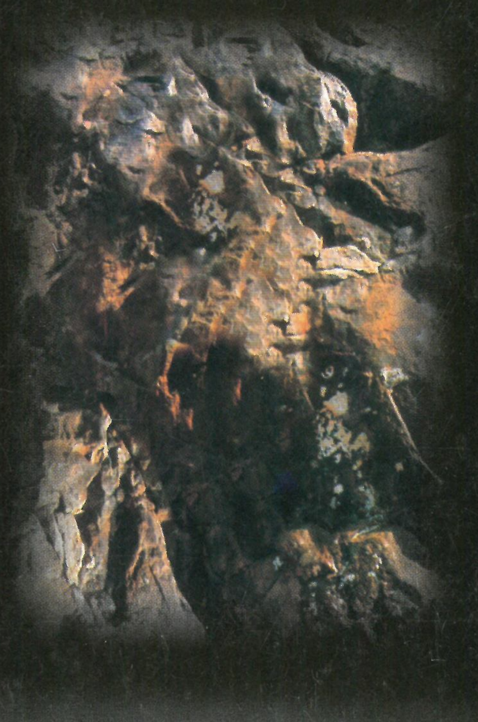
Government of India
Ministry of Mines

IRON ORE

A MARKET SURVEY



INDIAN BUREAU OF MINES
Nagpur

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A MARKET SURVEY

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Nagpur

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Preface

Iron Ore—A Market Survey is the 28th Publication in the series of Market Survey Reports on minerals brought out by Indian Bureau of Mines. The intent of the Report is to reflect the potency of the mineral Iron Ore and its derivative Steel in the present day context and prognosticate its utility and demand with exhaustive database that not only forms the integral part of the text but also principally complements the content of the publication.

Iron & Steel, virtually, engined the vitality of economies worldwide and bolstered growth of nations since the industrialisation era. The demand for Steel never subsided—it only rose and significantly so since the onset of the new millennium. Indian Steel Sector in tandem with its global counterparts, spired its position, by virtue of India's naturally endowed iron ore resources, to get to the reckoning and now has poised itself for ambitious growth prospects. Escalating demands globally and unrelenting domestic consumption of steel in India have opened up vistas for perpetual growth in the Sector. Proposals to commission new plants were put in place and the existing steel manufacturers to purvey to the demand augmented their existing capacities many folds.

Owing to the vibrancy of the subject, i.e., Iron & Steel, this publication under its ambit of study provides a complete perspective on the demand-supply position of Iron Ore; demand-supply relationship and export prospect of iron ore; uses and specifications; internal demand; supply position; resources, production and beneficiation; foreign market; and prices of iron ore. Furthermore, the future status of Iron & Steel Sector and other auguries have been discussed with emphasis on forecast of domestic as well as foreign demand up to 2020, estimated supply position up to 2020, analysis of resources, mining and other portended problems besides the R & D activities of the government and private agencies to meet the futuristic demands.

The methodologies adopted to formulate the content of this study basically were desk survey and field survey. The desk survey comprised literature consultations, assimilation of information from various reports/records and collection and perusal of information from producers, consumers, exporters and other concerned organisations through questionnaires, browsing websites etc. Field survey, on the other hand, involved visiting various ferro-alloy plants in the country for data collection. Additionally, the correspondences from various Central and State Government Departments, joint plant committees, producers, consumers, beneficiation plants both capitive and non-capitive, national laboratories and various manufacturers' associations yielded comprehensible data inputs that appropriately were woven into the text and at some sections of the text have formed the crux of the matter. Indian Bureau of Mines duly acknowledges the cooperation extended by all these agencies. Our thanks are also due to foreign embassies in India and Indian embassies abroad who responded to our questionnaire promptly.

It is earnestly believed that this Market Survey Report on Iron Ore will address the needs of all its readers specifically the producers, consumers, exporters and beneficiation plants and benefit all those who are directly or indirectly associated with this branch of study.

Nagpur
Dated: 11 September 2007

(C.P. Ambesh)
Controller General
Indian Bureau of Mines

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Chapter 1
Introduction

Iron is the most common and indispensable metal. Its applications over the years has broadened its realms to unimaginable proportions. Iron ore is the basic raw material mainly used in the making of pig iron, sponge iron, steel and alloy steel. Iron & steel industry is the major consumer of iron ore in the country. This industry uses iron ore in lumps and as ore fines after pelletisation, sintering or briquetting. Sponge iron is another major consumer of iron ore. Sponge iron is used as a substitute in place of scrap in electric arc furnaces and in mini-steel plants. The other important iron ore consuming industries are cement, coal washeries and ferro-alloys industries.

The dawn of the new millennium witnessed sea changes in the northward direction in every aspect of iron ore, such as, production, domestic demand, foreign demand, prices, etc. This phenomenal change is attributed to the hectic development activities in the Asian countries like China, India, South Korea and Japan. In the recent past, China and India have emerged as the most successful economies in the world with China being the main engine of all activities engendering overseas demand in respect of iron ore as well as steel. Joining the bandwagon, India too has augmented its production capacities for fulfillment of domestic as well as external demands of iron ore.

It is a well known fact that India is endowed with rich deposits of iron ore both qualitywise and quantitywise. Indian iron ores are in good demand in the international market especially in Asian markets. India could further explore markets in the Middle East and Europe as it is well placed geographically to these regions in comparison to other leading iron ore exporting countries in the world.

To cope with the increased demand, mining activities have to be accelerated. Mechanisation of iron ore mines is imperative not only to increase production but also to reduce production cost. The leading iron producing countries like Brazil, South Africa and Australia have increased their iron ore production by adopting cost-effective and technologically advanced schemes of mining.

Beneficiation of low grade iron ore and fines that are in plenitude in India could be another viable prospect. This will fetch good export value to the indigenous iron ore and create job opportunities in the Sector. The Regional Research Laboratory (RRL), Bhubaneswar, Ore Dressing Division of IBM and National Metallurgical Laboratory (NML), Jamshedpur, have developed techniques of iron ore beneficiation on pilot scale. RRL, Bhubaneswar has developed a technique (with the combination of hydro-cyclone, magnetic separation, gravity separation etc.) on pilot scale to beneficiate the slime generated during washing of iron ore. The slime generated from the mine can be beneficiated to obtain concentrates containing 63 to 65.9% Fe.

Although India is endowed with substantial resources of iron ore, many prospective areas in the country have still not been explored. Detailed exploration may result in further augmentation of iron ore resources. With increased use of iron ore with around 50% Fe in global steel plants there is a need to reassess the iron ore resources of the country. Banded Iron Formation, namely, Banded Haematite-Quartzite (BHQ)/Jasper and Banded Magnetite-Quartzite (BMQ) are other potential sources of iron ore and need exploration for assessment of technology to beneficiate BHQ/BMQ to extract iron ore from these sources.

To make exports of Indian iron ore internationally competitive there is an inexorable compulsion to develop infrastructure like road, railways and ports to match international standards.

The National Steel Policy 2005, has proposed a target of 110 million tonnes of steel production by 2019-20. If this has to be achieved amidst other compulsions of export demands, there is little choice but to develop and enhance mine capacities.

Ascribing to the above aspects and owing to the gravity of the subject, i.e., iron ore, the necessity to carry out a detailed market survey on iron ore and find out the demand-supply relationship for the present and also for the future (up to the year 2020) was felt essential and was concertedly done so by Indian Bureau of Mines.

Chapter 2

Uses and Specifications

MINERALOGY

Commercially, iron is a very important metal. It is found in its elementary as well as in the form of chemical compounds with other elements in a number of minerals. Natural occurrences of iron ore are abundant all over the world. Iron ore occurs most abundantly in the form of oxides. Other forms are carbonates, hydroxides, sulphides and silicates. It is also found in association with titanium dioxide. A list of common iron-bearing minerals is given in Table 2.1.

Table 2.1: List of Common Iron-bearing Minerals

Mineral	Composition	Iron content (Percentage)	Specific gravity	Hardness (Mho's scale)	Colour
NATIVE IRON	Fe	100	7.3–7.87	4–5	Steel grey to red
OXIDES					
Haematite (alpha) & Martite	α - Fe_2O_3 (Haematite pseudomorphous after magnetitte)	70	4.9–5.3	5.5–6.5	Steel grey to red
Turgite	2 $Fe_2O_3 .H_2O$	66.1	4.2–4.6	6.5	Brown to red
Goethite	$Fe_2O_3 . H_2O$				
Limonite	$2Fe_2O_3 . H_2O$	62.9 60	3.4–4.4	5–5.5	Brown to red Brown to yellow
Lepidocrosite	$Fe_2O_3 .H_2O$	62	4.09	5	Brown to reddish brown
Ilmenite	$FeTiO_2$	36.8	4.5	5–6	Black-brown-black
Maghemite (gamma)	γ - Fe_2O_3	69.9	4.88	5	Brown
Magnetite	Fe_3O_4	72.4	5.17	5.5–6.5	Black, blue or brown black
CARBONATES					
Siderite	$FeCO_3$	48.2	3.7–3.9	3.5–4.5	Ash grey to brown
SULPLHIDES					
Pyrite	FeS_2	46.6	4.8–5.1	6–6.5	Brass yellow
Marcasite	FeS_2	46.6	4.9	6–6.5	Light brass yellow
Pyrrhotite	FeS_2	61.6	4.4–4.65	3.5–4.5	Bronze yellow
SILICATES					
Chamosite	$(Mg.Fe.Al)_6 (Si.Al)_4O_{14}(OH)_8$	33.42	3–3.5	3	Green to light yellow

Commercially, the most important minerals of iron are in the form of oxides, i.e., haematite (Fe_2O_3) and magnetite (Fe_3O_4).

Haematite

The most important deposits of haematite in India occur in the Pre-Cambrian rocks of Dharwarian formations. The ores are formed by the enrichment of banded ferruginous rocks, such as, banded haematite-quartzite (BHQ) or banded haematite-jasper (BHJ) by removal of silica.

Haematite is the most abundant iron ore mineral and is the main raw material for iron & steel industry. It is the red oxide crystallising in hexagonal system and occurs in the form of lumps and fines. Fine-grained haematite is deep red or brownish red or bluish red in colour which may be compact or highly porous to friable or granular or in the form of dense hard lumps. The coarse-grained haematite appears as steel grey with bright metallic to dull grey luster. Occasionally, the coarse crystals have deep bluish to purplish iridescent surface. The hardness varies from 5.5 to 6.5 on Mho's scale. The specific gravity varies from 4.9 to 5.3. Ideally, haematite contains 69.94% iron and 30.06 % oxygen. Its chemical composition is Fe_2O_3 and is feebly magnetic in nature. The chemical composition and physical characteristics of haematite vary from place to place. The variations in chemical composition and physical characteristics in iron ore found in different regions in India are given in Table 2.2.

Table 2.2: Characteristics of Important Haematite Deposits in India

S. No	Type of ore	Iron content	Bulk density/tonnage factor
1.	**Singhbhum-Keonjhar-Bonai Deposits**		
	a) Massive ore	65 to 69.9%	4.5 to 5
	b) Laminated ore	55 to 65%	3.5 to 4.8
	c) Blue dust	65%	3.3 to 3.4
	d) Lateritic ore	52%	2.3
2.	**Goan Deposits**		
	a) Massive bedded ore	59 to 62%	3 to 3.4
	b) Platy ore	58 to 62%	3 to 3.2
	c) Brecciated ore	56 to 62%	2.8 to 3.2
	d) Mixed ore	45 to 59%	2.5 to 3.0
	e) Biscuity ore	59 to 65%	2.9 to 3.1
	f) Concretionary ore	57 to 62%	3.1 to 3.4
	g) Lateritic	40 to 50%	2.3 to 3.3
	h) Blue dust or powdery ore	58 to 66%	2.8 to 3.0
3.	**Bellary-Hospet Deposits**		
	a) Lumpy ore (massive & laminated)	67 to 69%	3 to 3.5
	b) Blue dust	Average 65%	3.8
4.	**Bailadila Deposits**		
	a) Massive ore and Massive & Laminated ore	67 to 68.26%	4.69 to 5.11
	b) Laminated ore	63.47%	3.4 to 4.19
	c) Lateritic ore	47.46%	3.46 to 3.65

Magnetite

It is the second most important iron ore mineral of economic importance. It is found as black, blue or brown black mineral. It is black magnetic oxide of iron crystallising in isometric system. The specific gravity is 5.18 and its hardness varies from 5.5 to 6.5 on Mho's scale. It is strongly magnetic and the magnetic attractibility is 40.18 as compared to 100 of pure iron. The chemical formula of magnetite in pure form is Fe_3O_4.

Large deposits of magnetite are considered to be the result of magnetic segregation. Its low grade deposits occur as disseminations in metamorphic and igneous rocks. It also occurs as replacement product in sedimentary or metamorphic rocks. The most important deposit of magnetite is at Kudremukh in Chikmagalur district of Karnataka.

USES

Iron ore is used mainly for manufacture of iron and steel. In ancient times iron was used in the form of wrought iron and cast iron for making weapons like swords, daggers, rods etc. Later on, it was used to make guns and other ammunitions. With the invention of the technology to produce steel, iron has become a necessary factor in every phase of modern civilisation. Iron and steel together form the largest manufactured products in the world. The most important use of iron ore is in the making of steel which is essentially an alloy of iron with small and carefully controlled quantities of carbon and many other components depending upon its end-use specifications. Steel is also made from sponge iron obtained by direct reduction of iron ore, thus bypassing the blast furnace step in steel making. Iron ore is used in the following industries as basic raw material:

1. Iron & steel
2. Sponge iron.
3. Ferro-alloys
4. Alloy steel
5. Cement
6. Coal washery

Iron & Steel Industry

Iron, as such in pure form, is not used as a commercial article. It is marketed in the form of cast iron, pig iron or wrought iron, etc.

Cast Iron

Cast iron is made mostly by melting steel scrap, cast iron scrap, pig iron scrap and ferro-alloys scrap. Typical mould of cast iron contains 94% iron, 4% carbon and 2% other impurities. Cast iron is then made malleable by subsequent treatment without fusion. They are made as cast iron and then rendered tough and malleable by heat treatment. The malleable cast iron is tough, strong, ductile, corrosion resistant, machinable and castable. It finds wide usage in automobile and other basic industries. In automobile industry, it is used in manufacturing the block of engine. Cast iron is also used for manufacturing the main body of water pumps used for irrigation, domestic and industrial purposes.

Pig Iron

Most of the pig iron manufactured is refined to make steel. Some pig iron is used to manufacture cast iron. Pig iron is also known as hot metal and it is the main product of blast furnace. It can also be considered as an intermediate product in the process of steel making. The name pig iron is also applied to molten cast iron, which could readily be cast into pigs before it has ever been cast into any other form. Pig iron is also used in the alloy steel and foundry industries for manufacturing machine components.

Wrought Iron

Wrought iron is low carbon steel which is forged to the desired size and form. It contains less than 0.12 percent carbon. The main distinction between low carbon steel and wrought iron is that wrought iron is made by the process, which finishes it in a pasty form instead of a liquid form and leaves about 1 to 2% slag mechanically disseminated through it. So wrought iron is slag bearing malleable iron which does not harden materially when suddenly cooled. Wrought iron is used in many basic industries. Wrought iron nowadays is increasingly being used in making household and office furniture. The furniture made of wrought iron is preferred to the conventional wooden furniture due to its durability and trendy look. Being a metal, it can be moulded into various designs and can be painted with attractive and matching colours.

Sponge Iron

It is also known as DRI (Directly Reduced Iron). The manufacture of sponge iron requires non-coking coal or natural gas as reducing agents. Sponge iron is a very good substitute for scrap, which is required by the electric arc furnaces, induction furnaces or mini-steel plants.

Sponge iron is used by the secondary steel plants instead of scrap. In the early days scrap was imported to meet the demand of secondary steel plants and it was not economical. Nowadays sponge iron is widely utilized as alternative feed in secondary steel sector. Sponge iron is also used in the alloy steel industry as a source of iron. It has also found use in the foundry industry recently.

Steel

Steel is more pure and much stronger than cast iron. The purification of pig iron is carried out in the convertors. In the convertors, technically pure oxygen is blown from top through water-cooled lance so as to remove the impurities of hot metal by oxidation and thus transform the hot metal into steel. It can be produced in various forms and sizes by melting and casting in a mould or by forging. It usually contains 98% iron, less than 1.5% carbon and small quantities of other constituents as per the specific market demands. Steel is considered to be an alloy of iron containing less than 2% carbon and small quantities of other metals or ferro-alloys added to it for specific purposes. Based on its carbon contents, steel can be categorised into three types.

1. Low-carbon steel
2. Medium-carbon steel
3. High-carbon steel

Low-carbon Steel

Low-carbon steel is also known as mild steel. It contains less than 0.25% carbon. These steels are easily hot-worked in austere conditions. It is mostly used in steel structures, buildings and construction. It is manufactured on a very large-scale in the form of rods, bars, angles, strips, channels and wire products. It is also used for fabricating windows, grills, grill doors, automobile body, panels, tin plates, etc.

Medium-carbon Steel

Medium-carbon steel contains 0.25 to 0.70% carbon. It is mostly used in heat-treated condition for machine components that require high strength and good fatigue resistance, such as, shafts, axles, gears, etc. Steels containing 0.40 to 0.60% carbon are also used for rails, railway wheels and axles. The medium carbon steel having 0.30% carbon and up to 1.50% manganese is used in stamping, forging, seamless tubes and boiler plates.

High-carbon Steel

The steel containing more than 0.70% carbon is known as high-carbon steel. It is a special category of steel having high hardness and low toughness. The combination of such properties makes it useful in the application where resistance is important and the compressive loading minimises brittle fractures that might develop on tensile loading, for example, spring material and high strength wires which are used for special purposes.

Ferro-alloys

Iron ore is also used in the production of ferro-alloys. Important ferro-alloys are ferro-manganese, ferro-chrome, ferro-silicon, ferro-tungsten and ferro-boron. Ferro-alloys are mainly classified into two categories.

1. Bulk ferro-alloys
2. Noble ferro-alloys

Bulk ferro-alloys consist of principal ferro-alloys, such as, ferro-manganese, ferro-chrome, charge-chrome, ferro-silicon, etc. The noble ferro-alloys include ferro-vanadium, ferro-niobium, ferro-molybdenum, etc.

The consumption of iron in ferro-alloys industry is in the form of iron ore, sponge iron or pig iron.

Alloy Steel

Alloy steel is used mainly in machinery manufacturing industry. It is a special type of steel in which various ferro-alloys are used for different types of alloy steels as per market specifications. Iron ore is consumed in alloy steel industry mainly in the form of pig iron or sponge iron.

Cement Industry

Cement is also one of the consumers of iron ore. Generally, low grade iron ore is used in the manufacture of cement. Iron ore lumps, fines and blue dust containing +58% Fe are preferred. Sometimes, laterite containing high Fe content is also used. Iron ore improves the burning properties of cement. It imparts colour and also balances the composition of cement.

Coal Washery

In coal washeries, magnetite is used because of its high specific gravity, for preparation of heavy media. Coal is washed to reduce its ash content. The ash content of raw coal varies from 24 to 33% whereas that of the washed coal varies from 19 to 22 percent.

