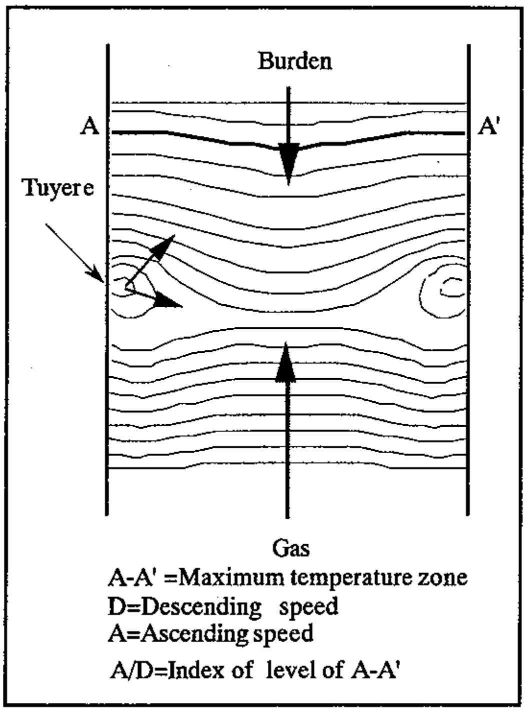


Figure-52-1 Image of isobaric curve in furnace

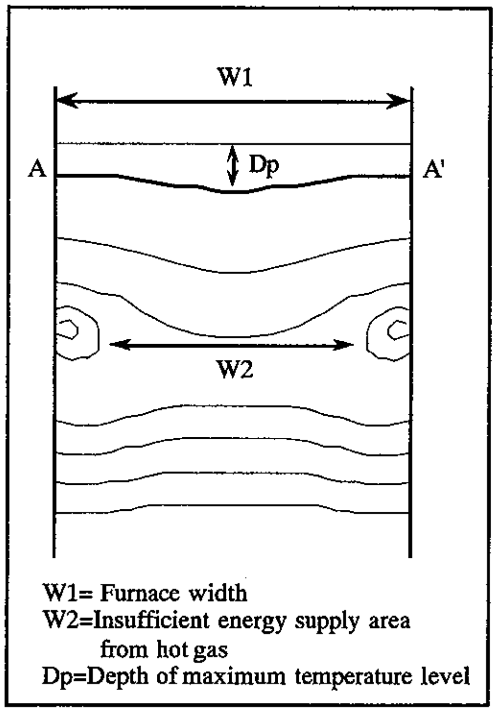


Figure-52-2 Definition of positions

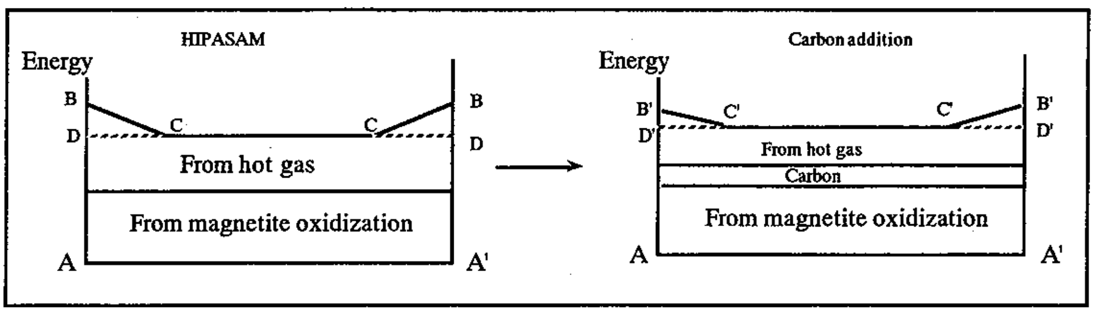


Figure-52-3 Induration energy

(6) Modification of index conveyor (refer to **Fig.-53**)

The index conveyor was exposed to high temperatures when it entered the hood on the furnace and stacked green pellets From a visual survey the frame is deformed and conveyor belts are damaged.

It is better to renew the conveyor. It was operated with a complicated movement for synchronizing it. This movement was controlled mechanically through a chain and stretch in the chain frequently caused wrong-movement. All movement should be controlled by electrical signal. All driving force should be supplied from an independent motor. Already some improvement has been made. Instead of a chain for the transfer of driving force to No.11 conveyor belt an independent motor B was installed.

For above improvement;

- 4 index conveyors to be renewed.
- control circuit to be made within PLC.

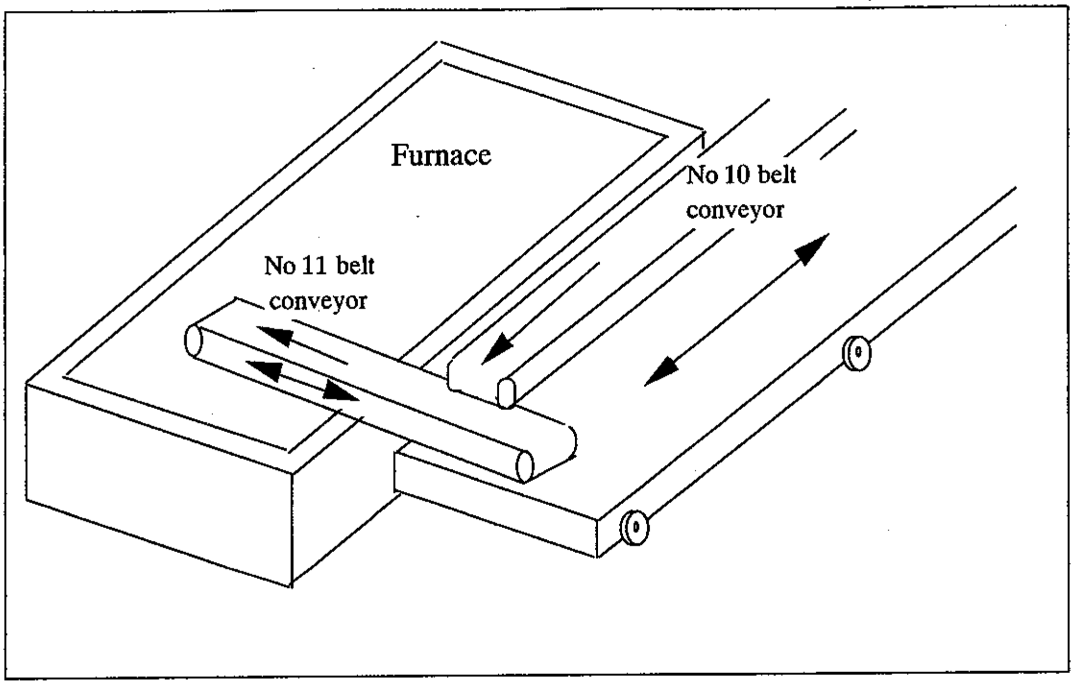


Figure-53-1 Bird-eye view of index feeder

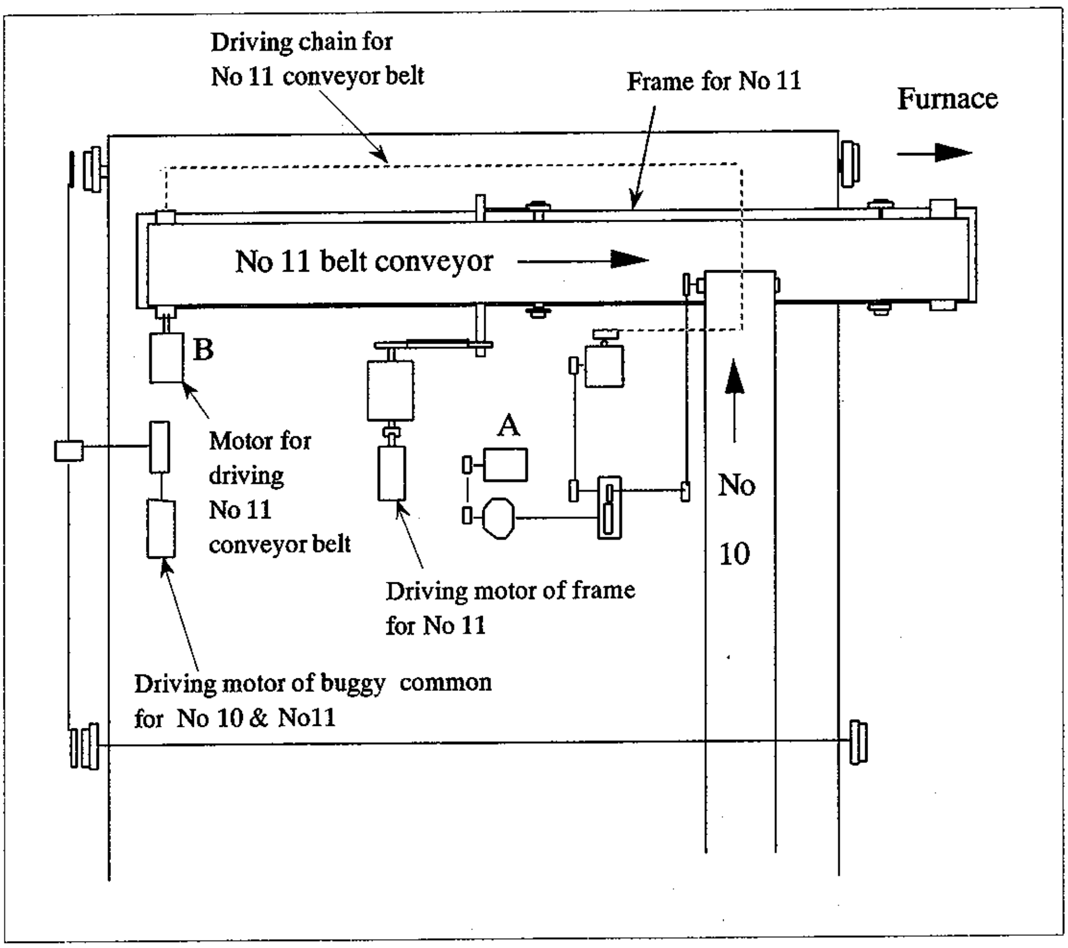


Figure-53-2 Plot plan of index conveyor

(7) Modification of hot gas duct

One of reasons which made availability is grout. (refer to (5)-4 in 6.3.1 and **Fig.-38**)

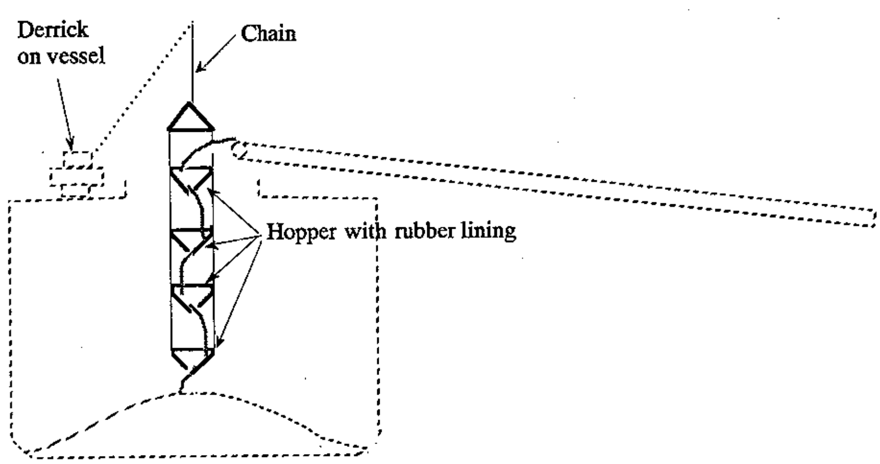
For example to solve this problem;

- To reduce stoppage.
- Some counter measure as shown in **Fig.-38-3**, which changes structure steel shell and brick with some gap against the expansion, by heats required after engineering study.

(8) Modification of loading system when HBI plan is put into application

When HBI is shipped much HBI is broken by shock caused by high-height-fall as reported from another HBI producing company. Soft loading using 4 hoppers combined with chain folded by derrick crane on the vessel may be required as shown in **Fig.-54**. For this purpose, It is needed to hire vessels with derrick cranes.

Fig.-54 Soft loading of HBI



6.3.5 Forecast of operation

(1) Period of operation of furnaces

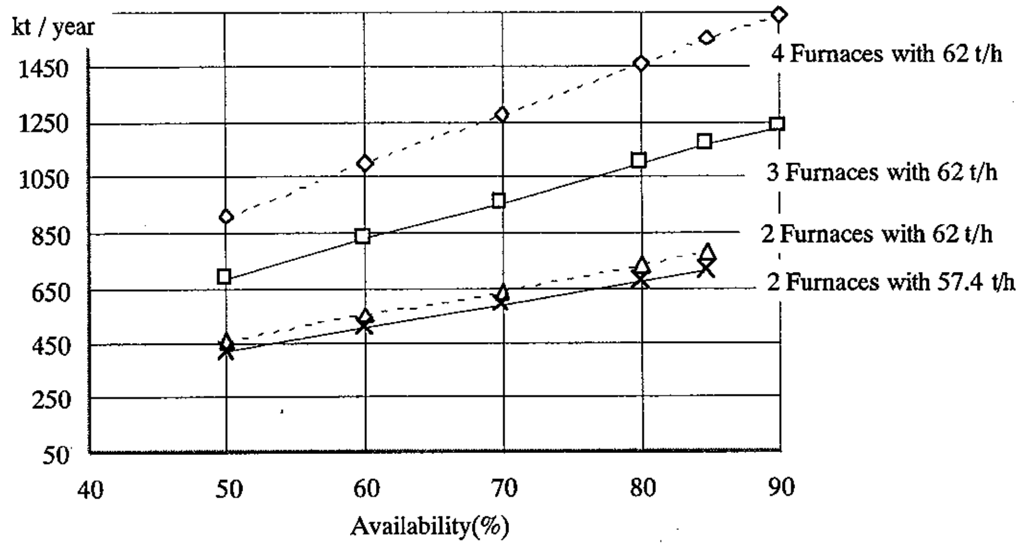
It can be assumed that 16 months could be the period for one operation, time from furnace start up to end, which will be decided by the requirement for partial brick re-lining. Whole bricks are reported to be re-lined every 7 years in other plants.

