EXECUTIVE SUMMARY

1. General

Xindia Steels Ltd. (XSL) is promoted by Sigma Minmet Ltd. along with Xinxing Heavy Machinery Ltd., Beijing and China Minmetals Corporation, China as joint venture partners. XSL propose to set up a 0.8 Mt/yr pelletising plant near Kunikere village and Hirebaganal Village in Koppal Taluk and District of Karnataka State.

XSL have assigned the job of preparing the project report for the pelletising plant to Ferro Green Technologies Pvt. Ltd. (FGT), a Bangalore based consultancy firm specializing in iron and steel domain.

2. Location

The pellet plant is to be located near Kunikere village and Hirebaganal Village in Koppal Taluk and District of Karnataka State. The site is close to Hospet Steel Ltd.

3. Demand Analysis

There was a gap of 14 million tons of DR grade pellets in the year 2006-07 and the demand for BF grade pellets of 5.958 Mt was mostly unfilled. Even with the commissioning the pellet plants of Arya Iron & Steel Co, BM Ispat Ltd. and Brahmani Steel Ltd. and increasing domestic sale by ESSAR Steels, there will be a gap of about 8 Mt/yr of DR grade pellets and 6 Mt/yr of BF grade pellets.

As per the analysis of CRU International Ltd., against world consumption of 56.11 Mt of DR grade pellets in the year 2005, supply was 51.894 million tons at 90% capacity utilization. Thus, the demand supply gap would be 4.23 Mt.

Based on the above there is adequate demand to justify setting up of pellet plants to bridge the above gap in Indian market as well as international market. Besides, 100% of the production of 0.8 Mt/yr would be exported.

4. Technological aspects

There are two established processes for pelletisation of iron ore fines, one the straight grate process, developed by M/s. Lurgi of Germany and M/s. Dravo of USA and the other developed by M/s. Allis Charmers Inc., USA called the grate kiln process. Both the processes (straight grate& grate-kiln) are suitable for the production of blast furnace/ direct reduction grade pellets. Both these processes are economical at capacities of 3.0 Mt/yr and above.

Chinese have modified the grate kiln process and succeeded in making it economical even at a production level of 0.6 Mt/yr. They offer pellet plants of sizes 0.6, 0.8, 1.0, 1.2, 2.0, 3.0 and 5.0 Mt/yr based on the grate kiln technology. Further, the Chinese technology replaces expensive fuel oil by cheaper coal as the source of heat for pelletising.

M/s. Xinxing have tested samples of iron ore from Bellary – Sandur region in their laboratory for the grate kiln process and confirmed that BF/ DRI grade pellets can be produced from such ore. They have projected the design parameters of the pelletising plant based on the tests. Based on the test results M/s.Sigma Minmet have given offer for the supply of 800,000 TPA pellet plant.

XSL have decided to adopt the grate kiln process provided by M/s Xinxing for the production of pellets.

5. Raw Materials

The main raw materials for the pellet plant are iron ore fines, coal and bentonite. The iron ore will be sourced from the iron ore mines of Bellary - Sandur region. The ore fines will be transported by rail/ road, from Bellary-Sandur region. Bentonite will be transported by rail/road from Gujarat. Coal will be imported and transported by sea and road. Annual requirement of raw materials is as follows:

Iron ore fines	8,08,000 t
Bentonite	5,600 t
Non Coking Coal	32,000 t

6. Layout and main plant facilities:

The layout has been so arranged as to facilitate unidirectional flow of materials from raw material stage to finished product. The major facilities in the pellet plant are

- Raw materials (ore fines and coal) storage yard
- Iron ore drying and grinding unit
- Coal grinding section
- Proportioning section
- Mixing section
- Balling building and green ball feeding section
- Induration unit (grate- kiln)
- Cooler
- Pellet storage yard

Raw materials for the pellet plant will come by rail / covered trucks and stock piled in the raw material storage yard. Ore fines will be conveyed to the ore bins in the iron ore drying and grinding unit. Coal will be conveyed to the coal grinding mill. The iron ore will be dried in a fluidized bed and then ground to the required size by a vertical roller grinding machine. The ground iron ore will be conveyed to the ore bins in the proportioning section. Ground Bentonite will be received in gunny bags and will be brought near the proportioning section.

The required quantities of ore fines and bentonite will be drawn and conveyed to the mixing section. During mixing water will be added. Thereafter, the mixed material will be conveyed to the balling building. The balling building will have 4 numbers of 6m dia. balling discs. After balling, the balled material will pass over roller screen where green balls of size below 9 mm will be screened out. The material will then be conveyed to traveling grate building. There will be a pendulum conveyor which will load wide belt conveyor and there will be another roller screen to screen out +16 mm green balls. 9 -16 mm sized green balls will be loaded on to the grate machine.

The green balls will be gradually dried and preheated to 1050-1100 deg C on the grate. This will increase the strength of green balls so that they can withstand the fall into the kiln without breakage. The fried green balls will be heat hardened by firing in the kiln at temperature up to 1350 deg C before being discharged onto the annular cooler.

In the grate kiln system, 3 units i.e., the grate, kiln and the cooler can be controlled independently. The speed of the grate can be adjusted to increase or decrease the drying time of the green balls. Similarly, the kiln speed is modified to keep a constant retention time for induration. The speed of the cooler can be controlled to achieve uniform total cooling to below 120 deg C. Then the pellets will be conveyed to pellet stock yard where they will be stock piled.

7. Services

Following service facilities have been envisaged to support the main plant units:

Water supply facilities

Fuel oil facilities

Compressed air facilities

Maintenance and repair facilities

Dedusting facilities

Fire-fighting facilities

8. Electrics

Power supply

The HT power supply for the plant will be received at the Main receiving station and stepped down to 11 kV for distribution to the HT loads and 11/0.415 kV transformers. The LT supply at 0.415kV will be provided by three 1250 kVA transformers in three substations located near traveling grate, rotary kiln and annular cooler. A lighting transformer will be additionally provided

The connected load for the plant will be around 10 MW and the maximum demand will be 8.2 MVA. Capacitors will be installed to improve the Power factor to 0.9.

Automation & Control system

Equipment control, process regulation and sequential control for various equipment and processes will be carried out with help of extensive instrumentation and control systems. Industrial PCs will be provided for the control which is through centralized PLC system. The DCS/ PLC system linkage with all technological processes will be established through redundant communication network. All equipments will be provided with local manual control and remote centralized control through PLC.

Lighting

The lighting for the plant will be provided from a separate lighting transformer. This will cover the shop lighting, road lighting and area lighting.

Lightning protection

Necessary lightning protection equipment and air craft warning lights will be provided in all tall structures like chimneys. This will be connected to separate earthing electrodes.

Communication

According to requirement from technological processes and size of plant, the communication system facilities such as landline phones, wireless handsets etc are provided. The Industrial CCTV provides information to the main control room from various camera locations.

Fire alarm & fire fighting system

Equipment for fire alarm system such as smoke detectors, temperature sensors and manually operated alarming buttons will be installed in main control room, high-voltage and low voltage power distribution rooms, transformer rooms, computer rooms and in cable channels. Necessary fire fighting equipments like fire extinguishers, sand buckets etc will be provided at necessary locations.

Air conditioning

The control rooms will be air conditioned. The switchgear room and other electrical rooms will be provided with pressurized ventilation systems.

9. Pollution control measures:

Pellet plant will handle very fine material and in order to make the plant environment friendly a number of measures have been foreseen.

All dust generating points like feed and discharge ends of grate, kiln, cooler, wind box discharge points, junction houses in conveyors will be provided with dust control equipment like suction hoods and ducts, bag filters, multi pipe dust collectors and electro static precipitators have been envisaged so that the pollution level in the gas let out to atmosphere will be much less than the statutory limits.

10. Construction Schedule

Schedule of 11 months from zero date has been drawn for commissioning of the plant. Critical and long delivery equipment will be identified and ordering and delivery for these will be expedited. Intermediate/ critical milestones will be identified and project monitoring will be carried out vigorously to ensure commissioning of the plant as planned.

11. Capital cost

The capital cost of the proposed pellet plant has been estimated as Rs 2185.9 million. including Rs 85 million towards margin money for working capital. The capital cost estimates are based on the prices prevailing in the fourth quarter of 2008 and do not take into account any future escalation in prices.

12. Production Cost

Production cost of pellets in the proposed plant is estimated based on the price levels prevailing in the fourth quarter of 2008. No provision has been made for escalation in prices. Production cost excluding capital related charges at 90% capacity utilization works out to Rs 1668.1/t.

13. Economic Appraisal

Based on the estimated capital costs and production costs as described in the preceding chapters, and sales realization of Rs 3000/t for export sales for pellets, the techno-economic appraisal for the project has been carried out and the salient techno-economic indices are given below:

Sl. No.	Indices	Unit	Value
1	Cumulative retained profit after tax over 10 years of operation	Rs million	3048.3
2	Average retained profit after tax per year over 10 years of operation	Rs million	304.8
3	Cumulative cash surplus over 10 years of operation	Rs million	3268.0
4	Debt Service Coverage Ratio (average for 8 years)	Ratio	1.98
5	Payback period after tax	Years	4.83

6	Internal rate of return (after tax)	%	26
7	Break-even capacity(average over 10 years operation)	%	43

14. Recommendation

It may be noted from the above analysis that the project having installed capacity of 800,000 TPA capacity Iron Ore Pellet plant would be justified and is viable commercially.

CONTENTS

1 INTRODUCTION

M/s. Xindia Steels Ltd. (XSL) is promoted by the share holders of Sigma Minmet Ltd., Bangalore along with Xinxing Heavy Machinery Ltd. and China Minmetals Corporation, China as joint venture partners.

M/s Sigma Minmet Ltd., Bangalore is a joint venture of Sigma Corporation of US and Manasara Group of India, with Registered Office in Bangalore and Corporate Office in Chennai.

M/s Sigma Corporation is incorporated in New Jersey, USA and is in business since 1985. Their product range comprises CI and DI pipe fittings and accessories, used extensively in water works conforming to AWWA/ ANSI standards C110/ A 21.10 and C153/A 21.53. They started production of these fittings in 1985 and they have grown to second largest AWWA pipe fittings supplier in US today and third largest in waterworks specific industry segment. M/s Minmetals of China hold 40% ownership in Sigma Corporation. They have offices in USA, UK, Korea, India and China. Revenues of Sigma Corporation for 2006 was in the range of US $ 250 million.

Manasara Group is founded by Mr. Alex P J, who has become angel investor after leaving Subex Systems Ltd. Alex has graduated in Electrical Engineering from NIT Durgapur. Manasara group has invested in Cellcomm Solutions Limited and Zealtec Infosolutions Limited. Both the companies provide innovative solutions, using a combination of software and hardware to their customers. They focus on industry verticals like Telecom, Banking and Insurance, Retail etc. Other focus areas are Infrastructure, Engineering services, Biotechnology and high end project consultancy.

Founder of the group, Mr. Alex has over 20 years of experience in infrastructure, metals, telecom, hardware and software He has a good track record of building successful organizations. He has interest and investment in telecom, software, hardware and infrastructure companies.

Xinxing Heavy Machinery Ltd is a member of Xinxing group. Xinxing Group was established in 1971 in the city of Beijing, China. They are among the bigger Fortune 100 companies of China. They are the second largest DI pipe manufacturers in the world and have five DI manufacturing units in Handan and Wuhu. They have highest productivity, lowest cost of production and very good R&D facilities in iron and steel manufacture. They also have six plants for manufacture of equipment for integrated steel plant, pelletisation plants, CNG & LNG transportation systems, Coal layer gas collecting units and power plants. They are a listed company paying high dividend for the last six years and have earned award for highest return on investment for the year 2006. Their present worth is around US $ 4 billion.