SPECIFICATIONS

The specifications of iron ore for use in different end-use industries are discussed below:

Iron ore is used for different purposes by different industries, i.e., for steel making, sponge iron, ferro-alloys, cement, coal washing, etc. The specifications required for each industry are different. The physical characteristics as well as chemical constituents should be considered before deciding the end-use grade. The specifications also depend upon the process of manufacture. For steel making, different industries use different grades of iron ore. The specifications for different industries prescribed/accepted by the Indian organisations are discussed below:

Pig Iron & Steel

The Expert Group on "Classification of minerals with regard to their possible optimum industrial use" constituted by Ministry of Mines presented their report in December 1989 which later was reaffirmed in September 2004. According to the recommendations of this Group, the specifications of iron contents and other impurities should be as follows:

1. Iron Content

Iron ore used should be of the highest possible grade. With every one percent rise in iron content in iron ore, the productivity of steel increases by 2% while coke consumption rate decreases by 3 percent. It leads to increase in steel productivity with reduced cost of fuel and ultimately reduces the production cost of steel . This is due to formation of small amount of slag in the case of high-grade ores. Ores with high content of iron silicate minerals are difficult to reduce in the blast furnace as they have low degree of oxidation. In domestic plants, the size of the iron ore lumps used varies from 10 mm to 75 mm and their Fe content ranges from 60.3% (RSP) to 66.6% (VSP).

2. Silica

Silica is the most important gangue component in iron ore. It is the main constituent of the slag produced during smelting. Proper volume of slag should be generated for optimum recovery of molten iron from the charge. The volume of slag generated depends upon the silica content of the feed material. Therefore, it is essential to restrict the silica percentage in feed grade iron ore to control the volume of slag generated during smelting.

A decrease of about 1.5% in the silica content of the feed will result in a drop in slag volume to about 65 kg per tonne of pig iron and an increase of 100 kg slag per tonne of pig iron will increase fuel consumption by 40 kg coke per tonne of pig iron. In domestic plants, silica in iron ore lumps varies from 0.9% in BSP to 2.5% in TISCO and to 5% in VISL. Ore containing silica above 7% is generally rejected.

3. Alumina

The fluidity of the slag depends upon the alumina content, therefore, the alumina content should not be very low. Ten to fifteen percent of alumina in the slag increases the fluidity of the slag and thus makes it possible to use a higher basicity, which facilitates the removal of sulphur. It is estimated that for every one percent reduction in the alumina content of the ore, coke and flux ratio decreases by 40 and 60 kg, respectively, per tonne of pig iron manufactured. The consequent increase in production of pig iron would be 2 to 2.5 percent. Iron ore analysing 1.8 to 5% Al_2O_3 is used in VISL. Phosphorus should not exceed 0.15%. BSP prefers up to 0.1 percent phosphorus.

4. Alumina-silica Ratio

The alumina-silica ratio is very important factor in case of coke blast furnace. The alumina-silica ratio should be 1:1 to 1:1.5 with silica predominant; together they should not be less than 5–6% and Al_2O_3 should not exceed 3% in an ideal blast furnace feed. The alumina percolates and segregates more into the fines when the ore is crushed and washed. Thus, the inherent alumina gets enhanced in the fines that are used in sinters and pellets.

Ferro-alloys

The specifications of iron ore consumed in ferro-alloys industry vary from product to product and plant to plant.

Cement Industry

Iron ore is used in cement industry to improve the burning properties, to impart colour to cement and to balance the composition of mix. Iron ore used in this industry is in the form of lumps or fines and the Fe content required is +58 percent. Al_2O_3 is also an important factor in this industry. Al_2O_3 contents of required iron ore largely depend upon Al_2O_3 contents of the limestone in the flux used by the particular cement plant. It may be noted that the specifications of iron ore required for cement industry vary from plant to plant.

Coal Washery

Iron ore that is used in coal washery is magnetite. The only purpose of magnetite is to form a heavy media for separation of coal from other impurities. Coal washeries use magnetite ore containing 80% Fe_3O_4 (min.) specific gravity 4.75 (min.) and size -13 to 76 mm. Magnetite content is 75% min by weight, size -1.25 to 5.00 mm and moisture should be less than 10 percent. The Bureau of Indian Standards (BIS) has prescribed the Specifications for magnetite to be used in coal washery (IS: 11894 - 1986) as given below:

Fe – 64% (min.); SiO_2+ Al_2O_3 – 10 to 12% (min.); and size – 100% - 53 µm

USER INDUSTRY SPECIFICATIONS

The specifications of iron ore vary for different end-use industries. Physical as well as chemical parameters are the important factors to be considered before deciding the end-use specifications of iron ore. The specifications for various industries prescribed and/or accepted by various Indian Organisations are given below:

Iron & Steel and Sponge Iron Industry

By and large, high-grade iron ore is consumed in the iron and steel industry. Generally, iron ore containing 62-64% Fe, 2.4% SiO_2 and about 4-6% Al_2O_3 is consumed in this industry. With regard to the physical specifications the lumpy iron ore of the size varying from 10–30 mm is preferred. Iron ore fines containing +62% Fe are also consumed after converting them into sinters or pellets. Availability of iron ore is a factor, which plays an important role in the grade of iron ore consumed in a particular steel plant. The specifications of iron ore consumed by major steel plants are given in Annexure-1, which depicts a clear picture of general specifications of iron ore required by the Indian steel industry. The quantity of iron ore consumed for production of one tonne of steel differs from plant to plant depending upon the feed grade of the iron ore. As communicated by various steel plants, the norm of consumption of iron ore varies from 1.4 to 1.6 tonnes per tonne of steel produced.

Sponge Iron Industry

Sponge iron industry prefers high-grade lumpy iron ore. Specifications prescribed by the Bureau of Indian Standards (BIS) for iron ore to be used in sponge iron industry by Direct Reduction Process (IS: 11093-1984) are as under:

Constituent	Percentage
Fe	62 min.
SiO_2 + Al_2O_3	7.0 max.
CaO + MgO	2.0 max.
S	0.03 max.
P	0.08 max.
Total of Pb, Zn, Cu, Sn, Cr and As	0.02 max.
Alkali (Na_2O + K_2O)	To be agreed upon between the supplier and the purchaser
Moisture	4.0 max. (during dry season) 10.0 max. (during rainy season) or as agreed upon in both cases

The chemical analysis of the iron ore lumps shall be determined by the method specified in IS:1493-1959 and IS:1493 (Part-I)-1981 or any other established instrumental/chemical method. In case of dispute, procedure in the latter edition of IS:1493 for chemical analysis shall be referred.

Size: The size range for iron ore lumps at the point of despatch shall be as follows:

+ 40 mm	2% max.
- 40 mm to +25 mm	10% max.
- 5 mm	2% max.

Requirement for iron ore lumps at the point of despatch is applicable to this clause only, as degradation of lump ore may occur during transportation.

The screen analysis of the material at the point of receipt will depend on the handling and transportation and shall, therefore, have to be agreed between the supplier and the purchaser and –5 mm fraction should not exceed 4 percent.

Tumbler Index: Tumbler index is another important factor while deciding the physical specifications of iron ore consumed in sponge iron industry. Tumbler index is a factor, which decides the relative friability of a particular size of iron ore. It is the liability to break into smaller pieces or fines when subjected to repeated handling at mine or during transportation of iron ore. The tumbler index is determined by the following formula:

$$\text{Tumbler Index} = \frac{\text{Weight of sample retained on 6.3 mm sieve x 100}}{\text{Weight of sample feed}}$$

The Tumbler index as specified by the BIS for iron ore consumed in sponge iron industries should be in the range from 85 to 92.

The specifications of iron ore consumed by important sponge iron plants are given in Annexure-2.

Internal Demand

Chapter 3

Iron ore is one of the important raw material for iron & steel and sponge iron industry. About 98% of iron ore is used in India for production of iron & steel and sponge iron. Iron ore is also used in small quantities in cement, alloy steel, coal washeries, ferro-alloys, chemical, foundry, refractory and glass industries.

PAST DEMAND

The data on consumption of iron ore during the last 13 years from 1991-92 to 2003-04 is given in Annexure 3. The industrywise breakup of consumption of iron ore as reported to Indian Bureau of Mines (IBM) by different industries from 1999-2000 to 2003-04 is given in Annexure-4. The consumption of iron ore as reported to IBM by different industries relates to Organised Sector only. The data pertaining to Unorganised Sector are not available. The past consumption data indicates overall increasing trend during 1991-92 to 2003-04 except in the year 1998-99 and 1999-2000. From Annexure-4, it is observed that in India 98% of iron ore is consumed by Iron & Steel and Sponge Iron industries. Steel Sector is the most important segment in iron ore consumption. However, due to paucity of data with Indian Bureau of Mines in respect of consumption on account of non-reporting of consumption by many units especially in the Unorganised Sector, complete coverage on consumption was not possible.

PRESENT DEMAND

Indian Bureau of Mines receives data on consumption of iron ore on non-statutory basis mostly from the Organised Sector. Data on consumption of iron ore in Unorganised Sector is not received by Indian Bureau of Mines. An effort has been made in this report to estimate the consumption of iron ore in Unorganised Sector also so that there is full coverage of consumption of iron ore in different industries. The estimated consumption of iron ore during 2004-05 is placed at about 62,818 thousand tonnes. This is inclusive of both Unorganised Sector and Sponge Iron Industry.

END-USE CONSUMPTION OF IRON ORE

Iron & Steel Industry

Over the years, the steel industry in India has undergone drastic change in respect of processing and technology in manufacturing of steel. The economic reforms and consequent liberalisation of iron & steel sector brought a sea change to the industry. India has one of the oldest iron and steel industries in the southern hemisphere and currently is the 8th largest producer of steel in the world. The iron and steel industries in India are mainly organised in two sectors, namely, Primary Sector (Integrated Steel Plants) and the Secondary Sector (Electric Arc Furnace, Induction Furnace, Pig Iron, Sponge Iron, etc.).

Total production capacity of steel in the country as on today is around 48 million tonnes, which include about 14 million tonnes capacities of Electric Arc Furnaces and Induction Furnaces. The production of finished carbon steel has reached a level of 42.3 million tonnes in the year 2004-05.

Primary Producers

The primary producers are those producers which are having integrated plants. Primary producers mainly produce pig iron, crude steel, finished steel, etc. which consumes iron ore as a raw material.

At present, there are 11 integrated steel plants, 7 in public sector and 4 in private sector in operation. Some new projects have also been commissioned in the country. The total annual installed capacity of crude steel is about 34 million tonnes.

The primary producers viz. SAIL, TISCO and RINL directly consume iron ore for production of steel. Similarly, JSW Steel Limited (Jindal Vijayanagar Steel Limited) and ISPAT (Dolvi) also consume iron ore directly in their plant. They possess blast furnace facility to produce hot metal. These producers contributed 22.6 million tonnes in total production out of 42.3 million tonnes of finished carbon steel produced in 2004-05.

Norm of Consumption of Iron Ore

The data on plantwise production of hot metal and corresponding consumption of iron ore as received from different plants is given in Annexure-5. Based on this data, plantwise norm of consumption of iron ore for production of one tonne of hot metal has been worked out. The average norm of consumption of iron ore comes to 1.54.

The production of hot metal during 2004-05 was 28.21 million tonnes as per the Annual Report 2005-06 of Ministry of Steel and information available on Secondary Sector. Based on the norm of consumption of 1.54, the estimated consumption of iron ore comes to 43.44 million tonnes.

Secondary Producers

The secondary steel sector has been defined to include not only the traditional Electric Arc Furnaces (EAF) and Induction Furnaces (IF) but also the Majors with large-scale electric steel making facilities, set up after the de-regulation of Indian Steel Industry in 1992. Thus, the Secondary Sector is a conglomeration of steel makers with widely divergent scales of operation and technological capabilities. While the scale of operation in the older EAF/IF units varies from very small to medium, the new majors are all large-scale state-of-the-art units with capacities ranging between 1.7 to 2.6 million tonnes annually. The most notable among the new majors are Essar, Ispat and JSW Steel Limited.

Pig Iron

Pig iron is the basic raw material in foundry and casting industry. The main producers of pig iron have traditionally been integrated steel plants of SAIL, besides TISCO and Rashtriya Ispat Nigam Ltd. The Secondary Sector consumes pig iron produced by integrated steel plants and hence is not considered for calculation of demand of iron ore.

Sponge Iron

Sponge iron is a metallic product produced by direct reduction of high grade ore or iron ore pellets in the solid state. Sponge iron is also known as Direct Reduced Iron (DRI) or Hot Briquetted Iron (HBI). It is a good substitute for scrap, which is required by Electric Arc Furnaces and Induction Furnaces in secondary sector. Today, India is the largest producer of sponge iron in the world with an output of 10.30 million tonnes in 2004-05.

As per the Annual Report (2005-06) of Ministry of Steel, 227 sponge iron units are installed in the country with a capacity of around 18.65 million tonnes per annum. In tune with this the total production of sponge iron in 2004-05 as per Ministry of Steel is 10.30 million tonnes.

The norm of consumption of iron ore per tonne of sponge iron produced as reported by different sponge iron plants is given in Annexure-6. Norms of consumption of iron ore varies from 1.5 to 1.85. The average norm works out to be 1.65. SIMA (Sponge Iron Manufacturers Association) has reported 1.7 tonnes as norm of consumption of iron ore per tonne of product manufactured. Hence this (1.7 tonnes) norm of consumption is adopted for estimation of iron ore in sponge iron industry. Based on this norm, the consumption of iron ore for production of 10.3 million tonnes of sponge iron during 2004-05 works out to be around 17.51 million tonnes.

Induction Furnace Industry

Mini-blast Furnaces, Induction Furnaces and Energy Optimising Furnaces (EOF) are also producing steel. As per the Ministry of Steel, during 2004-05, 719 units with a capacity of 12.35 million tonnes were in operation. The total production during 2004-05 was 8.24 million tonnes against a production of 6.00 million tonnes in 2003-04. As reported by the All India Induction Furnaces Association, the induction furnaces do not consume iron ore. Instead they consume scrap and sponge iron. Hence the Induction Furnace industry has not been considered for estimation of iron ore consumption. Some of the Mini-blast Furnaces and EOF are consuming iron ore, but the consumption of iron ore in these industries has been considered in pig iron/ hot metal category.

Electric Arc Furnace Industry

At present there are 38 Electric Arc Furnaces based steel plants working in the country with an aggregate capacity of 8.15 million tonnes per annum. Production of ingots/concast billets from the EAF units was 7.77 million tonnes during 2004-05. These units are consuming either scrap or sponge iron.

Cement

Iron ore lumps/powder and blue dust with +58% Fe are normally used in cement industry to improve the burning properties, impart colour and balance the composition of the mixture utilised for cement manufacturing. In the organised sector of cement industry, 13 kg of iron ore is reportedly consumed for one tonne of cement production. Same has been considered as a norm of consumption of iron ore in cement industry. The production of cement during 2004-05 was 130 million tonnes. Based on this norm of consumption, the estimated consumption of iron ore in cement industry during 2004-05 was about 1.768 million tonnes for production of 130 million tonnes of cement.

Ferro-alloys

In ferro-manganese plants, iron ore is used in order to maintain Mn/Fe ratio and stable operation of the plant. Some ferro-manganese plants, such as, MOIL and a few others consume iron ore as the manganese ore contains less Fe. Iron ore consumption in ferro-manganese plants as reported by the industry was 5,800 tonnes in 2004-05.

Alloy Steel

In the production of alloy steel, iron ore is not directly used but pig iron or hot metal is used for the production of alloy steel. Fourteen alloy steel units have reported consumption of 360,400 tonnes of iron ore during 2004-05, for production of 953,000 tonnes of alloy steel. This consumption has been included in the Secondary Sector for production of hot metal/pig iron through B.F. route.

Coal Washery

Magnetite ore is used in the preparation of heavy media in coal washeries. Magnetite variety of iron ore in powdered form, when mixed with water increases the density of the media used for beneficiation of coal by floatation process. Coal is made up from organic and mineral matter and since their densities are different, a sample of coal particles varying in degree of liberalisation can be divided into various density fractions in a float-sink test in which different density heavy liquids can be utilised for floatation of coal. Presently, there are 20 coal-washery plants with a raw-coal feed capacity of 30.78 million tonnes. The average norm of consumption of magnetite comes to 2.97 kg/TRC. During 2004-05, the coal feed was 16.6 million tonnes of coking coal and 14.6 million tonnes of non-coking coal. Based on this, the demand of iron ore in coal washery industry works out to be 92,000 tonnes.

Other Industries

The reported consumption of iron ore in chemical and other industries like foundry, glass, refractories, etc. during the last 5 years was almost static at around 1000 tonnes. The estimate consumption may remain the same in 2004-05 as well.

TOTAL PRESENT DEMAND

The estimated total consumption of iron ore in different industries in 2004-05 is given in Table 3.1.

Table 3.1 : Estimated Consumption of Iron Ore , 2004-05

Industries	Quantity (In tonnes)	Percent share
All industries	**62,817,500**	**100**
Cement[2/]	1,768,700	2.8
Coal washery[2/]	92,000	0.2
Ferro-alloys[2/]	5,800	++
Iron and steel[1/]	43,440,000	69.1
Sponge Iron[3/]	17,510,000	27.9
Others (Foundry, Chemical, Glass & Refractories)[2/]	1,000	++

++ *Negligible*

1/ *Estimated on the basis of average consumption norm of 1.54 of iron ore for production of hot metal.*

2/ *Replies received from consumers on non-statutory basis and estimated on the basis of average norm of consumption of iron ore.*

3/ *Estimated on the basis of average consumption norm of 1.70 of iron ore.*

As evident from the above table, the estimated consumption of iron ore during 2004-05 was 62.82 million tonnes. It was further observed that iron & steel and sponge iron industries accounted for 97.8% (60.95 million tonnes) consumption in 2004-05, followed by the cement industry (2.8%). Other industries viz. chemical, coal washery, ferro-alloys, foundry, glass and refractories accounted for the balance.

FUTURE DEMAND

The different methods adopted for estimating future demand of iron ore are 1. Statistical method, 2. Economic growth rate, 3. End-use method.

1. Demand Projection by Statistical Method

The demand of iron ore has been forecast by various statistical methods. The consumption data of iron ore of the past 14 years starting from 1991-92 to 2003-04 and the estimated consumption during 2004-05 (Annexure-3 and Table 3.1) have been utilised for this purpose.

a) Arithmetic Averaging of Growth Rate

In this method, the percentage change in each successive year was first calculated. Then, by taking simple arithmetic average of these percentages, the overall growth rate of 6.5% in demand was worked out, which is assumed to hold good for future years. By this method, the future demand of iron ore in all industries works out to be 70,839 thousand tonnes, 97,056 thousand tonnes and 160,677 thousand tonnes by 2006-07, 2011-12 and 2019-20, respectively.

b) Moving Average

This method is a slightly sophisticated version of simple averaging method. The moving average was calculated by forming overlapping blocks, each of

3 years and then the overall average annual growth rate was calculated which is 6.4 percent. By applying this growth rate, the future demand of iron ore in all industries works out to be 70,706 thousand tonnes, 96,419 thousand tonnes and 158,379 thousand tonnes by 2006-07, 2011-12 and 2019-20, respectively.

c) *Trend Analysis*

The basic tendency of the industry is to grow or decline through the years which are usually referred to as "secular movement" or trend in the series. The concept of trend logically requires a smooth line because the secular movement is determined by forces which work out gradually with passage of time. Influences, such as, improvements in technology, increase/decrease in demand and change in consumption patterns produce gradual changes in the outlook for a particular industry. The primary purpose in statistical analysis of economic time series is to discover and measure such factors which characterise the movement of data through time.

The mathematical model for the straight line is taken as follows:

$$Y = A + Bx,$$

where

Y = the ordinate or computed annual consumption of trend
x = time in year
A = value of the trend line at its origin
B = coefficient of regression or average annual growth rate

By using this technique, demand of iron ore in all industries has been estimated at 63,833 thousand tonnes, 87,020 thousand tonnes and 124,119 thousand tonnes by 2006-07, 2011-12 and 2019-20, respectively. The trend line is depicted in Fig. 1.