(2) Operation mode of 4 furnaces

Relation between annual production and availability is shown in **Fig.-55.**

To produce 1.1 million-t/year, 3 furnaces with 62 t/h of production rate for each are to be operated simultaneously and the other furnace is to be under stand-by. This means that it is possible to produce 1.1 million-t/year with 3 furnaces operating and 1 furnace being relined partially with brick during 4 months.

Fig.-55 Relation between annual production, product rate and availability



Definition of availability(Av)

$$Av = \frac{\text{Annual net production hour}}{\text{Annual calendar hour-major and minor shut down}}$$

Major shut down does not include relining time of brick and modification

(3) Operating hour/year

Precise estimation of operation hour with a margin for the study is shown in **Table-107**.

Table-107 Estimation of operation time for the study

Item No.	Items for time	h/year*3	%*3	h/year*5	%*5
1	Available hour for production	7509.8	85.7	6077.8	69.4
2	Stoppage due to Initial stage trouble	128.6	1.5	128.6	1.5
3	Stoppage due to Control system trouble	13.6	0.2	13.6	0.2
4	Stoppage due to peculiar cause for this plant	100.0	1.1	100.0	1.1
5	Stoppage due to the cause of "out of control"				
6	Stoppage due to special cause*4			1000.0	11.4
7	Minor scheduled shut down	288.0	3.3	576.0	6.6
8	Major scheduled shut down	480.0	5.5	480.0	5.5
9	Operating time loss for cooling down and heating before and after scheduled shut down	240.0	2.7	384.0	4.4
10	Total	8760.0	100.0	8760.0	100.0

*3: Refer to Table-101

*4: arrival delay of spare parts, delay of fabrication, etc.

*5: Time distribution for production plan in this study

(4) Production rate

It will be possible to produce pellets at 62 t/h as shown in **Table-57**.

(5) DR pellets or BF pellets

Which pellets will be produced has not been decided. Blending shown in **Table-108** will be investigated for the study and chemistry is estimated when concentrates with 68.7% Fe and 70% Fe. For the pelletizing study, unit consumption of energy is calculated with the premise that concentrate with Fe 68.7% would be used.

Table-108 Raw material and chemistry of product pellets

	Conc Fe=68.7	Conc Fe=68.7	Conc Fe=70.0	Conc Fe=70.0
	Pellets for BF	Pellets for DR	Pellets for BF	Pellets for DR
Bentonite (kg/P)	10.0	10	10.0	10
Dolomite (kg/P)	72.0		39.0	
H.Lime (kg/P)	6.5		2.6	
T.Fe (%) in product	64.1	66.85	66.6	68.1
SiO_2 (%) in product	2.3	2.3	1.4	1.3
CaO (%) in product	2.8	0.32	1.6	0.3
MgO (%) in product	1.5	0.12	0.9	0.1
C/S	1.2	0.14	1.2	0.3

(6) Unit consumption of electric power

Fig.-56 shows actual monthly results of electric unit consumption in 1989. The consumption was very high due to low availability and low production rate. (Designed unit consumption is estimated to be 50kWh/t-p with 4 furnace operation producing 67.5t/h for 312.5 days/year. As there is no documents about the design concept, the unit consumption is estimated.)

In 1989, 2 furnaces were operated simultaneously and the production rate was almost the same in every month. The tendency is that increase of availability decreases unit consumption. There are many facilities which are used as common use for all 4 lines (pelletizing and indurating). When only 2 furnaces were operated, electric consumption by these common facilities must be divided between 2 furnace production. This means that increase of operating furnace number decreases unit consumption.

Fig.-57 shows this tendency and unit consumption can be estimated to be 60kWh/t with 3 furnace operation at 62t/h for each furnace and 85% availability to produce 1.1 million-t/year.

For the study, the unit consumption can be assumed 60kWh/t-p for producing BF pellets and 58kWh/t-p for producing DR pellets without operation of mills for additives and with reduction of mass ratio compared with BF pellets.

Fig.-56 Actual result of electric unit consumption

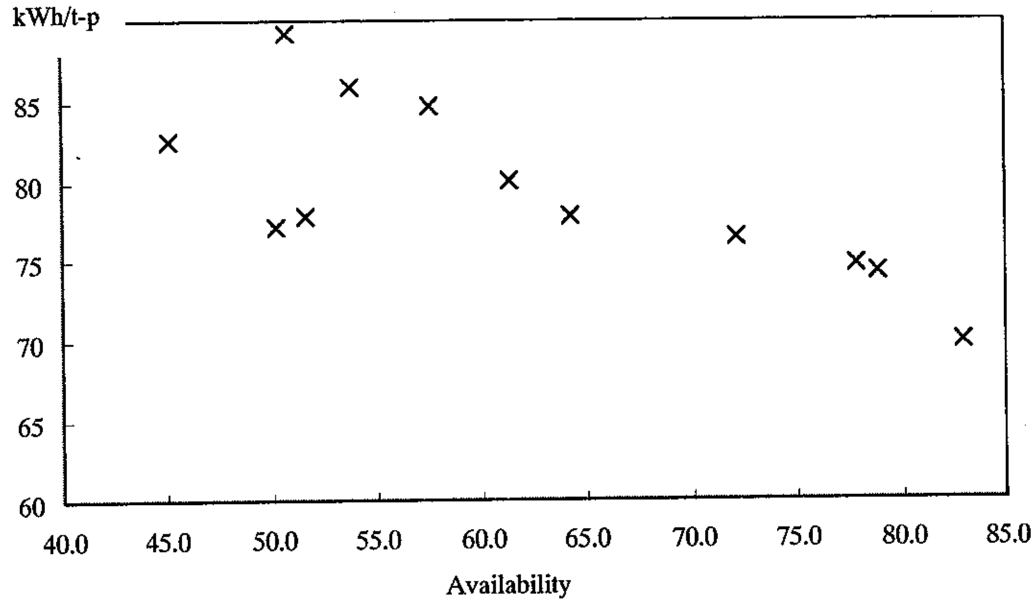
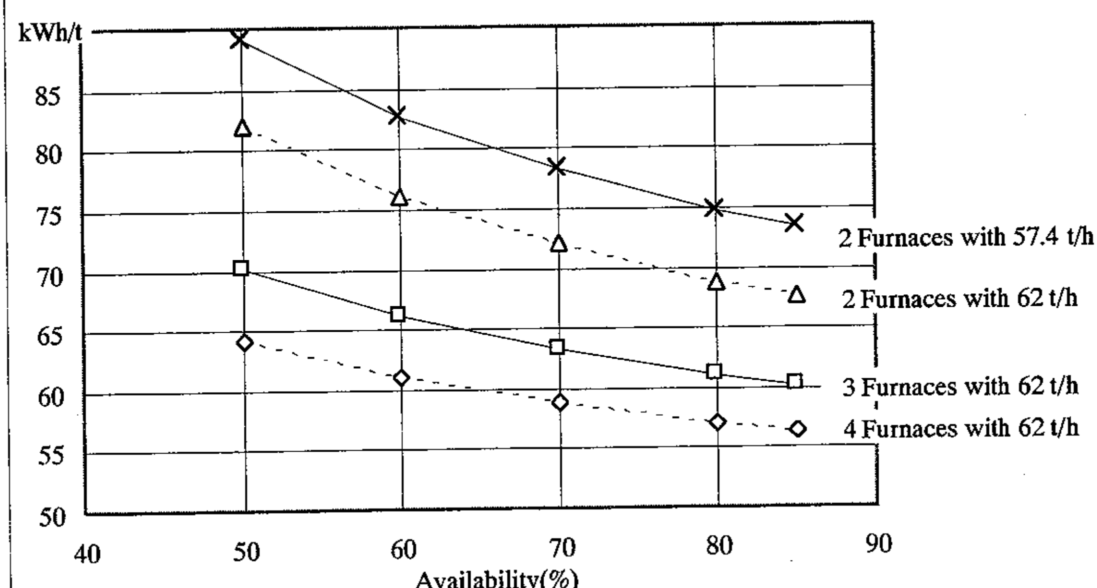


Fig.-57 Estimated unit consumption



Definition of availability(Av)

$$Av = \frac{\text{Annual net production hour}}{\text{Annual calendar hour-major and minor shut down}}$$

Major shut down does not include relining time of brick and modification

(7) Unit consumption of induration energy

By changing heat pattern for deepening the level of firing, it can be forecast that exhausted gas temperature will decrease. Decrease of green pellets moisture decreases heat loss.

As for raw material, new blending for new BF and DR pellets make the change of indurating energy. New blending is based on the cases with 68.7 % Fe content in **Table-108**.

Table-109 shows unit consumption of energy and related data. Provided that wasted gas temperature is lowered according to the heat pattern change and there is a small increase of heat loss brought out from the furnace by pellets, unit consumption is estimated.

Table-109 Unit consumption

	BF pellets in HIPASAM	New BF pellets	DR pellets
Bentonite (kg/t-p)	15.5	10.0	10.0
Dolomite (kg/t-p)	17.7	72.0	0.0
Silica (kg/t-p)	6.8	0.0	0.0
Hydrated lime (kg/t-p)	0.6	6.5	0.0
Waste gas temp (℃)	280	180	180
Heat loss by waste gas (mega cal/t-p)	99	59	55
Decomposition heat (mega cal/t-p)	6	23	0.7
Green pellets moisture(%)	11.0	9.3	9.3
Heat loss of water evaporation (mega cal/t-p)	74	65	60
N.Gas consumption (Nm^3/t-p)	27	18	15
Carbon consumption (kg/t-p)	0	6	6
Total in duration heat (mega cal/t-p)	239	220	200

Attachment-13 Concept of the shaft furnace operation

(A) Green pellets stacking and descending of pellets layer

Green pellets are charged into shaft furnace by reciprocating conveyor (generally named as index feeder). The head of index feeder on a plane beyond the furnace top moves as shown in Fig.- 1, and place green balls on the top surface of already charged pellets in furnace. When the head moves from E to W, green pellets are charged on to the top surface and when the head moves from W to E green pellets are charged on to the index feeder. By repeating this movement (E1, W1, E2, ----E7, W7, E8, W8 to E1 again) and cycle (E1 to E1), green pellets are placed evenly on the top surface.

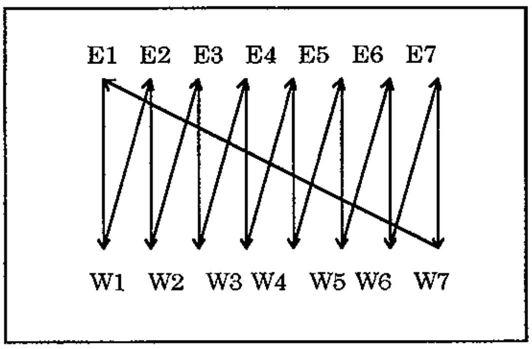


Figure -1 Horizontal movement of the head of index feeder

Vertical movement of green pellets are shown as in Figure- 2.

Thickness of one layer formed by 1 travel of index feeder (from E side to W side) is in proportion to green pellets production rate (t/h). To keep the level of the top surface at same level constantly, relation between descending speed of burden, thickness of one layer and cycle time can be shown as following equation.

descending speed of burden = thickness of one layer / cycle time

* Generally thickness of one layer is in proportion to green pellets production.

(B) Heating of newly stacked pellets layer

Newly stacked layer starts to descend and receive heat from ascending hot gas.

It must be heated to be completely dried to get enough strength to endure the shock and weight made by the fall of the next newly stacked layer. In Figure 2, upper level of Ⅰ layer must be dried up until next stacking of Ⅱ layer. And lower level of Ⅱ layer is immediately exposed to the same temperature of upper level of Ⅰ layer which has been dried up and reached a high temperature.

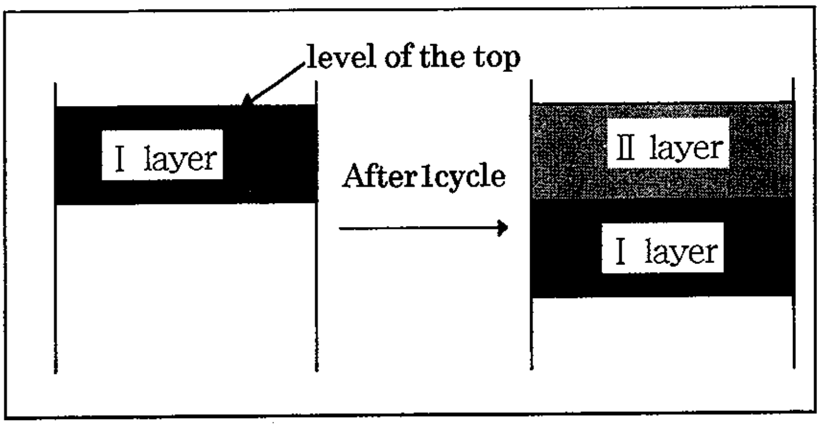


Figure 2: Movement of layers at furnace top

(C) Heat supply

In shaft pelletizing furnace, pellet is indurated with the heat exchange of counter flow of descending pellet and ascending hot gas.

The heat for the induration is supplied by hot gas (1250 to 1260℃) from combustion chamber, by hot gas from lower part furnace after exchanging heat with already indurated pellets which is descending to the outlet of furnace and by reaction heat of magnetite-oxidization.

(D) Heating to maximum temperature.

Pellets layer is stacked on the top surface formed by layer previously stacked. The layer is heated by ascending hot gas and dried up completely in a short time near the surface. After drying, pellets layer is heated more by ascending gas with higher temperature and magnetite oxidization occurs. The oxidization heat the layer up to the maximum temperature 1350 to 1360℃ upper hot gas temperature. Generally, the maximum temperature zone exists at the level below 20 cm to 40 cm from the top surface.