China Minmetals Corporation is owned by Government of China and was established in 1950. They are one of world's largest international manufacturing and trading group in ferrous and non-ferrous metals, minerals and electrical products. They are eleventh largest company in China and are among Fortune 100 companies in the world. Their present worth is around US $ 18 billion.

XSL propose to set up a 0.8 Mt/yr pellet plant in Koppal District of Karnataka State. In the first phase, the pellets produced will be exported and at a later stage, Xindia Steel Ltd., would be setting up a steel plant where part of the pellets will be consumed. This report is based on the test report on the iron ore fines and other technical information collected from Xindia Steel Ltd., and information from other agencies.

2 MARKET REVIEW

2.1 General

Steel is the material of choice for industrial applications due to its high specific strength and relatively low cost per unit weight. Present per capita steel consumption in India is about 39 kg as compared to 500 kg to 700 kg in countries like Japan, European Union, South Korea, USA etc. Even Brazil, Mexico and China have per capita consumption of 110 kg to 150 kg and the world average is about 150 kg.

Steel is made through Blast Furnace/Basic Oxygen Furnace Route (BF-BOF-CC) or Sponge Iron/ Electric Arc Furnace Route (DR-EAF-CC). Principal raw material is iron ore lumps/ pellets and sinter in BF route and iron ore lumps/ pellets in DR route.

Development of iron ore agglomeration processes and their widespread applications have contributed a great deal to the progress of iron and steel industry in recent years. Among various types of agglomerates, sinter is predominantly used in blast furnace operation, while pellets are of special significance in direct reduction processes.

Mining of iron ore generates considerable natural fines including what is known as “Blue Dust”. Also, sizing of ore by crushing generates large amount of fines. Pellets are value added products manufactured using such iron ore fines, which otherwise would have been wasted and could have created pollution problems at the mines.

Depletion of high grade iron ore reserves and metallurgical coal reserves, environmental concerns in coke making, sinter plant and blast furnace have forced developed countries to look into steel making through EAF route. Shortages, quality and price fluctuations of steel scrap and availability of huge quantities of non coking coal have led to increase in DRI capacity. Pellets and non coking coal/gas are the principal raw materials in the coal/gas based DRI process.

2.2 Domestic Steel Demand Projection

In India, apparent consumption of steel increased from 14.8 Mt in 1991-92 to 51.5 Mt in 2007-08. Apparent consumption is Production + Imports - Exports. Production of crude steel in the last few years in India is given below:

Year	Production in Mt
2003-04	38.72
2004-05	43.43
2005-06	46.46
2006-07	50.85
2007-08	53.90

As per the National Steel Policy - 2005 of Govt. of India, the demand-supply scenario for steel during next fifteen years, is as given below:

(in million tons)

Year	Production	Imports	Exports	Consumption
2004-05	38	2	4	36
2019-20	110	6	26	90
CAGR	7.3%	7.1%	13.3%	6.9%

International Iron & Steel Institute (IISI), Brussels have made the following projections for demand for finished steel in India:

Calendar year	Mt/yr
2005	38.1
2006	41.9
2007	45.7
2008	48.9
2009	52.3
2010	56.0
2015	81.2

IISI has considered an annual growth rate of 7% during 2005 to 2010 and 7.7% thereafter up to 2015. On the other hand, National Steel Policy of Government of India have considered growth rate of 7.3% per annum. The actual growth of consumption during 2005-2006, according to Steel Ministry, was 13.88% with an estimated consumption of 41.3 million tons. Considering the higher growth achieved, Ministry of Steel have revised the target for steel production to 200 mtpa.

Even if a lower growth rate of 10% per annum is assumed, the demand for finished steel works out to 60.65 million tons in the year 2009-10 and 97.67 million tons for the year 2014-15.

In terms of crude steel, this demand works out to 65.5 million tons and 105.5 million tons for 2009-2010 and 2014-15 respectively. Production of crude steel during 2005-06 was 42.1 million tons. It can be seen from the above that demand is likely to be more than double in the next ten years.

In September 2008, unprecedented changes have occurred in the global economic scenario triggered by the financial crisis in U.S. Global growth is projected to slow substantially in 2008 and a modest recovery would only begin later in 2009. In keeping with this trend, IMF has altered downwards its earlier projections on the expected rate of growth in GDP of different countries during 2008 and 2009. The projected growth rate for India is 7 % for 2008 and 6.9 % for 2009.

World Steel Association (formerly International Iron& Steel association), Brussels, while acknowledging the adverse impact of current financial crisis on steel demand, projects a growth of about 2.5% in global steel consumption during 2009. It is projected that world steel consumption may grow to about 1932 million ton in 2020. The consensus appears to be that though the industry is adversely affected at present by the current global situation by way of low demand, there is lot of potential for growth that will be realized in the medium term.

The latest economic scenario indicates that the Indian economy may grow only by 7% during 2008 - 09 and 2009 - 10. This is against the earlier projection of 9.5% growth rate. The earlier projections on steel production capacity have been revised due to delay/ withdrawal of some projects to about 128 million ton in India by 2020.

2.3 Steel Metallics Scenario

The annual global requirement of Metallics - pig iron, steel scrap and steel scrap substitutes including DRI - for steel and foundry industry is about 1.4 – 1.5 billion tons. The supply is made up of about 52% pig iron, 40% steel scrap and 4% steel scrap substitutes. The present global consumption of scrap varies between 380 and 400 million tons per annum. World Steel Dynamics has forecast that total global requirements of metallics are expected to rise to 1.6 -1.7 billion tons by 2010.

Total consumption of ferrous scrap (melting scrap, cast iron scrap, re-rollable scrap and industrial scrap) in Indian steel sector is around 18 million tons. The overall availability of various types of scrap in Indian Steel Sector is around 15 million tons.

Excess of domestic demand over domestic availability of quality ferrous scrap led to import of scrap. However, with the development of DRI industry in the country, the import of scrap has come down substantially. Since the scrap is procured from different sources, quality of liquid steel has to be monitored very closely and corrective action taken. Advantage of using DRI over scrap is the reliability of DR quality and absence of tramp elements.

Installed capacity for production of DRI in India is given below:

	DRI Plants	**Mt/yr**
I	**Gas based plants**	
	Essar Steel Ltd.	5.0
	Ispat Industries Ltd.	1.6
	Vikram Ispat Ltd.	0.9
	Subtotal	**7.5**
	DRI Plants	**Mt/yr**
II	**Coal based Plants**	
	Jindal Steel & Power Ltd.	1.4
	Prakash Industries Ltd.	0.4
	Tata Sponge Iron Ltd.	0.4
	Monnet Ispat Ltd.	0.3
	Other units	10.0
	Subtotal	**12.5**
	Total (Gas and coal based)	**20.0**

The production of DRI in India has increased from 0.86 million tons in 1990-91 to more than 16 million tons in 2006-07. India has emerged as the largest producer of DRI in the world displacing Venezuela.

DRI production in the last few years worldwide is given below:

Year	World production in million tons
1999	38.7
2000	42.9
2001	39.2
2002	44.2
2003	47.8
2004	54.1
2005	56.2
2006	59.8

Production of DRI in India in the last few years is given below:

Year	Production in million tons
2000-01	5.481
2001-02	5.657
2002-03	6.90
2003-04	8.08
2004-05	10.29
2005-06	14.74
2006-07	16.28

The share of gas and coal based DRI in 2006-07 was about 45% and 55% respectively.

2.4 DR grade pellets

Iron ore is upgraded or beneficiated through washing, beneficiation and agglomerated through sintering and pelletising. Sinter and pellets are used as Blast furnace feed. Lump ore and pellets are the feed material for production of DRI.

On an average, 1.6 tons of feed is required to produce one ton of DRI. Though, the percentage of pellets in feed for sponge iron varies (there are plants using 100% pellets), 30% lump and 70% pellet is the norm in DRI industry. Therefore 1.12 tons of pellets is required per ton of DRI production.

Hence, requirement of pellets at 1.12t/t of DRI based on the DRI production level of 16 Mt achieved in 2006-07 works out to 18 Mt. Requirement of pellets excluding the requirement of JVSL and ESSAR works out to 16 Mt.

2.5 BF grade pellets

Pellet usage in Blast Furnace will be to the extent of 10%, with sinter accounting for 80%. Considering total charge per ton of hot metal as 1.655 tons, requirement of pellet at 0.1655t for 36 Mt steel production is 5.958 Mt for the year 2006-07.

Thus, the total demand of pellets for 2006-07 is around 22 Mt.

2.6 Availability

Following are the capacities of pellet plants existing as on date:

	Plant	Mt/yr
1	Kudremukh Iron Ore Co. Ltd.	3.5
2	Mandovi Pellets Ltd.	1.8
3	Essar Steel Ltd.	8.0
4	JSW Steel Ltd.	5.0
5	Arya Iron & Steel Co. Ltd. (AISCO)	1.2
6	BMM Ispat Ltd.	1.2
7	Brahmani River Pellets Ltd.	4.0

8.0 Mt/yr pellet plant of Essar Steel and 5.0 Mt/yr Pellet plant of JSW Steel are basically for captive consumption and pellets left after meeting the in house requirement are available for sale. Pellet plant of M/s KIOCL with a capacity of 3.5 Mt/yr and Mandovi Pellet Plant in Goa of capacity 1.8 Mt/yr are stand alone pellet plants, producing pellets. Mandovi Pellets is virtually closed. AISCO and BMM Ispat are likely to be commissioned shortly. Almost entire production by M/s KIOCL in 2005-06 was exported and only a small quantity was sold in the Indian Market to Grasim etc. Out of 3.799 Mt production by JSW Steel, 3.54 Mt was consumed in-house, and 0.26 Mt was sold within the country. Almost entire pellet production of 3.1 Mt in 2005-06 was consumed by Essar Steel themselves. However, new pellet capacity of 4 Mt/yr will be available from 2006-07 onwards, bulk of which has to be exported to meet EPCG obligation. Thus, it can be seen that domestic availability may be around 2.5 Mt.

2.7 Gap

Thus, there is a gap of 14 million tons of DR grade pellets in the year 2006-07 and the demand for BF grade pellets of 5.958 Mt is mostly unfilled. Even with the commissioning of the pellets plants of AISCO, BMM and Brahmani and increasing domestic sale by Essar, there will be a gap of around 8 million tonne DR grade pellets and 6 million tons of BF grade pellets.

2.8 Export Potential

As per the projections prepared by CRU International Ltd., region wise consumption and installed capacity of DR grade pellets in million tons for the year 2005 is given below:

	Region	**Consumption**	**Installed capacity**
1	North America	3.51	1.11
2	Latin America	19.79	33.65
3	Western Europe	0.55	4.30
4	Eastern Europe and CIS	2.72	2.50
5	Asia	24.70	16.00
6	Africa & Oceania	4.84	0.10
	Total	**56.11**	**57.66**

As can be seen from above, as against consumption of 56.11 million tons, supply would be 51.894 million tons at 90% capacity utilization. Thus, the demand supply gap would be 4.23 million tons.

2.9 Conclusion

Based on the above there is adequate demand to justify setting up of pellet plants to bridge the above gap in Indian market as well as international market. It is proposed to export the entire production of pellets.