2. Demand Projection of All Industries based on Economic Growth Rate on Estimated Consumption

The future demand of iron ore has been estimated based on the estimated consumption data of 2004-05. By applying 8% economic growth rate to the consumption of 62,820 thousand tonnes estimated in 2004-05 for all industries, future demand of iron ore has been estimated at 72,847 thousand tonnes, 107,037 thousand tonnes and 198,118 thousand tonnes by 2006-07, 2011-12 and 2019-20, respectively. The growth rate of 8% has been adopted by study on the basis of overall growth rate of finished carbon steel production during last 5 years and is considered as realistic for future estimation of steel production.

3. End-use Method

A. *Steel Industry*

(i) Demand Projection as per the 10th Five-Year Plan (2002-07): The 10th Five Year Plan Working Committee had projected the demand of finished steel for 2006-07 and 2011-12 at 38.22 million tonnes and 52.02 million tonnes, respectively.

The 10th Five Year Working Group had estimated the demand of iron ore in domestic steel industry including pig iron, sponge iron, pelletisation etc. at 84 million tonnes and 113 million tonnes by 2006-07 and 2011-12, respectively.

In the present context, these projections are irrelevant the reason being that the total production of finished carbon steel has crossed the projection made for 2006-07 and reached a level of 42.3 million tonnes in 2004-05. The working Group has not made any projection for the year 2019-20. Hence, the projections of Xth Five Year Plan have not been considered in this report.

(ii) Demand Projection as per Steel Policy (Steel): As per National Steel Policy 2005, the domestic finished steel production is projected at 110 million tonnes by 2019-2020. The projection is based on the projected Compounded Annual Growth Rate (CAGR) of 7.3% per annum in India which compares well with the projected national income growth rate of 7.8 % per annum given on income elasticity of steel consumption of around 1.

As per the policy, the projected demand of finished steel will be 43.75 million tonnes, 62.22 million tonnes and 110 million tonnes by 2006-07, 2011-12 and 2019-20, respectively.

To meet the above projected tonnage of steel, the requirements of iron ore, as per the policy will be 75.68 million tonnes, 107.83 million tonnes and 190 million tonnes by 2006-07, 2011-12 and 2019-20, respectively.

B. Industries Other than Steel

An effort has been made to estimate the future demand of iron ore in other industries as well.

(i) Cement Industry: In the last year of the current Five Year Plan, i.e., 2006-07, the production of cement is estimated to be 162 million tonnes. The Working Group on Cement has projected the demand of cement at 292.24 million tonnes for 2011-12 assuming an average growth of 8.5% in GDP and 11% in cement industry. Further on assuming that if the same growth rate continues in the future as well, the estimated demand of cement in 2019-20 would be 672.91 million tonnes . Assuming the norm of consumption of 13 kg of iron ore per tonne of cement produced, the future estimated demand of iron ore works out to be 2.106 million tonnes by 2006-07, 3.796 million tonnes by 2011-12 and 8.749 million tonnes by 2019-20.

(ii) Ferro-alloys Industry: The production of ferro-manganese during 2004-05 was 2,70,000 tonnes. Assuming a growth rate of 8%, the future production of ferro-manganese works out to be 315,000 tonnes by 2006-07, 463,000 tonnes by 2011-12 and 856,000 tonnes by 2019-20. However, a few plants mainly MOIL and a few others are using iron ore in order to maintain Mn/ Fe ratio for stable operations of the plants. Iron ore is used in those ferro-alloys plants where the manganese ore contains less Fe. During 2004-05, the consumption of iron ore in these plants was 5,800 tonnes. Assuming a growth

Plate – 1

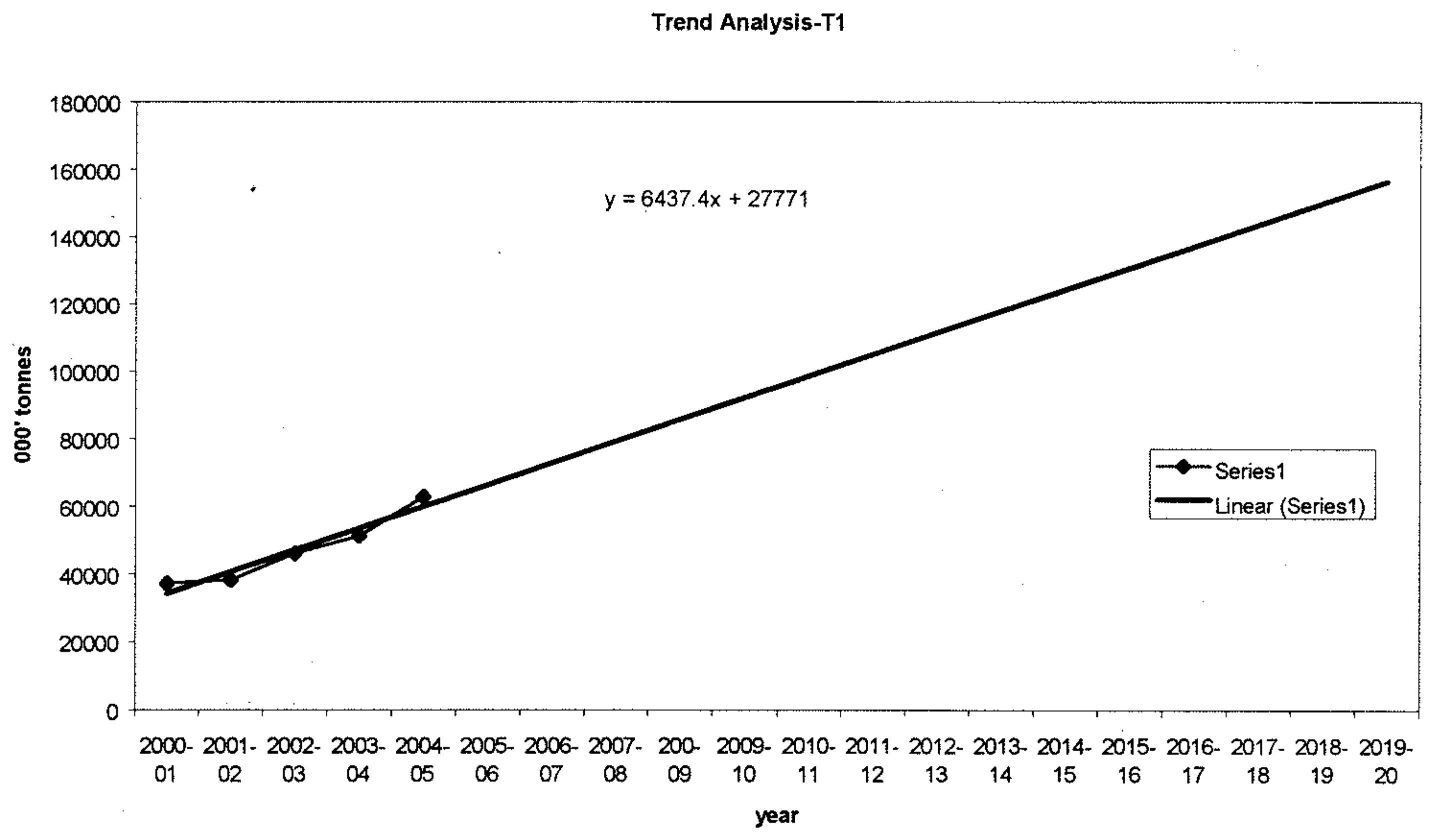

Fig. 1: Trend Analysis –T1

rate of 8% in consumption, the projected consumption of iron ore in ferro-alloys industry will be 6,800 tonnes, 9,950 tonnes and 18,400 tonnes by 2006-07, 2011-12 and 2019-20, respectively.

(iii) Coal Washery: The capacity of coal washery is placed at 30.78 million tonnes as on 1.4.2005. In view of the projected steel growth, the capacity and consequently demand for washed coal are also likely to grow. An economic growth rate of 8% has been assumed and accordingly the future capacities of coal washeries is estimated at 35.90 million tonnes by 2006-07, 52.75 million tonnes by 2011-12 and 97.64 million tonnes by 2019-20. Assuming norm of consumption of 2.97 kg/tonne of feed coal, the demand of iron is estimated at 106,623 tonnes by 2006-07, 1,56,668 tonnes by 2011-12 and 2,89,991 tonnes by 2019-20.

(iv) Other Industries: Other iron ore consuming industries like chemical, glass, refractory etc. presently consume 1000 tonnes. Assuming a growth rate of 8% the projected demand of iron ore is worked out to be 1,166 tonnes by 2006-07, 1,714 tonnes by 2011-12 and 3,172 tonnes by 2019-20.

Future Domestic Demand by End-use Method

The total demand of iron ore in different industries based on end-use method has been estimated to be 78 million tonnes in 2006-07, 112 million tonnes in 2011-12 and 199 million tonnes in 2019-20 and is tabulated in Table 3.2.

Table 3.2: Industrywise Projected Domestic Demand of Iron Ore

(In '000 tonnes)

S.No.	Industry	2006-07	2011-12	2019-20
	Total	**77,900.5**	**111794.35**	**199060.57**
1.	Iron & Steel and Sponge Iron	75,680	107,830	190,000
2.	Cement	2106	3796	8749
3.	Ferro-alloys	6.8	9.95	18.4
4.	Coal Washery	106.6	156.7	290
5.	Others, Chemicals etc.	1.1	1.7	3.17

METHODS OF FORECASTING — A CRITICAL ANALYSIS

The merits and demerits of different methods of forecasting used in the demand projections and finally the method adopted in the report are analysed below. The demand projections of iron ore by various methods for the year 2006-07, 2011-12 and 2019-20 are given in Table 3.3.

Table 3.3: Demand Projections of Iron Ore by 2006-07, 2011-12 and 2019-20 by Different Methods

(In '000 tonnes)

Methods of demand projection	Demand by 2006-07	Demand by 2011-12	Demand by 2019-20
1. Statistical methods			
a) Arithmetic averaging	70,839	97,056	160,677
b) Moving average	70,706	96,419	158,379
c) Trend analysis	63,833	87,020	124,119
2. Economic growth rate	72,847	107,037	198,118
3. End-use Method	77,900	111,794	199,061

Statistical Methods

a) & b) Arithmetic Averaging & Moving Average Methods

In these methods, it is assumed that the consumption of mineral changes automatically with the passage of time and all other influences are taken care of by the time factor. It is also assumed that the past trend of changes shall continue in future. The drawback of these methods is that they are over-simplified. The success of this method mainly depends upon the past consumption data, which in this case appears to be on lower side due to non-reporting by some consuming units.

c) Trend Analysis

In this method, demand data is assumed to be in the form of a time series but its reliability is questionable due to non-recognition of the relationship between the mineral demand and the economic and technological factors. It is mostly based on the past consumption data, which is inadequate as mentioned above. Hence, the future demand derived from this method is also on the lower side.

Demand Projection Based on Economic Growth

In this method, the growth rate of 8% has been adopted in the study on the basis of overall growth rate of finished carbon steel production during last 5 years and is considered as realistic for future estimation of steel production. By applying 8% economic growth rate to the consumption of 62,818 thousand tonnes estimated in 2004-05 for all industries, future demand of iron ore has been estimated at 72,847 thousand tonnes, 107,037 thousand tonnes and 198,118 thousand tonnes by 2006-07, 2011-12 and 2019-20, respectively.

The drawback in this method is that economic growth rate of 8% in all industries may not take place and may vary from industry to industry as in the case of cement industry. Hence, the projection by this method has not been adopted.

End-use Method and Judgmental Analysis

In the Judgmental analysis due weightage and consideration have been given to techno-economic condition of individual industries including availability of raw material, infrastructure, etc. while making projections.

In judgmental analysis, a projection of Steel Policy has been considered for future estimation of steel production for each year up to 2019-20. This includes Iron & Steel and Sponge iron industry. The scenario based on 7.3% annual average growth rate of GDP has been considered as realistic. Similarly, the other end-use consuming industries of iron ore have also been considered on the basis of past consumption data for the study. In this method all end-user industries of iron ore have been taken into consideration for future estimation. Hence, this method is considered more realistic than other methods.

Thus, the total projected domestic demand of iron ore will be 78 million tonnes in 2006-07, 112 million tonnes in 2011-12 and 199 million tonnes in 2019-20 as per the estimates emerged during this study. These estimates are considered realistic.

Chapter 4

Foreign Market

WORLD SCENARIO

The iron ore trade has experienced quite a few ups and downs in the recent past. Due to synchronised global economic recession, world iron ore production witnessed a decline in 1998-99. International iron ore trade gathered momentum after 2000 as world economic activity and industrial production began to improve. Australia and Brazil continued to dominate world iron ore seaborne trade.

The major world resources of iron ore are located in Ukraine, Brazil, Russia, China, Australia, Kazakhstan, USA and India whereas the major consuming industries are located in developing countries like China, S. Korea, Japan and India. There is a remarkable rise in the demand of iron ore in China due to rise in steel production and consumption in China.

World Resources

As per Mineral Commodity Summaries, the world reserve base of iron ore was of the order of 370 billion tonnes (Annexure-7). Over 86% of these is located in Ukraine, Brazil, Russia, China, Australia, Kazakhstan, India and Sweden. Out of 370 billion tonnes, 18% are accounted for by Ukraine followed by Brazil (16%), Russia (15%), China (12%), Australia (11%), Kazakhastan (5%), USA (4%), India (3%) and Sweden (2%). The remaining 14% is shared by Canada, Venezuela, South Africa and other countries. India's share of the world resources of iron ore is 3%.

World Production

Brazil, China and Australia are the leading producers of iron ore. The production of iron ore by various countries from 1996 to 2005 is given in Annexure-8. Analysis of the world production data of iron ore reflected a fluctuating trend during 1996-2001. Since 2001, the production witnessed an increasing trend. The production of iron ore reached a level of 1,544 million tonnes in 2005 from 1,049 million tonnes in 2001 recording an increase of 47 percent. Annexure-8 reveals that China was the largest producer of iron ore in 2005 with 420 million tonnes of iron ore production followed by Brazil (281 million tonnes), Australia (262 million tonnes), India (154 million tonnes) and Russia (97 million tonnes). The remaining production of 330 million tonnes was shared by South Africa, Ukraine, USA and other countries. Australia and Brazil are likely to continue their dominatation in the iron ore production front. Their shares are expected to rise as both countries have large iron ore resources that are well delineated, coupled with sophisticated transport system and state-of-the-art port facilities needed to deliver ore in efficient manner to global markets. Further, both countries have developed some of the largest iron ore mines in the world and have benefited from the resultant low production cost per unit of output.

India ranks high in the world resources and equally high in the world production of iron ore. In India, the production of iron ore in general has shown an increasing trend since 1992-93. The production was 57.5 million tonnes in 1992-93, which increased by over 154% to 146 million tonnes in 2004-05 and further to 154 million tonnes in 2005-06.

World Trade

World Exports

Iron ore is a highly traded mineral both in quantity and value. Iron ore is the main raw material in the production of steel. World iron ore trade was estimated at around 670 million tonnes in 2004. Australia and Brazil continued to dominate world seaborne trade. The world exports during 1995 to 2004 of iron ore are given in Annexure-9.

Analysis of exports of iron ore in the world showed a rising trend during the last four years from 2001 to 2004. It was 481 million tonnes in 2001, which increased to 668 million tonnes in 2004 showing an increase of 39 percent. The main exporters of iron ore in 2004 were Brazil (32.6%), Australia (31.4%), India (12.4%), Ukraine (4.0%), Canada (3.4%), South Africa (3.7%), Sweden (2.5%) and Russia (1.9%). The remaining (8.1%) was accounted for by USA, Chile, Venezuela and other countries.

World Imports

The world imports of iron ore during 1995 to 2004 are given in Annexure-10. World imports of iron ore recorded a fluctuating trend between 1995 and 2001. Post 2002, imports showed an increasing trend. The imports, which were 497 million tonnes in 2001, increased to 632 million tonnes in 2004. Robust economic growth rate in China continued to drive the world iron ore trade since 2001.

However, in general, the world imports, which stood at 508 million tonnes in 2000, increased to 632 million tonnes in 2004 registering a net increase of 24.4 percent. This overall increasing trend observed in these five years was due to higher imports by China which registered a three-fold increase with 208.09 million tonnes in 2004 as compared to 70 million tonnes in 2000. Besides China, both Japan and South Korea were the other major importing countries. It was observed that the western developed countries like Germany, France and UK were also major importers of iron ore. However, their demands were rather static. During 2004, China and Japan held major share in the total world imports contributing 32.9% and 21.4% respectively followed by South Korea (6.9%), Germany (6.8%), France (3.3%), Italy (2.68%), UK & Taiwan (2.37%) each, Netherlands (2.05%), USA (1.89%), Poland (1.74%) and Russia (1.58%). The remaining 14.02% was shared by Czechoslovakia Rep., Canada, Romania, Spain and other countries.

From the above, it can be summarised that China was not only a major producer but also a major importer of iron ore. Hence the total change that occurred in the world's iron ore scenario was chiefly due to China. The other major importers were Japan, South Korea, Germany, UK and France. In world exports, besides India, the other major exporting countries of iron ore included Brazil, Australia, Canada, Ukraine, South Africa and Sweden.

World Market

The countrywise world scenario is discussed in the following paragraphs to shed light on the present and the prospective future markets for Indian iron ore. An attempt is also made to identify the main competitors for Indian iron ore. China, Brazil, Australia, India and Russia are the world leaders in iron ore production. Ukraine, USA and South Africa are the other major producers. Several other countries also do pitch in their contribution in the world market.

As far as consumption of iron ore is concerned, China was the major consuming country. Other major consuming countries were Japan, USA, Russia, Korea, Germany, Ukraine, India, Brazil, Italy, etc.

COUNTRYWISE ANALYSIS

1. Australia

Australia is estimated to have 40 billion tonnes of iron ore resources and is a major iron ore producing country. In Australia, over 95% of iron ore production comes from Hamersley Basin of Western Australia. Small production are also reported from other parts of Western Australia, Tasmania and South Australia.

The Australian iron ore occurrences are distributed in South Australia, New South Wales, Tasmania & Western Australia. In South Australia the types of ores vary from hard, blue and massive to soft, friable or schistose. The iron content varies from 64 to 68% and phosphorus from 0.02 to 0.14 percent.

In New South Wales, small deposits of haematite, magnetite and limonite are found to occur. They are of good grade but are not large in quantity.

Important iron ore deposits are located in Pilbara region and Koolanobbing in Western Australia, Iron knob and Iron Duke in South Australia and Savage River in Tasmania. Ninety-five percent of Australian iron ore deposits occur in Western Australia.

Western Australia

BHP Billiton Iron Ore operates mines in the Newman area, which includes Mount Whaleback and Satellite orebodies 23, 25, 29 and 35. The Mount

Whaleback is the largest high grade deposit in the Pilbara region. BHP Billiton Iron Ore also operates the Jimbledhar (formerly McCamey's Monster mine), which is 42 km east of Newman. Together these mines produce over 30 million tonnes/year. BHP also operates Yarrie and Nimingara mines wherein the production averages 7 million tonnes/year. The Company's Yandi mine produces around 31 million tonnes/year of pisolitic fine ore. Long-haul plans have been drawn to increase production to 50 million tonnes/year.

Other major deposits held by BHP Billiton are Newman Satellite orebody 18 (Shorelauna North), orebody 24 and Mining Area 'C', 100 km northwest of Newman.