(E) Furnace control

In proportion to the descending speed of burden in shaft, total air volume is determined by automatic control according to the setting value of Air Ratio, herein under AR. Air volume to combustion chamber is determined by automatic control according to the setting value of Air Split, herein under AS. Fuel gas volume is determined by automatic controller of hot gas temperature according to the setting value of the temperature and by descending speed × AR × AR.

6.4 STUDY OF ECONOMICAL HBI MAKING METHODS

(1) Review of iron making processes

Mainly due to the comparatively high investment cost and inherent lack of flexibility of conventional Blast Furnace, alternate iron making processes continue to proliferate. In order to select the most suitable iron making process in 20 or more new iron making processes the following 3 points have to be considered.

1) Final product
① Molten iron
② Pig iron
③ Hot briquetted iron
④ Sponge iron
⑤ Iron carbide (Fe_3C)

2) Iron ore
① Lumpy and/or oxide pellet
② Fine ore
- Pellet feed (< 44 μ : more than 75%)
- Sinter feed (～ 6 mm)
- Fine ore with size limitation

3) Reductants
① Natural gas
② Coal

Comparison of new iron making processes on these 3 points is shown in **Table-110**. In the table, COREX, FIOR, HYL III, Iron Carbide, MIDREX and SL/RN processes are operating on commercial scale.FINMET process is under construction in north-west Australia as a modified process of FIOR.

Table-110 Iron Making Process

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Circofer	Circored	COMET	FASTMET	FINMET	FIOR	HYL III	MIDREX	Iron Carbide	Inmetco	SL/RN	COREX	Cleansmelt	Ifcon	Romelt	DIOS	Hi-smelt	Technored
Products																		
DRI (Sponge iron)			☆	☆			☆	☆		☆	☆							
HBI (Hot Briqutted iron)	☆	☆		☆	☆	☆	☆	☆		☆								
Molten iron												☆	☆	☆	☆	☆	☆	☆
Pig iron												☆						
Iron carbide (Fe3C)									☆									
Raw Materials																		
Pellet / Lump							☆	☆			☆	☆						
Fine (Pellet feed)*1	☆*	☆*	☆	☆						☆								
Fine (Iron carbide feed)*2									☆									
Fine (Finmet feed)*3					☆	☆												
Fine (Sinter feed)*4													☆	☆	☆	☆	☆	
Fine (Circo- feed)*5	☆	☆																
Fine (Other limitation)																		☆
Reductants																		
Natural gas		☆			☆	☆	☆	☆	☆									
Coal	☆		☆	☆						☆	☆	☆	☆	☆	☆	☆	☆	☆

Source : Midrex report and others

Note
*1 : size of ore < 44 μ more than 75%
*2 : size range of ore 0.1 - 1 mm
*3 : size of ore > 6mm max15%, < 0.15mm max25%
*4 : size range of ore < 6mm
*5 : size range of ore 30 μ - 1mm
☆ *: micro pellet is applicable

(2) Selection of iron making processes

From the view point of reactivation of HIPARSA, the above mentioned 3 points shall be considered as follow.

1) Final product

As reduced iron produced in HIPARSA shall be sold to domestic and/or North/South American market as a main iron source of EAF, product shall be stored in HIPARSA stockyard at first, transported in land and/or ocean, stored in consumers' stockyard and charged into melting furnaces.

Accordingly product must have characteristics that resists reoxidation during handling.

As a result pig iron, hot briquetted iron (HBI) and iron carbide are applicable on HIPARSA.

2) Iron ore

The fluid bed technologies require as raw material fines iron ore with a size bigger than 44 microns, but this problem was solved by means of a micropeletization, which raised the granulometry up to 500 microns, according to the test made in Germany with the mineral of Sierra Grande in 1994.

Iron Carbide technology is operating from 1996 in Trinidad-Tobago, selling its product to Nucor Company of USA. FINMET is a modification and improvement of FIOR of Venezuela, which had been producing HBI for many years. CIRCORED have been installed in Trinidad-Tobago, but until now have not any commercial production on the world.

From the point of view of this Mission, no one of these technologies could be recommended to the reactivation of HIPARSA, because they are not proved as the process MIDREX and HYL, which are producing 63.5% and 26.4%, respectably, of the total world DR iron.

3) Reductants

Natural gas shall be able to be supplied from the existing main gas line by installing a new branch line around 47 km to Puerto Colorada.

Cost of gas is stated to be US$ 0.062179/m^3 (Calorific value : 9700 kcal/m^3 , US$ 1.6/mmBTU). Rio Turbio coal which is produced in Santa Cruz is also available and cost (cif US$ 40/t, Calorific value : 6500 kcal/kg, US$ 1.55/mmBTU) is competitive with gas.

However, volatile matter, ash content and Fixed Carbon are so much different from the specified coal which is recommended on FASTMET process that Rio Turbio coal will not be able to be used as reductant for FAST MET process.

As a result, processes what satisfy the above mentioned 3 points are MIDREX and HYL III only and in both cases the product is Hot Briquetted Iron (HBI). Typical data about final product, iron ore and reductants of MIDREX, HYL III and FAST MET (as reference) are shown in **Table-111**.

Process detail and typical operation parameters are also shown in **Table-112**. MIDREX and HYL III have already been commercialized and both have enough operation result.

Specification of DR grade pellet and typical characteristics of HBI/DRI produced in commercial plants are shown in **Attachment-14** and **Attachment-15.**

Table-111 Comparison of MIDREX, HYL III and FAST MET

	MIDREX	HYL III	FAST MET
Product			
Type	HBI / DRI	HBI / DRI	HBI / DRI
Total Fe (%)	90 to 94	91 to 93	86 to 92
Metallic Fe (%)	83 to 89	83 to 88	80 to 87
Metallization (%)	92 to 95	92 to 95	92 to 95
Gangue minerals (%)	2.0 to 6.0	2.0 to 6.0	4.0 to 8.0
C (%)	0.8 to 1.2	1.2	1.0 to 6.0
Iron Oxide			
Type	Pellet / Lump	Pellet / Lump	Pellet feed
Size (mm)	Pellet 9 - 16	Pellet 9 - 16	< 0.044 more than 75%
	Lump 10 - 35	Lump 10 - 35	
Operation Parameter			
Iron ore (t / t-HBI)	1.45	1.45	1.3
Nat. gas (Gcal / t-HBI)	2.6	2.8	0.6
Coal (75%FC, t / t-HBI)	—	—	0.35
Binder (kg / t-HBI)	—	—	2.6
Electricity (kWh / t-HBI)	130	90	90
Water (m^3 / t-HBI)	1.5	1.8	1.0

(Source : MIDREX report)

Table-112 Comparison of MIDREX, HYL III and FAST MET

	MIDREX	HYL-III	FAST MET
Technology Owner	Midrex International BV	Hylsa S.A.	Midrex / Kobe Steel
Process Description	Oxide pellet and / or lump ore charged from the top of shaft furnace are reduced by reducing gas which is generated in a stoichiometric CO2 reformer and fed directly from tuyers to furnace. Charged material descend from top to bottom by around 6 to 8 hours, and discharged at ambient temperature or hot briqutted.	Oxide pellet and / or lump ore charged from the top of shaft furnace are reduced by reducing gas which is generated in a steam reformer, with the reformed gas quenched and reheated, and fed from tuyers to the furnace. Charged material descend from top to bottom by around 6 to 8 hours, and discharged at ambient temperature or hot briqutted.	Green ball produced from mixed cake of iron ore fines, coal fines and binder are dried at low temperature and charged to a rotary hearth (RHF) furnace by one layer deep. Burners located in the RHF heat the pellet, which gasifies the coal within the pellets and reduces the iron ore. After one revolution of the RHF, the pellets are discharged hot and charged to meltshop directly or briqutted.
Standard Process Flow	(refer **Figure-58**)	(refer **Figure-59**)	(refer **Figure-60**)
Process Details			
Reactor type	Shaft furnace	Shaft furnace	Rotary hearth furnace
Reactor temperature (℃)	750 to 900	750 to 900	1350
Reactor pressure (atm)	2.0	6.0	1.0
Reformer type	CO2 or steam	Steam	(None)
Reductant	HC gas	HC gas	Coal, Coke
CO2 removal	No	Yes	No
Export gas	No	No	No
Residence time	6 - 8 hours	6 - 8 hours	8 - 12 min
Commercial Plant	46 modules approx. 25.6 mtpy	15 modules approx. 8.8 mtpy	None

(Source : Midrex report and others)