3 TECHNOLOGICAL ASPECTS OF PELLETISING

3.1 Selection of pelletising process

The proposed pellet plant will be designed to produce 0.8 Mt/yr of pellets suitable for use in both direct reduction process as well as blast furnace.

Different process steps involved in pelletisation are feed preparation, green ball formation, heat hardening, cooling and product despatch. All over the world, heat hardening of pellets is carried out by one of the two processes, namely the straight grate process and the grate- kiln process. Drying, preheating, induration and cooling of the pellets occur in the same machine in the straight grate process whereas the pellets are dried and preheated on a grate machine, heat hardened in a rotary kiln and cooled in annular cooler in the grate-kiln process.

The technical aspects of the two processes are given in table below:

Sl.No.	Item	Straight Grate	Grate- kiln
1	**Process and equipment design**		
	i Heat hardening cycle	Drying, preheating, heat hardening and cooling are carried out on a single straight grate machine	Drying and preheating are carried out on a straight grate and heat hardening is carried out in a rotary kiln. Cooling is done in a separate annular cooler.
	ii. Grate bars	Since all processes are carried out on the grate, the grate bars are subjected to high temperature in cycles and are made of alloy steels. Since the bed depth is also high, use of side and bed layers (heat hardened pellets) is absolutely necessary.	The grate bars are subjected to lower temperature. No side or bed layer is necessary as bed depth is less than half of that in the straight grate process.

Sl.No.	Item	Straight Grate	Grate- kiln
	iii. Pellet movement	Pellets remain stationery through out the process.	Pellets are tumbled during heat hardening in kiln.
	iv. Type of fuel in burners	Liquid or gaseous	Gaseous or solid fuel.
2	**Process Control**		
	i. Burners	There are number of burners in the heat hardening portion of the straight grate.	A single burner is used in the kiln.
	ii. Fans	Several fans operate with multiple controls	Less number of fans with single control.
	iii. Ability to produce different grades of pellets.	Possible	Possible.
3	Unit capacity	Generally built in units of capacities of 3 Mt/yr and more.	Can be built in units of capacities ranging from 0.6 Mt/yr

Both the processes are technically suitable to produce iron ore pellets. The production of pellets all over the world is practically through either of these two processes. Ultimately, the selection of the process is done on commercial consideration. In the Indian context, where liquid and gaseous fuels are very expensive compared to import of low ash non coking coal, grate kiln process has an edge over straight grate process, especially for smaller capacities. XSL have chosen the grate kiln process with know how and equipment supplied by the promoter, Xinxing Heavy Machinery Ltd.

3.2 Production plan

The plant will be rated to produce 0.8 Mt of pellets annually with 330 working days per year. This would correspond to a planned production of 2424 t/d and 101 t/h.

The desired product properties are

Size	9 – 16 mm
FeO content	1% maximum
Cold compression strength	2500 N/pellet minimum
ISO tumbler index (+6.3 mm)	93% minimum
Abrasion index (-0.5 mm)	5 % maximum

3.3 Summary of pelletising tests

The proposed pellet plant will be designed on the basis of the successful pelletising tests on Indian iron ore from Bellary region. Pelletising tests were carried out with the aim of producing fired pellets of suitable quality. The tests were carried out by M/s. Xinxing in the laboratory, based on iron ore and bentonite supplied by XSL, where as the coal used was non coking coal from China.

The chemical composition of the iron ore fines tested is as follows.

Fe total	65 %
FeO	0.5 %
SiO2	3.1 %
Al2O3	2.11 %
CaO	0.1 %
MgO	0.083 %
MnO	0.015 %
K2O	0.04 %
Na2o	0.031%
CuO	0.0074 %
PbO	0.003 %
ZnO	0.019 %
S	0.02 %
P	0.03 %
LOI	1.15 %

The size distribution of the ore fines was as follows:

Size	Percentage by weight
Above 8 mm	10 %
8 – 5 mm	10.5 %
5 – 3 mm	18 %
3 – 1 mm	9.3 %
1 – 0.5 mm	8.53 %
0.5 – 0.2 mm	5.4 %
0.2 – 0.125 mm	11.64 %
0.125 – 0.074 mm	2.8 %
0.074 +0.044 mm	11.78 %
Below 0.074 mm	12.2 %

The bentonite used was from Gujarat, supplied by M/s. Ashapura International Ltd. This bentonite is used all over the world for production of pellets. It has very good properties suitable for use as a binder for iron ore pelletisation. The chemical analysis (in %) of bentonite is as follows:

Fe total	10.8 %
FeO	0.3 %
SiO2	48.4 %
Al2O3	12.9 %
CaO	3.2 %
MgO	3.1 %
MnO	0.14 %
K2O	0.09 %
Na2O	3.0 %
P	0.04 %

The grindability of iron ore was tested in which bond work index was found out for grinding ore fines to 70% -200 mesh. Bentonite was characterized for colloidal percentage, swelling, water absorbency and methyelene blue uptake ability and montmorillonite content.

Laboratory small scale tests were conducted by balling in a disc of one meter dia. The pellet size was controlled to 12-16mm by screening. These pellets were dried in an oven to 200 deg C for 4 hours for heat hardening. The drop number and compressive strength of finished green pellets were measured to evaluate the ability of green pellets to remain in tact and retain shape during handling.

Similarly, sensitivity of green balls to different rates of heating during drying and preheating was checked. Then a small scale test of firing of pellets was conducted in electrical tube furnace. The pellets were preheated and indurated. The time and temperature were varied. The pellets were first dried to 105 deg C, and then they underwent four stage temperature variations including preheating at 1100 deg C, firing at 1300 deg C, and then soaking at 1000 - 1300 deg C and then cooled to room temperature in air. Thereafter, the pellet properties were tested.

Large scale tests were conducted which included proportioning, blending, mixing, balling, drying, preheating and firing. In the large scale test, drying and preheating were done in a pot grate and firing was done in a rotary kiln. In the pot grate, the bed height was varied. Updraft drying, down draft drying and preheating were done at different temperature, and gas flow rates. After preheating was completed, preheated pellets were transferred into a rotary kiln. Here again, the temperature and time were varied. Thereafter the pellets were tested for compressive strength, tumbler index and mineralogy. Metallurgical properties such as reducibility, swelling, softening and melting were studied.

Test results

It was found that the ore fines supplied had good grindability with a bond work index of 7.5 kwh/t for grinding to 70%, minus 200 mesh. The Blaine number was 2100. The green ball strength was adequate to meet the requirements for handling even without the addition of bentonite as binder. However, bentonite needs to be added in order to improve the thermal spalling temperature and also the drying parameters have to be optimized.

The bentonite used in the test was of good quality and a suitable dosage was found to be in the range 0.6 – 0.8%.

The optimum balling variables were as follows:

Feed size of iron ore fines	70% minus 200 mesh
Blaine no	2100

Bentonite	0.7 % and
Moisture	7.5 – 8.5%.

The wet drop strength was more than 20 drops. Wet crushing strength was more than 15N per pellet. Spalling temperature was 225 – 240 deg C. Green ball size was controlled in the range 9-16mm.

The optimum variables for updraft drying were found to be

Temperature	130 – 180 deg C,
Drying time	3-5 minutes and
Air flow rate	1 m/sec.

Optimum condition for down draft drying were found to be

Temperature	180 – 200 deg C,
Drying time	6-8 minutes and
Air flow rate	1-1.2 m/sec

Optimum condition for preheating were found to be

Temperature	1050 -1100 deg C,
Drying time	8-11minutes and
Air flow rate	2-2.2m/sec

Optimum firing temperature was found to be 1280 – 1320 deg C with duration of 10 minutes.

The mechanical strength of the fired pellet was good at 3050 to 3170 N/pellet. Tumbler index was 96.7 to 97.8% and abrasion index was 1-1.1%.

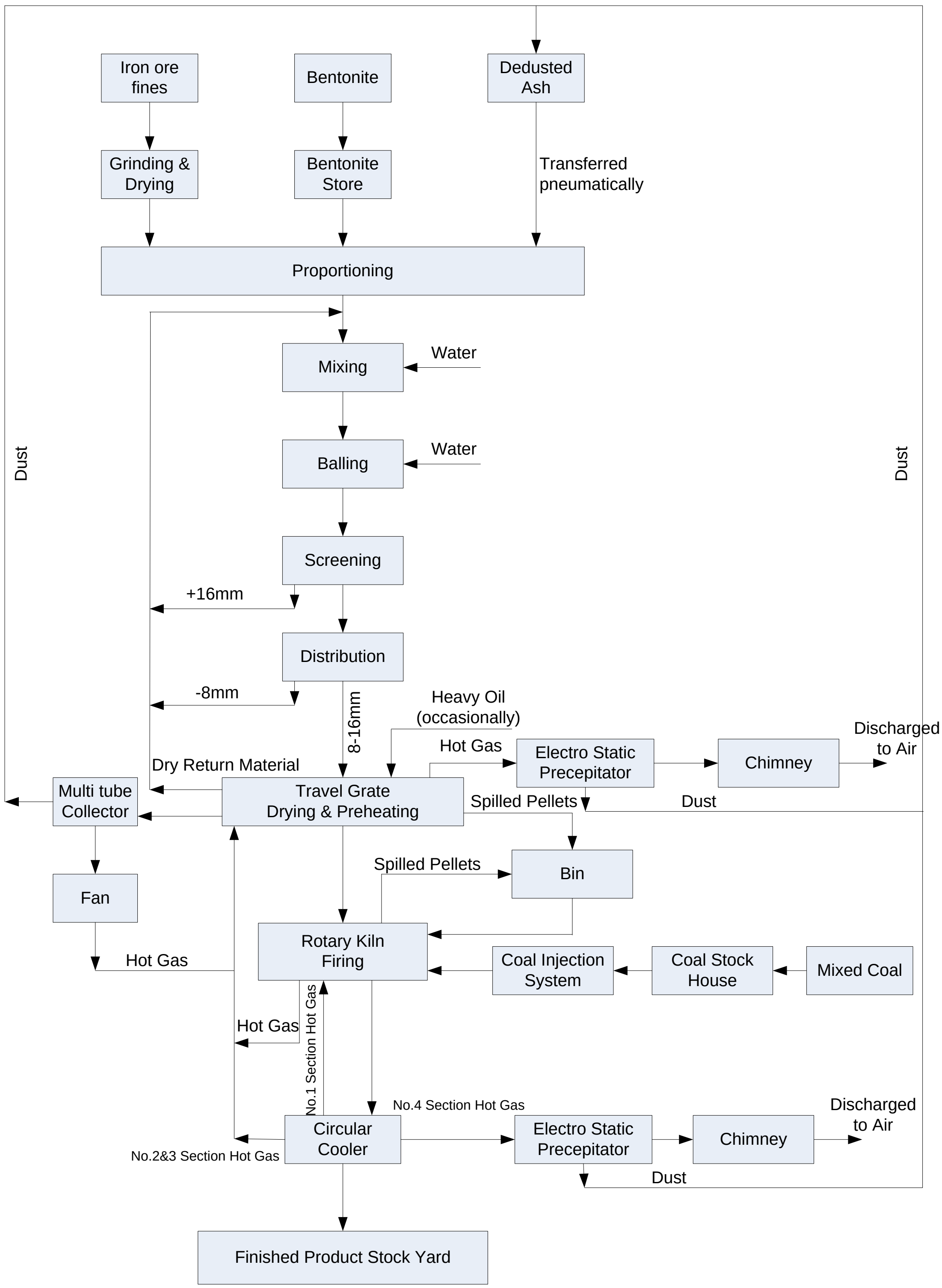
Fe in pellet was 64.9%, reducibility index was 70%, swelling index 10% and strength after reduction was 400 N. Softening and melting temperatures were higher and temperature range between softening and melting was narrow.