Rio Tinto's subsidiary Hamersley Iron Pty Ltd operates mines at Paraburdoo, Mt Tom Price, Brockman, Yandicoogina and Marandoo. Hamersley also operates Channar mine as a joint venture with the Chinese Government organisation.

Robe River Iron Associates has its mines at Mesa J, West Angelas, and Pannawanica. The production from these mines is around 37 million tonnes. It has undeveloped deposits at Eastern Deepdale, Deepdale Mesa S, Mesa K and Mesa L deposits.

M/s Portman Ltd operates at Koolanobbing, 425 km east-northeast of Perth, Mount Jackson and Windarling in Kalgoorlies areas. It has a number of lenticular iron ore deposits at Mount Jackson and Windarling with lower grade material at Bungalin, between 60 and 90 km north-northwest of Koolanobbing. Portman Ltd has also its stake in Cockatoo Island located in Yompi Sound, 140 km north of Derby. Portman Ltd had plans to resume production of premium fine ore from this area.

Australia has been experiencing an increasing trend in the production of iron ore. In 1996 the reported production was 152 million tonnes, which constantly increased to 262 million tonnes in 2005 except for a decline in 1999 (Annexure-8). Australia was the second major exporter after Brazil and exported 210 million tonnes of iron ore in 2004 registering an increase of 12% over the previous year (187 million tonnes). During 1995–1998, exports of iron ore from Australia recorded fluctuating trends and varied between 128 and 146 million tonnes. However post 1999, exports of iron ore recorded an increasing trend and increased to 210 million tonnes in 2004 from 146 million tonnes in 1999 with an overall increase of 44 percent.

From the above, it is clear that the production as well as exports of iron ore in respect of Australia have been on an increasing trend. As reported in Annual Mining Review, 2005, China imported 37.5% (i.e., 78 million tonnes) of its total imports from Australia in 2004, whereas the contribution of India in the total imports of China during the same year was 24% (i.e., 50 million tonnes). Australia is the main competitor for Indian iron ore as far as Chinese market is concerned. Indian exporters may have to make extra efforts to increase the Indian share in Chinese market.

2. Brazil

Major iron ore deposits in Brazil are located in the States of Minas Gerais, Para, Mato Grosso do Sul and Sao Paulo. The most important iron ore deposits in Brazil are located at northwest of Rio de Janeiro. Here the iron ore is derived from enrichment of the Itabirito formations which is composed of granular quartz and iron oxides with 45 to 50% iron and silica of about 25 percent. The deposits are of Pre-Cambrian age and are of Lake Superior type.

Brazil is rich in iron ore with 61 billion tonnes of resources. Brazilian production of iron ore was 263 million tonnes in 2004 which increased to 280 million tonnes in 2005 making it one of the largest producing countries of iron ore in the world. Four companies accounted for more than 90% of production, namely, Cia Vale do Rio Doce (CVRD), Mineracao Brasileiras Reunidas (MBR), Samarco Mineracao and Cia Siderurgica Nacional (CSN).

In 2004, for the fifth consecutive year, CVRD set an historic record, selling iron ore to the tune of 231.5 million tonnes. Of the total sales, exports accounted for 179 million tonnes. In 2004 the expansion of two projects of iron ore viz. production capacity at Carajas and the third Pier (pier III) at the Ponta da Madeira meritime Terminal were completed.

CVRD plans to invest in five new iron ore projects in the southern system, namely, a) Brucutu, b) Fabrica Nova, c) Itabira, d) Fazendao, and e) Fabrica in addition to the production increase programmed for Carajas and accordingly have devised strategies to expand the capacity at Fabrica Nova to 15 million tonnes per year.

Mineracao Brasileiras Reunidas (MBR) (part of the Caemi group, controlled by CVRD) produced 42 million tonnes of iron ore in 2004, 10.5% higher than the 38 million tonnes produced in 2003.

Samarco Mineracao (CVRD 50% and BHP Billiton 50%) produced 15.9 million tonnes of iron ore in 2004. Samarco is evaluating and drawing up plans to include a third pellet plant in Espirito Santo, laying second ore pipeline between Minas Gerais and Espirito Santo to handle 16.5 million tonnes of iron ore slurry and to introduce improvements in mining operations at Minas Gerais with an investment of about US$900 million. The Company plans to expand its pellet production from the current 14.0 million tonnes/year to 21.5 million tonnes/year.

Cia Siderurgica Nacional (CSN) produced 15.5 million tonnes of iron ore in 2004, 10% more than 14.1 million tonnes produced in 2003. Out of the total production 8.2 million tonnes was for CSN's own consumption and 7.3 million tonnes were sold. CSN has raised annual production capacity from 16 to 40 million tonnes/year with an investment of US$ 308 million and plans to build a 6 million tonnes/year capacity pellet plant.

Brazil was the topmost exporter of iron ore in the world closely followed by Australia. The exports from Brazil have been on a rise since the last five years. Exports which was 157 million tonnes in 2000, increased by 39% to 218 million tonnes in 2004.

In 2004, iron ore was Brazil's second most important export commodity (after oil), accounting for 4.93% of the total value of Brazilian exports of US$96.4 billion. Exports of iron ore increased from 174.80 million tonnes in 2003 to about 218 million tonnes in 2004. Exports were destined to 40 countries, the biggest importer being China with a share of about 23.4% of total shipments by value, followed by Germany 11.8%, Japan 10.8%, Italy 6.0% and South Korea 5.9 percent.

Brazil (the topmost exporter of iron ore in the world closely followed by Australia), is considered as main competitor for Indian iron ore. China, Japan and South Korea are the major export destinations for Brazilian iron ore. Apparently, these three countries are the main customers of Indian iron ore as well. In the light of the above facts, India will have to adopt suitable marketing strategies to acquire and maintain a share in iron ore exports keeping in view the competition from Brazil.

3. Canada

Canada is estimated to have 3,900 million tonnes of iron ore resources. Quebec-Labrador region, Ontario and British Columbia are the main areas where iron ore deposits are located in Canada. These deposits are of Pre-Cambrian age. The deposits are of mixed haematite and goethite type. Canada's iron ore production is mainly concentrated in the Labrador Trough and three mines are operated by M/s Iron ore of Canada (IOC), Quebec Cartier Mining Co. (QCM) and Wabush mines.

The production of Canadian iron ore shows a steady trend as compared to other producers in the world. Canada has produced 28 million tonnes of iron ore in 2005. Canada was a major exporter of iron ore in the year 2004. It exported 23 million tonnes of iron ore in 2004. USA, Germany & UK were the major importers of Canadian iron ore.

4. China

The iron and steel industry in China has been stimulated by strong domestic demand, particularly from the construction industry, manufacturing and automotive sectors. On the basis of ISSB (Iron & Steel Statistics Bureau), production of steel products reached 349 million tonnes in 2005, a 28% increase from 272 million tonnes during 2004 and this in effect positions China as the only country with annual steel output in excess of 300 million tonnes. China is the largest consumer of iron ore in the world, accounting for about one-third of the global market. It is the rapid growth of China's steel industry that escalated the demand of iron ore world wide.

China's total resources of iron ore is placed at 46 billion tonnes. The main deposits of iron ore in China are of Lake Superior type located in Liaoning Province. The iron content is 30–35% and the silica percentage varies from 40–50 percent. The quantities of high grade iron ore containing 60–70% Fe are limited.

The banded ore contains thin bands of haematite and magnetite alternating with bands of quartz schist, jasper and iron silicate. Oolitic haematite deposits also occur in the vicinity of Hisuan-hua. Oolitic haemetite is also distributed in Human, Kiangsi in Southern China.

China's production of iron ore in 2005 was 420 million tonnes, an increase of 35% as compared to that in the previous year (310 million tonnes). Around 50% of iron ore production is reported from mines located in Northern provinces. The other provinces and regions that produce iron ore include Beijing, Shanxi Province, Sichuan Province and Inner Mongolia.

However, to meet the demand of the domestic steel industry, China has to import substantial quantities of iron ore. China imports iron ore from many countries and is the largest importer of iron ore in the world. In 2004 China imported 208 million tonnes. The main suppliers were Australia, Brazil, India and South Africa.

China imported large quantity of iron ore (both lumps and fines) from India and is the main market for Indian iron ore. An increasing trend has been observed in the imports of iron ore from India since last 3 years. China imported 25 million tonnes of iron ore in 2002-03 which increased to 60 million tonnes in 2004-05 and further to about 70 million tonnes in 2005-06. The exports of iron ore from India to China are given in Annexures 12-A to 12-C.

From the above, it is evident that the demand of iron ore from China is increasing and this trend may continue in the near future as well, as the steel producing capacity of China is high and burgeoning. Indian exporters should concentrate on Chinese market. They should concentrate their efforts to increase the Indian share in this market by making long term contracts with Chinese Steel makers.

5. Iran

Iran, with an estimate of 2500 million tonnes, is quite substantive in its iron ore resources. Out of 2500 million tonnes, 1800 million tonnes are proved reserves. Iran has the potential to raise its steel output. There are three main deposits, namely, Choghart, Chadormalou and Sangan which are currently being exploited. The exploited iron ore is sent to Isfahan steel work, Mobarakeh direct reduction steel plant, Khorasan steel Complex, etc. for steel manufacturing.

The production of iron ore in Iran was 17 million tonnes in 2005. The production of iron ore is reported from the mine of Choghart, Gol-e-Gohar and Chadormalou. Choghart supplies about 3.5 million tonnes/year of lumpy agglomerated high grade iron ore (magnetite) to Isfahan steel work. Chadormalou has a capacity of 5.1 million tonnes/year and is the largest operating mine.

The National Iron and Steel Co. (NISCO) plans to expand production capacity at Gol-e-Gohar from 3.5. to 5.0 million tonnes/year and commission the third mine at Gol-e-Gohar to increase the output to 10 million tonnes/ year of iron ore concentrate. Also there is plan to increase concentrate production at Chadormalou from 5.1 to 8.5 million tonnes per year.

The Sangan (north-eastern Province of Khorassan near the border Afghanistan) iron ore deposit is under development and is expected to produce 3.4 million tonnes/year of concentrate for supply to Neyshaboor mill in Khorassan.

There are also plans to increase the concentrate production by 2 million tonnes per year at the Jalal Abad-e-Zarand mine (Kerman), 2.6 million tonnes per year at Bafgh-e-yazd mine and 2.5 million tonnes per year at Yazd north mines. There are also plans to increase production by 1.5 million tonnes per year at Chahgaz-e-Yazd mine. Commencement of 6 million tonnes per year pellet production at Gol-e-Gohar, 2.6 million tonnes per year at Sangan and agglomerate production of 800,000 t/y at Bafgh are in the pipeline.

Iran exports iron ore up to 7 million tonnes. As per the statistics released by the International Iron & Steel Institute (IISI), Iran has produced 9.4 million tonnes of crude steel only during 2005 as against 8.7 million tonnes in 2004 registering an increase of 8 percent. Iran intends to increase its steel production to 54.6 million tonnes by 2020 from the current 9.4 million tonnes.

Additional iron ore production by capacity addition in iron ore mines, expansion of the existing mine at Gol-e-Gohar and new development at Sangan are proposals under active consideration. Focus towards increasing the concentrate production is also on the anvil. The additional iron ore & concentrate are for the purpose of enhancing Iran's steel production.

It could be observed from the above information that Iran is developing value addition facilities in the field of iron ore with a view to fetch good price for its iron ore. Statusque in Iran's iron ore exports will probably be maintained till new capacity addition of steel is achieved.

6. Kazakhstan

Kazakhstan with 19 billion tonnes of iron ore, occupies a respectably high position in the world with respect to iron ore resources. Kazakhstan produced 19 million tonnes of iron ore in 2005, as against 20 million tonnes produced in 2004. The country's biggest iron ore producer is Sokolov-Sarbai Mining Production Association (SSGPO) which increased output by 6% to 15.4 million tonnes, including 9.35 million tonnes of pellets. SSGPO also plans to launch a hot-briquette iron (HBI) plant costing US$587 million.

The Company's operating mines include the Sarbai Sokolov, Kurzhunkul and Kachar open pits and the Sokolovskaya underground mine. Production of steel in Kazakhstan is insignificant. The production of crude steel in 2004 was 5.38 million tonnes which decreased to 4.45 million tonnes in 2005. The main export market for iron ore & concentrate of Kazakhstan is still Russia, particularly, the Magnitogorsk Metallurgical Combine (MMK), to which SSGPO ships 10 million tonnes/year of product. It sells about 3 million tonnes/year of iron ore commodities in the domestic market and about 1 million tonnes/year is exported to China.

Ispat Karmet, Kazakhstan's largest steel producer is based in the Karaganda region with capacity of 5.5 million tonnes/year. It exports steel to more than 65 countries.

By 2008, Ispat International, a division of LNM Group, plans to invest US $400–450 million in Ispat-Karmet. The Company has invested more than US$1 billion in Ispat-Karmet over the past eight years and intends to introduce continuous casting technology.

It therefore can be inferred that Kazakhstan is not exhibiting any strong activities in the field of iron ore. Hence, Kazakhstan cannot be viewed as a competitor for Indian iron ore market.

7. South Korea

South Korea is deficient in iron ore resources. Its production of iron ore was 20 million tonnes in 2005. The steel industry in South Korea depends largely upon imports of iron ore. The most interesting fact is that the capacity and production of steel are steadily increasing. As on today, Korea is among the top five in production of steel in the world. Korea produced 47.8 million tonnes of steel in 2005 as against 47.5 million tonnes in 2004. The major steel producer POSCO in Korea has shown interest in establishing steel plants in India and in other iron ore producing countries.

The imports of iron ore were 44 million tonnes in 2004 registering an increase of 29% as compared to 34 million tonnes in 1998. India exported 2.7 million tonnes of iron ore to Korea during 2004-05.

South Korea has been one of the major export markets for India. In view of increased steel capacities, there are prospects for increase in exports of iron ore to South Korea.

8. Mexico

Mexico is a small producer of iron ore. Mexico's largest reserves of iron ore are found at Hercules (168 million tonnes) and Pena Colorada (131 million tonnes).

Mexico's iron ore production increased to 6.9 million tonnes in 2004 from 6.8 million tonnes in 2003.

The Pena Colorada mine has an annual capacity of 3.5 million tonnes/year of concentrates and has expansion plans to up the production to 4.0 million tonnes/year. Concentrates are pelletised at the Company's facilities at the nearby port of Manzanillo.

Mexico's steel production in 2005 was 16.28 million tonnes, a slight decrease of 2.6% with respect to 16.73 million tonnes in 2004.

The production of steel in Mexico is expected to increase in future. Mexico relies on imported iron ore to meet its increasing demand. Indian iron ore producers could explore the possibilities of tapping the Mexican market.

9. Poland

The Polish steel industry relies entirely on imported iron ores and concentrates. In 2004 imports of iron ore was 11 million tonnes coming primarily from Russia, Ukraine and Brazil.

Pig iron is currently produced by three steelworks which reported an increased output in 2004 by 14% as compared to 6.4 million tonnes in the previous year. Almost 99% of pig iron was produced by Mittal Steel Polska SA.

Crude steel output in 2004 was 6.8 million tonnes. There are 10 producers, but 67% of production comes from two large steelworks—Sendzimir and Katowice. Polish steelworks have made significant technical and environmental improvements in the past decade, spending a total of more than US$2.5 billion on modernisation. The modernisation has been mostly focused on raw steel production rather than on manufacturing finished steel products.

It is expected that the demand of iron ore in Poland will rise in the coming years. Polish market could become a prospective market for exports of Indian iron ore.

10. Russia

Russia with 56 billion tonnes resources of iron ore ranks among the highest positions in the world. The largest reserves of high-grade iron ore in Russia are found in the Saksagam iron ore field. The Kremchung iron ore region contains eight iron ore deposits. These deposits form a continuous north-south band of ferruginous quartzite which is 45 km long and 0.2 to 0.7 km wide.

The production of iron ore in Russia was 83 million tonnes in 2001 which increased to around 95 million tonnes in 2005. Russia also exported iron ore to the tune of 13 million tonnes in 2004. Imports showed a static trend till 2003 and increased slightly in 2004 to 10 million tonnes from 9 million tonnes in 2003.

Lebedinsky Mining and Processing Integrated Work is one of the leading manufacturers of iron ore products with 21% share in the domestic market. Lebedinsky Mining Processing Integrated work is a universally recognised producer of high quality iron ore concentrate, pellets and hot briquettes. It is the only European mining and processing integrated works that employs direct reduction process technology. Its annual production is 21 million tonnes of concentrate, over 10 million tonnes of pellets and 1 million tonnes of hot briquetted iron.

Mikhailovsky Mining and Processing Integrated Works is another large enterprise in the Russian Mining Industry. It owns the world's largest iron ore reserves (over 11 billion tonnes). Its annual production is over 19 million tonnes and caters to 20% of the Russian market. The products of Mikhailovsky are exported to Austria, Czechoslovakia Republic, Slovakia, Poland, Romania, Ukraine and China.

Production of iron ore increased by 19% to 17.97 million tonnes at the Mikhailovsky GOK. Concentrate output also rose by 20% to 15.63 million tonnes. Stoilensky GOK increased its iron ore output to 12.83 million tonnes in 2003 thereby registering a rise of 1.6 percent.

The leading pellet producer, Karelsky Okatysh (Kostomuksha GOK), increased output by 11% to 9.23 million tonnes. In February 2004, Karelsky Okatysh began operations at the northern section of the Kostomuksha deposit.

Russia is also a major exporter of iron ore. It exported 13 million tonnes of iron ore in 2004. Russia's steel production is also quite substantial. It was among the top four major steel producing countries and reported production of 66.1 million tonnes in 2005 registering a slight increase as compared to 65.6 million tonnes in 2004. Keeping in view the fact that Russia imports about 10 million tonnes of iron ore, there are prospects to tap the Russian market.

11. South Africa

South Africa possesses an estimated 2.3 billion tonnes of iron ore resources. In South Africa, large deposits of rich iron ore are derived from Pre-Cambrian banded iron ore formations. The ore is hard massive haematite with iron content as high as 66 to 68 percent. Large reserves of oolitic iron ore deposits also occur in the Transvaal system.

South Africa has reported production of 40 million tonnes of iron ore. The production of iron ore has been steadily increasing in the last 5 years. It rose by 14% in 2005 to 40 million tonnes as compared to 35 million tonnes in 2001. It is also a major exporter of iron ore. The exports at 21 million tonnes in 2000 rose to 25 million tonnes in 2004 registering a rise of 19% during the last five years. European countries, Japan and China were the major customers of South African iron ore.

New mines have started operation in the Northern Cape Province. Assmang and Kumba are two other locations where mining activity received boosts. Iron ore capacity expansion in South Africa is being led by Anglo-American's majority owned Kumba Resources in Assmang, which finally started work to develop deposits in Northern Cape Province after sealing deals with the country's rail and port operators.

It is expected that there will be some hectic activities in South Africa's iron ore production as well as export fronts. It is quite discernible that South Africa is emerging as an exporter of iron ore and could offer a fair competition to Indian iron ore, particularly, in the Japanese and Chinese markets in the coming years.

12. Sweden

Sweden is one of the self-sufficient countries in iron ore with a reserve base of 7,800 million tonnes. The most important iron ore deposits are located around Kiruna and Malmberget. Most of the exploited ores belong to the earlier Pre-Cambrian formations. The ore bodies usually dip or incline steeply and the workings proceed quickly and continuously to depths. Nearly all the mines are being worked underground. Kiruna mine is now the world's largest underground iron ore mine with an annual capacity of over 22 million tonnes of crude ore.

The Skarn iron ore and the banded iron ore in Sweden occur mostly in the outer zones of the large volcanic complexes. The ore body at Kiruna is about 4 km long and varies from 20 to 200 m in width. The deposits consist mainly of magnetite and occasionally haematite.