Figure-58 MIDREX Process Flow

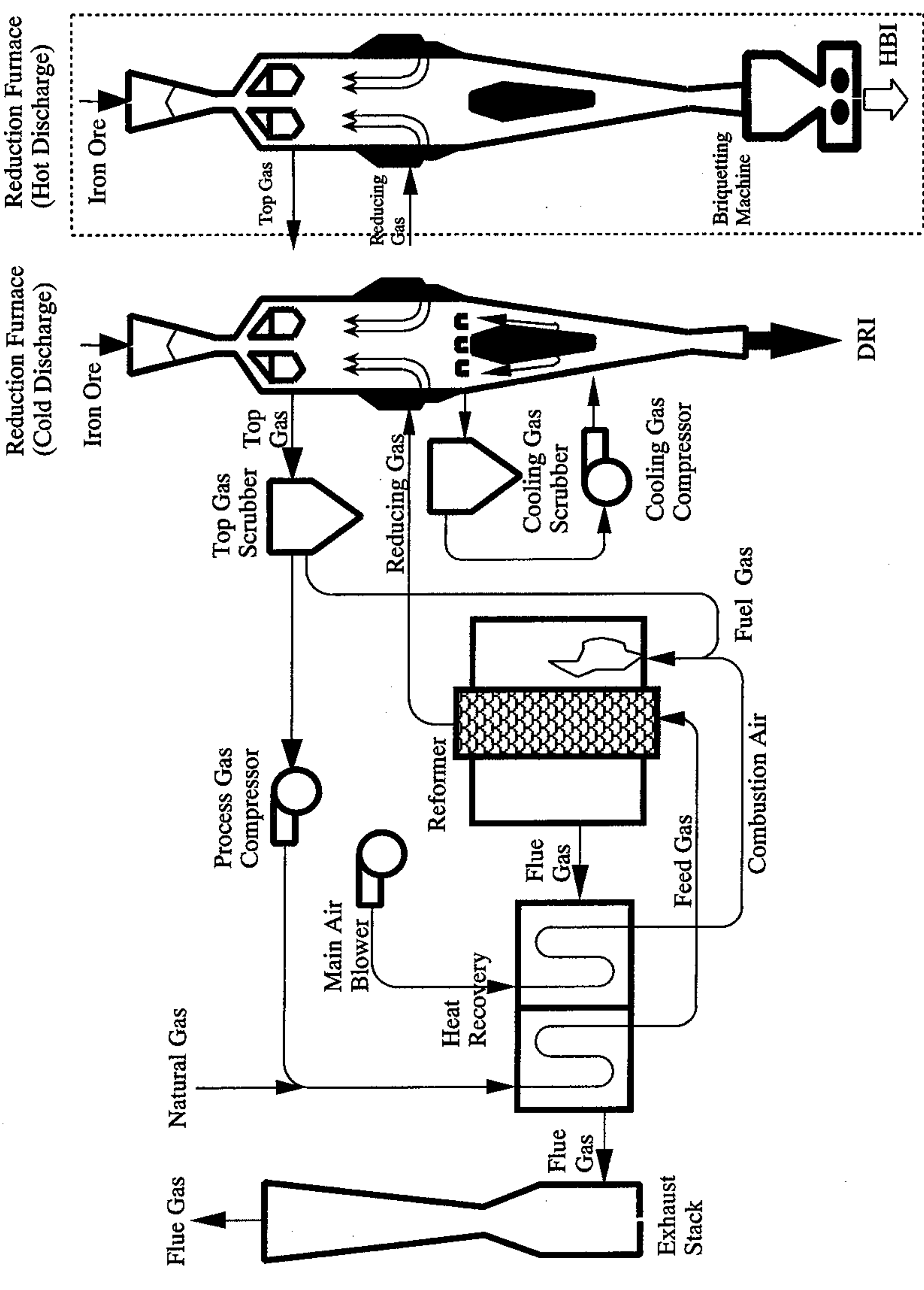


Figure-59 HYL-III Process Flow

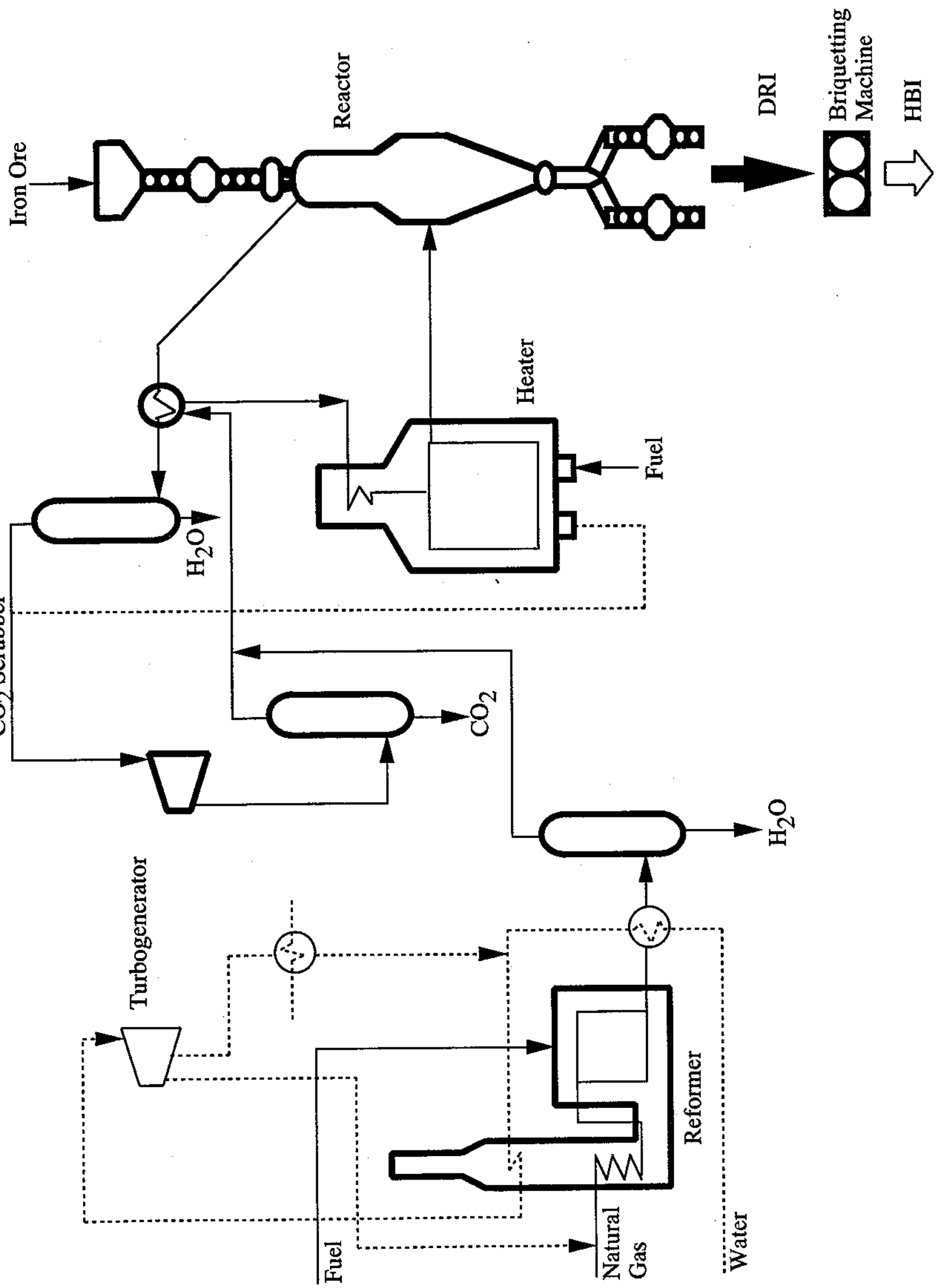
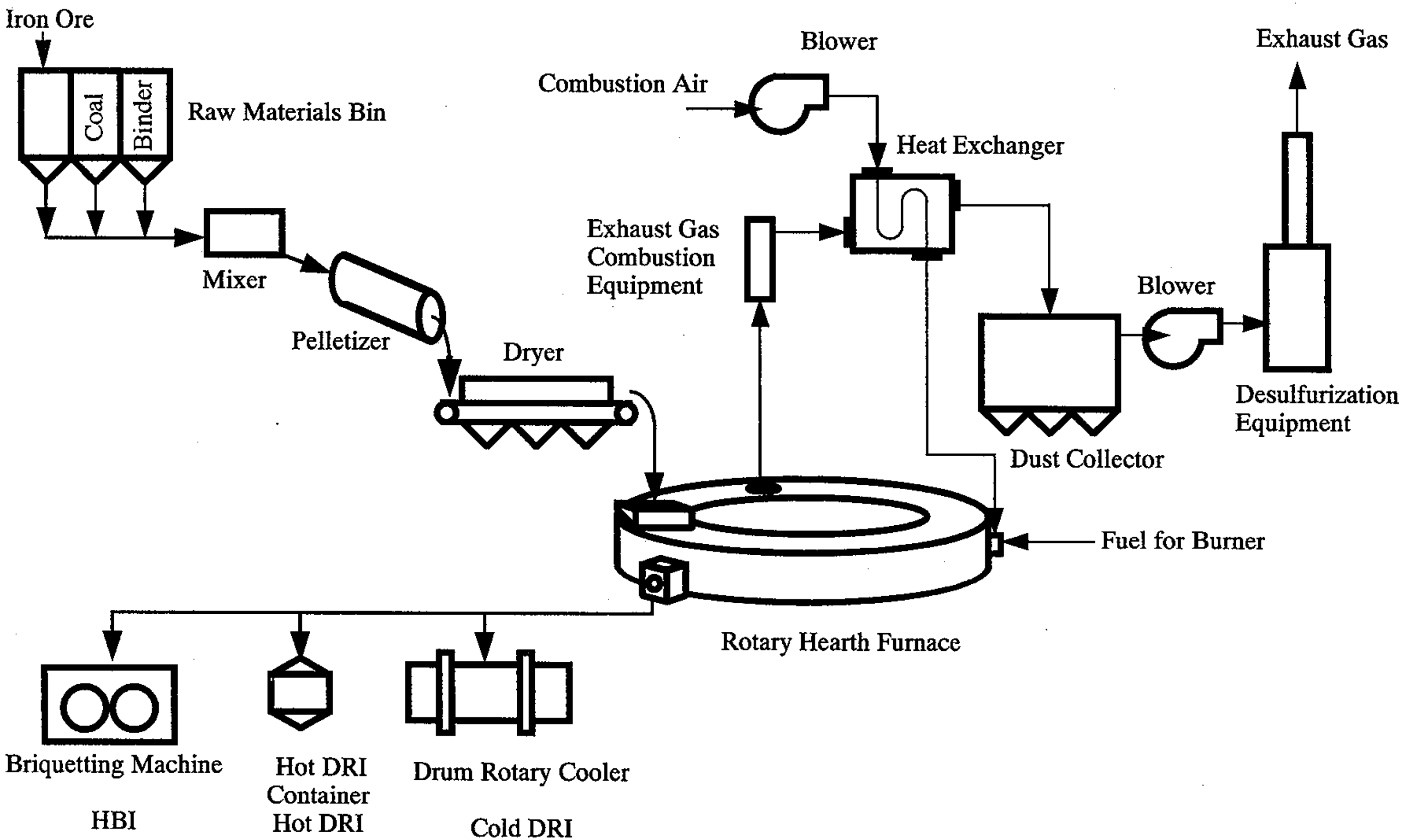


Figure-60 FASTMET Process Flow



Attachment-14 Specification of DR Grade Pellet

	Specification		Commercial Product (as an example)				
	Actual	Desired	C	L	S	K	G
Chemical (%)							
Fe	> 66.0	> 67.0	67.8	67.5	67.4	67.22	67.3
$SiO_2 + Al_2O_3$	< 3.5	< 2.0	1.45	1.20	2.4	3.0	1.9
P	< 0.03	< 0.02	0.02	0.025	0.05	0.019	0.024
S	< 0.025	< 0.015	0.004	0.001	n.d.	0.005	0.004
CaO			0.89	1.05	0.8	1.16	1.5
MgO			0.78	0.75	0.4	0.17	0.3
TiO_2	< 0.35	< 0.15	n.d.	0.18	n.d.	n.d.	n.d.
Physical							
Size 9 - 16 mm (%)	> 85	> 90	87.3	92	90		94
- 6.3mm (%)		< 4.0	1.4	<5 1	1.5	4.1	<5 0.15
Compression str.							
Average (kg)	> 200	> 250	300	270	300		340
< 50kg (%)	< 5	< 2					
Tumble strength							
> 6.3 mm (%)		> 94.0		95	95		
< 1 mm (%)		< 3.0		4			
Metallurgical							
Linder (760℃)							
Fine (< 3.3 mm %)		< 3.0	<6 2.19	<6 1		<6 3.68	
Comp. str (kg)		> 50	90				78
Metallization %)		> 92.0	91.2	90.9		95.5	91.4
Static bed reduction							
with load (815℃)							
Tumble (> 6.3 mm %)		> 90.0	>3.3 99.5				
Clustering		none					

Attachment-15 Typical Characteristics of HBI

	Typical	Commercial			
		A	B	C (DRI)	D (DRI)
Chemical (%)					
T.Fe	91～93	93.2	91.3	93.0	91.4
M.Fe	83～88	86.9	82.3	87.38	81.96
Metallization	92～95	93.3	90.1	94.0	89.71
C	1.0～1.5	0.4	1.4	2.0	1.94
SiO_2	2.0～3.5				
Al_2O_3	0.5～1.5				
CaO	0.2～1.6	4.5	3.9	3.5	3.4
MgO	0.3～1.1				
MnO	0.1～0.2				
P	< 0.04	0.07	0.13	0.035	0.018
S	< 0.015	0.008	0.018	0.003	0.001
V	< 0.2	n.d.	n.d.	n.d.	n.d.
Ni,Sn,Zn,Cr,Cu	trace	n.d.	n.d.	n.d.	n.d.
Physical					
Bulk density (t/m^3)	2.6～2.7	n.d.	2.7	2.01	1.7
Aprt. density (t/m^3)	5.5	5.3	5.1	3.23	2.85
Nom. size (mm)	30 x 60 x 90	30 x 60 x 90	34 x 61 x 97	n.d.	n.d.

(3) Required utilities

Required quantity of utilities and their properties are shown in **Table-113** and **Table-114**, on the base of 750 kilo-t/year HBI will be produced at Puerto Colorada. Unit consumption of coal in FAST MET process is adjusted by FC content.

(4) Capital cost and operation cost

Comparison of typical data on capital cost and operation cost are shown in **Table-115** as a preliminary on the base of 750 module HBI plant will be constructed at Puerto Colorada and 750 kilo-t/year HBI will be produced on a standard condition.

Table-113 Required Utility (Quantity)

	MIDREX		HYL III		FAST MET		Suppliability
Product (HBI)	750kilo-t/year	7500 h/year	750kilo-t/year	7500 h/year	870 kilo-t/year	7500 h/year	
	Unit cons. (per t-HBI)	Demand (per Year)	Unit cons. (per t-HBI)	Demand (per Year)	Unit cons. (per t-HBI)	Demand (per Year)	(per Year)
Natural gas (Gcal)	2.6 Gcal	1.95 x 10^6	2.8 Gcal	2.10 x 10^6	0.6 Gcal	0.52 x 10^6	
(Nm^3 - 8800 kcal/Nm^3)	295Nm^3	221 x 10^6	318Nm^3	239 x 10^6	68Nm^3	59.2 x 10^6	
20% allowance (Nm^3)		265 x 10^6		286 x 10^6		71.0 x 10^6	
Coal (44 %FC - ton)	—	—	—	—	0.58	504,600	
20% allowance (ton)						605,520	
Water (m^3)	1.5	1,125 x 10^3	1.8	1,350 x 10^3	1.0	870 x 10^3	
20% allowance (m^3)		1,350 x 10^3		1,620 x 10^3		1,044 x 10^3	
Electricity (kWh)	130	97.5 x 10^6	90	67.5 x 10^6	90	78.3x 10^6	
20% allowance (kWh)		117 x 10^6		81.0 x 10^3		94.0 x 10^3	

Table-114 Required Utility (Quality)

Natural Gas			Coal			Water		
		Pico Truncado			Rio Turbio			Available
Gas composition (%)			Proximate analysis (%)			Characteristics		
CH_4	65.0～96.0	90.02	Ash	10	16.0	PH value		
C_2H_6	1.0～26.0	4.81	Volatile matter	15	40.0		(mg/lit)	
C_3H_8	0.04～7.0	1.91	Fixed carbon	75	44.0	Total hardness	11.9～35	128, 170
other CmHn	～2.8	1.20	Ultimate analysis (%)			Calcium hardness	11.9～30	
			C		76.6	Total alkalinity	12.6～37	124, 147
CO_2	0.02～12.0	0.17	H		6.2	Suspended solids	0.5～10.5	
N_2	0.4～17.0	1.90	N		0.8	Dissolved solids	16～50	
H_2	～0.2	0.00	S		0.9	Sulfate	1.5～3.0	66, 94
O_2	0.01～1.0	0.00	O		15.5	Total Fe	0.16～2.4	< 0.1
			Ash analysis (%)			Dissolved Fe	0.16～0.8	
Net calorific value		9,700	Fe_2O_3 / TiO_2		13.2/0.9	Silica	3.4～10.9	
(Hh kcal/Nm³)			SiO_2 / Al_2O_3		52.2/20.3	Chloride	0.5～1.3	35, 50
Gross calorific value		8,800	CaO /MgO		7.9/0.9			
(Hl kcal/Nm³)			P_2O_5 / SO_3		P/S 0.1/3.4	Temperature (℃)	max 35	
			K_2O / Na_2O		0.4/0.6	Pressure(kg/cm²G)	5～7	
			Hardgrove Index		50			
			Moisture (%)		14			
			Calorific value (kcal/kg)		6500			
			Ash Soft. temp (℃)		1280-1300			
			Melt. temp (℃)		1350-1420			

Table-115 Comparison of Capital Cost and Operation Cost (Preliminary)

	MIDREX			HYL III			FAST MET		
General Spec.									
Nominal capacity (kilo-t/year)	750			750			870		
Module size	750			750			45×2		
Operation rate (h/year)	7,500			7,500			7,500		
Capital Cost (m$)	170			175					
Operation Cost	Unit cons. (per t-HBI)	Unit price ($)	Cost ($/t-HBI)	Unit cons. (per t-HBI)	Unit price ($)	Cost ($/t-HBI)	Unit cons. (per t-HBI)	Unit price ($)	Cost ($/t-HBI)
Iron ore (Pellet-t)	1.45	30	43.5	1.45	30	43.5	—		
(Conc.-t)	—			—			1.3	20	26
Natural gas (Nm³)	295	0.062179	18.34	318	0.062179	19.77	44	0.062179	2.74
Coal (75%FC-t)	—			—			0.58	40	23.20
Electricity (kWh)	130	0.040	5.20	90	0.040	3.60	90	0.040	3.60
Water (m³)	0.5	0.34	0.17	1.8	0.34	0.61	1.0	0.34	0.34
N_2 gas (Nm³)									
Binder (kg)	—			—			2.6	1.8*	4.68
Consumable									
Labor (m-h)	0.5	6	3.0	0.5	6	3.0	0.5	6	3.0
Maintenance ($)	6.0		6.0	9.0		6.0	6.0		6.0
Total			76.21			76.48			69.56

* Peridure : 1800$/t

6.5 REQUIRED UTILITIES FOR IRON ORE MINES, CONCENTRATION, PELLETIZING AND HBI MAKING PROCESS

Required utilities for mine, concentration plant, pelletizing plant and HBI plant are shown in **Table-116**.