Thus, the tests have established that it is feasible to produce good quality fired pellets suitable for blast furnace, using grate- kiln process from iron ore fines supplied.

3.4 Process Flow sheet

The process flow sheet for the plant is given in the next sheet.

PROCESS FLOW SHEET



4 RAW MATERIALS

The raw materials required for the proposed pellet plant are iron ore fines, coal and bentonite.

4.1 Sources of raw materials

Iron ore fines will be purchased from iron ore mines in the Sandur-Hospet area. The mines are located within a distance of 40 km from the pellet plant site. The mines are accessible by road as well as rail.

Low ash coal will be imported from China, South Africa or Australia.

Bentonite is available indigenously and will be sourced from Gujarat.

4.2 Characteristics of raw materials

Iron ore

The iron ore will be purchased in minus 10 mm size. The typical analysis of the ore is indicated in Chapter 3 while discussing the results of pelletising tests. The ore is soft and easy to grind.

Coal

Coal will be used for firing in the kiln and to generate hot gas for drying iron ore while grinding. The desired characteristics of coal are as follows:

Size	<80mm
Moisture content	8 % Maximum
Calorific value	6500 – 7500 kcal/kg
Volatile matter	20% Maximum
Ash	14% Maximum
Ash melting point	1400 deg C minimum

Bentonite

The desirable characteristics of bentonite are

Swelling Index	20 minimum
Water absorbency	120 mg/g minimum
Methylene Blue uptake ability	More than 35 ml
Size	Minus 200 Mesh 96% minimum

It is proposed to buy ground bentonite from M/s Ashapura Internationals Ltd., Gujarat, who are supplying the material worldwide. The characteristics of bentonite have also been indicated in Chapter 4 while discussing the results of pelletising tests.

4.3 Annual requirements of raw materials (Dry)

Raw materials	Requirement, t/yr
Iron Ore	808,000 t
Bentonite	5,600 t
Non coking coal	32,000 t

5 LOCATION AND GENERAL LAYOUT

5.1 Plant site

The pellet plant will be located in a site near Kunikere village and Hirebaganal Village in Koppal Taluk and District of Karnataka State. The site is 25 km away from Hospet and is about 10 km from NH 63 between Hospet and Koppal. A good metalled road connects the site to NH63. The nearest town Ginigera is about 5 km from the proposed site. Ginigera railway station, on the South Central railway board gauge line between Hospet and Koppal is to the east at about 7 km away. The backwaters of Tungabhadra reservoir run almost abutting the site on the east and are only about 1.5 km from the site, while Hirehalla river is 7 km from site.

5.2 Plant Layout

The layout of the plant has been developed so as to facilitate smooth flow of materials from raw material stage to the finished product stage.

The major technological units in the pellet plant are

- Raw materials (ore fines and coal) storage yard
- Iron ore drying and grinding unit
- Coal grinding section
- Proportioning section
- Mixing section
- Balling building and green ball feeding section
- Induration unit (grate- kiln)
- Cooler
- Control room
- Pellet storage yard
- Dedusting units
- Quality control laboratory

The auxiliary units include water circulation system, compressed air station, fuel oil supply system, substation and power supply system, area lighting facilities, fire fighting facilities, stores and repair shops.

The above will be supported by administration building, employees' welfare facilities, security and time office etc.

All these units are shown in the layout drawing No. FGT/133/R/00/A3/001 (2 sheets).

6 MAIN PLANT FACILITIES

The main plant facilities include raw materials receipt and storage, drying and grinding of iron ore fines, proportioning section, mixing section, balling section, straight grate section, kiln section, cooling section, coal grinding section and product handling.

6.1 Raw material receipt and storage

The iron ore fines will be brought to the stock yard in trucks/tipplers or railway wagons. The main mode of transport of iron ore will be by rail. In the stock yard, the ore will be first unloaded into under ground hoppers and then carried by belt conveyors for stacking. The stockyard will have one stacker cum reclaimer. After reclaiming, the ore fines will be sent to the silos in the grinding section through belt conveyors.

Bentonite, ground to 90% - 200 mesh and packed in water proof bags, will be received in trucks. The bags will be taken near the proportioning section, opened and dumped into a ground hopper and pumped into bentonite bins in the proportioning section using compressed air and suction.

Coal will also be received by road. It will be first unloaded on ground and then stock piled with the help of three grab buckets. Coal yard can stock upto 10,000 t. Coal will be reclaimed by means of grab buckets and conveyed by belt conveyors to storage bins in the coal grinding section..

6.2 Ore grinding unit

The iron ore will be dried and ground to the required fineness in the grinding unit. A single machine will be used for both drying and grinding of ore. There will be two vertical roller grinding machines, in which the iron ore will be dried and ground to 80% below 200 mesh. Each grinding unit will have a dedicated coal fired fluidized bed and a hot air generator of 4 Gcal/h capacity. The ground iron ore will be collected in bag filters and conveyed to the ore bins in the proportioning section. Disc feeders under the ore silos in the grinding section will control the feed to the vertical grinding units. This unit will be provided with overhead crane for maintenance and repair

6.3 Proportioning section

The ground iron ore fines and the ground bentonite will be stored in the respective bins in this section. There will be 3 bins for iron ore, each of 23 m3 total volume. Bentonite will be stored in 3 bins, each of 6 m3 total volume. The disc feeders (each of 24 m3/h capacity) and belt weigh feeders below the ground iron ore bins will draw the required amount of iron ore fines and deliver it on to a collecting belt conveyor. The screw weigh feeders (10 m3/h each) below the bentonite bins will draw predetermined amount of bentonite and discharge it on to the collecting belt conveyor. The conveyor will take the mix to the mixing section.

An over head crane will be provided in this section for maintenance purposes.

6.4 Mixing section

In the mixing section, a very high intense vertical mixing machine with a capacity of 150 t/h will mix iron ore fines and bentonite thoroughly. The mix from the proportioning section will be delivered to the mixer through a 16 m3 bin. The required amount of water will also be added to the mix during mixing. The wet mixed material will be conveyed to the balling section.

This section will be provided with 10 t electric host for maintenance purposes.

6.5 Balling section

There will be four pelletising mix bins, each of 30 m3 total volume and feeding 3 balling discs each of 6 m diameter (40 to 75 t/h) through disc feeders and belt weigh feeders, where the mixed material will be rolled into green balls. The balling discs will be inclined at 45 – 47 deg and rotate at 6.5 – 9 rpm. Green balls of desired size will jump out from the discs and will be conveyed to 1.5 m wide 24-rollers small roller screen where over size material will be removed. The green balls will then be collected on a belt conveyor and sent to a swing belt conveyor, 800 mm wide, via a double layer 25/42 roller screens to remove the fines and oversize material, then go to the grate directly. The fines and oversize material will be returned to the mixing section by a system of belt conveyors after disintegrating the balls. The green balls of size 9-16 mm will be gently fed to a traveling grate machine.

For maintenance purpose, there will be two 10 t single beam bridge cranes and three electric hosts, one each of 5 t, 2 t and 1 t capacity provided in this section.

6.6 Induration of pellets

This is a major step in the process of pelletisation. The system for indurating pellets will consist of three main machines in series, a traveling grate, a rotary kiln and an annular cooler. The entire system is a gas-solid heat exchanger.

The green balls will be fed onto the grate, traveling in one direction, then gradually dried and heated to increase their strength so that they can survive the fall into the kiln without breakage. Pellets are heat hardened by firing in the kiln at temperatures up to 1380 deg C before being discharged onto the annular cooler, where they are cooled down to a temperature below 120 deg C.

Each machine can be controlled independently. The speed of the grate can be slowed to allow more drying time of the green balls. The kiln speed can be controlled to keep a constant retention time for proper induration. The speed of the cooler also can be controlled to achieve the desired cooling

6.7 Travelling grate

The drying and preheating of green ball are conducted on the grate machine. The 3.2 m wide 42 m long traveling grate will be made up of slotted castings and steel side plates, which are joined together to form a continuous chain. The rated capacity of the grate will be 101 t/h. The hood above the grate and the ducts leading to the grate will be refractory lined.

A level bed of green balls, 180 mm deep, will be fed onto the traveling grate. The conveying chain of the grate will convey the bed horizontally through the updraft drying zone, downdraft drying zone, No l pre-heating zone and No 2 pre-heating zone.

Updraft drying zone

In the updraft drying zone , the green balls dried by means of an upward flow of hot gas from the tertiary part of the annular cooler at about 200 - 250 deg C. The wet layer of green balls can play a role of filtration: Hot waste gas with moisture content coming from ball bed will be discharged into atmosphere through the chimney.

Downdraft drying zone

Drying will be completed in the downdraft drying zone by a downward flow of hot gas from No l pre-heating zone at about 350 – 450 deg C. It is also possible to use hot gas over 700 deg C from No. l pre-heating zone, if required.

No l pre-heating zone

The dried pellets will then enter this zone where they will be subjected to heating by downdraft hot gas at about 800 – 900 deg C. Main part of hot gas will come from annular cooler's No 2 cooling zone and the rest will be the exhaust from No 2 pre-heating zone (near 1000 deg C). This hot gas is introduced through holes of separating wall between No.1 pre-heating zone's hood. The hot gas from annular cooler's No 2 cooling zone comes directly through pipeline into No l pre-heating zone's hood.

In this zone, the balls will become drier and there will be initial oxidation of green balls. After treatment in this zone, the balls will be able to bear high temperatures of over 1000°C in No2 pre-heating zone.

No 2 pre-heating zone

In this zone, the pellets will be heated with kiln off-gases at about 1100-1200 deg C resulting in oxidation, decomposition and heating of balls. The balls will be sufficiently hardened so that these will be able to bear falling impact from grate machine into rotary kiln and impact during kiln's rotation without break.

Because of using hematite with low FeO content as the main raw material, it may be necessary to supplement the heat from the kiln off gases. For this purpose, it is proposed to install three oil burners on each side of the hood in this zone. These burners will use oil as fuel and will be operated as and when required.

On the top of No 2 pre-heating zone's hood there will be vent chimney and vent valve for the purpose of baking furnace refractory and in the case of emergency.

After being dried and pre-heated on the grate machine, the balls will possess enough strength to be transferred into kiln through spreading plate and chute.

Main exhaust system

One set of main exhaust fan will be adopted. After dedusting by electrostatic precipitator (ESP), the waste gas will be exhausted into the atmosphere through main exhaust fan and chimney. The dust content of the exhaust gas will be less than 40 mg/Nm3.

The waste gas from No l pre-heating zone will go through collecting pipeline located on both sides of wind box to meet with the waste gas from down draft drying zone, then it will be emitted into atmosphere through main ESP, main exhaust fan and chimney.

The dust collected by main ESP will be conveyed by means of a spiral conveyor to a dust bin from where it will be conveyed pneumatically to the dust bin in proportioning section.

System for returns

The drippings from grate machine's updraft drying zone and downdraft drying zone will be conveyed by a belt conveyor to drippings bunker located at kiln's tail end. Because of small quantity of the drippings, it is recommended to convey these in a handcart to stockyard, grind them with iron ore and then send for balling.

The drippings from grate machine's pre-heating zone will be conveyed by chain-scraper conveyer. These will go, together with drippings from grate machine's head and kiln's tail, through a chute into a heat-resistant bucket elevator for returning to rotary kiln.