The production of iron ore showed a steady increasing trend since last 5 years. The production, which was 19 million tonnes in 2001 increased to 23 million tonnes in 2005 registering an increase of about 21% in 5 years. The exports dipped in 2001 but registered a gradual rise in the last four years. The exports of iron ore from Sweden was 14 million tonnes during 2001 which increased to 17 million tonnes in 2004 with a rise of 21 percent. The imports also registered a rising trend but the rise was not very significant. It can be inferred that iron ore market of Sweden will not have any considerable impact on the Indian iron ore market.

13. United Kingdom

The United Kingdom with negligible production of iron ore is totally dependent on imports. The main supplying countries are Brazil and Australia.

Imports of iron ore in the UK exhibited a peculiar trend since 2000. The imports which were at 17 million tonnes in 2000 decreased to 15 million tonnes in 2001 and further decreased to 13.32 in 2002. The imports suddenly increased to 16 million tonnes in 2003, only to decrease to 15 million tonnes in 2004. India exported 200,000 tonnes iron ore (fines) to UK in 2004-05.

Brazil has replaced Australia as the main source of iron ore for the Anglo-Dutch Corus Group, UK, which has signed a 10-year agreement with Brazilian CVRD, the world's largest iron ore producer, to supply about 10 million tonnes/year.

The production of steel in UK which was 13.77 million tonnes in 2004 decreased marginally to 13.20 million tonnes in 2005.

Indian Iron ore exporters could further their engagement with the UK by ratifying long term pacts for supply of iron ore (as done by CVRD, Brazil). India though is already exporting iron ore to UK, the quantity is not very significant. Export prospects could be enhanced to capitalise on the imports-dependent UK market to the fullest.

14. Ukraine

Resources of iron ore in Ukraine are estimated at around 68 billion tonnes and is at 1st position in the world. The largest iron ore basin is Krivoi Rog in Dnepropetrovsk region, where the bulk of the reserves (as well as key iron ore mines) are located.

Metamorphosed iron ore deposits are found in the Ukranian shield in an almost west trending belt that extends to about 700 km. These deposits occur in synclinal zones of lenticular masses of heamatite with an average of 63% Fe.

Ukrainian production of iron ore grew at 4.5% to 69 million tonnes in 2005 as compared to 66 million tonnes in 2004. An increasing trend was observed since 2000. Rich iron ore is being mined in the deposits within the Kryvorizkiy, Kremenchutskiy and Bilozerskiy basins.

Ukrainian iron ore exports also showed an increasing trend since 2000. The exports of iron ore were 27 million tonnes in 2004. Nearly all the exports were to countries outside the CIS (Commonwealth of Independent States).

Ukraine with steel production of 38.64 million tonnes in 2005 was listed as one of the major steel producing countries. The steel production showed rising trend since 2001. Production of steel was 33 million tonnes in 2001. It increased to about 39 million tonnes in 2005.

In spite of its top position in the resource tally, Ukraine was at seventh position in the world as far as production of iron ore is concerned.

15. USA

Iron ore resources in USA are estimated at 15 billion tonnes.The deposits of iron ore in the USA mainly consist of finely intermixed limonite and clay with small quantities of fine-grained quartz and muscovite. Other important deposits in the Lake Superior region occur in banded formations (oxides, silicates, carbonates or combination of these minerals) and as alternate silica rich layers (chert or fine-grained quartz). Main producing areas are Alabama, Kentucky, Virginia and Pennsylvania.

Cleveland-cliffs is the largest producer of iron ore in North America. The company operates six iron ore mines located in Michigan, Minnesota on Eastern Canada that currently have capacity to produce 37.5 million tonnes of iron ore pellets annually. The company created Cleveland-cliffs Michigan operations by combining the operations of Empire and Tilden mine on Marquette iron range in Michigan's Upper Peninsula. The mining operations of Tilden and Empire Pits have separate processing plants. Many of the management functions, such as, accounting, finance, purchase and information technology were combined to operate as a single unit. This is to enable more effective utilisation and coordination of the combined resources of both mines.

The mining operations at Empire began in early 1960s. At present, the mine has capacity to produce 8.0 million tonnes of pellets per year.

Tilden's mining activities began in early 1970s. This mine has a capacity to produce 8.0 million tonnes of pellets per year. In 1987, Tilden became a leader within the industry by beginning production of fluxed pellets. During 1989 new equipment were added to increase the capacity of the mine and improvise processing of magnetite ore. Today, Tilden has the only iron ore processing facility in the world with capacity to produce both haematite and magnetite iron ore pellets.

USA produced 55 million tonnes of iron ore in 2005 which was almost the same as that in the previous year. The trend in production since 2000 seemed fluctuating. The exports of iron ore showed a gradual rise during the period between 2000 and 2004. It was 6 million tonnes in 2000 and 8 million tonnes in 2004. The imports of iron ore, on the other hand, showed a mixed trend during 2000 to 2004. The imports which were at 15.66 million tonnes in 2000 decreased to 10.65 million tonnes in 2001, it climbed to 13 million tonnes in 2002 and dipped to 12 million tonnes in 2004.

USA is one of the major steel producing countries in the world after China and Japan. The production of steel continuously increased since 2001 till 2004 from 90.1 million tonnes to 98.4 million tonnes, but dropped to 93.9 million tonnes in 2005.

It is observed that the iron & steel industry in USA is structured to consume recycled scrap. Therefore, recycled iron & steel scrap is the main raw material for production of new iron & steel products.

16. Venezuela

The iron ore in Venezuela is mainly massive haematite with small quantities of magnetite. The iron contents range between 64 and 70 percent. The phosphorous content averages 0.04 percent. Elpao is the oldest iron ore mine in Venezuela. The other deposit comprises two types of ores—hard massive and soft friable consisting of black and brown fines. The proportion of hard and soft iron ore is 30:70.

Venezuela has fairly good resources of iron ore and the reserve base is of the order of 6 billion tonnes. The production trend since 2000 has shown a gradual rise. The production touched 22 million tonnes during 2005 from 17 million tonnes in 2001. Exports of iron ore were almost static at around 7 million tonnes in the last five years. The country is a net exporter of iron ore.

In 2005, Venezuela's iron ore output reached 22 million tonnes, the highest production in the past decade. State-owned Corporacion Venezolana de Guyana (CVG) is the only iron ore producer in the country which through its subsidiary, Ferrominera del Orinoco, operates three open pit mines in Bolivar State.

Met-Chem Canada Inc and Spanish Engineering & Construction Company, Duro Felguera SA, were awarded US$5 million engineering contract by Ferrominera to construct a new 8 million tonnes/year capacity concentrator in Piar iron-ore district.

INDIAN TRADE

Iron ore with exports of around 84 million tonnes valued at Rs 16828 crores in 2005-06 is an important export-oriented commodity. Small quantities of around 5 lakh tonnes are also imported.

Export-Import Policy

The Export-Import (Exim) Policy of iron ore is decided by Ministry of Commerce, Government of India. The gist of the Policy is as below:

Export Policy

The export policy for the years 2004-2009 is highlighted in Table 4.1.

Table 4.1: Export Policy, 2004–2009

Item	Policy	Nature of Restriction
Iron ore other than those specified under free category	STE	Export through MMTC Limited
Iron ore of Goa origin when exported to China, Europe, Japan, South Korea and Taiwan, irrespective of Fe content	Free	No restriction
Iron ore of Redi origin to all markets, irrespective of Fe content	Free	No restriction
All iron ore of Fe content up to 64%	Free	No restriction
Iron ore concentrate prepared by beneficiation and/ or concentration of low-grade ore containing 40 percent or less of iron produced by Kudremukh Iron Ore Company Limited	STE	By Kudremukh Iron Ore Company Limited, Bangalore.
Iron ore pellets manufactured by Kudremukh Iron Ore Company Limited out of concentrates produced by it.	STE	By Kudremukh Iron Ore Company Ltd., Bangalore
Rejects of iron ore chips and like generated from the manufacturing process after using imported raw material subject to the following conditions : (i) The quantity of export of such rejects shall not be more than 10% of the imported raw materials, i.e., pellets. (ii) The size of the rejected pellets chips (fines) shall be less than 6 mm.	Free	—

STE – State Trading Enterprises

Source: *Export- Import Policy, 2004-09 (Edition 2006, Vol. 3)*

As inferred from Table 4.1, iron ore of Goa can be exported to China, Europe, Japan, South Korea and Taiwan irrespective of Fe content, while that of Redi origin can be exported to all countries irrespective of Fe content. Further, all iron ore up to 64% Fe can be exported freely while iron ore with +64% Fe can be exported through MMTC.

Import Policy

There is no restriction on import of any grade of iron ore. The import policy for iron ore for the period 2004-09 along with duty structure is given in Table 4.2.

Table 4.2: Import Policy, 2004–2009

Item description	Policy	Basic Duty	Pref. Duty	CVD+E. Ed. Cess	Custom Ed. Cess	Special CVD	Total
Iron ores and concn. including roasted iron pyrites							
Iron ores and concn. other than roasted iron pyrites							
Non-agglomerated:							
Iron ore lumps (60% Fe and above)	Free	2*	-	0#	2	4	6.12160#
Iron ore lumps (below 60% Fe, including black iron ore containing up to 10% Mn)	Free	2*	-	0#	2	4	6.12160#
Iron ore fines (62% Fe and above)	Free	2*	-	0#	2	4	6.12160#
Iron ore fines (below 62% Fe)	Free	2*	-	0#	2	4	6.12160#
Iron ore concentrates	Free	2*	-	0#	2	4	6.12160#
Other	Free	2*	-	0#	2	4	6.12160#
Agglomerated:							
Iron ore pellets	Free	2*	-	0#	2	4	6.12160#
Other	Free	2*	-	0#	2	4	6.12160#
Roasted iron pyrites	Free	2*	-	0#	2	4	6.12160#

Source: Export-Import Policy, 2004-09 (Edition 2006, Vol. 3)
* : *Vide Notification No.21/2002-Cus.,dated 1-3-2002; CVD: Counter Veil Duty*
# : *Subject to eligibility to exemption from duty*

Indian Exports

India plays an important role in the world export market of iron ore and has sustained its hold on the Asian export market as far as iron ore is concerned. India exports iron ore mainly to China, Japan, Korea and Pakistan besides other countries like Romania, Netherlands etc. The total exports of iron ore during 1992-93 to 2004-05 are summarised in Table 4.3.

Table 4.3: India's Export of Iron Ore during 1992-93 to 2004-05

(Qty in '000 tonnes; Value in Rs '000)

Year	Quantity	Value
1992-93	22,168	11,040,865
1993-94	26,857	13,736,746
1994-95	26,062	12,976,318
1995-96	31,719	17,210,269
1996-97	27,627	17,064,413

contd...

Year	Quantity	Value
1997-98	29,496	17,696,984
1998-99	22,274	16,154,995
1999-2000	15,717	11,753,248
2000-01	20,162	16,337,958
2001-02	23,086	20,335,519
2002-03	57,094	42,004,409
2003-04	51,495*	51,736,229
2004-05	87184	147,272,483

Source: DGCI&S.

*: *As per the Goa Mineral Ore Exporter's Association, exports of iron ore reported is 63 million tonnes for the year 2003-04.*

As evident from the above Table, iron ore exports from India recorded an increasing trend during 1992-93 to 1995-96. Thereafter during 1996-97 to 2001-02, it recorded a fluctuating trend. Post 2000-01, exports recorded increasing trend and touched a figure of 87.2 million tonnes in 2004-05 as compared to 20.16 million tonnes in 2000-01. During 2005-06, the exports were around 84 million tonnes valued at Rs. 16828 crores.

Gradewise Exports

The gradewise exports of iron ore from India during 2002-03 to 2005-06 are given in Annexure-11. The countrywise and gradewise exports of iron ore from India during 2002-03 to 2005-06 are given in Annexures 12-A to 12-D. On analysis of the Annexures, it reveals that exports of all the grades have shown increasing trends. Among all grades, the quantity of fines above 62% Fe is the highest and has increased to 52,444 thousand tonnes in 2005-06 as compared to 37,770 thousand tonnes in 2002-03.

During 2005-06, out of 52.4 million tonnes of iron ore fines with (+) 62% Fe exported, 45.3 million tonnes (86.4%) were exported to China, 5 million tonnes (9.53 %) to Japan and 549 thousand tonnes (1.04 %) to Netherlands. The remaining 3.03% were exported to other countries like Korea, Republic of, Romania, Turkey, UAE, Pakistan, etc. As far as lumps – the high-grade lumps, i.e., above 60% Fe – are concerned, exports have increased to 16.8 million tonnes from 12.3 million tonnes in 2002-03.

Out of 16.8 million tonnes of high grade lumps with (+) 60% Fe, China accounted for 71.42%, followed by Japan 21% and Korea, Republic of, 4.4%. The remaining 3.18% was exported to Pakistan, Hong Kong, etc.

The exports of concentrates declined from 2,201 thousand tonnes in 2002-03 to 1,940 thousand tonnes in 2005-06.

During 2005-06, out of 1940 thousand tonnes of non-agglomerated concentrates, 1,549 thousand tonnes was exported to China. Small quantities of concentrates were exported to Japan, Hong Kong and UAE.

The exports of pellets have increased to 3,548 thousand tonnes from a meagre 1,253 thousand tonnes in 2002-03. Out of 3,548 million tonnes, 99.2% were exported to China and the remaining to Switzerland. Exports of low-grade fines, i.e., below 62% Fe and low-grade lumps, i.e., below 60% Fe have also increased but the increase was not as high as the other higher grades. Gradewise and countrywise exports from India during 2002-03 to 2005-06 are given in Annexures 12-A to 12-D and concisely in Table 4.4.

Table 4.4: Gradewise Export of Iron Ore from India, in 1995-96 to 2005-06

(In '000 tonnes)

Year	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62%Fe	-62% Fe	+60%Fe	-60%Fe		
1995-96	3,924	11,450	2,958	9,228	1,682	2,477	31,719
1996-97	3,185	10,946	1,659	8,584	1,142	2,101	27,617
1997-98	4,632	13,268	1,157	7,448	1,179	1,812	29,496
1998-99	2,850	8,484	734	5,111	3,302	1,793	22,274
1999-00	4,041	3,956	572	3,693	1,463	1,992	15,717
2000-01	2,352	7,475	1,105	6,066	1,912	1,252	20,162
2001-02	3,224	8,466	1,509	8,245	645	997	23,086
2002-03	2,201	37,770	2,175	12,351	1,345	1,253	57,095
2003-04	3,168	31,398	2,642	10,864	960	2,465	51,497*
2004-05	8,377	46,872	4,698	19,767	2,138	5,332	87,184
2005-06	1,940	52,444	6,383	16,812	2,919	3,548	84,046

*: *As per the Goa Mineral Ore Exporter's Association, exports of iron ore reported was 63 million tonnes in the year 2003-04.*

From Table 4.4 it can be inferred that exports of non-agglomerated concentrates of iron ore showed considerable fluctuation and varied from 3,924 thousand tonnes in 1995-96 to 2,201 thousand tonnes in 2002-03. In 2003-04 and 2004-05 it recorded a rise but in 2005-06 it dropped to 1940 thousand tonnes.

During 1995-96 to 1999-2000 the exports of high-grade fines (i.e., 62% Fe and above) fluctuated from high of 11,450 thousand tonnes in 1996-97 to a low of 3,956 thousand tonnes in 1999-2000. After 2000-01, the exports rose from 7,475 thousand tonnes to a whopping 37,770 thousand tonnes in 2002-03 and further to 52,444 thousand tonnes in 2005-06 after a slight fall in 2003-04.

The exports of low-grade fines (i.e., below 62% Fe) showed a steady decrease till the year 1999-2000. It decreased to 572 thousand tonnes in 1999-2000 from 2958 thousand tonnes in 1995-96. Thereafter, the trend reversed upwards steadily and reached 6,383 thousand tonnes in 2005-06.

Similar trend was observed in the case of exports of high-grade lumps (60% Fe & above). The exports of high-grade lumps which were at 9,228 thousand tonnes in 1995-96 decreased to 3,693 thousand tonnes in 1999-2000. Post 2000-01 the exports began to rise except in the year 2003-04 when it slumped to 10,864 thousand tonnes, after which it recovered to19,767 thousand tonnes in 2004-05 and declined again to 16,812 thousand tonnes in 2005-06.

A fluctuating trend was observed in the exports of low-grade lumps (below 60% Fe) between 1996-97 and 2005-06. The maximum exports reported was 3,302 thousand tonnes during 1998-99 and the minimum was 645 thousand tonnes in 2001-02.

In case of pellets similar fluctuating trend was observed. The exports of pellets which was 2,477 thousand tonnes in 1995-96 steadily decreased to 1,793 thousand tonnes in 1998-99. It posted a rise to 1,992 thousand tonnes in 1999-2000 only to decrease again to 1,252 thousand tonnes in 2000-01 and further to 997 thousand tonnes in 2001-02. After 2001-02 an increasing trend was observed and the export of pellets reached a level of 5,332 thousand tonnes in 2004-05. However, in 2005-06 it decreased to 3,548 thousand tonnes.

Imports

The imports of iron ore by India recorded a fluctuating trend with a minimum of 27 thousand tonnes in 1992-93 and a maximum of 1,587 thousand tonnes in 2003-04. The major suppliers of iron ore to India were Brazil and Bahrain. The imports of iron ore during 1992-93 to 2005-06 are given in the following Table 4.5.

Table 4.5: India's Imports of Iron Ore during 1992-93 to 2005-06

(Qty in '000 tonnes; Value in Rs '000)

Year	Quantity	Value
1992-93	27	132,844
1993-94	164	438,022
1994-95	1,523	2,140,345
1995-96	879	1,446,357
1996-97	853	1,252,915
1997-98	372	770,067
1998-99	149	249,378
1999-2000	644	1,076,868
2000-01	487	750,935
2001-02	395	841,554
2002-03	520	1,027,372
2003-04	1,587*	3,591,796
2004-05	485	1,780,126
2005-06	611	2,737,452

*: *Includes iron pyrites*

Gradewise Imports

Gradewise imports of iron ore into India for the years between 2002-03 and 2004-05 are given in Annexure-13. Gradewise imports of iron ore into India for last 10 years are given in Table 4.6. Table 4.6 reveals that the quantity of imports into India is very low as compared to exports. It can also be seen from the Table that India imports pellets every year. There is also a considerable quantity of imports of non-agglomerated iron ore concentrates. Imports of 890 thousand tonnes of high grade fines (+62% Fe) was reported in 2003-04. Similarly imports of 119 thousand tonnes of high grade lumps (above 60% Fe) was reported in 2002-03 which increased to 330 thousand tonnes in 2003-04, decreased to 140 thousand tonnes in 2004-05 and rose again to 323 thousand tonnes in 2005-06.

As regards iron ore pellets, fluctuating trend was observed. The imports of iron ore pellets which was 846 thousand tonnes in 1995-96 decreased continuously and reached 149 thousand tonnes in 1998-99. The imports of pellets abruptly increased in the year 1999-2000 to 532 thousand tonnes and declined again to 375 thousand tonnes in 2001-02. There was again an increase in 2002-03 to 401 thousand tonnes followed by a decrease in 2005-06 to 288 thousand tonnes.

The gradewise and countrywise imports of iron ore are given in Annexures 13-A to 13-D and concisely in Table 4.6.