Table-116 Required Utilities in Normal Operation

		Mine 2,600,000t/year	Conc.Plant 1,100,000t/year	Pellet Plant 1,100,000t/year	HBI Plant 750,000t/year	Others		Total
Natural Gas	Nm^3/t	-	-	15	295			
	$Nm^3/year$	-	-	16.5 x 10^6	221x 10^6			
Coal	kg/t	-	-	6	0			
	t/year	-	-	6,600	0			
Water	m^3/t	0.15	1.80	0.3	0.5			
	$m^3/year$	390 x 10^3	1,980 x 10^3	330 x 10^3	375 x 10^3			
Electricity	kWh/t	15.0	63.5	73.0	130			
	kWh/year	39.0 x 10^6	69.9 x 10^6	80.3 x 10^6	97.5 x 10^6			

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.

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/m^3	2.0 - 2.3 t/m^3	2.6 - 2.7 t/m^3
Aparent density			5.5 t/m^3
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

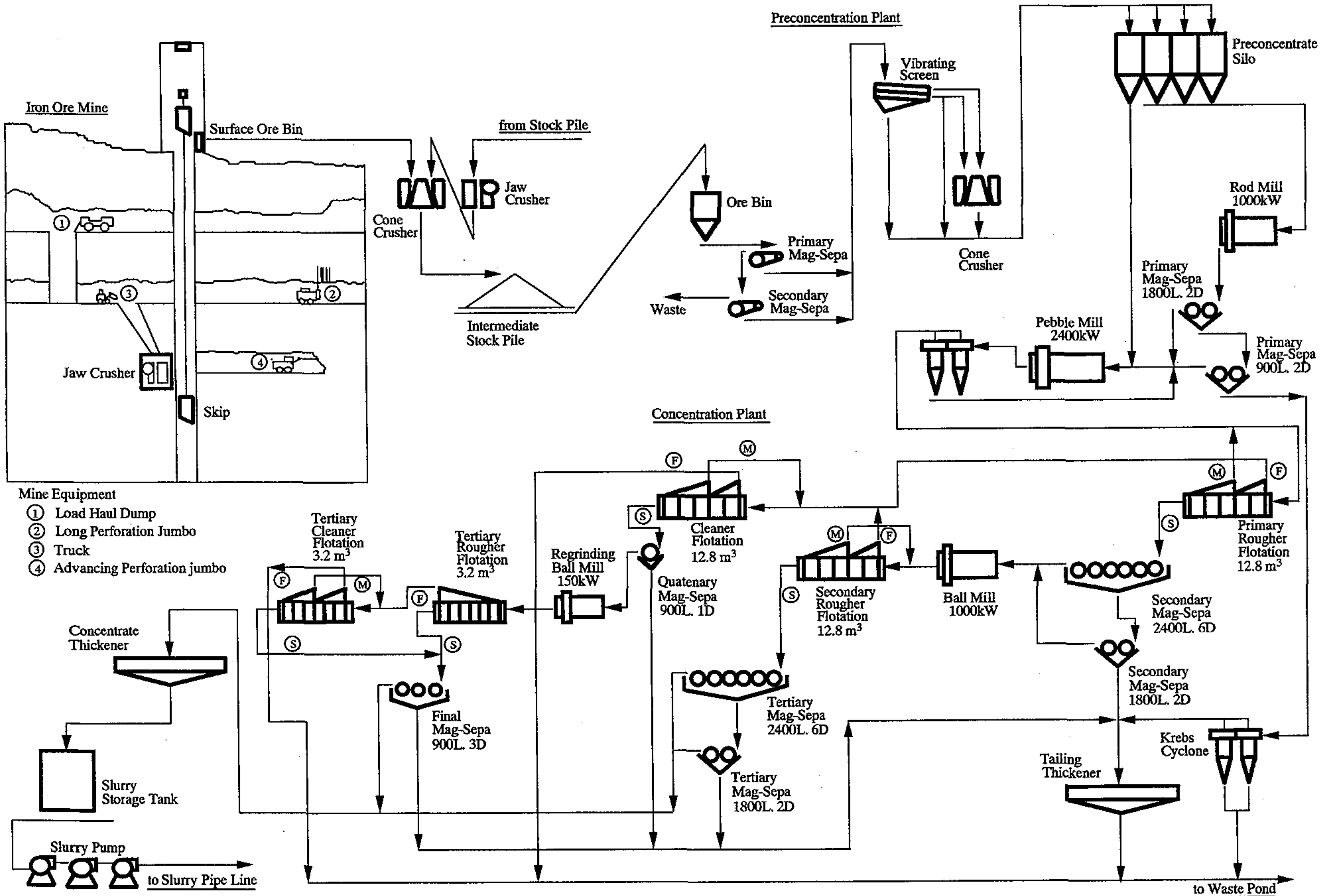
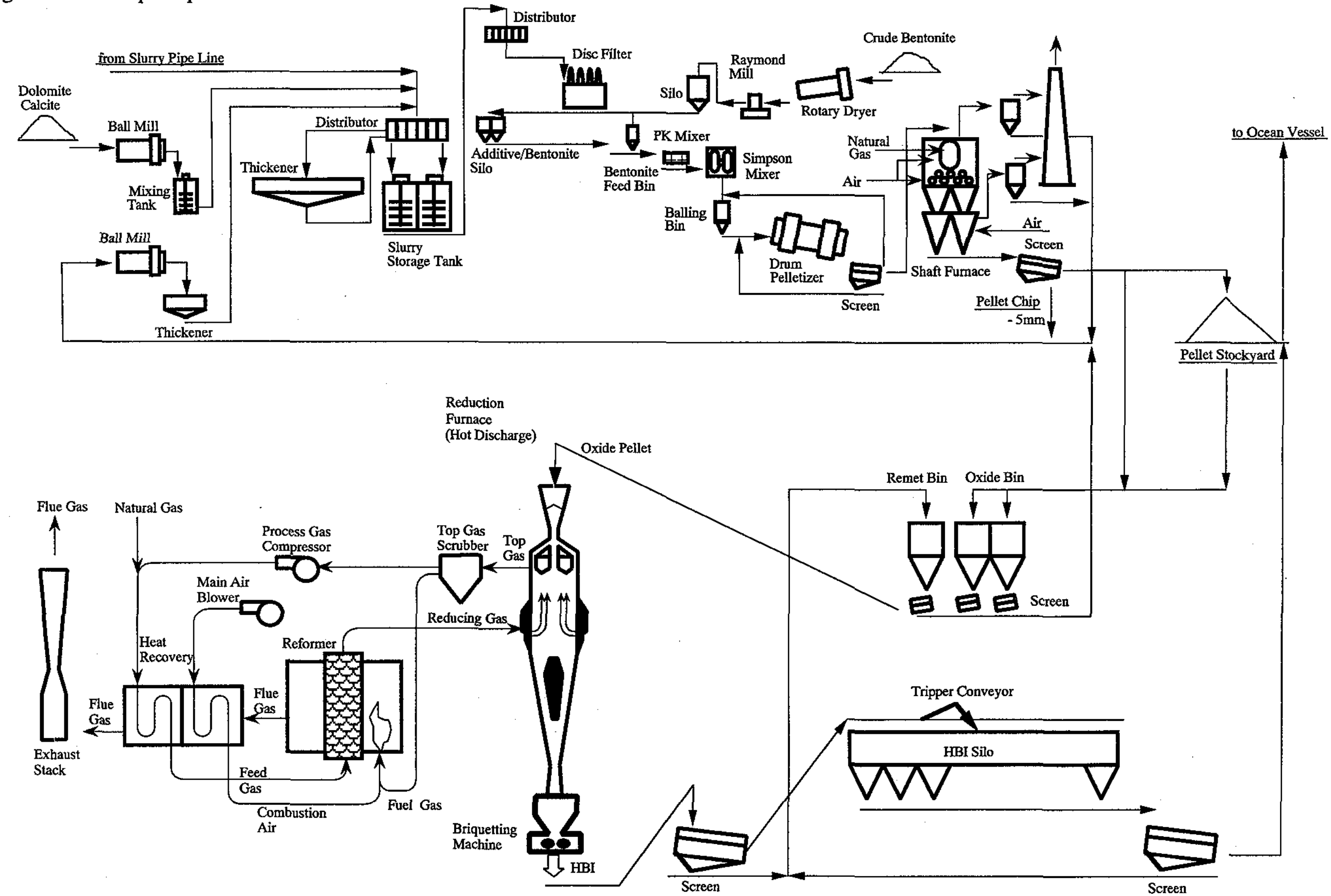


Figure-62 Conceptual process flow



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.

Investment for natural gas pipe line and water supply pipe line to be investigated in the second site survey.

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

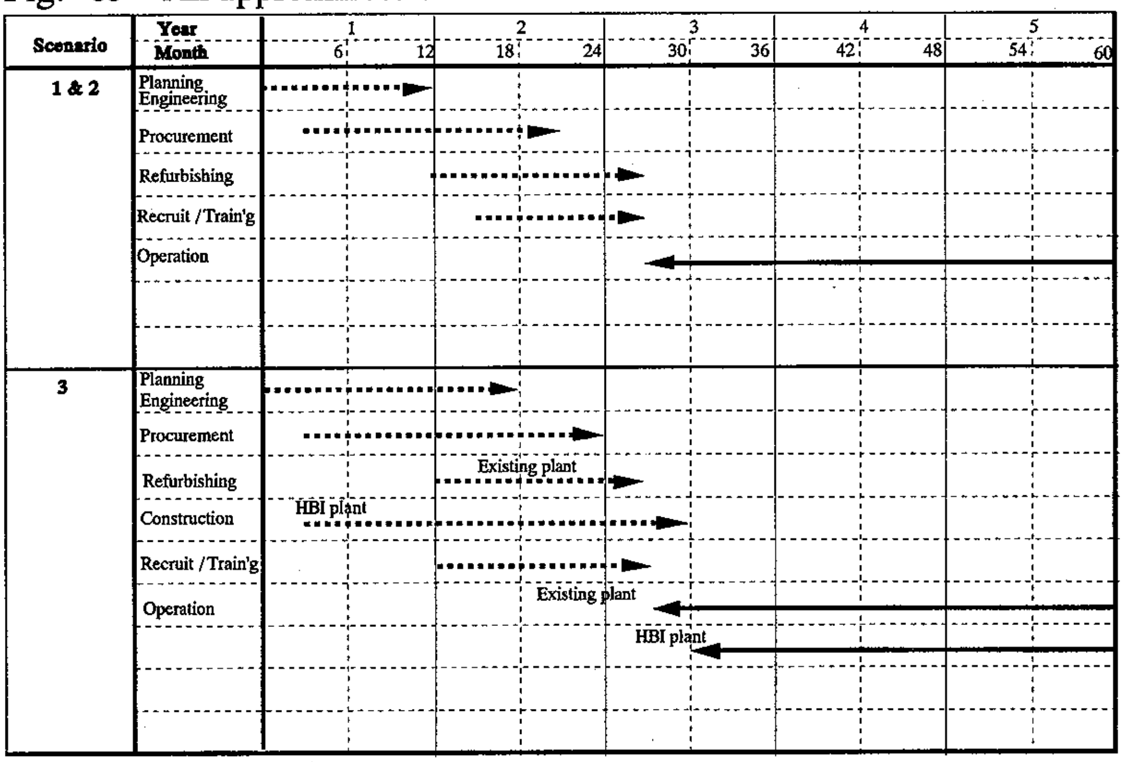
Item		Unit	Price	Unit Consumption	Cost	Note
			US$	per ton	US$/t	
Raw Material	Pellet	ton	31.38	1.45	45.50	
	Remet					
	Chips etc.					
Total RM.						
Variable	Electricity	kWh	0.04	130	5.20	
	Natural Gas	Nm^3	0.062	295	18.29	
	Coal	ton	—	—	—	
	Water	m^3	0.1	0.5	0.05	
	Consumable - 1					
	Screen plate					
	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**.

The 4 scenarios are: -

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.

(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.

Concerning on major facilities, each scenario does not have specific difficulty, but capacity up of water suppliability is required for every scenarios and natural gas for S-3.

(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. Although Sideral is expected to be the one customer and as CVRD has a 5 % share in Sideral it may be difficult to sell all 1,130 kilo-t/year.

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

---to be sutudied further

(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

The Reactivation Program is largely influenced by the preparation periods required such as an international tender. The Program after construction is started can estimate fairly accurately.

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.

The Program is not very different between S-1,S-2 and S-3, because the critical path of the Program is the procurement of the main equipment.

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"

Comparison between S-2 and S-3,recovery of investment is almost same, but sales price in S-3 is quite conservative and to be investigate further, while sales price in S-2 is actual market price, so, superiority of S-3 will be enlarged. Moreover a lot of jobs can be created by selecting S-3 in Sierra Grande area.

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.

However the conclusion will have to be drawn from the premises that phosphorus content of iron ore concentrate will be able to be decreased to the acceptable level through the economically acceptable procedure.

Chapter 9

FORMULATION OF A REACTIVATION PLAN FOR HIPARSA

Data presented in Chapter 7 and 8 were 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.

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** ,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**. Comparison of past records and laboratory test is shown in **Fig.-30** to **Fig.-32**.