The dust from grate machine's dust bin will be sent through a belt conveyor and chute to dripping bunker located at grate machine's tail end where it will be mixed with drippings from drying zone.

The grate section will be provided with two 10 t single beam bridge cranes and two electric hoists, one each of 2 t and 1 t for maintenance purposes.

6.8 Rotary kiln

Rotary kiln is a refractory lined cylinder with a diameter of 4.3 m and a length of 40 m. It will be rated to produce 101 t/h of pellets. It will have an inclination of 4.25% towards the discharge end. The kiln filling coefficient will be 8.2 % and it will be rotated at 0.45 – 1.35 rpm. The kiln will be supported by two piers, one 11 X 10 m, 4 m high and the other 2.7 X 10 m, 4 m high.

In the kiln, the preheated balls will be heated to 1300 – 1350 deg C and maintained at the quality temperature to develop desired pellet quality.

The kiln will be designed for a retention time based upon the pellet feed and product quality requirement. This retention time will be sufficient to uniformly indurate all pellets. Depending upon the pellet quality, the designed retention time will vary from 20 to 30 minutes. A variable speed drive unit will be considered for the kiln for process control and optimization.

At the discharge end, the kiln will be provided with a single burner. The burner will be designed to fire coal fines at a rate of 6.4 t/h. The burner will utilize preheated air at around 1100 deg C from the initial part of the cooler for combustion and creating the desired flame pattern. The coal fines will be injected into the kiln.

System for oxidation roasting and hardening

The roasting and hardening of balls will be carried out in the rotary kiln. The balls, after getting preheated in the grate machine, will be fed through a spreading plate and feeding chute into the rotary kiln. While rotating along kiln's inner periphery, the balls will move in the kiln's axial direction toward the discharge end. At the kiln's discharge end head, a telescopic coal burner of special design will be installed that will control the flame length and coal consumption by regulating the air-coal ratio. At the same time, the waste gas with a temperature near 1100 deg C from annular cooler's No 1 cooling zone will be introduced into the hood at kiln's head to ensure the temperature needed for roasting and hardening. During rotation and axial movement, the balls will be roasted and hardened evenly through radiant heat. The temperature needed for roasting and hardening is 1300-1350 deg C.

The pellet after roasting and hardening will be discharged into the annular cooler's receiving bunker through a chute and fixed screen located in the hood of kiln's head. Under high temperature, fine grains and molten balls may stick to kiln's wall (kiln ring formation), and this "ring" will casually fall down and get mixed with pellets. The fixed screen will separate the lumps over 200 mm size. These lumps will be broken manually and mixed with the final product.

The kiln section will be provided with 50 t capacity EOT crane/ 5 t capacity electric host for maintenance purposes.

6.9 Annular cooler

The annular cooler will be 12.5 m in diameter and has a 1.8 m wide annulus made of rotating pallets sealed by water. The annular cooler will have an effective area 50 m2. The annulus will have refractory lined side walls. It will be supported on a 12.5 m diameter platform, 4.5 m high. Its rated capacity will be 116 t/h of pellets.

The hot pellets discharged from the kiln with a temperature of approx 1250 deg C, will pile up in the cooler feed hopper and as the cooler rotates these will be drawn out under an air cooled screened wall, which will level the bed of pellets to 650-700 mm depth. A level detector will control the cooler speed in order to maintain the screening action across the whole width of the pellet bed. An air cooled grizzly above the cooler feed hopper will separate big chunks that may be created in the kiln.

The cooler will be divided into four cooling zones with separate wind-boxes. The area above the bed of pellets will be correspondingly divided into four zones. In each zone, sufficient cooling air will be provided to produce the mass of air at temperature required by the kiln and the grate. The cooling zones will be separated by air cooled refractory baffle walls. Each cooling zone will have its own fan.

In the primary zone (16 m2), the pellets will be cooled by an upward flow of cooling air. The air will be heated to about 1100- 1200 deg C and will be drawn directly into the kiln via a duct and through the cooler loading zone.

The secondary cooling zone (20 m2) will be connected to the No 1 preheating zone of the grate by a duct, delivering 800-900 deg C heated air for conditioning the pellets prior to preheating.

The waste gas at about 100 deg C from No 3 cooling zone (14 m2) will be discharged into atmosphere through a chimney above annular cooler. The updraft cooling fan for annular cooler regulates the cooling air flow by means of adjusting air inlet valve and controls the temperature of returned air.

While being cooled to less than 120 deg C, the pellets will be oxidized further in the cooler so that the FeO content in the cooled pellets will be reduced to below 1%.

At annular cooler's discharging bunker, sensor for monitoring material level will be installed. Discharge of pellets will be controlled by electro-hydraulic segmental valve that will ensure even discharge of pellets (below 100 deg C) from bunker onto a belt conveyer. This conveyor will take the pellets to the load out bunker or to the pellet storage yard.

To facilitate maintenance of equipment, the cooler area will be provided with an over head crane.

6.10 Storage of pellets

The finished product will be stored in four bunkers of total stock 4,800 t, from where they can be discharged directly into road vehicles or rail wagons. The pellets can also be stockpiled in the storage yard with the help of belt conveyors with traveling tripper. Total storage capacity of pellets will be 100,000 t. The pellets will be reclaimed with the help of five 5 t front end loaders and transported to the load out bunker by means of a belt conveyor.

6.11 Thermal regime

An appropriate thermal regime is a key point to achieve satisfactory performance of grate-kiln technology. To ensure smooth operation and obtain optimum indices, it is absolutely essential to determine technological parameters of grate machine, rotary kiln and annular cooler according to different properties of ore and to different requirements on product's quality and output. It is important as well to establish an appropriate thermal regime relating to drying, pre-heating and roasting and hardening processes.

The roasting and hardening of pellets made from hematite consumes more energy (temperature is 50°C approx. higher) than that pellets made from magnetite. Besides, the range of temperature is narrow so the operational accuracy required is quite high. However, the roasting of hematite pellets using coal burning technology plus strict management and automatic control is absolutely practicable.

6.12 Coal grinding unit

Raw coal will be fed by a 5 t grab crane into a coal bin, 35 m3 in volume. Coal will be withdrawn from the bin by a vibro feeder and charged to a 40 m3 bin through a belt conveyor and a bucket elevator. A belt weigh feeder will withdraw coal from this bin and feed to a medium speed grinding Machine of 12.5t/h capacity for grinding in a fluidized bed. The ground coal will be collected by a dust collector and stored in a 50 m3 volume bin. The coal dust will be transported to the kiln burner pneumatically. The coal grinding unit will have explosion proof equipment and special fire fighting facilities such as dry powder fire extinguishers, nitrogen cylinder group and automatic fire alarming facility.

Two 5 t hoists and one 3 t hoist will be provided for maintenance purposes in this unit.

6.13 Plant dedusting facilities

The ambient atmosphere in the pellet plant will be kept with low dust level in order to maintain clean working conditions as well as to facilitate plant maintenance. All dust generating areas within the pellet plant will be covered with hoods/casings and connected to dedusting systems with bag filters. Electro static precipitators and multiclones will be used to clean the gases in grate, kiln and cooler sections. The height of stacks and chimneys will be decided to sufficiently disperse the pollutants so that the air pollution is with in the prescribed limits.

6.14 Central control room

The plant will be controlled and operated from a central control room. All information required for operating and maintaining the plant will be indicated/ recorded in the control room. All equipment in the plant can be started/ stopped from the control room. Individual units can also be started/ stopped locally. The central control room will have a DCS.

6.15 Laboratory

The plant will be equipped with very modern laboratory where the required tests on raw materials, green balls and pellets can be carried out. The main facilities provided in the laboratory will be as follows:

- Sample preparation
- Chemical analysis
- Sieve and sub-sieve analysis
- Particle size analyzer
- High Temperature Furnaces
- Universal testing machine
- Tumbler index apparatus
- Screens, weighing scales and analytical balances
- Swelling index apparatus
- LTBT apparatus
- Reducibility index and high temperature breakdown test

7 SERVICE FACILITIES

7.1 Water supply facilities

Requirement of water

Water will be required for controlling the moisture content of the pelletising mix and cooling of equipment. Water will also be required for dust suppression by water spray and drinking, fire fighting etc.

Water requirement for the plant is estimated as below:

Circulating water	600 m3/h at 4 bar pressure
Make up water	18 m3/h at 2 - 4 bar pressure
Drinking water	0.5 - 0.6 m3/h

Raw water storage and treatment

The source of water supply to the pellet plant will be Tungabhadra reservoir. The water will be pumped from the source into a storage reservoir of capacity 72,000 m3 meeting the makeup water requirement for about 120 days.

A circulation water pump house is envisaged for housing the following pump equipment of the water circulation systems.

- 2 pumps. (1 working + 1 standby), each of 200 - 250 m^3/h, head 24 - 25 m WC for pumping water to cooling tower.
- 3 pumps (2 working + 1 standby), each of capacity 150 - 200 m^3/h, head 65 – 70 m WC for supplying water to grate area.
- 2 pumps. (1 working + 1 standby), each of 100 - 200 m^3/h, head 44 - 48 m WC for pumping water for cooling process fans, rotary kiln, instrument etc.
- 2 pumps. (1 working + 1 standby), each of 50 m^3/h, head 70 - 76 m WC for pumping water to fire fighting.
- 2 drain pumps. (1 working + 1 standby), each of 55 m3/h, head 16 m WC for draining water.

The water circulation system will be complete with self cleaning filter, electric water treatment facility, reinforced glass cooling tower etc.

The drive motor for three essential pumps will be connected to emergency power supply to ensure cooling water supply to lintels during prolonged power failure.

Piping System

Interplant underground water piping networks is envisaged to supply make up water to different consumers.

Inside the plant buildings, the pipelines will be laid over-ground supported from the building column structures and in some cases in pipe trenches.

7.2 Compressed air supply system

Compressed air is required to meet the following:

- Operation and control of various pneumatic instruments and control valves.
- Industrial requirement such as burner control of grate machine, lubrication system of pelletising discs, fluidizing bentonite bins. etc.
- Cleaning of various bag filters.

The requirement of compressed air is estimated to be 360 Nm3/h at a pressure of 8 -10 bar.

To meet this requirement, three 20 Nm3/min compressors and three 2 m3 compressed air vessels will be provided.

Piping System

Interplant over-ground piping network is envisaged for the supply of compressed air to different consumers. Inside the various plant buildings, the pipelines will be laid over-ground supported from the building column structures and in some cases in pipe trenches.

7.3 Fuel oil storage & handling

Liquid fuel will be required for heating the hood above the grate and kiln during start up. It will also be required occasionally, during operation of the pellet plant, to maintain the temperature in No. 2 preheating zone on the grate. The burners in this zone will be designed for consuming 707 liter per hour of furnace oil.

Two bulk oil storage tanks, each with 50 kl capacity have been envisaged for storing the fuel. There will be a day tank having a capacity of 20 kl near the discharge end of the grate.

Oil will be received in road tankers. Two unloading pumps will be installed for unloading oil from road tankers into bulk storage tanks. Two transfer pumps will be provided for transferring oil from bulk storage tank to day storage tank.

Interplant over-ground piping network is envisaged for the supply of furnace oil.

7.4 Repair facilities

A mechanical and electrical repair post equipped with necessary repair tools hoisting facilities will be provided for routine repair work.

7.5 Fire fighting facilities

Indoor and outdoor fire fighting water network is envisaged. Suitable type of fire extinguishers will be placed in coal grinding area, fuel oil storage area, substation, power distribution room, main control room and shift room etc.