Table 4.6: Gradewise Imports of Iron Ore in India during 1995-96 to 2005-06

(In '000 tonnes)

Year	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	- 62% Fe	+60%Fe	- 60%Fe		
1995-96	33	-	-	-	-	846	879
1996-97	228	-	-	-	-	624	853
1997-98	-	-	-	-	-	372	372
1998-99	-	-	-	-	-	149	149
1999-2000	112	-	-	-	-	532	644
2000-01	-	-	-	-	-	487	487
2001-02	20	-	-	-	-	375	395
2002-03	++	-	-	119	-	401	520
2003-04	-	890	-	330	-	347	1,567
2004-05	++	-	-	140	++	345	485
2005-06	-	-	-	323	-	288	611

++ Negligible

EXPORT PROSPECTS

Iron ore is a major raw material for production of steel. India has abundant resources of iron ore, both in terms of quantity and quality. It can meet the domestic as well as overseas demand. Hectic activity has been observed since last few years in the world iron ore market. Exports of iron ore from India has been on a steady rise. It is hoped that this increasing trend will continue for a few more years. India is well-poised to meet this increasing export demand and can emerge as a leading exporter of iron ore in Asian continent. To achieve this goal, it is imperative to augment production capacity of iron ore through appropriate technology upgradation.

The major overseas markets for Indian iron ore presently are China, Japan, Korea, Pakistan and Iran in Asian continent. Besides, India is also exporting considerable quantity of iron ore and concentrates to Romania, Netherlands, Italy, etc. Small quantities are also exported to UK, France, Kuwait, etc. Recently, Indian Iron ore pellets and concentrates have found markets in countries like Saudi Arabia, Indonesia, Switzerland and Sweden.

As discussed earlier, China is the engine behind the boom in the international trade of iron ore. The boom is expected to continue for a few more years in the future. After that the demand of iron ore from China is expected to stabilise.

The detailed study of the steel producing countries carried out revealed that besides China, Japan and Korea, countries like France, Iran, Italy, Mexico, Netherlands, Poland, UK, etc. are also experiencing hectic activities in their respective steel sectors. It is observed that potential markets for Indian iron ore could open up in these countries in the immediate future.

Iran

Iran intends to increase its steel production to 55 million tonnes by 2020 from 9 million tonnes in 2004. To achieve this target Iran may have to import iron ore from other countries.

France

France is also increasing its steel capacity. French steel producer Usinor SA merged with two other steel producers Aceralia of Spain and Arbed to form Arcelor. Arcelor is now the world's largest steel producer with an annual production of more than 45 million tonnes in 2004. Presently, Arcelor has been taken over by Mittal Steel. This Company is also looking forward to acquire leases and land for iron ore and establishment of new steel plant in India. Besides, the imports by France are also showing an increasing trend.

Mexico

Mexico's steel production increased by 10% in 2004 to reach 16.7 million tonnes. The Mexican Association of Steel Producers (Canacero) have announced further investment of US $ 350 million to enhance steel production in the coming years. Privatisation of steel industry in Mexico has resulted in the formation of 5 large steel producers. This is bound to increase steel production in Mexico. Consequently the demand of iron ore is also bound to increase.

Poland

Poland's crude steel production was 6.92 million tonnes in 2005. The Polish Government's Industry restructuring strategy has led foreign investors like Mittal Steel and a few other small investors show expression of interest. These facts also suggest that the demand of iron ore in Poland is all set to rise in the near future.

The above countries, namely, Iran, France, Mexico, Poland and other countries like UK, Germany, Italy, USA, Spain though possess good capacities for production of steel they are deficient in good quality iron ore. These markets could be tapped for iron ore exports.

It can be concluded that presently China is the main market for India's iron ore and is likely to continue in the near future. Other countries, viz., Japan, South Korea, Pakistan, Iran, etc. in the Asian continent are also important destinations of Indian iron ore with Japan being a traditional market. Besides, considerable quantity of iron ore is exported to Romania, Netherlands, Italy, etc. There is a lot of scope to enhance exports to these countries. U.K., France, Kuwait, Saudi Arabia, Indonesia, Sweden, Switzerland, etc. are prospective markets and could become possible export destinations. The countries, which do not have indigenous iron ore to feed their steel plants and depend entirely on imports are, France, Mexico, Poland, Germany, etc. These countries may also be explored for exports of Indian iron ore and concentrates.

QUANTITATIVE ESTIMATION OF EXPORT PROSPECTS

The world imports of iron ore ranged from 508 to 632 million tonnes during 2000–2004. The main importers were China, Japan, S. Korea, Germany, France and Russia. India's share in the world trade was 12.4% in 2004. China was the main market for Indian iron ore followed by Japan & Korea. In 2004, China imported 208.09 million tonnes from all over the world. Chinese imports from India were 25.15 million tonnes, 35.22 million tonnes, 60.25 million tonnes and 69.75 million tonnes during 2002-03, 2003-04, 2004-05 and 2005-06 respectively. During 2005-06, China imported 45.33 million tonnes of high-grade iron ore fines, 12 million tonnes of high-grade iron ore lumps, 1.54 million tonnes of concentrate (non-agglomerated), 5.56 million tonnes of low-grade fines (i.e., below 62% Fe), 1.77 million tonnes of low-grade lumps (i.e., below 60% Fe) and 3.52 million tonnes of pellets from India.

The present spurt in the trend in India's exports is due to increased share of Indian exports to China. The imports of iron ore in China were stimulated by its strong domestic demand particularly in the construction industry. China also imports iron ore from other countries like Australia, South Africa, Russia, Ukraine, etc. It is also reported that large as well as small mines in China are adopting measures to step up their production in the coming years. This activity may cause reduction in imports of iron ore in China and accordingly may help in the stablisation of exports of Indian iron ore to China.

Considering the above facts, attempt has been made to estimate the future export demand up to 2010. As per National Steel Policy, 2005, investments are likely to be made for beneficiation, sintering and pelletisation in the country, which will use iron ore fines. Looking at the needs of the country, exports of iron ore, especially high-grade lumps, would be leveraged for imports of coking coal or for investment in India. During 2004 total world's import of iron ore was 632 million tonnes. China and Japan's share in the total world import, were 208 million tonnes (32.9%) and 135 million tonnes (21.36%) respectively contributing 54% to the total world imports. South Korea, Germany and France are also important importers of iron ore. South Korea with 44 million tonnes (6.9%), Germany with 43 million tonnes (6.8%) and France with 21 million tonnes (3.3%) contribute about 17% of the total world imports. Thus five countries namely China, Japan, South Korea, Germany and France account for 71% of total imports. The remaining 29% import is by other countries. The consumption of steel in China as forecasted by International Iron & Steel Institute (IISI) will be around 540 million tonnes by 2010. As far as iron ore is concerned, the consumption of iron ore in China will be about 750 million tonnes by 2010. China is expected to fulfil this demand by its domestic production and imports. Looking at the trend, the imports of iron ore by China, Japan, South Korea, Germany and France by 2010 will hover around 520 million tonnes, 150 million tonnes, 50 million tonnes, 40 million tonnes and 20 million tonnes respectively. The imports of iron ore by developed countries may reduce due to recycling of scrap. Scrap generation is bound to rise in the developed countries than in developing countries.

Expansion of steel capacity in China, has led Australia and Brazil to increase their iron ore production capacity by 100 million tonnes as Australia and Brazil are the major exporters of iron ore to China. Based on the present trend, it is estimated that Australia and Brazil are likely to export about 290 –310 million tonnes and 320–340 million tonnes of iron ore respectively by 2010. The other exporters of iron ore, namely, India, Ukraine, South Africa and Canada also are likely to increase their exports of iron ore to the tune of about 88–90 million tonnes, 30–40 million tonnes, 25–35 million tonnes and 23–33 million tonnes respectively by 2010.

As far as India's exports of iron ore are concerned, the requirement of iron ore by 2020 has been forecasted in the steel policy, 2005 for indigenous as well as exports purposes and as per the forecast the requirements for the years 2006-07, 2009-10, 2011-12 & 2019-20 are likely to be 85.26, 88.65, 90.91 and 100 million tonnes, respectively. These figures have been arrived at after duly considering the various factors with respect to exploitation of iron ore.

India's expansion programmes for steel capacity prognosticates 60 million tonnes by 2012 and 110 million tonnes by 2020. This implies that iron ore consumption in India is bound to increase with capacity addition of steel. After stabilisation of Chinese Steel Industry, China could enter into long-term agreements for iron ore import with Indian iron ore producers to ensure uninterrupted supply of quality iron ore for longer period of time. It is envisaged that India's long-term agreement for exports of iron ore with China could be about 40 million tonnes of which Goa region would supply 25 million tonnes and Karnataka region would supply the remaining 15 million tonnes. At present in India the iron ore mines are in segregated situation. No large capacity mines of iron ore have been designed for export purpose. There is a need to develop suitable network in India to establish control and coordination between all iron ore producers. MMTC is already working as a coordinating agency for exports of minerals. Besides, suitable arrangement for continuous mechanical loading at railway siding is also needed with combination of crusher, stocker for stockpiling, reclaimer for lifting of stocked iron ore so that continuous loading at railway siding may be possible. Presently, mechanical loaders with low capacity are used at loading sides at some railway sidings. Infrastructure facilities by expansion of railway siding and port facilities are cricial for India to cope and cater to its domestic and foreign markets.

Indian iron ore industry is well-poised to meet the domestic requirement of existing as well as for new capacity addition in the Steel Sector. India, as per its present mine capacity, is in a position to export about 100 million tonnes of iron ore after meeting its domestic demand. There is, however, a perceptible compulsion to strike a judicious balance between exports and domestic supply of iron ore, so that Indian steel industry is adequately gaurded.

Chapter 5

Supply

Iron and Steel is considered as the backbone of the modern civilised economy. In the present scenario, consumption of steel is used as a yardstick for measuring industrial growth and socio-economic development of a nation. Iron and steel is used in almost all industries for number of applications. It has great demand in growing economies. Iron ore is one of the basic raw materials for iron and steel industry. India has substantial reserves/resources of good quality iron ore which are distributed mainly in Jharkhand, Orissa, Chhattisgarh, Karnataka & Goa and is in a reasonable position to obviate the growing demand of iron ore in both its domestic iron & steel industries and external trade purposes. With the total resources of over 25 billion tonnes (both haematite and magnetite), India is one of the leading producers as well as exporters of iron ore in the world.

This Chapter comprises three sections—Resources, Production and Beneficiation. Under the head 'Resources', a brief description about geology, occurrences and reserves/resources of iron ore as per UNFC as on 1.4.2005 is discussed. The Section on 'Production' analyses the gradewise, statewise, districtwise production of iron ore and its concentrates in India during the six years starting from 2000-01 to 2005-06. The Section on 'Beneficiation' discusses the various activities under beneficiation, R & D works carried out at different organisations, namely, IBM, RRL, NML and a gist on some of the important beneficiation plants in the country.

RESOURCES

Geology

Iron ore occurs in different geological formations in India, but the most important deposits belong to the Pre-Cambrian age. Iron ore deposits of Pre-Cambrian age in India are associated with Banded Haematite-Jasper (BHJ) and Banded Haematite-Quartzite (BHQ) of the Dharwarian formations of South India and their equivalent of the Iron Ore Series found in Northern India. The ores are derived from the enrichment of banded ferruginous rocks by the removal of silica. The ore body generally forms the tops of the ridges and hillocks which are often of great magnitude. Most of them contain high-grade ores near the surface with an iron content of over 60 percent, however, deposits with seemingly large quantities of low-grade ores are also found to occur. Whether metamorphosed regionally or by igneous intrusives, these Banded Haematite-Jaspers have been converted into Banded-Magnetite-Quartzite rocks, which also attain considerable importance in certain areas in Tamil Nadu and in Southern Karnataka. These ores are of low-grade, containing only about 35 to 40 percent iron, but are amenable to concentration after crushing to a suitable size. At some places in Singhbhum West and Mayurbhanj districts, vanadiferous and titaniferous magnetite bodies are associated with basic and ultrabasic intrusives. These deposits are considered to be of Singhbhum West belt that contains apatite-magnetite ores associated with granodiorite.

Geographically, the Pre-Cambrian banded iron ore formations are distributed in five broad belts:

Zone A: Singhbhum in Jharkhand & Cuttack in Orissa.

Zone B: Dantewada, Durg in Chhattisgarh and Chandrapur, Gadchiroli in Maharashtra.

Zone C: Bellary-Hospet belt in Karnataka.

Zone D: Goa, Ratnagiri in Maharashtra & North Karnataka.

Zone E: Metamorphosed Banded Iron Formation along the West Coast in Karnataka and Kerala.

From the above belts, haematite – a product of enrichment of Pre-Cambrian iron formation – is the principal ore mined for iron and steel making in the country.

Other geological formations of iron ore in India are less important as they contain low-grade ores and are smaller in size. The later formations especially Gondwanas and the Deccan Traps contain ores which are comparatively of little importance in the present day, though they were once used in the indigenous furnaces.

Occurrences

The total all India resources of iron ore (haematite + magnetite) is placed at 25,250 million tonnes. In India, iron ore occurrences are reported from many States, namely, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal etc. Out of these, the major States are Orissa, Jharkhand, Chhattisgarh and Karnataka which account for 19%, 16%, 11% and 38% respectively. The balance 16% resources is shared by other States. The Statewise/Districtwise occurrences of iron ore deposits (haematite & magnetite) are given in Tables 5.1 & 5.2.

Table 5.1: Statewise/Districtwise Iron Ore (Haematite) Deposits in India

S.No.	States	Districts
1.	Andhra Pradesh	Anantpur, Cuddapah, Guntur, Khammam, Krishna, Kurnool and Nellore
2.	Assam	Kokrajhar
3.	Bihar	Bhagalpur
4.	Chhattisgarh	Bastar, Dantewada, Durg and Kanker
5.	Goa	North Goa and South Goa

contd...

(concld)

S.No.	States	Districts
6.	Jharkhand	Singhbhum (West)
7.	Karnataka	Bagalkot, Bellary, Bijapur, Chikmagalur, Chitradurga, Dharwar, North Kanara, Shimoga and Tumkur
8.	Madhya Pradesh	Betul, Gwalior, Jabalpur and Katni
9.	Maharashtra	Chandrapur, Gadchiroli, Sindhudurg and Ratnagiri
10.	Orissa	Dhenkanal, Jajpur, Keonjhar, Koraput, Mayurbanj, Sambalpur and Sundergarh
11.	Rajasthan	Dausa, Jaipur, Jhunjhunu, Sikar and Udaipur
12.	Uttar Pradesh	Lalitpur

Table 5.2: Statewise/Districtwise Iron Ore (Magnetite) Deposits in India

S. No.	States	Districts
1.	Andhra Pradesh	Adilabad, Prakasam and Warangal
2.	Assam	Bhuburi, Goalpara and Kokrajhar
3.	Bihar	Gaya
4.	Jharkhand	Gumla, Hazaribagh, Palamau and Singhbhum (East)
5.	Karnataka	Chikmagalur, Hassan, North Kanara, Shimoga and South Kanara
6.	Kerala	Kozhikode and Malappuram
7.	Maharashtra	Gondia
8.	Rajasthan	Bhilwara, Jhunjhunu and Sikar
9.	Tamil Nadu	Dharampuri, Erode, Nilgiri, Salem, Thiruvannamalai, Tiruchirapalli and Villupuram

IMPORTANT DEPOSITS/BELTS OF IRON ORE IN INDIA

India is endowed with rich deposits of iron ore, mainly, haematite. These deposits are largely located in Jharkhand, Orissa, Chhattisgarh, Karnataka, Goa, Maharashtra and Andhra Pradesh.

The Singhbhum-Keonjhar-Bonai Group of Deposits are the most important group of iron ore deposits in India. These deposits occur in series of prominent hills stretching from Singhbhum (W) district in Jharkhand to Bonai range of hills running through Keonjhar and Sundergarh districts in Orissa covering an area of 1,550 sq.km.

The statewise and districtwise important deposits of iron ore are discussed below:

Jharkhand

Singhbhum West District

In Singhbhum West district, the important deposits are Chiria, Gua, Noamundi, Barajamda, Kiriburu, Megahatuburu and Manoharpur. Some of them are discussed below in brief.

1. Chiria Deposit: This is the largest single deposit of iron ore in India. It is located near Village Chiria, Manoharpur taluka, Singhbhum West district, Jharkhand. Structurally, this deposit forms a part of the north-western limb of the "Iron ore Synclinorium". It covers in tabular blanket over the high topographical hills and ridges of Saranda Reserve Forest, namely the peaks of Budhaburu, Bogorduiburu and other adjoining hills. The deposit extends for a strike length of 6.5 km with average width of about 2.5 km. Geologically, the formations comprise oldest metasedimentary–metavolcanics of iron ore Group. The BIF exhibits converging dips resulting in major synforms and antiforms. MECL has explored the deposit during 1976 to 1979 and assessed the resources of iron ore at about 2000 million tonnes. The major working mine in this area at Manoharpur is being operated by Indian Iron & Steel Co. Ltd. (IISCO). In this deposit the ores occur as soft laminated, hard laminated or as blue dust with average Fe content of 62.15 percent.

2. Noamundi Deposit: This deposit is also located in Singhbhum West district, Jharkhand. The major mine being worked in the area is the Noamundi mine of M/s Tata Iron & Steel Co. Ltd. The ores found to occur in this deposit are hard, soft to friable and in the form of blue dust. The Fe content in the hard ore varies from 65 to 69% and that in the soft ore from 57 to 66.8 percent. The blue dust is of high-grade having Fe content from 65 to 69 percent. DGM, Jharkhand carried out some preliminary exploration in the free hold area of this deposit while M/s TISCO Ltd explored the leasehold area.

3. Kiriburu & Megahataburu Deposits: The Kiriburu and Megahataburu deposits are situated in the western limb of main Bonai Iron Ore range near Jharkhand–Orissa boundary and form a part of Iron Ore Series. Kiriburu deposit is located in Singhbhum West district in Chaibasa taluka. The ore body in north Kiriburu area strikes over a length of 2000 m with width averaging 300 m. The deposit is situated in a rugged terrain. The difference in the highest point and the lowest point of the ore body is about 100 m and the average iron content is 63.5 percent.

The Megahataburu deposit is located 5 km away from Kiriburu deposit. This deposit extends over a strike length of about 960 m and a width of about 450 m. Exploration data revealed that the deposit contains about 115 million tonnes of resources of iron ore with average Fe content of 63.3 per cent. The host rocks of these deposits are Banded haematite quartzite/ jasper and shale. The maximum depth of borehole in Kiriburu was 156 meters whereas in Megahataburu it was 129 meters. The exploration agencies were NMDC and MECL.

Orissa

Sundergarh District

Malangtoli Deposit: The Malangtoli deposits occupy the southern tip of the famous horseshoe-shaped Bonai synclinorium and are spread over an area of 200 sq. km. Structurally this deposit is very complex. The distribution of ore is influenced by this complex structure of the deposit. The deposit comprises almost 48 iron ore occurrences of variable sizes. GSI carried out initial exploration on a group of 14 deposits of Malangtoli area located between Piropokri to the North and Sirkaguty to the South. In the Malangtoli group of 14 deposits, M/s OMC has a large mining lease of 52.26 sq. km covering nearly 11 deposits. The types of ore found to occur in this area are hard, massive, soft laminated and powdery. Laterite also occurs at these places. Host rocks are Banded Haematite-Quartzite/Jasper.

Keonjhar District

1. Thakurani Deposit: The Thakurani deposit in Keonjhar district is one of the important deposits, which extends for 10 km in length and 5 km in width near Barbil town. This is one of the oldest deposits in Keonjhar district.The iron ore in this deposit is hard, massive or laminated, soft laminated and powdery. The ore occurs in the Banded Haematite-Quartzite/ Jasper and Shale of the Iron Ore Series. The major mine operating in this area is Thakurani mines of Block B of M/s Sunderlal Sarda & Mohanlal Sarda. Production is also reported by M/s Kay pee Enterprises & M/s Bharat Processing and Mechanical Engineering Ltd.