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

62×6077.8×3=1.13 million-t/year

(5) Unit consumption

1) From pot test result (6.3.2) 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 (**Table-127**)

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).(Expected specification of HBI is shown in **Table-128.**)

Figure-64 750 HBI Plant

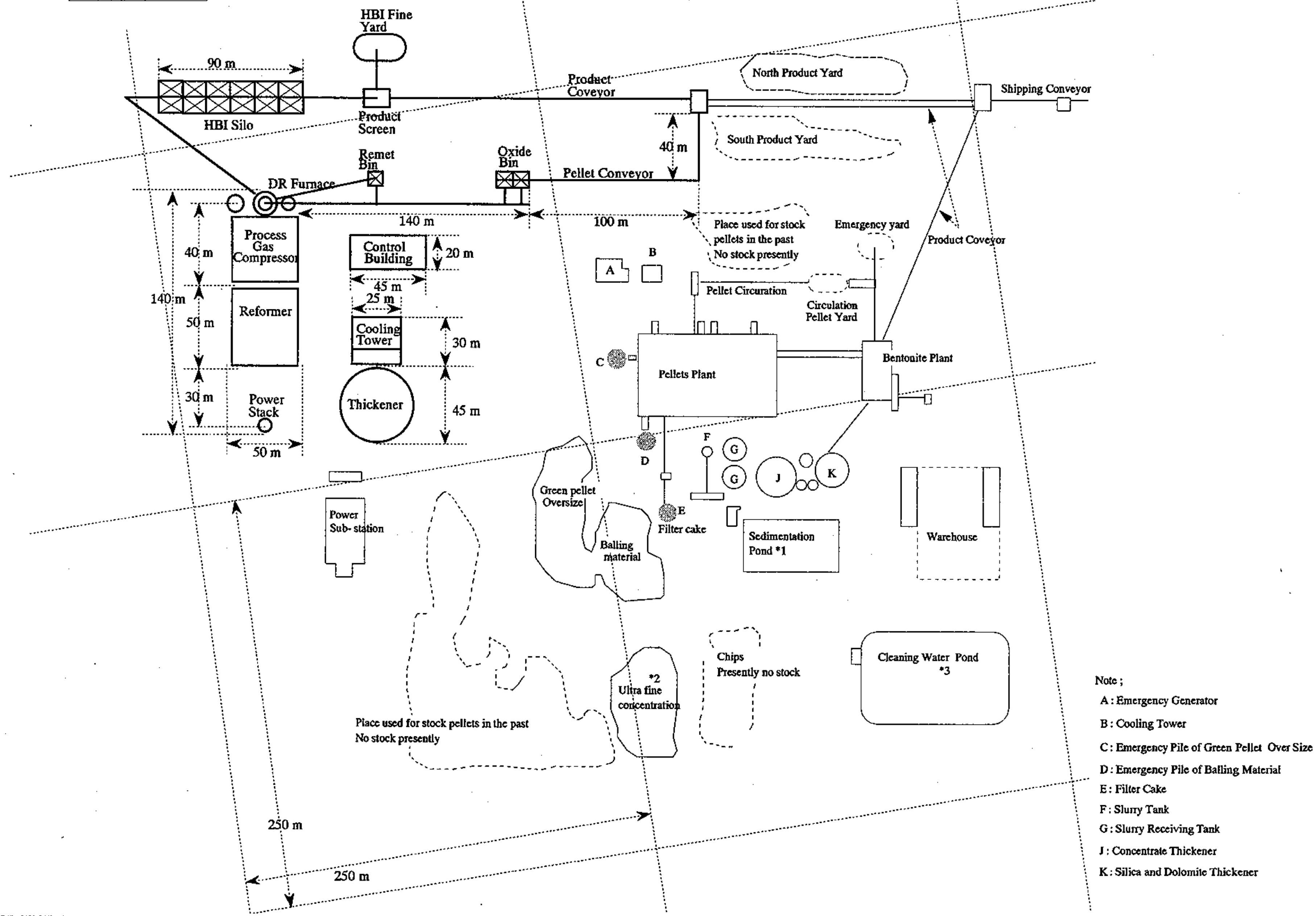


Table-128 Expected Specification of Iron ore/Concentrate/Pellet/HBI

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/m^3	—	—	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/cm^2	n.d.
H_2		0	CaO		6.4			
Calorific value	Kcal/Nm^3	9,658-9,731	MgO		1.4			
Hh		Ave.9,692	P		0.3			
Calorific value	Kcal/Nm^3	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. (Refer to **Attachment-6**.)

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. Initial investment of a required 16 inch diameter water pipeline and booster pump station will be at US$32.3-million cost.

(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" ϕ $\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" ϕ $\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.

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	

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).

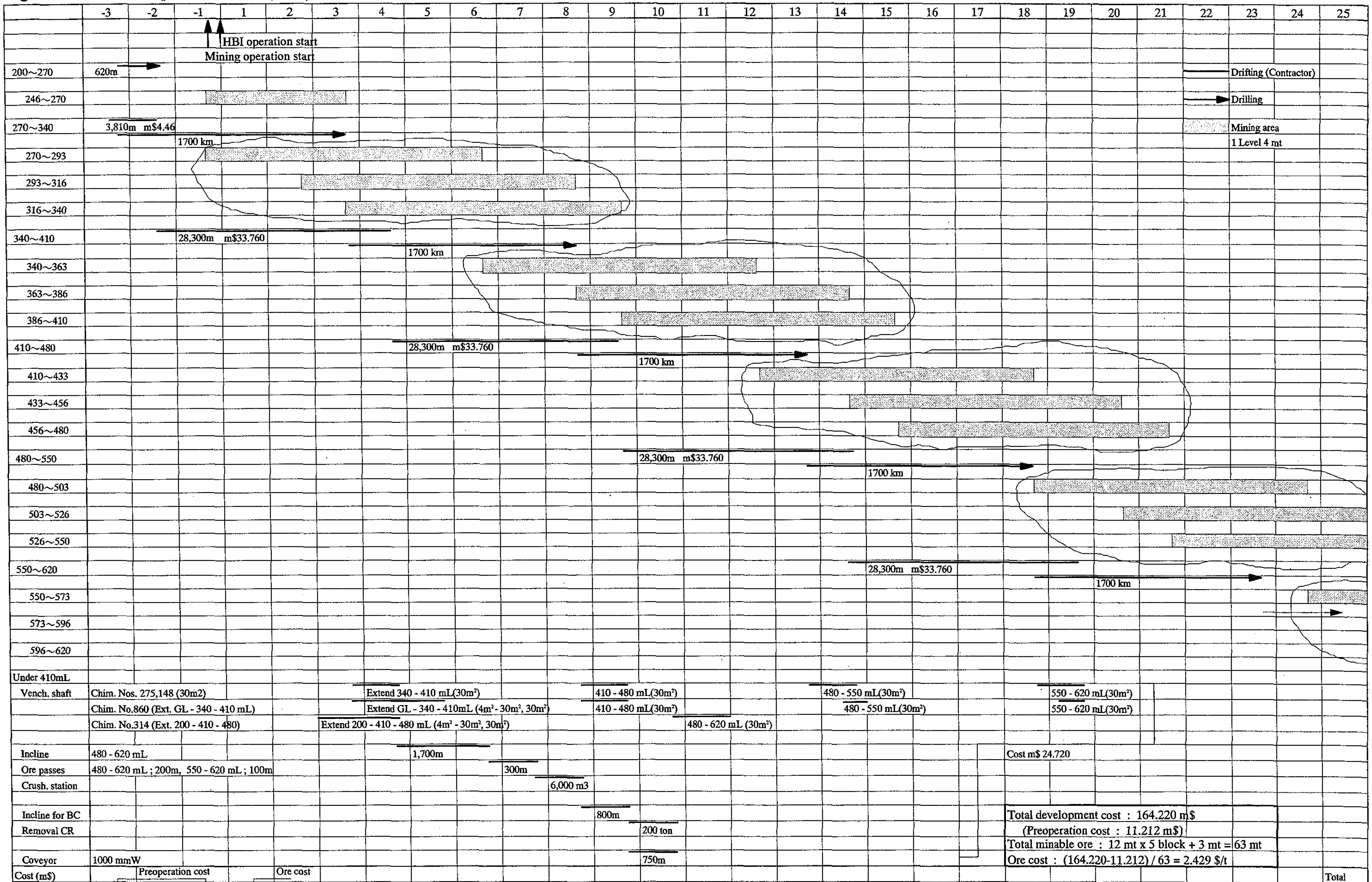
Namely, total required cost for development after commissioning :

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**.

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	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

9.3.2 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.

9.3.4 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.

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.

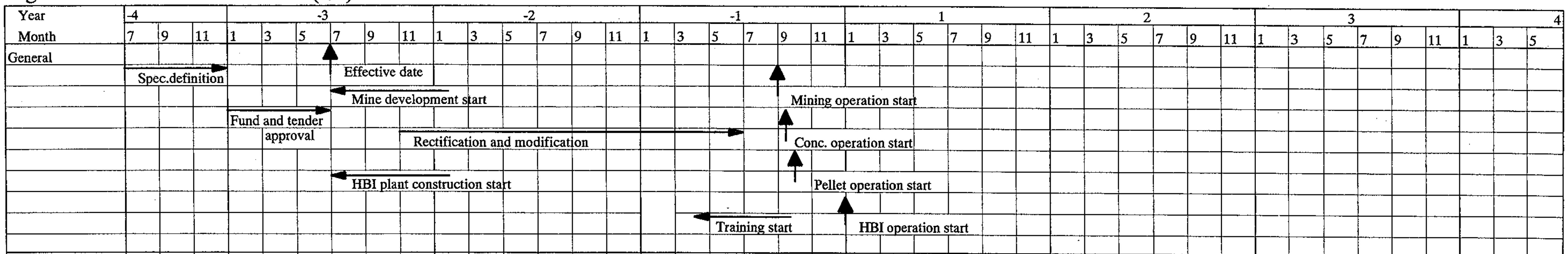
Considering the pellet storage capacity and the learning curve of the plants, pellet plant operation shall be started 3 months before HBI plant commissioning.

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



Production (kt/m)

	Year -1, M9	Year -1, M11	Year 1, M1	Year 1, M3	Year 1, M5	Year 1, M7	Year 1, M9	Year 2, M1	Year 2, M5	Year 3, M5	Year 4, M1
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

Note:Excluding of stope development contractor and system operation contractor

Recruiting Schedule

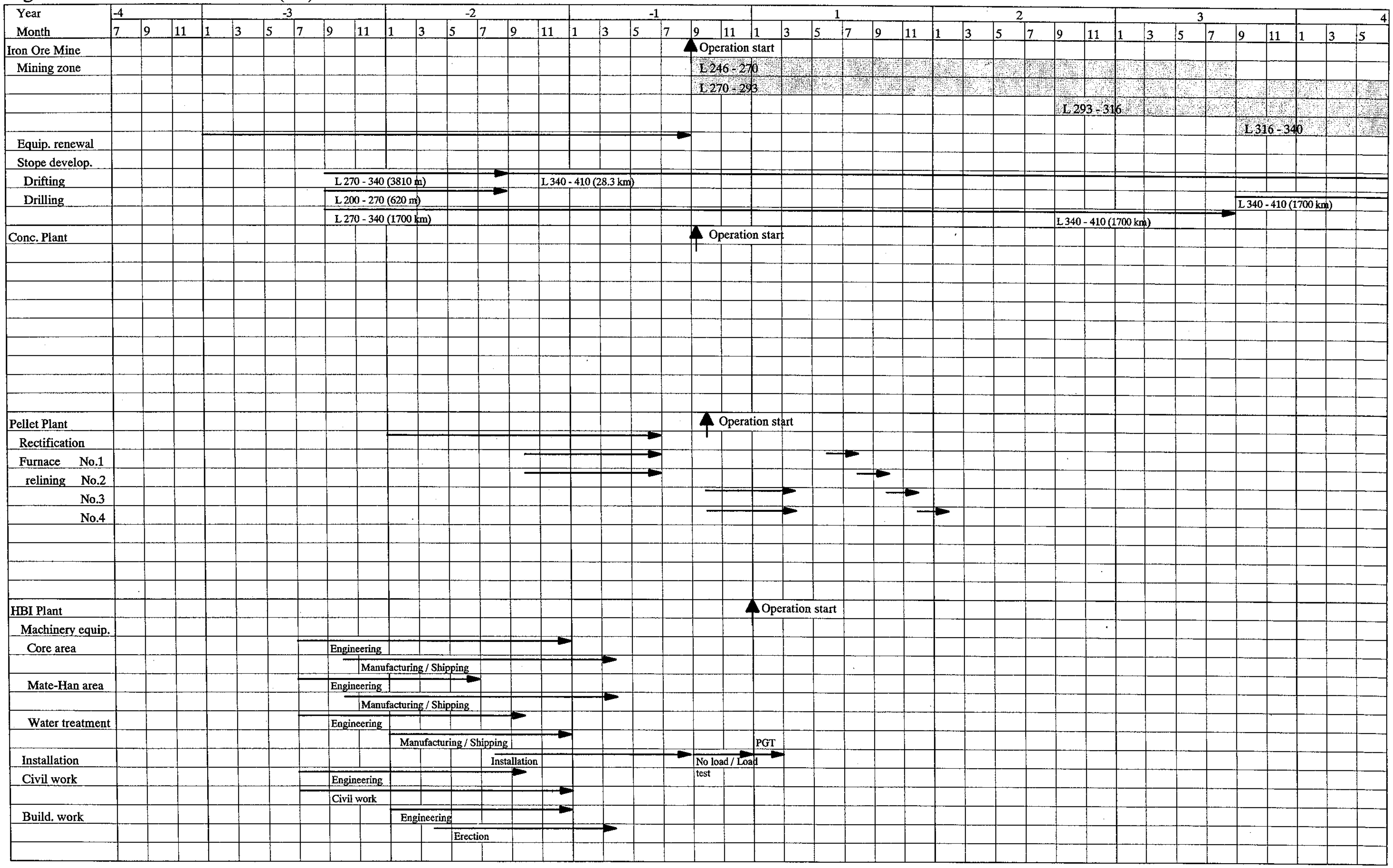
Planning staff (from Year -4, M7) — Construction staff (from Year -3, M7) — Trainer/Core staff (from Year -1, M1)