7.6 Plant stores

A plant stores building has been planned to store spares and refractories. The building will be provided with necessary lifting tackles.

8 ELECTRICAL FACILITIES

8.1 Electric load

The connected load for the plant is estimated to be around 10 MW and the Maximum demand 8.2 MVA. Capacitors will be installed to improve the Power factor to 0.9 as per statutory requirement. The annual requirement of electrical energy is estimated as 40 GWh.

8.2 Power supply

Power will be supplied to main receiving station of the plant from Gulbarga Electric Supply Company, the State agency for power supply. This will be stepped down by 12.5 MVA transformer to 11 kV for distribution to the HT loads and 11/0.415 kV transformers. The LT supply at 0.415 kV will be provided by six 1250 kVA transformers located in three substations. A lighting transformer (630 kVA) will be additionally provided

The high voltage power distributed in the plant will be 11 kV while the low voltage power will be 415/230 V. Motors over 200 kW will use 11 kV. Motors below 200 kW will use 415 V. The voltage used by lighting system will be 230 V. Lighting lamps for the purpose of maintenance and repair will use 36 V or 12 V.

High voltage power distribution

The high voltage power distribution for the pellet plant is at 11 kV. The high-voltage power distribution room will be located near balling section. The High Voltage Panel with two incomers will receive power from two sections of the High Voltage panel at the main Receiving station to increase reliability. The 11 kV is fed to high-voltage motors and transformer substations in different shops. The high-voltage motors will be

- Circulation Blower 400 kW×2
- Vertical Roller Grinding Machine 2000 kW×1
- Vertical Roller Grinding Blower 2000 kW×1
- Kiln Tail Blower 1120 kW
- Blower for cooling zone 1 of cooler 250 kW
- Blower for cooling zone 2 & 3 of cooler 250 kW×2
- Exhaust fan of coal grinding 160 kW

Low-voltage power distribution

Three 11 kV/ 0.415kV transformers will be installed near balling section. The transformers will be rated such that in case one transformer fails, another one is able to ensure smooth running of equipment with full load.

8.3 Cable laying

Following class of cables will be used;

- Power cables will be of Copper or Aluminium depending on the equipment and all control cables will be of copper.
- High-voltage cable will be XLPE type
- Heat-resistant cable will be used where high temperature occurs.
- Shielded Cables will be used for DLC system

The laying of cable will be done on racks and GI conduits.

8.4 Lighting

The lighting for the plant will be provided from a separate lighting transformer. This will cover the shop lighting, road lighting and area lighting. In coal grinding unit, explosion proof light fittings will be provided.

8.5 Lightning protection

Necessary lightning protection for equipment and air craft warning lights will be provided in all tall structures like chimneys. This will be connected to separate earthing electrodes.

8.6 Communication

According to the requirement from technological processes and size of plant, the communication system facilities such as landline phones, wireless handsets etc will be provided. The Industrial CCTV will provide information to the main control room from various camera locations.

8.7 Air conditioning

The control rooms will be air conditioned. The switchgear room and other electrical rooms will be provided with pressurized ventilation systems.

8.8 Instrumentation

The following parameters will be measured and monitored:

- Material volume for proportioning
- Moisture content of pelletising mix
- Constant weight of pelletising mix for balling
- Level of pelletising mix bin for balling
- Green ball quantity and returns rate
- Temperature inside hood of grate machine's updraft drying zone
- Pressure inside hood of grate machine's updraft drying zone
- Temperature of wind box of grate machine's updraft drying zone
- Pressure of wind box of grate machine's updraft drying zone
- Temperature in hood of grate machine's downdraft drying zone
- Pressure in hood of grate machine's downdraft drying zone
- Temperature of wind box of grate machine's downdraft drying zone
- Pressure of wind box of grate machine's downdraft drying zone
- Temperature inside hood of grate machine's pre-heating zone No.1 and 2
- Pressure inside hood of grate machine's pre-heating zone
- Temperature of wind box of grate machine's pre-heating zone
- Pressure of wind box of grate machine's pre-heating zone
- Return Water volume of grate machine
- Pressure of inlet water of grate machine
- Coal injection rate for ignition in kiln
- Primary air volume needed by kiln's burner
- Secondary air volume needed by kiln's burner

- Peak temperature of gas inside kiln
- Roasting temperature of gas inside kiln
- Temperature of kiln’s shell
- Temperature inside seal hood of kiln’s head and tail
- Return cooling water flow for fixed screen at kiln’s head
- Return cooling water pressure for fixed screen at kiln’s head
- Temperature of hot gas returned from No.1 cooling zone of annular cooler
- Temperature of hot gas returned from No.2 cooling zone of annular cooler
- Temperature of hot gas returned from No.3 cooling zone of annular cooler
- Pressure of hot gas returned from No.2 cooling zone of annular cooler
- Pressure of hot gas returned from No.3 cooling zone of annular cooler
- Pressure at outlet of updraft fan of annular cooler
- Flow and pressure of cooling water for annular cooler
- Temperature of material discharged from annular cooler
- Level of bin containing material discharged from annular cooler
- Quantity of concentrate, bentonite and final product
- Temperature at inlet and outlet of main ESP
- Pressure at inlet and outlet of main ESP
- Level of dust bin of main ESP
- Temperature of bearing of fan for returning hot gas
- Temperature of bearing of fan for updraft drying
- Temperature of bearing of main exhaust fan
- Temperature of bearing of updraft fan for annular cooler

- Temperature of motor's bearing of fan for return hot gas
- Temperature of motor's bearing of fan for updraft drying
- Temperature of motor's bearing of main exhaust fan
- Temperature of motor's bearing of updraft fan for annular cooler
- Vibration of main exhaust fan
- Opening of air gate of updraft drying fan, hot returning gas fan and main exhaust fan
- Temperature, pressure and flow rate of normal-pressure circulating water
- Temperature, pressure and flow rate of low-pressure circulating water Pressure and flow of water for fire-fighting and production
- Pressure and flow of water for daily life
- Level of cold water pond, hot water pond and general purpose water pond
- Pressure and flow of water supplied to main exhaust fan room

Selection of instruments

Instruments will be selected considering good quality, high reliability, latest techniques, and easy availability. Thermal-resistors, thermocouples and infra-ray thermometers will be used to measure and monitor temperature.

Electromagnetic intelligent pressure-transmitters and differential pressure transmitters will be used to measure and monitor pressure.

Electromagnetic flow meters of hole plate or constant flow tube type will be employed to measure and monitor flow rate.

For bin level measuring and monitoring, weighing device will be preferred.

Belt weigh feeders will be of full-hanging type.

Infrared moisture-meters will be used to measure and monitor water content. Electronic belt weigh feeders will be used in belt conveyor for iron ore, belt conveyor under proportioning bins and product conveyor.

To ensure reliable and accurate data from technological processes, a workshop will be provided which will be responsible for equipment application, maintenance and repair and calibration of measuring tools, automatic instruments and computer system.

8.9 Automation and control system

Equipment control, process regulation and sequential control of various equipment and processes will be carried out with help of extensive instrumentation and control systems. Industrial PCs will be provided for the control which will be through centralized PLC system. The DCS/PLC system linkage with all technological processes will be established through redundant communication network. All equipment will be provided with local manual control and remote centralized control through PLC.

The following are the main technological processes:

- Raw materials receipt, storage and handling
- Drying and grinding
- Proportioning and mixing
- Balling
- Induration
- Product handling
- Hot air circulation in grate, kiln and cooler area
- Dedusting using ESP
- Dedusting using bag filters

Automation and control of technological processes

The pellet production is a very complicated technology adopting special equipment, process regulation and sequential control. Due to the complexity of technological processes, a mode of centralized and distributed control by computer system is adopted. The DCS system will take PLC as core and build a computer control system combining instrument with electric equipment. The linkage with all technological processes will be established through redundant control (communication) network. There will be basically two modes of control, local manual control and remote centralized control through PLC.

Arrangement of control station, operation station and monitoring station

According to the requirement from technological processes, from design of electric and instrumental engineering and I/O points of whole plant's control system, four control stations, one operation station and one monitoring station will be provided as follows:

- Control station for balling, control station for proportioning, control station for final product
- Main operation station for balling
- Monitoring station for operator on duty

The main operation station for balling will be the main control room of the whole plant. It will consist of five control and monitoring interfaces of which three will be responsible for operation and for recording technological data, making statistics and forms; two will be responsible for control and operation of auxiliary devices such as dedusting equipment and for engineer working station.

The monitoring station for operator on duty is a terminal used for operation and maintenance.

Main items of regulation and control will be

- Iron ore-bentonite ratio
- Volume of mixture
- Water addition into mixture in balling machine
- Constant weight feeding of mixture into balling machine
- Moisture of mixture in balling machine
- Speed of grate machine
- Temperature and pressure inside hood of grate machine's updraft drying zone
- Temperature and pressure inside hood of grate machine's downdraft drying zone
- Coal flow for burning in kiln
- Primary air volume used by kiln's burner for burning
- Secondary air volume used by kiln's burner for burning
- Gas temperature inside kiln for roasting and hardening

- Speed of kiln
- Low speed running control of kiln in emergency
- Feeding from bunker into annular cooler
- Speed of cooler
- Level of discharge bunker of cooler
- Speed ratio between grate machine, rotary kiln and annular cooler
- Speed of pendulum belt conveyer and wide belt conveyer

Main functions of control system

The operation stations will be linked with scattered PLCs through industry-purpose control network. The operators in operation station exercise the control of the plant through industrial-purpose computer based on monitoring & control software. Real-time control and data collection are possible including:

- General simulation diagram of the whole plant
- Detailed simulation diagram of the whole plant
- Data collection and treatment
- Data display (bin level, temperature etc)
- Status display (motor running, on& off of valve)
- Trend curve display of important data
- Detailed display of circuits
- Display of trends
- Listing of alarms & cases
- Simulation diagram display of different technological processes
- Alarming, recording and printing of technological variables
- Listing and printing of operational parameters

The system will be able to print and output automatically or according to requirement the alarms & cases, operator's manipulation, data to be filed, diagram trend and screen hard copy lists. The alarms generated from monitoring &control software will be marked with time and date and divided into different classes of emergency.

The operators can easily change the preset items of control and regulation; modify the sequential staring & stopping of technological equipment and the independent starting & stopping of individual machine. Provision will be made in the software for authentication of the user and the rights for the user using password.

All the technological and auxiliary electric equipment will be monitored and controlled through PLC system. Before starting belt conveyer or other special equipment, predicting signal will be given for a while so the PLC can execute the program of "safe starting". In addition to routine signals of motor's starting & stopping, operation mode selection, contactor's and thermal relay's control, the current drawn by large motors (over 55 kW) will be also sent in the form of standard signals into PLC system for the purpose of equipment control.

Specification of PLC and MMI

Intelligent continuous AC 220V power source (UPS) will be provided to supply power to computer system and its main peripheral equipment. The computers will be provided with redundant CPUs. In case one processor fails, another one will continue working. The PLC host machine's memory capacity will be such that real-time and multi-task operations are possible. It will be possible to insert or draw out PLC's I/O card (excluding CPU card) without switching off of power and without interrupting normal running of system (Hot swap).

Industrial type of control network will be provided. The communication network will be of redundant type to ensure normal communication in case a single net fails. The configuration and maintenance of network will be simple.

Industrial standard and industry-purpose computer will be used for man-machine interface and engineer station. Industry-purpose computer will be of the latest industry standards. All the software will be based on Windows platform using English language.