2. Banspani Deposit: This is also an important deposit located in Keonjhar district. This deposit covers an area of 20 sq. km and exhibits an 'U-shaped' structure in the area. The range is capped by massive haematite for most of its parts with lateritisation of the cappings at places. The rocks in this area belong to the Iron Ore Series of Pre-Cambrian age. The general strike of the range is E-W to NW-SE. The Banded Haematite-Quartzite (BHQ) or the Banded Haematite-Jasper (BHJ) forms the hanging wall side of the ore body whereas ferruginous phyllites form the foot wall side. The BHQ/ BHJ consists of alternating bands of quartz in the form of chalcedony or jasper and haematite. It is believed that this quartz has been leached out giving rise to enrichment of iron ore. The ore occurring in this area varies considerably in both physical and chemical nature. In this deposit, the major mine is of M/s OMC Ltd.

Chhattisgarh

Dantewada District

Bailadila Deposits: These are one of the important deposits in the country located in the Dantewada district, Chhattisgarh. The rocks of the Bailadila Iron Ore deposit resemble the Iron Ore Series or the Sinbhghum-Keonjhar-Bonai Iron Ore Series of Jharkhand & Orissa. The Bailadila range is located in the southern part of the district and 14 iron ore deposits occur along the crests of the two parallel ridges which are known as Sonadehi Dongri, Pargal Hill, Khondighat Dongri, North Hahaladdi Hill, South Hahaladdi Hill, Tarai Kohli Hill, Bajmari Dongri, Dorkenhur Dongri, Ghoradar Dongri, Pitehur Dongri Hills, West of Amapara, Hill NW of Kwachi Katel, Berahus Donger and Hakirihur Donger. They belong to the Upper Pre-Cambrian age. The ore bodies are not confined to any particular horizon. They attain their maximum development near the junction of BHQ and the underlying schists. The iron ore bodies occupy synclinal troughs and the folding is usually isoclinal. The two main ridges in the region are synclines and the valley in between is an eroded anticline.

The whole deposit is divided into 14 deposits and is better known as deposit No. 1 to 14. Out of these 14 deposits, 8 deposits namely 1,2,3,5,6, 10, 13 & 14 are fairly large and contain substantial reserves of high-grade iron ore. Iron ore in Bailadila area occurs as massive and laminated types. Blue dust is also seen which is considered to have formed due to the physical degradation of laminated ore. The iron ore found in this deposit is massive near the surface where the original banding had disappeared. Float ores in large quantity are available at the foots of hills surrounding the major deposits.

The Fe content in Bailadila deposit varies from 60 to 69 percent. The massive ore is the best quality ore with an average Fe content of 68.26% followed by the massive laminated with 67 per cent. This deposit has been explored by GSI. The deposit is proven up to a depth of 218 meters. The deposit is being presently worked by National Mineral Development Corporation Ltd.

Bastar District

Rowghat Deposit: The Rowghat Iron Ore deposit is located at about 20 km WNW of Narayanpur. The ore occurs in the Banded Haematite-quartzite. Structurally the deposit is folded. Exploration work carried out involved drilling, pitting etc. and the maximum depth of the boreholes drilled was 112 m.

The deposit is divided into 6 deposits, namely, A, B, C, D, E & F. Except Deposit 'E' which is located in the western limb, all other deposits are located in the eastern limb of Rowghat Synform. Iron ore of deposits A to E are generally massive, hard and compact. The grade is uniform and high. Deposit 'F' is the largest and the richest deposit in Rowghat area. Fe content of the iron ore varies from 60 to 66 percent.

Durg District

Rajhara and Kauchar Deposits: Geologically, these deposits are quite similar to the Bailadila deposits. The Rajhara and Kauchar deposits are important deposits in Durg district. The Rajhara deposit is located on the ridge called Dalli Rajhara hills and the Kauchar deposit is located SW of Dalli Rajhara at a distance of 12 km. The Rajhara deposits are of high-grade iron ore associated with BHQ. Large lenticular patches of high-grade iron ore are found at different locations. The iron ore bearing formations form the southern limb of a pitching horseshoe-shaped synclinal basin. The formations belong to Dharwar metamorphites. The lateritic ores are located near Khairgarh, Borla, Katul kassa, Jurlakhar, Chitrala and Kumi. Fe content in the iron ore of the area is 61% to 66%. In Kauchar deposits, the BHQ is overlain & underlain by ferruginous shale and phyllites. Here the colour of ore varies from steel grey to brownish grey in the limonitic variety.

Karnataka

The most important iron ore deposits of Karnataka State are Sandur hills of Bellary-Hospet sector in Bellary district, Bababudhan hills and Kudremukh-Gangmuta range of Chikmangalur district. Other districts with deposits of iron ore, are Chitradurga, Shimoga, Bijapur, North Kanara, South Kanara, and Hassan. Minor deposits/occurrences are reported from Belgaum, Bidar, Dharwar, Mandya and Raichur districts. Titaniferous magnetite deposits occur in Bangalore, Hassan, North Kanara and Tumkur districts.

Bellary District

Bellary-Hospet Deposits: These deposits are considered to be the richest iron ore deposits next to those located in Jharkhand, Orissa and Chhattisgarh. The BHQ in this region is similar to those of Singhbhum-Keonjhar-Bonai deposits. The hill ranges and the valley constitute the Sandur synclinorium where the stratas are tightly folded. The laterite capping varies from 1 m to 15 m in thickness. The different types of ore, i.e., massive compact, laminated and powdery occur in these deposits and differ largely in their iron content from as low as 55 to 69 percent. The ore bearing terrains comprise Ramdurg, Kumarswamy, Donimalai, Thimmappanaguddi and Devadrigudda sections along eastern to western range of Sandur hills as well as the Copper Mountain near Bellary town. In this area, the iron ore that is massive has iron content varying from 67 to 69%, the compact laminated variety shows 65% Fe and the powdery ore contains 65% Fe.

Chikmagalur District

1. Deposits of Bababudan Hills: The deposits of Bababudan hills in Chikmagalur district comprise chain of hills of horseshoe shape and are about 22 km wide in east-west direction and 19 km in north-south direction. Fe content varies from 55 to 64 percent. In the northern part of Bababudan range, three blocks, viz., Kalhatgiri, Kemmangundi northeast and Totluhhon-Hebbegiri area show thick bands of Banded Magnetite-Quartzite (BMQ). Kemmangundi deposit is a captive source for VISL.

2. Kudremukh Deposit: This deposit is exclusively of magnetite ore. The rugged ranges between Kudremukh and Gangmula contain extensive deposits of magnetite ore at Gostaikal, Nellibidu and Aroli. The iron ore bearing formations are considered to be metamorphosed iron bearing Dharwarian rocks of sedimentary origin. The mineralisation is confined to the Banded Magnetite-Quartzite (BMQ). The true thickness of BMQ bands in Aroli deposit is around 100 m. The strike of the formations varies from N-S to NNW-SSE and the dip varies from 30° to 85° towards east. This area is structurally a series of asymmetrically overturned folds with two sets of joints that played an important role in weathering and oxidation of BMQ. Weathering of iron ore formations near the surface has rendered the ore as friable and leaching away of silica and alumina has left void spaces between the layers. The iron content here varies from 38 to 40% and is fully amenable to beneficiation. This ore is beneficiated and upgraded up to 67% iron content. This deposit was mined by M/s KIOCL but mining has been stopped due to environmental reasons.

Goa

Goan Deposits

The iron ore deposits are located in NW-SE direction in general, over a length of 95 km from Naibagh in the NW on the Goa-Maharashtra border to Salginim in the SE near the Goa-Karnataka border. In this State, from northwest to southeast more than thirty iron ore deposits have been identified. Among them Bicholem –Sirrigaon and Valguem–Pale in North Goa are the best. Iron ore deposits of South Goa are comparatively smaller in size. The iron ore mineralisation in these deposits is generally confined to pink phyllites, which resembles the shales of Singhbhum-Keonjhar-Bonai deposits of Jharkhand and Orissa. These deposits consist of essentially haematite and partly magnetite. Generally, the ore is hard lumpy close to the surface followed at depth by friable and powdery ore. The powdery ore of Goa popularly known as "Blue dust" is a well-known variety, which occurs in Goan deposits in substantial quantity. The iron contents of Goan iron ores vary from 56 to 65 per cent.

Maharashtra

Sindhudurg District

Redi Deposit: This deposit is situated in VillageRedi, i.e., close to Redi port in Sindhudurg district of Maharashtra. The iron ore is found to occur under a laterite capping of thickness varying from 1.5 to 9 m that has been derived by the supergene alteration of BHQ. The iron ore is generally confined to BHQ formation of Dharwar age. Sometimes the associated phyllites are also enriched in iron and show good grade at places. The iron content of the deposit varies from 55% to 65%. Other important aspect of the Redi deposit is that, gold is reported to occur (though not economically significant) in the laterite profile and the powdery zone of the Redi and Kalne deposits in Konkan region.

Other States

Andhra Pradesh is also an iron ore producing State. Iron ore is produced in Anantpur, Cuddappah, Kurnool, Nellore, Khammam & Prakasam districts of Andhra Pradesh. However, production of iron ore in Andhra Pradesh was meagre. Iron ore is also reported to occur in the States of Tamil Nadu, Kerala and Rajasthan.

Reserves/Resources

The Indian Bureau of Mines (IBM) has prepared the National Mineral Inventory (NMI) on iron ore as on 1.4.2005 wherein reserves/resources are classified according to the United Nations Framework Classification (UNFC) and Grade Classification for end-use grade application of the iron ore. NMI has adopted the UNFC and Grade Classification for categorywise and gradewise calculation of iron ore resources. The details about United Nations Framework Classification (UNFC) are furnished in the Annexure-14. The Grade Classification is based mainly on four chemical constituents viz. Fe, SiO_2, Al_2O_3, and P as per the recommendations of the Expert Group on Classification of Minerals with regard to their Possible Optimum Industrial Use (June, 2004). As per NMI, iron ore (haematite) has been classified into 17 grades, namely, (1) Lump, high grade; (2) Lump, medium grade; (3) Lump, low grade; (4) Lump, unclassified grade; (5) Fines, high grade;(6) Fines, medium grade; (7) Fines, low grade; (8) Fines, unclassified grade; (9) Lumps & fine, high grade;(10) Lumps & fines, medium grade; (11) Lumps & fines, low grade; (12) Lumps & fines, unclassified grade; (13) Blue dust; (14) Black iron ore; (15) Others; (16) Unclassified; (17) Not known. Similarly, iron ore (magnetite) has been classified into 6 grades, namely (1) Metallurgical; (2) Coal washery; (3) Foundry; (4) Unclassified; (5) Not known; and (6) Others. Gradewise Classification on the basis of chemical constituents of all these grades of haematite and magnetite stated above is furnished in Tables 5.3 and 5.4, respectively.

Table 5.3: End-Use Grade Classification on the Basis of Chemical Constituents of Haematite

S. No.	Grade	Chemical Constituents
1.	High grade(lumps, fines & blue dust)	Fe : 65% and above SiO_2 : 2% (max) Al_2O_3 : 2% (max)
2.	Medium grade (lump, fines & blue dust)	Fe : 62 to 65% SiO_2 : 3% (max) Al_2O_3 : 3% (max) P : 0.1% (max)
3.	Low grade (lump, fines & blue dust)	Fe : 60 to 62% SiO_2 : 4.5% (max) Al_2O_3 : 4% (max) P : 0.1% (max)
4.	Unclassified	The range of minimum & maximum value of chemical constituents is too wide to be fitted into any of the above grade.
5.	Not known	The information on chemical analysis is not available or potential/actual use is not known.
6.	Black Iron ore	Haematite containing 10% manganese.
7.	Others	Estimation for marketable grades which could not be classified into the above grades.

***Source**: Indian Bureau of Mines*

Table 5.4: End-Use Grade Classification on the Basis of Chemical Constituents of Magnetite

S. No.	Grade	Requirement
1.	Metallurgical	Average (+) 38% Fe oxidised, weathered ore for making concentrates
2.	Coal Washery	64% Fe (minimum)
3.	Foundary	Actual use reported by exploitation agencies.
4.	Unclassified	Minimum & maximum range of value of chemical constituents are too wide to be fitted into any of the above grades and /or data on breakup of oxidised or unoxidised ore, resources are not available.
5.	Not known	The information on chemical constitutents is not available or potential/actual use is not reported.
6.	Others	Those grades, which could not be classified into the above grades.

Source: Indian Bureau of Mines

Based on the above classifications (UNFC and End-use grade) the NMI on iron ore has been prepared. The Total Resources (Reserves and Remaining Resources) of iron ore (haematite and magnetite) are discussed below:

As per the United Nations Framework Classification (UNFC) of mineral resources, the total iron ore resources in the country as on 1.4.2005 is placed at 25,250 million tonnes. Out of the total resources, haematite and magnetite are placed at 14,630.39 million tonnes and 10,619.48 million tonnes, respectively. However, the total reserves of haematite and magnetite are confined to the tune of 7,004.17 million tonnes and 58.50 million tonnes, respectively. The remaining resources of haematite and magnetite are placed at 7,626.22 million tonnes and 10,560.98 million tonnes, respectively. The gradewise, categorywise and statewise resources of haematite and magnetite are given in Annexures 15 and 16, respectively and summarised in Table 5.5.

Table 5.5: Total Resources of Iron Ore in India as on 1.4.2005

(In million tonnes)

Iron Ore	Total Reserves	Total Remaining Resources	Total Resources
1. Haematite	7,004.17	7,626.22	14,630.39
2. Magnetite	58.50	10,560.98	10,619.48
Total	**7,062.67**	**18,187.20**	**25249.87**

Source: Indian Bureau of Mines

As per the above Table/cited Annexures, the salient features of the NMI of iron ore (haematite and magnetite) as on 1.4.2005 are as below:

Haematite

1. Out of 14,630 million tonnes of total resources of haematite, the reserves are 7,004 million tonnes (47.87%) and the remaining resources are 7,626 million tonnes (52.13%).
2. Out of 7,004 million tonnes of haematite reserves, 4,945 million tonnes are in proved category and 2,059 million tonnes in probable category.

Out of 7,626 million tonnes of the remaining resources, feasible resources, prefeasible resources, measured resources, indicated resources and inferred resources are placed at 178 million tonnes, 369 million tonnes, 492 million tonnes, 1,032 million tonnes and 4,022 million tonnes, respectively. Besides, there are 1,534 million tonnes of reconnaissance resources.

3. Haematite in the country occurs in different grades in lumps and fines forms. Out of 7,004 million tonnes of the total reserves, high, medium, low and other grades account for 1,304 million tonnes, 3,544 million tonnes, 1,989 million tonnes and 166 million tonnes, respectively.
4. Bulk of reserves of haematite about 2,494 million tonnes are located in Jharkhand followed by Orissa 2,252 million tonnes, Chhattisgarh 761 million tonnes, Karnataka 940 million tonnes and Goa 459 million tonnes. Andhra Pradesh, Madhya Pradesh, Maharashtra and Rajasthan are the other States with minor amount of reserves.
5. It is estimated that the country has 1,304 million tonnes of high-grade and 3,544 million tonnes of medium-grade reserves of haematite, which are in great demand at present. Reserves of low and other grades after beneficiation could qualitatively enhance the reserve base. Similarly, 7,626 million tonnes of remaining resources need further detailed exploration studies to convert them into reserves.

Magnetite

1. Out of the total 10,619 million tonnes resources of magnetite, the total reserves are 58.50 million tonnes (0.6%), and the remaining resources are 10,561 million tonnes (99%). Out of 58.50 million tonnes of magnetite reserves, 14 million tonnes are in proved category and 44 million tonnes in possible category. Out of 10,561 million tonnes of remaining resources, feasibility resources are 173 million tonnes; pre-feasibility resources are 34.6 million tonnes; measured resources are 1,625 million tonnes; indicated resources are 1,878 million tonnes; inferred resources are 6,281 million tonnes; and reconnaissance resources are 569 million tonnes, respectively.
2. Magnetite reserves are graded into metallurgical 0.69 million tonnes (1.18%), coal washery 3.33 million tonnes (5.69%) and unclassified grade 52.64 million tonnes (89.97%). Goa with 50 million tonnes and Jharkhand with 3.4 million tonnes are the two major States with established reserves of magnetite. Further, Goa alone accounts for 11 million tonnes of magnetite reserves under proved category.
3. It is estimated that the country has 0.69 million tonnes of metallurgical grade and 3.33 million tonnes of coal washery grade reserves of magnetite and these grades are in great demand. Further, the unclassified grade reserves could be made usable by carrying out detailed R & D studies.
4. It is also analysed that 99.4% of the magnetite resources in the country are yet to be converted into reserves and it needs a greater deal of efforts by exploration and R&D institutions.

Scope for Resource Augmentation

The average Fe cut-off considered for estimation of iron ore resources is 55 percent. However, technological developments have led to use of low grade iron ore and in many of the countries iron ore with 45 percent Fe is being used. In view of this, there is a need to pre-assess the iron ore resources of the country with a cut-off of 45 percent Fe which may result in substantial augmentation of resources. Further, Banded Iron Formation (BIF), namely, Banded Haematite-Quartzite/Jasper and Banded Magnetite-Quartzite are other potential sources of iron ore since technology is available for extraction of iron ore from these BIFs. This demands concerted exploration for estimation of iron ore available in these BHQ/BHJ/BMQ.

PRODUCTION

Iron ore is one of the major important metallic minerals produced in India. Although the occurrences of iron ore are spread over in a number of States in India, the production of iron ore has been reported from about nine States. The prominent producing States are Jharkhand, Orissa, Chhattisgarh, Goa and Karnataka. The all-India production and value of iron ore during the thirteen years from 1993-94 to 2005-06; all-India gradewise, statewise production of iron ore during the six years starting from 2000-01 to 2005-06 and all-India gradewise, statewise & districtwise production of iron ore for 2003-04, 2004-05 and 2005-06 are given in Annexures 17, 18, 19, 20 and 21 respectively. As per the Annexures, the production trend of iron ore from 1993-94 to 2004-05 maintained an increasing gradient except for a slight decrease in 1998-99. The production of iron ore reached an all time high level of 154.43 million tonnes in 2005-06 from 59.64 million tonnes in 1993-94, recording more than two-fold increase. Orissa continued to be the major producing State of iron ore both in terms of quantity and value, accounting for 32% production in 2005-06. The contribution of other iron ore producing States are Karnataka (22%), Chhattisgarh & Goa (16% each), Jharkhand (11%) and the remaining (3%) by Andhra Pradesh, Maharashtra, Madhya Pradesh and Rajasthan.

The production of iron ore is reported in three physical forms according to size and processing of iron ore. These forms are (i) Lumps, (ii) Fines and (iii) Concentrates. All iron ore producing States report production of

Table 5.6: All India Iron Ore Production & Percentage of Lumps, Fines and Concentrates during 2000-01 to 2005-06

(Quantity in '000 tonnes)

Forms	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Total	**80,762**	**86,226**	**99,072**	**122,838**	**145,942**	**154,436**
Lumps	33,567(42%)	34,572 (40%)	39,581 (40%)	48,959(39%)	58,152(40%)	62,643(41%)
Fines	41,189(51%)	45,224 (52%)	52,994 (54%)	67,680(56%)	82,537(56%)	87,900(57%)
Concentrates	6,006(7%)	6,430 (8%)	6,497 (6%)	6,199(5%)	5,253(4%)	3,893(2%)

Source: Indian Bureau of Mines

lumps and fines. Only Karnataka and Goa report production of concentrates. The production and percentage of iron ore lumps, fines and concentrates during 2000-01 to 2005-06 are given in Table 5.6. The production of iron ore during 2005-06 was 154 million tonnes, out of which lumps were 62.6 million tonnes, fines 87.9 million tonnes and concentrates 3.9 million tonnes.