	Year -4, M7	Year -3, M7	Year -1, M1	Year -1, M3–M5	Year -1, M7	Year -1, M9	Year 1, 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, M3 to Year -1, M7)
- Gas line: Construction (Year -1, M5 to Year -1, M11)

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	286,156	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

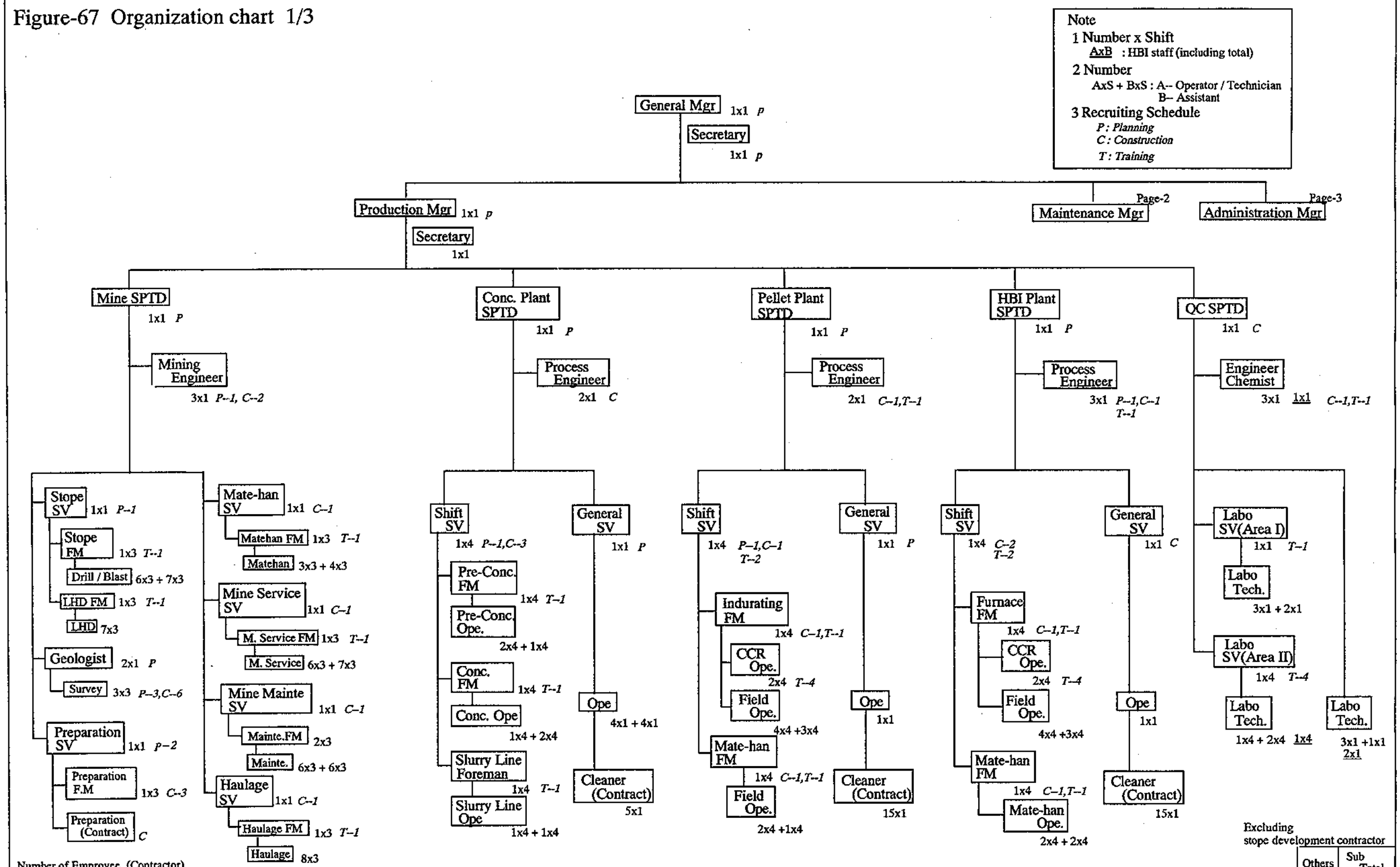
The organization and manpower allocation is shown in **Fig.-67** and **Table-133**.

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

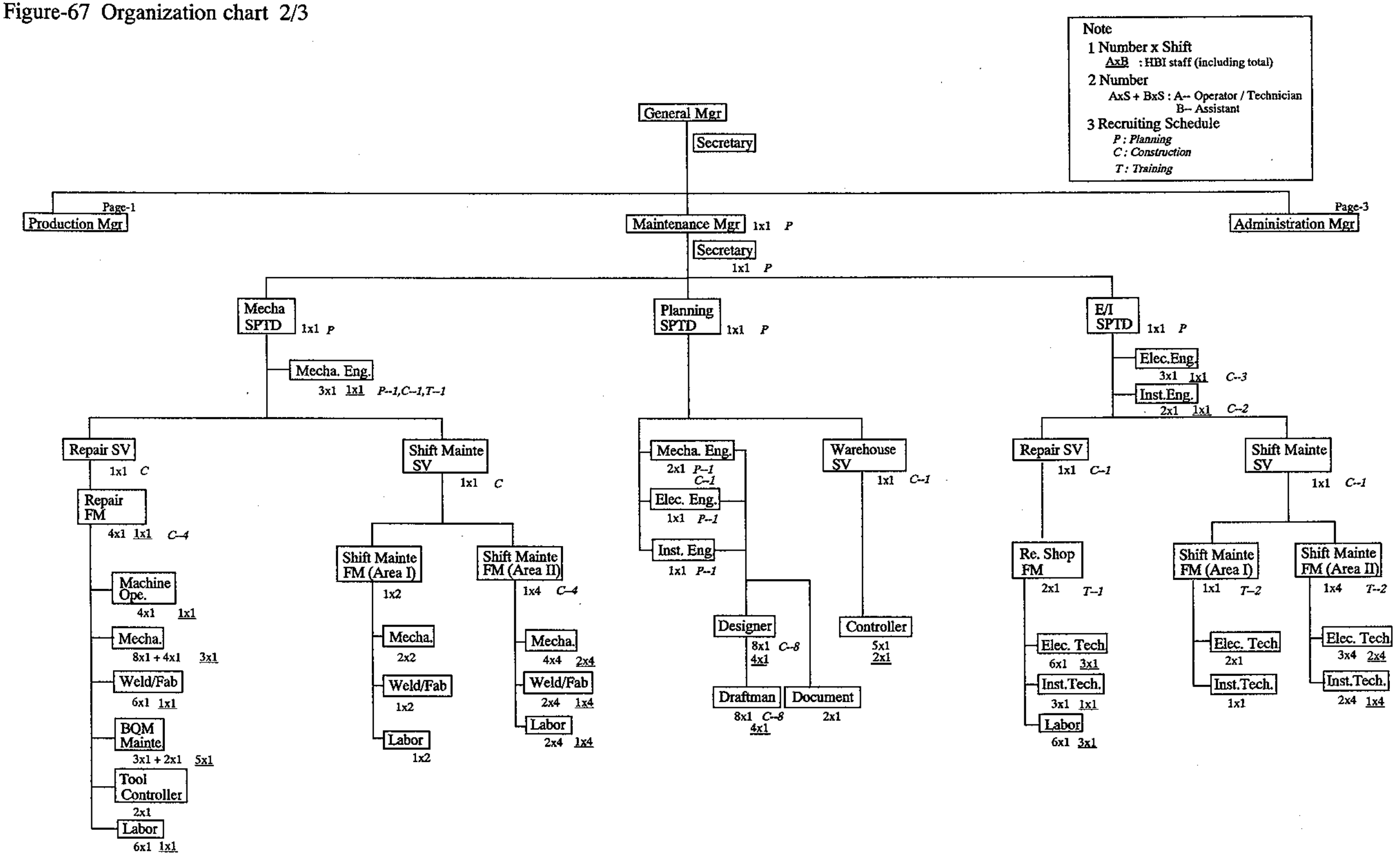


Number of Empioyee (Contractor)

Excluding stope development 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)

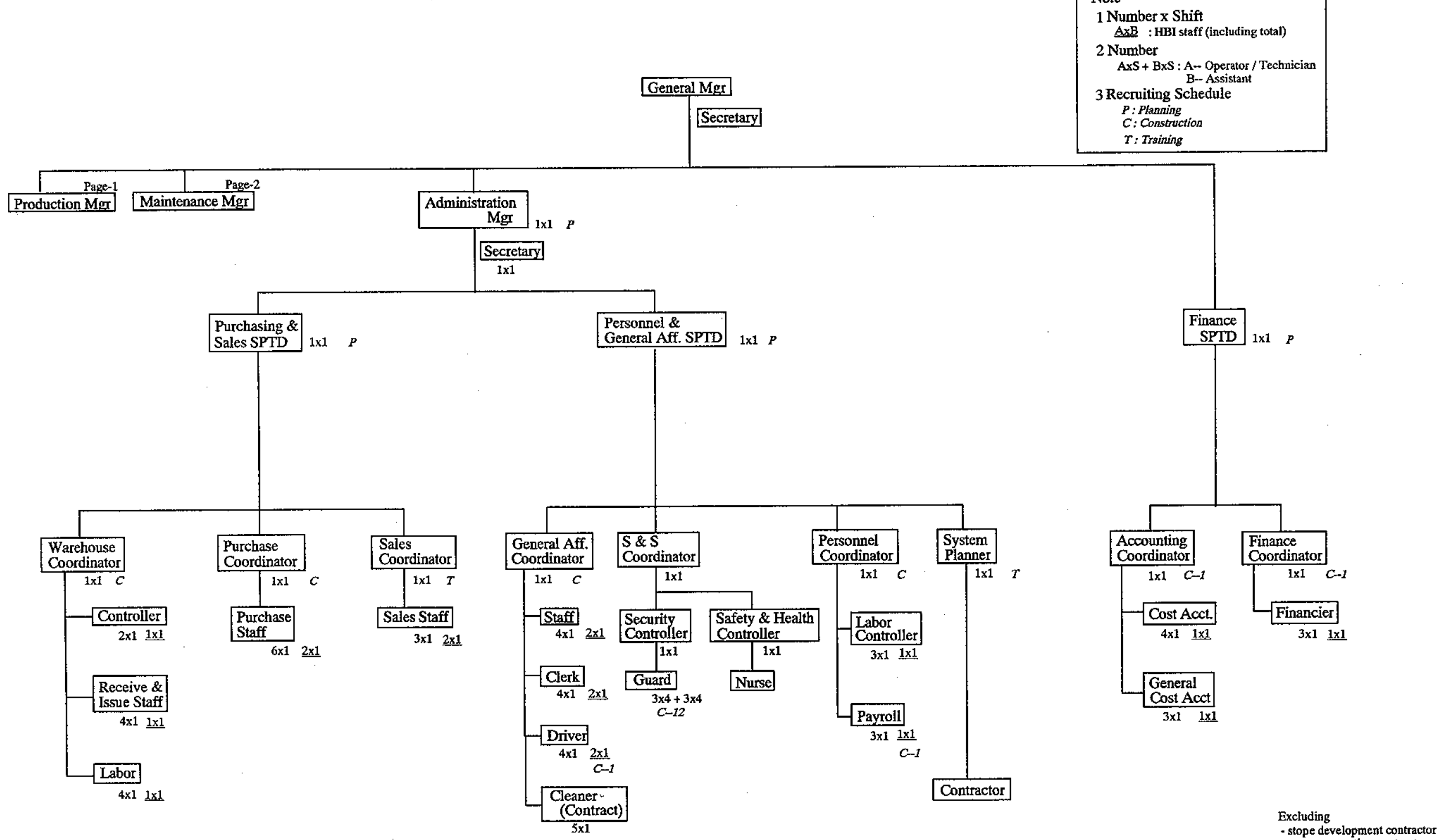
Figure-67 Organization chart 2/3



Number of Empoyee (Contractor)

	Mecha		Planning		E/I		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 Empoyee (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. Environmental law is enacted by the Federation Government, and each Provincial Government basically accepts and enforces the environmental standards.

Rio Negro Provincial Government the applicable agency for this project enforces the environmental law according to the environmental standards of the Federal Government. An investigation report "Environmental Impact Assessment" was submitted to the Provincial Government by all the enterprises who carried out production activities coming under the mining law in Rio Negro Province in 1996.

Thus, Rio Negro Provincial Government has begun to harmonize the environment and production activities by implementing the environmental impact assessments. It is necessary to carry out an investigation before hand when not only newly-constructed plant, but also the existing plants of HIPARSA are put into operation again.

It is confirmed that an investigation for an "Environmental Impact Assessment", is required to be submitted to the Provincial Government, in order to obtain the approval of the Provincial Government through the Head of the Environmental Department of the Federal Government and Rio Negro Provincial Government at the stage when HIPARSA is re-activated. 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

The information received from three experienced consultant companies which are able to carry out the investigations for the "Environmental Impact Assessment" as recommended by the Federal Government and the Provincial Government. has resulted in the following points being clarified with regard to the investigation of the Environmental Impact Assessment of the mining production activity.

(1) On this 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.

(4) It was clarified that Ambiental SA carried out the investigation of the Environmental Impact Assessment, and produced the report when HIPASAM stopped, and closed its production activity. This report was obtained from HIPARSA.