For taking printouts, two sets of printers will be provided.

8.10 Automatic Fire alarm & Fire fighting system

Equipment for fire alarm system such as smoke detectors, temperature sensors and manually operated alarm system will be installed in main control room, high-voltage & low voltage power distribution rooms, transformer rooms, computer rooms and in cable channels. Necessary fire fighting equipments like fire extinguishers, sand buckets etc will be provided at necessary locations.

9 POLLUTION CONTROL MEASURES

General

The proposed pelletisation plant is to be located near Kunikere village and Hirebaganal Village in Koppal Taluk and District of Karnataka State.

The pollution control measures adopted are aimed at reducing the pollution of air and water bodies and limiting pollution levels to those specified by the State Pollution Control Board.

In raw materials storage yard, dust suppression by water spray system will be provided. The pellet plant will have, to contain the dust generated at material transfer points, dust extraction systems with bag filters. The exhaust gas from the process carrying fine dust will be cleaned by Electro Static Precipitators (ESP) and multiclones. The clean air from the bag filters and ESP will be let into atmosphere through stacks limiting dust content in the outgoing gases to within the prescribed limits. The dust collected in the bag filters and ESP will be recycled to the process.

The dedusting systems provided include 2 sets of multi-pipe dust collector, 1 set of 180 m2 ESP, 2 sets of bag filter and the attached chimney & stacks and dust pipeline.

Electro static precipitators

- 180 m2 ESP will dedust gases from the kiln tail end. It will treat 550,000m3/h gases at 120 deg C. The inlet dust content will be ≤35g/Nm3. The dust in the cleaned gases will be ≤40mg/Nm3.
- Multi tube collector will dedust the gas from the preheating zone and the gas will be passed through a fan back into the down draft section of the grate machine. The dust collected will be recirculated.

Bag filters

- One (1) dedusting unit for the iron ore grinding units. The flow rate is 320,000 nm3/h.The inlet dust content will be<20g/Nm3,while the dust in the cleaned gas will be <100 mg/Nm3.
- One(1) dedusting unit for coal grinding unit. The flow rate will be 30,000 Nm3/h. The inlet dust content will be<20g/Nm3,while the dust in the cleaned gas will be <100 mg/Nm3

The exhaust stack/ chimney envisaged are

- RCC Chimney, 80m high, top dia 4m, bottom dia 7.2m for the kiln tail end ESP.
- One (1) steel chimney, 28m high, top dia 1.5m, bottom dia 1.5m, for the grate head(emergency)
- One (1) steel chimney, 40m high, top dia 2.8 m, bottom dia 4.4 m, for iron ore grinding unit
- One (1) steel chimney, 28m high, top dia 1.25 m, bottom dia 1.25 m, for the coal grinding unit.

Solid wastes

All the dust collected in the dedusting systems will be used in the pelletising mix.

Liquid effluents

There will be no liquid effluents from the plant. Even the blow down water will be used for dust suppression in the raw material storage yard. As such, the plant will work on zero discharge basis.

Gaseous pollution

The NOx and SO2 will be mainly present in the gases circulated in the grate section. The extent of gas pollution has been estimated to be as below:

Total volume of gases	550,000 Nm3/h
SO2 in gases	140 mg/Nm3
NOx in gases	0.08 mg/Nm3

The gases will be emitted to the atmosphere through RCC chimney, whose height of 80 m will be adequate to disperse the pollutants adequately so that the gas pollution will be with in prescribed limits.

Measures for abatement of noise pollution

The noise will mainly come from the high rotation equipments such as blowers and balling discs. The measures for abatement of noise pollution include installation of silencers, shock pads, vibration dampers which control the generation of noise and reduce the impact of noise on environment.

All high pressure blowers will be equipped with shock pads. On the suction side of blowers for annular cooler, silencers will be installed.

10 MANPOWER

The pellet plant will operate in three shifts a day through out the year. Only the administration, finance and commercial departments will work in day shift. The manpower required for operation and maintenance of the plant is estimated as below:

Sl.No.	Unit/ building	Persons/Shift	Total
1	Raw Material storage yard	8	24
2	Iron ore grinding	2	8
3	Proportioning section	1	4
4	Mixing section	1	4
5	Balling section	2	8
6	Grate section	2	8
7	Rotary Kiln section	1	4
8	Annular Cooler section	1	8
9	Circulation and, drying blowers and dedusting systems	2	2
10	Main Control Room	1	4
11	High Tension Room	1	4
12	Chemical Laboratory	2	8
13	Water Pump House	2	8
14	Shift in charge	4	12
15	Managerial/ clerical staff	3	3
16	Electrical maintenance	8	14
17	Mechanical maintenance	12	21
18	Miscellaneous	1	3
	Total		147

11 CONSTRUCTION SCHEDULE

Schedule of 11 months has been considered for commissioning of the plant from zero date, which will be the date of obtaining all the statutory clearances and financial closure. Critical and long delivery equipment have been identified and ordering is being processed. Intermediate/ critical milestones have been identified and project monitoring will be carried out vigorously to ensure commissioning of the plant as planned.

12 CAPITAL COST

12.1 General

The capital cost of the proposed pellet plant having annual rated production of 2,000,000 t per year is estimated as Rs. 2185.9 million including Rs 85 million towards margin money for working capital. The estimates are summarized in the following table.

SUMMARY OF ESTIMATED COST OF PROJECT

Sl. No.	Item	Cost in Rs million
1	Land and site development	102.5
2	Buildings	344.0
3.	Plant & Machinery	1378.6
4.	Technical knowhow fees and engineering	44.8
5.	Training	7.0
6.	Miscellaneous fixed assets	40.0
7.	Pre operative expenses	135.0
8.	Provision for contingencies	49.0
	Sub-total (1 to 8)	2100.9
9.	Margin money for working capital	85.0
	Total Capital Cost	2185.9

Details are given in Annexure I.

The capital cost estimates are based on the prices prevailing in the fourth quarter of 2008 and do not take into account any future escalation in prices.

Cost of the project includes cost towards land and site development, buildings, plant and machinery, engineering expenses on drawings and documents, miscellaneous fixed assets, preliminary and pre-operative expenses, provision for contingencies and margin money for working capital.

12.2 Land

Land requirement for the plant is 40 acres.

12.3 Civil and Structural works

The facilities included under this head are factory buildings for main and auxiliary units, open yards, conveyor galleries and junction houses, project office, non factory buildings and other miscellaneous civil engineering works. The cost of these facilities have been estimated on the basis of preliminary layouts and designs of facilities discussed in the previous chapters, taking into consideration the cost of construction materials prevailing in the region.

12.4 Plant and Machinery

Cost of equipment both imported and indigenous including charges for basic engineering is based on quotations. Cost of plant and machinery includes, besides the basic cost, costs towards spares, taxes and duties, ocean freight, port clearance, inland transport and transit insurance etc.

Spares have been considered at about 2% of equipment cost and amount to Rs 22 million.

12.5 Know-how, engineering, documentation and consultancy fee

Cost estimated under this head includes engineering and consultancy charges which mainly comprise of preparation of project reports, technical specifications, and detailed engineering and inspection services.

12.6 Training of Indian Technicians

Cost of training of Indian technicians abroad is included in this head.

Training of Indian technicians is based on the fee charged, living expenses abroad and return air fare.

12.5 Miscellaneous Fixed Assets

Miscellaneous fixed assets include cost towards servers, desktops, laptops, furniture, office equipment etc.

12.6 Pre-operative expenses including interest during construction

This includes costs towards establishment, rents, rates and taxes, traveling expenses, communication, interest and commitment charges on borrowings, insurance during construction including erection insurance, start up expenses etc.

Interest on long term borrowings has been considered at 13%.

Interest on short term borrowings/ working capital is at 15%.

Debt Equity ratio is 2:1.

12.7 Contingencies

Provision of Rs 49 million has been made towards contingencies which are around 2% of the non-firm cost to cover unforeseen aspects of the estimate.

12.8 Margin money for working capital

Provision has been made in the estimate towards margin money for working capital. Margin money would be finance in the same debt equity ratio as fixed capital and the interest rate on term loan would be 13%.

12.9 Means of financing

Project cost including margin money for working capital would be financed in the debt- equity ratio of 2:1.

12.10 Basis of Estimates

Capital cost estimates indicated above are based on the following assumptions:

Estimates are based on the price levels prevailing in fourth quarter of 2008.

Estimates do not have any provision for escalation in price levels, variation in foreign exchange rates and variation in statutory duties and taxes.

13 PRODUCTION COST

13.1 General

Production cost of pellets from the proposed plant is estimated based on the price levels prevailing in the fourth quarter of 2008. No provision has been made for escalation in prices. Detailed breakup of production cost at 100% capacity utilization excluding depreciation and interest is given in the table below.

Table 13.01

Unit production cost at 100% capacity utilization

Sl. No.	Description	Unit	Specific Consumption	Unit rate, Rs	Cost, Rs
A. RAW MATERIALS & CHEMICALS					
a)	Iron ore fines	t	1.01	1,000	1,010.0
b)	Coal	t	0.04	5,000	200.0
c)	Bentonite	t	0.007	3,300	23.1
	Sub-total(A)				1,233.1
B. UTILITIES					
a)	Power	kWh	50	5.5	275.0
b)	Water	m3	0.3	50.0	15.0
	Sub-total(B)				290.0
C. FACTORY OVERHEADS					145.0
	Total cost of manufacture				1668.1

Details are given in Annexure II.

Details of Manufacturing expenses are given in Annexure III.

13.2 Raw Materials

The key raw material required for manufacture of pellets is iron ore, non coking coal and bentonite.

Costs of major raw materials as delivered at site have been taken as follows:

Sl. No.	Item	Unit	Rupees per unit
1.	Iron ore	ton	1,000
2.	Bentonite	ton	3,300
3.	Non coking Coal	ton	5,000

13.3 Consumables

Cost towards consumables includes various consumables like refractories, grinding balls, filter bags, grate bars etc.

13.4 Utilities

Costs of major utilities considered are as follows:

Sl. No.	Item	Unit	Rate (Rs/unit)
1	Purchased electricity	kWh	5.5
2	Make up water	m3	50

13.5 Labour and Supervision

Provision for labour and supervision is based on the operational and maintenance requirement for the proposed plant and takes into account salaries and wages including applicable fringe benefits. Provision is made for an annual increase of 5% in salaries and wages to cover increments and promotions.

13.6 Factory overheads

Factory overheads include provision for repair and maintenance, rents and taxes on factory assets, insurance, miscellaneous factory expenses etc.

13.7 Administrative and Selling Expenses

Provisions towards administrative expenses include the administrative salaries, remuneration to directors, office expenses, and other administrative overheads. Provision has also been kept for annual increase in salaries at 5%.

Provision for selling expenses includes expenses towards sales promotion, sales commission etc.

13.8 Depreciation

Depreciation has been worked out as per the provisions of Schedule 14 of Companies Act.

13.9 Interest

Following interest rates have been considered during operation for various types of borrowings.

Term loan	13%
Borrowings for Working Capital	15%

14 FINANCIAL APPRAISAL

14.1 General

Based on the estimated capital costs and production costs as described in the preceding chapters, the techno-economic appraisal for the project has been carried out and the salient techno-economic indices are summarised below:

Sl. No.	Indices	Unit	Value
1	Cumulative retained profit after tax over 10 years of operation	Rs million	3048.3
2	Average retained profit after tax per year over 10 years of operation	Rs million	304.8
3	Cumulative cash surplus over 10 years of operation	Rs million	3268.0
4	Debt Service Coverage Ratio (average for 8 years)	Ratio	1.98
5	Payback period after tax	Years	4.83
6	Internal rate of return (after tax)	%	26
7	Break-even capacity(average over 10 years operation)	%	43

Profit & Loss Statement, Cash flow and Balance Sheet are given in Annexure IV, V & VI respectively.

14.2 Assumptions

Sales realization of pellets is taken as Rs 3000/t for export sales.

Total project cost including margin money for working capital would be financed in debt-equity ratio of 2:1.

Term loan would be repaid in five years, with two years moratorium period after commissioning of the plant.

Interest rates considered for borrowings are as follows:

Term loan	13%
Borrowings for working capital	15%

Depreciation has been calculated on straight line basis at rates as per Company's Act for profit and loss statement and as per Income Tax Act for taxation purpose.

15. RECOMMENDATION

It may be noted from the above analysis that the project having installed capacity of 800,000 TPA capacity Iron Ore Pellet plant would be justified and is viable commercially.

ANNEXURE – I

ESTIMATED COST OF THE PROJECT

Sl. No.	Item	Cost in Rs million
1	Land & site development	
	a)Cost of land	
	-factory 40 acres @ Rs 13 lakhs/acre	52.0
	-township 15 acres @ Rs 13 lakhs/acre	19.5
	-Railway siding 10 acres @ Rs 30 lakhs/acre	30.0
	b)Cost of levelling and development	1.0
	c)Compound walls	12.0
	d)Roads, Reservoirs, Camps and others	32.0
	Sub-total(1)	146.5
2	Buildings	300.0
3	Plant & Machinery	
	i)Equipment	
	-Annular Cooler	78.2
	-Travelling Grate	185.4
	-Rotary kiln	261.0
	-Other machineries	469.5
	-Refractory materials	17.5
	-Electrical Equipment	92.4
	-Cables	27.6
	ii)Machinery stores and spares	22.0
	iii) Erection & Commissioning	225.0
	Sub-total(3)	1378.6
4	Technical knowhow fee, Engineering	44.8
	and expenses on drawings and	
	documentation	

Sl. No.	Item	Cost in Rs million
5	Expenses on technicians and	7.0
	training of Indian technicians	
6	Miscellaneous fixed assets	
	-Servers	9.0
	-Desktops	3.5
	-Laptops	2.0
	-Printers	0.6
	-Videoconference equipments	0.5
	-EPABX	0.5
	-Office interiors like Sofa, cafeteria, air conditioner etc.	5.0
	-Executive Chairs	0.4
	-Vehicles	10.0
	-Road equipment	2.0
	-Construction Office	6.5
	Subtotal(6)	40.0
7	Pre-operative expenses	
	-Salaries of employees	20.0
	-Administrative expenses	10.0
	-Legal & Professional Charges	5.0
	-Interest during construction	100.0
	Sub-total(7)	135.0
8	Provision for contingencies	49.0
	Sub-total(1 to 8)	2100.9
9	Margin money for working capital	85.0
	Total capital cost(1 to 9)	2185.9

ANNEXURE - II

Pellet Plant				
Production in tpa			800000	
Description	unit	Sp.consumption	Rate in Rs/unit	Cost in Rs/t
Raw materials				
iron ore fines	t	1.010	1000	1010.00
Bentonite	t	0.0070	3300	23.10
Coal	t	0.040	5000	200.00
Sub total				1233.10
Utilities and services				
Water	m3	0.300	50	15.00
Electrical energy	kWh	50.000	5.50	275.00
Sub total				290.00
Labour				100.00
Repair & maintenance				30.00
Overheads				15.00
Cost of pellets				**1668.10**

ANNEXURE - III
MANUFACTURING EXPENSES

Unit : Rs million

Sl. No.	Description\year	1	2	3	4	5	6	7	8	9	10
A.	RAW MATERIALS & CHEMICALS										
a)	Iron ore fines	565.6	646.4	727.2	727.2	727.2	727.2	727.2	727.2	727.2	727.2
b)	Coal	112.0	128.0	144.0	144.0	144.0	144.0	144.0	144.0	144.0	144.0
c)	Bentonite	129.4	147.8	166.3	166.3	166.3	166.3	166.3	166.3	166.3	415.8
	Sub-total(A)	807.0	922.2	1037.5	1037.5	1037.5	1037.5	1037.5	1037.5	1037.5	1037.5
B.	UTILITIES										
a)	Power	154.0	176.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0
b)	Water	8.4	9.6	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
	Sub-total(B)	162.4	185.6	208.8	208.8	208.8	208.8	208.8	208.8	208.8	208.8
C.	LABOUR & SUPERVISION										
	Wages, bonus,perks etc.	35.0	36.8	38.5	40.3	42.0	43.8	45.5	47.3	49.0	50.8
	Sub-total(C)	35.0	36.8	38.5	40.3	42.0	43.8	45.5	47.3	49.0	50.8
D	FACTORY OVERHEADS										
a)	Repair & Maintenance	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
b)	Other factory overheads and insurance etc.	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
	Sub-total(D)	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
F.	ADMINISTRATIVE EXPENSES										
a)	Administrative salaries	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
b)	Light,postage,telegram,telephone,	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	directors remuneration &										
	miscellaneous expenses										
	Sub-total(F)	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
G.	SELLING EXPENSES	16.8	19.2	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6
H.	TOTAL COST OF MANUFACTURE	1057.2	1199.9	1342.6	1344.5	1346.3	1348.2	1350.0	1351.9	1353.7	1355.6

ANNEXURE - IV

PROFIT AND LOSS STATEMENT

Unit : Rs million

Sl. No.	Item\Year of operation	1	2	3	4	5	6	7	8	9	10
1	Total Manufacturing Expenses	1057.2	1199.9	1342.6	1344.5	1346.3	1348.2	1350.0	1351.9	1353.7	1355.6
2	Expected sales	1680.0	1920.0	2160.0	2160.0	2160.0	2160.0	2160.0	2160.0	2160.0	2160.0
3	Gross profit before interest	622.8	720.1	817.4	817.4	817.4	817.4	817.4	817.4	817.4	817.4
4	Interest on term loan	189.4	189.4	170.5	132.6	94.7	56.8	18.9	0.0	0.0	0.0
5	Interest on bank borrowings for	19.9	23.8	28.4	32.9	37.4	42.0	46.5	51.1	55.6	60.1
	working capital										
6	Total Financial expenses	209.3	213.3	198.9	165.5	132.2	98.8	65.5	51.1	55.6	60.1
7	Depreciation	167.7	167.7	167.7	167.7	167.7	167.7	167.7	167.7	167.7	167.7
8	Operating Profit	245.8	339.1	450.8	482.3	513.8	545.3	576.8	589.4	583.0	576.6
9	Provision for taxation	49.6	103.0	156.5	178.9	198.4	215.8	231.5	239.7	240.6	240.8
11	Profit after tax	196.2	236.2	294.3	303.4	315.4	329.6	345.3	349.7	342.4	335.8
12	Retained Profit:										
	-Current	196.2	236.2	294.3	303.4	315.4	329.6	345.3	349.7	342.4	335.8
	-Cumulative	196.2	432.4	726.7	1030.1	1345.5	1675.1	2020.4	2370.1	2712.5	3048.3

ANNEXURE – V

CASH FLOW STATEMENT

Unit : Rs million

Sl. No.	Item\Year of operation	Construction period	1	2	3	4	5	6	7	8	9	10
A	SOURCES OF FUNDS											
1	Equity											
	-Fixed capital	700.3										
	-Margin money		28.3									
2	Profit before interest and tax		455.1	552.4	649.7	647.8	646.0	644.1	642.3	640.4	638.6	636.7
3	Depreciation and preliminary		167.7	167.7	167.7	167.7	167.7	167.7	167.7	167.7	167.7	167.7
	expenses written off											
4	Term loan											
	-Fixed capital	1400.6										
	-Margin money		56.7									
5	Increase in bank borrowings		132.4	26.5	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3
	for working capital											
6	Overdraft											
	Total cash inflow(A)	2100.9	840.2	746.6	847.6	845.8	843.9	842.1	840.2	838.4	836.5	834.7
B	DISPOSITION OF FUNDS											
1	Capital Expenditure	2100.9										
2	Decrease in long term loan		0.0	0.0	291.5	291.5	291.5	291.5	291.5	0.0	0.0	0.0
3	Increase in working capital		217.4	26.5	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3
4	Interest on term loan		189.4	189.4	170.5	132.6	94.7	56.8	18.9	0.0	0.0	0.0
5	Interest on bank borrowings for		19.9	23.8	28.4	32.9	37.4	42.0	46.5	51.1	55.6	60.1
	working capital											
8	Provision for taxation		49.6	103.0	156.5	178.9	198.4	215.8	231.5	239.7	240.6	240.8
9	Dividend on equity		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total cash outflow(B)	2100.9	476.3	342.7	677.1	666.1	652.3	636.3	618.7	321.0	326.4	331.2
	Net cash accruals(A-B)	0.0	363.9	403.9	170.6	179.6	191.7	205.8	221.6	517.4	510.1	503.5
	Opening Balance	0.0	0.0	363.9	767.8	938.3	1118.0	1309.7	1515.5	1737.0	2254.4	2764.5
	Cumulative cash surplus	0.0	363.9	767.8	938.3	1118.0	1309.7	1515.5	1737.0	2254.4	2764.5	3268.0

ANNEXURE – VI

STATEMENT SHOWING PROJECTED BALANCE SHEET

		Unit : Rs million									
Particulars/Year	Construction period	1	2	3	4	5	6	7	8	9	10
Source of Funds											
Share Capital	700.3	728.6	728.6	728.6	728.6	728.6	728.6	728.6	728.6	728.6	728.6
Reserves & Surplus		196.2	432.4	726.7	1030.1	1345.5	1675.1	2020.4	2370.1	2712.5	3048.3
Term Loan	1400.6	1457.3	1457.3	1165.8	874.4	582.9	291.5	0.0	0.0	0.0	0.0
Working Capital Finance		132.4	158.9	189.2	219.4	249.7	279.9	310.2	340.4	370.7	400.9
Total	**2100.9**	**2514.5**	**2777.2**	**2810.3**	**2852.5**	**2906.7**	**2975.1**	**3059.2**	**3439.1**	**3811.8**	**4177.8**
Application of Funds											
Gross Block of Fixed Assets	2100.9	2100.9	2100.9	2100.9	2100.9	2100.9	2100.9	2100.9	2100.9	2100.9	2100.9
Less: Depreciation Reserve	0.0	167.7	335.4	503.1	670.8	838.5	1006.2	1173.9	1341.6	1509.3	1677.0
Net Block of Assets	2100.9	1933.2	1765.5	1597.8	1430.1	1262.4	1094.7	927.0	759.3	591.6	423.9
Current Assets	0.0	217.4	243.9	274.1	304.4	334.6	364.9	395.2	425.4	455.7	485.9
Less: Current Liabilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Working Capital	0.0	217.4	243.9	274.1	304.4	334.6	364.9	395.2	425.4	455.7	485.9
Deposits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash &Bank Balance	0.0	363.9	767.8	938.4	1118.0	1309.7	1515.5	1737.1	2254.4	2764.5	3268.0
Miscellaneous Expenditure	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**2100.9**	**2514.5**	**2777.2**	**2810.3**	**2852.5**	**2906.7**	**2975.1**	**3059.2**	**3439.1**	**3811.8**	**4177.8**