(5) The Environmental impact assessment at the stage when the production activity of HIPASAM was stopped is evaluated by the following numerical values as a result of the investigation of Ambiental SA as shown in **Table-135～139**.

(6) The law, the government ordinance, and the resolution concerning the environmental protection is classified as shown in **Table-140**. It is understood that a lot of laws, decrees, and regulations concerning the environmental protection exist.

Table-135 Solid composition which is separated from the process of pre-concentration and concentration

PARAMETROS		UNIDAD	No MUESTRA			
			1	2	5	6
Barlo	Ba	ppm	<1	<1	<1	<1
Manganeso	Mn	ppm	4.95	4.2	63.2	17.7
Ceamo	Cr	ppm	<0.2	<0.2	<0.2	<0.2
Plomo	Pb	ppm	<0.2	<0.2	<0.2	<0.2
Cadmio	Cd	ppm	<0.05	<0.05	<0.05	<0.05
Mercurio	Mg	ppm	<0.02	<0.02	<0.02	<0.02
Plata	Ag	ppm	<0.5	<0.5	<0.5	<0.5
Selenio	Se	ppm	<0.1	<0.1	<0.1	<0.1
Arsenico	Ar	ppm	0.09	<0.05	<0.05	0.06
Sulfatos	SO_4	ppm/kg	1.110	240	11.540	315
Cloruros	CL-	ppm/kg	350	440	9.700	530
Nitaratos	NO_3	ppm/kg	26	8.8	107	34.9
Fosforo	P	ppm/kg	6.9	<0.2	<0.2	<0.2

1. Laguna negra. Concentrado fuera de especificacion
2. Monticulos de material esteril. Etapa preconcentracion
5. Laguna blanca
6. Mineral de deposito intermedio

Table-136 Liquid exhaust which is produced from the process of mineral processing

PARAMETROS	UNIDAD	No MUESTRA 3	No MUESTRA 4	No MUESTRA 5	To Sewerage*	To Rain water Conduit / To Water Course	To Sewerage**
Sulfatos	mg/liter	11100	890	56.8			1.000
Cloruros	mg/liter	28600	870	150			
Nitaratos	mg/liter	2.2	19.6	0.9			30.0
Fosforo	mg/liter	0.42	<0.2	0.4			10.0
Dureza total como CO_3Ca	mg/liter	3960	560	170			
Alcalonidad como CO_3Ca	mg/liter	330	130	300			
Cianuro	mg/liter	<0.002	<0.002	<0.002	0.1		0.1
OD	mg/liter	2.6	7.8	8.5	50	20	
Solidos totalee disueltos	mg/liter	45690	2550	690			
Hidorocarburos	mg/liter	<0.5	-	-	50	50	100
PH	pH	8.1	8.2	8.3	5.5~10	5.5~10	7~10
Barlo	ppm	<0.10	<0.10	<0.1			
Manganeso	ppm	4.2	<0.02	<0.02			1.0
Cromo	ppm	<0.02	<0.02	<0.02	Cr+6 0.2 Cr+3 2	0.2 2	Total 2.0
Plamo	ppm	<0.02	<0.02	<0.02	0.5	0.5	2.0
Cadmio	ppm	<0.01	<0.01	<0.01	0.1	0.1	0.5
Mercurio	ppm	<0.01	<0.01	<0.01	0.005	0.005	0.05
Plata	ppm	<0.05	<0.05	<0.05			
Arsenico	ppm	<0.02	<0.02	<0.02	0.5	0.5	
Selenio	ppm	<0.02	<0.02	<0.02			
BOD	mg/liter				250	50	
Phenolic Substances	mg/liter				5	0.05	2.0
Temp.	℃				45.1	45.1	45

3. Laguna de clarificacion
4. Laguna Blanca
5. Espesador de Concentrado

* Resolution 79179/90 (Federal Level)
**Resolution 287/90 (Provincial Level)

Table-137 Pellet, concentrate with additives, and concentrate

PARAMETROS	UNUDAD	No MUESTRA		
		9	10	11
Bario	ppm	<1	<1	<1
Manganeso	ppm	8.55	<0.1	<0.1
Cromo	ppm	<0.2	<0.2	<0.2
Plomo	ppm	<0.2	<0.2	<0.2
Cadmio	ppm	<0.05	<0.05	<0.05
Mercurio	ppm	<0.02	<0.02	<0.02
Plata	ppm	<0.5	<0.5	<0.5
Selenio	ppm	<0.1	<0.1	<0.1
Arsenico	ppm	<0.05	<0.05	<0.05
Sulfatos	mg/kg	265	690	2540
Cloruros	mg/kg	2470	1050	1720
Nitaratos	mg/kg	93	17.5	118
Fosforo	mg/kg	<0.2	4.2	4.1

9. Pellets al alre libre

10. Concentrado con aditivos

11. Concentrado

Table-138 Solution quantity from solid waste

(Unit: mg/liter)

CONTAMINANTE	VALOR LIMITE EN REPUBLICA ARGENTINA(1)	VALOR LIMITE US-EPA(2)
Arsenico(As)	1	5
Bario (Ba)	100	100
Cadmio (Cd)	0.5	1
Cinc (Zn)	5	-
Cobre (Cu)	1	-
Cromo total (Cr)	5	5
Mercurio (Hg)	0.1	0.2
Niquel (Ni)	1.34	-
Plata (Ag)	5	5
Plomo (Pb)	1	5
Selenio (Se)	1	1

1) Decreo 831/93- Anexo VI (Reglamentario Ley 24051)-Residuos peligrosos

2)Test Methods for evaluating.Solid Waste-Volume One(US-EPA SW-826/sept. 1986)

Table-139 Water quality of river, drain ditch, and sea

	Unit	Nacion	Provincia de Rio Negro
Temparatura	℃	<45	<50
pH	-	5.5-10.0	6.0-10.0
SSEE:Sustancias solubles en eter etllica	mg/liter	<100	<100
Sulfuros	mg/liter	<1.0	<1.0
DBO (sobre muestra bruta)	mg/liter	<50	<50
Claro residual	mg/liter	<0.1	<5
Clanuros	mg/liter	<0.	<0.1
Hidrocarburos	mg/liter	<50	<30
Cromo trivalente	mg/liter	<2	<2
Cromo hexavalente	mg/liter	<0.2	<0.2
Deter gentes	mg/liter	<5	<1
Cadmio	mg/liter	<0.1	<0.1
Plomo	mg/liter	<0.5	<0.5
Mercurio	mg/liter	<0.005	<0.005
Arsenico(As)	mg/liter	<0.5	<0.5
Fenoles	mg/liter	<0.5	<0.5
Califormes lotales	(NMP/100ml)	<5000	
DAO (sobre muestra bruta)	mg/liter		<250

Table-140

Laws concerning environment of federation government and state government in Argentina

	FEDERAL LEVEL	PROVINCIAL LEVEL
Air quality and emission	Law 20,284/73 Law 24,051/91 Decree 831/93 Law 23,778/88 Law 20,040/89	Law 5965/58 Decree 2009/60 Municipal Ordinance 27708 /73 Decree 2752/85 Decree 3395/96 Resolution 242/97 Decree 2264/97 Law 2472
Water protection and waste Water	Law 24,051/91 Law 2797/1891 Law 4198/1903 Law 21,172/75 Decree 351/79 Decree 674/89 Resolution 79179/90 Decree 776/92 Resolution of Application of Decree 776/92 Provision 3/92 Resolution 314/92 Resolution 455/92 Resolution 231/93 Resolution 242/93 Provision 013/93 Decree 831/93	Law 5965/58 Decree 2009/60 Decree 3790/90 Resolution 287/90 Decree 1209/84 and Resolution 510/94 Law 2472 Law 269/89 Law2952 Law 2391 Decree 1894/91 Resolution 378/92 Resolution 1302/92 Resolution 1443/92 Resolution 2398/93
Hazardous waste and subs-tances	Decree 674/89 Resolution 577/91 Law 23,922/92 Decree 181/92 Law 24,951/91 and Decree 831/93 Resolution 157/93 Resolution 413/93 Resolution 106/94 Resolution 224/94 Resolution 123/95 Resolution 184/95 Resolution 189/96 Resolution 206/96 Resolution 236/96 Resolution 238/97 Resolution 351/97 Law 24,449/94, Decrees 2264, and Resolutions 720/91 and 195/97	Decree 2009/60 Law 8981/78 Law 9111/78 General Ordinance 220/78 Proviso 197/94 Law 11,720/95 and Decree 806/97 Resolution 231/98 Law 2472 Law 269/89 Law 2391 Decree 1894/91 Resolution 378/92 Resolution 1302/92
Occupational hygiene and Safety	Law 19,587/72 Decree 351/79 Resolution 444/91 Law 24,557/94 Resolution 577/91 Resolution 369/91 Law 24,051/91 and Decree 831/93 Ordinance 1/95 Ordinance 2/95 Ordinance 8/95	Decree 2752/85 Decree 1628/85
Land use and zoning	Law 22,928 Law 24,051/91 and Decree 831/93	Law 8912/77 Decree 1359/78 Decree 1549/83
Fuels	Law 13,660/49 Decree 351/79 Law 24,051/91 Resolution 419/93 Resolution 404/94	
Classification and industrial register		Law 11,459/93 and Decree 1741/96
Presion vessel	Resolution 231/96 Resolution 129/96	
Mining	Law 22,259	

c.f.: underline shows the laws of RIO NEGRO state

9.5.2 Conditions related to environmental protection

The environmental elements which are the object of the Environmental Impact Assessment's in Japan are set as follows:

The area covering the atmosphere, the ground, the hydrosphere, living things, and other items, and every area is composed of some environmental elements respectively. A solid fact exists in each environmental element, and it is necessary to investigate each of them.

However, the main environmental elements for this project are consolidated in the atmosphere, the hydrosphere, the area of the ground, and the hydrosphere which is an especially important point as shown in **Table-141.**

On the other hand, 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 fertilizer produced was executed. The possibility of the effective use for the solid waste was shown as a result.

Table-141 Environmental elements which becomes E.I.A's object

	Environmental elements	Items
Atmosphere	Atmospheric quality	Sulfur oxide, nitrogen oxide, mono-carbon oxide, floating particles, hydrocarbon, oxidant, dust, asbestos, harmful substance, additionally necessary substance, dioxin, agricultural chemicals, mercury etc..
	Stink	Stink prevention method specification substance, Stench strength, Stench index, Substance except Specified ones, Additionally necessary item

Atmosphere	Noise	Environmental noise. Traffic noise of road, High speed railway noise. Conventional railway noise. Factory work noise. Construction work noise. Others (blast noise, speaker noise, bustle noise etc.)
	Low frequency Air vibration	Road traffic, Railway, Aircraft, Factory work, Air Vibration of low frequency with construction work etc.
	Weather・climate	Influence on wind direction, wind velocity, generation of fog, snow-fall, flying fine sand, and temperature
	Wind trouble	Generation of strong wind, Ventilation trouble
	Electric wave trouble	Trouble to television reception.
	Sunshiny obstruction	Influence on sunshiny time etc.
Ground-sphere	Vibration	Road traffic vibration, High speed railway vibration, Conventional railway vibration, Factory work vibration, Construction work vibration, Others (blast vibration etc.)
	Geographical fea ture & geological feature	Modification of important /valuable geographical and Geological features in natural and environmental maintenance. Modification of peculiar geographical & Geological features. Modification of peculiar and natural phenomenon.
	Soil	Soil pollution with regulations system substance. Soil Pollution by environmental standard item. Soil pollution by zinc & nickel etc.. Influence of land on productivity.
	Ground	Subsidence. Ground transformation. Influence on underground water level.
	Country mainte nance	Mountain stream ruin. Hillside collapse.
	Others	Country maintenance. Mountain stream ruin.
Hydro-sphere	Water quality -public water region -bottom quality	Pollution concerning life environmental items such as BOD, COD and SS. Healthy item. Pollution concerning harmful substance. Influence on special items such as water temperature, turbidity, transparency, seeing through degree, salinity, ion density, and phenol etc.. Agricultural chemicals etc.. Pollution concerning harmful substances such as PCB, sulfide, oil, COD etc..

Hydro- sphere	Water quality -underground -water	Pollution of harmful substances and agricultural chemicals etc.. Pollution of industrial method by injection of chemicals liquid.
	Water resource	Influence on volume of water quantity, water temperature, and usage of water.
	Hydrography	Influence of flow rate, water level, flow velocity, flow condition, valley, lakes and marshes water revenue and expenditure, tendency, ebb & tide, waves spring water, and underground water level etc..
Living- sphere	Ecosystem commonness	Decrease of various kinds. Influence of scarce kinds/ exterminating misgivings kinds. Destruction of food link. Obstruction of a pass & movement for wildlife. Influence on productivity.
	Plant	Modification of valuable/important plant kinds and of environment for the grow. Influence on plant aspect, amount of the green, and green land area.
	Animal	Decree of valuable/important plant kinds and of inhabit number in the grow environment. Influence on most significant prey kinds, large-scale kinds, and long life strange kinds.
Others	Spectacle	Influence on valuable/important natural spectacle and view in natural environmental maintenance. Influence on main view point. Influence on regional spectacle. Influence on atmosphere which region cause. Influence on historical and cultural spectacle.
	Outdoor recrea tion ground/re- creation resource	Influence on valuable/important outdoors recreation ground in natural environmental maintenance. Influence on recreation facilities. Influence on recreation resource.
	Historic site • cultural asset	Influence on historic site, cultural asset, and cultural Inheritance etc..
	Waste	Kinds. Amount of generation.
	Regional analysis	Regional dividing into parts. Influence on community facilities. Influence of region on organization. Influence on transportation and route
	Safety	Influence on dangerous articles, slope collapses, and flood controls. Influence on safe traffic.
	Land use	Influence of land on form.

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**.

Environmental protection and control in the mining production activity belong to the Mining Department of Rio Negro Province.

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