It is evident from the above Table that although the quantum of production of iron ore lumps registered an increase, the percentage share of lumps produced in the above years was more or less static around 40%. In the same period, the percentage share of fines produced slowly rose from 51% to 56% and that of concentrates produced showed a steady decrease from 8% in 2001-02 to 2% in 2005-06. The cause of this dwindling production of concentrates is due to the closure of KIOCL whose iron ore mining activity was put to halt for environmental reasons from 31 December 2005. KIOCL's major iron ore concentrates producing plant at Kudremukh also suffered closure. However, it is understood that Union Government has decided to allot iron ore from Donimalai deposits to Mangalore Pellet Plant of KIOCL, to produce 3.5–3.7 million tonnes of pellets/year. Arrangements have also been made to transport fine ore by train from Bellary-Hospet region to the Pellet Plant at Mangalore. KIOCL has installed three grinding facilities at the Mangalore Pellet Plant to crush the iron ore received from Bellary sector. The grinding mill can process 15,000 tpd of fines below 10 mm size to produce 12,000 tpd pellet feed. The cost of pellet production is bound to shoot up due to additional cost incurred as a result of transportation of iron ore by train from Bellary. This alternative arrangements for supply of iron ore have been made to keep the pellet production at Mangalore facilities at bay.

Lumps and Fines

The lumps and fines are further classified into different grades based on their Fe contents. The iron ore lumps are classified into four grades. These grades are Fe content below 60%, Fe content from 60 to 62%, Fe content from 62 to 65% and Fe content above 65 percent. Similarly, iron ore fines are classified into three grades. These grades are Fe content below 62%, Fe content from 62 to 65% and Fe content above 65 percent. Production of various grades of lumps, fines and concentrates for the years 2000-01 to 2005-06 is given in Annexure-18 and discussed below:

In the year 2000-01, gradewise analysis revealed that out of the total output of 80.76 million tonnes, iron ore lumps constituted 33.56 million tonnes, i.e., about 42%, fines constituted 41.19 million tonnes, i.e., about 51% and concentrates constituted 6.0 million tonnes, i.e., about 7%. Of the total output of iron ore lumps, 16.32 million tonnes or 49% was of grade 65% Fe & above, 11.31 million tonnes or 34% was of grade 62 to 65% Fe, 4.07 million tonnes or 12% of grade 60 to 62% Fe and the rest 1.87 million tonnes or about 5% production was of grade below 60% Fe. In the case of iron ore fines, 14.84 million tonnes or 36% of the production was of grade 65% Fe & above, 19.26 million tonnes or 47% of grade 62 to 65% Fe and the balance 7.08 million tonnes or about 17% was of grade below 62% Fe. The grade of iron ore concentrates produced in Karnataka and Goa was above 67% Fe.

In the year 2001-02, gradewise analysis revealed that out of the total output of 86.23 million tonnes, iron ore lumps constituted 34.57 million tonnes, i.e., about 40%, fines constituted 45.22 million tonnes, i.e., about 52% and concentrates constituted 6.4 million tonnes, i.e., about 8%. Of the total output of iron ore lumps, 19.70 million tonnes or 57% was of grade 65% Fe & above, 9.53 million tonnes or 28% of grade 62 to 65% Fe, 3.01 million tonnes or 9% of grade 60 to 62% Fe and the rest 2.33 million tonnes or about 6% production was of grade below 60% Fe. In the case of iron ore fines, 15.96 million tonnes or 35% of the production was of grade 65% Fe & above, 20.06 million tonnes or 44% of grade 62 to 65% Fe and the balance 9.20 million tonnes or about 21% was of grade below 62% Fe.

In the year 2002-03, gradewise analysis of the year's output revealed that out of the total output of 99.07 million tonnes, iron ore lumps constituted 39.58 million tonnes, i.e., about 40%, fines constituted 53.0 million tonnes, i.e., about 53% and concentrates constituted 6.5 million tonnes; i.e., about 7%. Of the total output of iron ore lumps, 22.34 million tonnes or 56% was of grade 65% Fe & above, 11.91 million tonnes or 30% of grade 62 to 65% Fe, 3.23 million tonnes or 8% of grade above 60% and below 62% Fe and the rest 2.1 million tonnes or about 6% production was of grade below 60% Fe. In the case of iron ore fines, 18.84 million tonnes or 36% of the production was of grade 65% Fe & above, 23.96 million tonnes or 45% of grade 62 to 65% Fe and the balance 10.20 million tonnes or about 19% was of grade below 62% Fe.

In the year 2003-04, gradewise analysis revealed that out of the total output of 122.84 million tonnes, iron ore lumps constituted 49 million tonnes, i.e., about 40%, fines constituted 67.68 million tonnes, i.e., about 55% and concentrates constituted 6.2 million tonnes, i.e., about 5%. Of the total output of iron ore lumps, 26.4 million tonnes or 54% was of grade 65% Fe & above, 16.56 million tonnes or 33% of grade 62 to 65% Fe, 3.23 million tonnes or 7% of grade 60 to 62% Fe and 2.74 million tonnes or about 6% production was of grade below 60% Fe. In the case of iron ore fines, 22.5 million tonnes or 33% of the production was of grade 65% Fe & above, 31.42 million tonnes or 46% of grade 62 to 65% Fe and the balance 13.74 million tonnes or about 20% was of grade below 62% Fe.

In the year 2004-05, gradewise analysis reveals that out of the total output of 145.9 million tonnes, iron ore lumps constituted 58.2 million tonnes or about 40%, fines 82.5 million tonnes or about 56% and concentrates 5.2 million tonnes or about 4%. Of the total output of iron ore lumps, 30.1 million tonnes or 52% was of grade 65% Fe & above, 19.8 million tonnes or

34% of grade 62 to 65% Fe, 4.4 million tonnes or 7% of grade 60 to 62% Fe and the rest 3.8 million tonnes or about 7% of the production was of grade below 60% Fe. In the case of iron ore fines, 25.8 million tonnes or 31% of the production was of grade 65% Fe & above, 37.4 million tonnes or 45% of grade 62 to 65% Fe and the balance 19.4 million tonnes or about 24% of grade below 62% Fe.

In the year 2005-06, gradewise analysis reveals that out of the total output of 154.4 million tonnes, iron ore lumps constituted 62.6 million tonnes or about 40.5%, fines constituted 87.9 million tonnes or 57% and concentrates constituted 3.9 million tonnes or 2.5 percent. Of the total output of iron ore lumps, 31.9 million tonnes or 51% was of grade 65% Fe & above, 22.2 million tonnes or 36% of grade 62-65% Fe, 4 million tonnes or 6% of grade 60-62% Fe and the balance 4 million tonnes or 7% was of grade below 60% Fe. In the case of iron ore fines, 21.2 million tonnes or 24% was of grade 65% Fe & above, 47.2 million tonnes or 54% of grade 62-65% Fe and the balance 19.4 million tonnes or 22% was of grade below 62% Fe.

From the above analysis, it is inferred that the production of high-grade iron ore, i.e., 65% & above Fe content is on the rise as compared to that of the lower grades. As analysed in the resources section in this chapter, the reserves of high-grade iron ore (lump and fines) are limited. Hence, it is imperative that definite positive steps towards conservation of the high-grade iron ore must be taken and alternatively the iron ore of lower grade should be beneficiated and upgraded to meet the domestic as well as foreign demands of high-grade iron ore (i.e., with 65% & above Fe content).

Concentrates

Concentrates are enriched ores produced after removal of waste materials from iron ore. Beneficiation of iron ore is being carried out at number of beneficiation plants in the country. The proportions of different products are generally lumps about 50% of the feed, fines 30-35% and slimes nearly 15-20% of the feed. The proportion of lump and fines changes according to the nature of mined ore fed to the plants.

It is estimated that there is nearly 125 million tonnes of accumulated unutilised fines stacked at various mines and generation of about 8 million tonnes of slimes (below 0.2 mm) annually containing 48-60% Fe that are lost as tailings in beneficiation/washing plants. For utilisation of these wastes, combinations of various beneficiation processes have been adopted by different organisations – IBM, NML, RRL etc. – which are discussed under the Section on "Beneficiation". The feed grades are generally low-grade iron ore lumps and fines. The combination of various beneficiation processes has produced satisfactory Fe percentage in the yield.

The All-India production of iron ore concentrates starting from 1993-94 to 2005-06 is given in Annexure-17. All-India statewise & gradewise production for the last six years starting from 2000-01 to 2005-06 and sectorwise, statewise, districtwise & gradewise production from 2003-04 to 2005-06 are given in Annexures 18, 19, 20 and 21 respectively. From Annexure-17, it is observed that there has been a fluctuating trend in production of concentrates during the six years from 2000-01 to 2005-06. In 2000-01, production of concentrates of iron was 6,006 thousand tonnes which increased to 6,430 thousand tonnes in 2001-02 and further to 6,497 thousand tonnes in 2002-03. The production of concentrates of iron decreased to 6,199 thousand tonnes in 2003-04 and further decreased to 3,893 thousand tonnes in 2005-06. The share of public sector in the production of concentrates (Annexure-18) during 2000-01, 2001-02, 2002-03, 2003-04 and 2004-05 was 5,000 thousand tonnes (83%), 5,410 thousand tonnes (84 %), 5,532 thousand tonnes (85%), 5,090 thousand tonnes (82%) and 4,350 thousand tonnes (83%) respectively. Iron ore concentrates are produced by Public Sector in Karnataka and by Private Sector in Goa. During 2005-06, the share of public sector was 75 percent.

It is also inferred that concentrates are produced from magnetite-rich areas and that there is significant scope for production of concentrates from haematite-rich areas as well where high-grade fines are lying unutilised.

Districtwise and Statewise Production

Production of iron ore is reported from States viz. Orissa, Karnataka, Chhattisgarh, Goa, Jharkhand, Andhra Pradesh, Maharashtra, Madhya Pradesh and Rajasthan. In 2005-06, five States viz. Orissa, Karnataka, Chhattisgarh, Goa and Jharkhand were the major iron ore producing states contributing 96.79% of the total production. The remaining 3.21% was contributed by other States. Among the leading iron ore producing States, Orissa recorded the highest production of 49.88 million tonnes or about 32% of the country's production in 2005-06. Karnataka attained the second place with a production of 33.67 million tonnes or about 22%, followed by Chhattisgarh 24.75 million tonnes or 16%, Goa 23.74 million tonnes or 15% and Jharkhand 17.43 million tonnes or 12 percent. Besides, about 4.9 million tonnes or 3% of iron ore production was also reported from the States of Andhra Pradesh, Madhya Pradesh, Maharashtra and Rajasthan.

The statewise and districtwise production of iron ore of the 5 major producing States is given in Annexure-18 and discussed below:

Orissa

Orissa with 49.88 million tonnes of iron ore production in 2005-06 was the largest producing State in India. The production of iron ore increased by 19.47% as compared to 41.75 million tonnes reported in the previous year. Eighty-one mines reported production in the State. Keonjhar with 50 mines was major producing district. The production in Keonjhar district in 2005-06 was 39.21 million tonnes, which increased by 16.17% over 33.75 million tonnes reported in the previous year. Second major producing district was Sundargarh with a production of 10.4 million tonnes from 24 mines followed by Mayurbhanj with 0.3 million tonnes of production from 7 mines. The major mines producing iron ore in the State were Bolani iron ore mines of SAIL, Daitari iron ore mines of M/s OMC Ltd., Joda iron ore mines of M/s TISCO Ltd., etc.

Karnataka

Karnataka was the second largest iron ore producing State that reported production of 33.67 million tonnes of iron ore during 2005-06. This was 11.30% lower than 37.96 million tonnes reported in the previous year. There were 72 mines in 5 districts that reported production in 2005-06. Bellary was the leading iron ore producing district. The district has produced 26.10 million tonnes from 54 mines and reported a decrease in production of 9.8% from 28.9 million tonnes in the previous year. Donimalai iron ore mines operated by M/s National Mineral Development Corporation Ltd was the largest producing mine in the district reporting 5 million tonnes of iron ore in 2005-06. Chikmagalur was the second major producing district in Karnataka with 2.9 million tonnes from a single mine followed by Chitradurga 2.45 million tonnes from 6 mines, Bagalkote 1.15 million tonnes from 2 mines and Tumkur 1.1 million tonnes from 9 mines. The major magnetite producing Kudremukh Iron ore mine of M/s KIOCL in Chikmagalur district was closed in December, 2005 for environmental reasons.

Chhattisgarh

Chhattisgarh reported production of 24.75 million tonnes in 2005-06 from 12 mines located in 4 districts, viz. Dantewada, Durg, Kanker and Rajnandgaon. Largest producing district was Dantewada with 17.5 million tonnes from 3 mines followed by Durg 6.96 million tonnes from 5 mines and the remaining 0.27 million tonnes from 4 mines was contributed by Rajnandgaon & Kanker districts. The production of 17.5 million tonnes in Dantewada district is reported from 3 mines belonging to Bailadila deposit operated by M/s National Mineral Development Corporation Ltd. The district reported an increase of 9.3% in the production over the previous year (16.03 million tonnes). The major mines reporting production from Durg district were Dalli & Rajhara mines of SAIL. Production from Durg district was static at 6.9 million tonnes during 2004-05 and 2005-06.

Goa

Goa is another important iron ore producing State. Most of the iron ore produced in this State is being exported from Mormugao and Panjim ports. The production reported from this State comes from 63 mines located in two districts viz.. North Goa and South Goa. The production of iron ore in the State showed an increase of 4.7% from 22.67 million tonnes in 2004-05 to 23.74 million tonnes in 2005-06. The North Goa district contributed 57.41% (13.63 million tonnes) from 29 mines and South Goa contributed remaining 42.59% (10.11 million tonnes) from 34 mines. The major mines reporting production in the State were

Bicholim Group of mines of M/s Dempo Mining Corporation, Surla iron ore mines of M/s V.M. Salgaonkar Bros. Pvt. Ltd and Gurumel iron ore mines of M/s Sesa Goa Ltd.

Jharkhand

Jharkhand is also an important iron ore producing State. The iron ore production in Jharkhand during 2005-06 was 17.43 million tonnes. Singhbhum West reported production of iron ore from 15 mines and is the only producing district in Jharkhand.

Jharkhand showed an increase of 4.2% in the production from 16.72 million tonnes in 2004-05 to 17.43 million tonnes in 2005-06. The major mines producing iron ore in the State are Gua iron ore mines of M/s IISCO, Noamundi iron ore mines of M/s TISCO, Kiriburu & Megahataburu iron ore mines of M/s SAIL, etc.

Production Capacity

The present total production capacity of iron ore in India is more than 154 million tonnes. There are 261 mines that reported production in 2005-06. Out of these, 41 mines are operated by public sector (contributing 38% production, i.e., 58.80 million tonnes) and 220 mines are operated by private sector (contributing 62% production, i.e., 95.6 millon tonnes). Among 41 public sector iron ore mines, 17 mines (5 mines in Chhattisgarh, 4 mines in Karnataka, 5 mines in Orissa and 3 in Jharkhand), each producing more than one million tonne annually accounted for 91% output in public sector and of 35% of the total production in the country in 2005-06. Out of 220 mines in private sector, 21 mines (8 mines in Orissa, 6 mines in Goa, 5 in Karnataka and 1 each in Andhra Pradesh and Jharkhand), each producing more than one million tonnes annually accounted for about 54% output of private sector and about 34% of the country's production. Thus, 38 mines, each producing more than one million tonnes of iron ore annually, contributed about 69% of the total output in 2005-06 in the country. The names of major companies reporting production above one million tonnes per annum in both the sectors are given in Annexure-22.

As far as captive mines are concerned, there are 21 captive mines in the country. Out of these captive mines, 15 are in the public sector and the remaining 6 are in private sector. Production of captive mines in the public sector in 2005-06 is 23.8 million tonnes or 40% sectoral output. On the other hand, production from captive mines in private sector is only 11.3 million tonnes or 12% output in private sector.

It is important to mention here that some of the major producers listed in Annexure-22 have more capacity to produce iron ore, if the mining problems faced by these companies, such as, machinery, labour, environmental etc. are overcome.

Mining

Mining of iron ore is carried out by opencast method. Depending upon the level of mechanisation, mining can be classified into three categories — 1. Manual, 2. Semi-mechanised, and 3. Mechanised. Manual mines and Semi-mechanised mines are mainly operated in private sector. Large mechanised mines are mostly operated in public sector. Some mechanised mines in Goa, Jharkhand and Orissa are also operated by the private sector.

During mining operation, initially the overburden is removed for exposure of iron ore bodies. The removal of overburden is carried out manually at manually-operated mines. If the overburden consists of hard lateritic ore, then drilling and blasting are carried out after which the overburden is removed either manually or by adopting suitable mechanised system. In the case of the mechanised mines, overburden removal is carried out with the help of suitable machines. If possible, separate machines are utilised for ore extraction and overburden removal.

1. Manual Mining

Generally, these mines are confined to float ores where mining is done by digging with picks, crowbars and spades. The mined material is screened manually to separate + 10 mm float ore which is then stacked separately. The waste is thrown back into the pits. In some reef workings, holes of 0.6 m deep and 35–40 mm diameter are drilled by hand-held jackhammers at a spacing of about 0.6 m and each hole is charged with 150–200 g gunpowder or special gelatin cartridges. Blasted tonnage/kg is usually 2.5–3 tonnes of iron ore. Blasted ore is manually loaded into trucks to transport to either railway sidings or to buyer's destination directly. Cost of mining and output per manshift (OMS) varies from mine to mine. Output per manshift (OMS) is normally 1.5 to 2 tonnes.

2. Semi-mechanised Mining

In a number of mines, mining operations are carried out by semi-mechanised method. The overburdens are removed manually as well as by use of suitable machines. Generally, semi-mechanised methods are adopted in pocket type or bouldery deposits. The pocket type or boulder deposits of iron ores are handled manually to avoid wastage of minerals whereas machines are generally engaged for removal of overburden. Wherever iron ore occurs in small pockets or lenses of boulder or as segregation in murrum and laterite, it is difficult to mechanise the mining operation.

3. Mechanised Mining

Most of the fully mechanised mines are captive mines of different steel plants and have been developed to meet their requirements. Mining is done by formation of systematic benches in overburden and ore. The height of the ore benches normally varies from 10 m to 12 m and width up to 20 m in the ore. Holes are usually drilled up to 300 mm diameter and 12 m depth by crawler drills and explosives, such as, ANFO, SMS and emulsion explosives are used for blasting. Loading is done by earth moving machinery powered by diesel or electric engines, such as, hydraulic excavators in the range from 1.9 to 10 cu. m. Ripper-dozers and motor-graders are also deployed for excavation and levelling purposes. Up to 120 tonnes capacity dumpers/trucks/tippers are deployed in mines like Kudremukh for transportation.

In some of the Goan mines, hydraulic shovels with boom height of 9 m are used for excavation and loading. Heights of the benches are restricted up to 7 m for efficient operations. Widths of working benches are maintained at more than 15 m and bench slope is maintained at about 80°. The ore thus produced is transported to short distances by dumpers up to 40 tonnes capacity. For longer distances and barge loading, dumpers up to 10 tonnes capacity are used. The barges carry the ore to harbours. The ore from barges is loaded on to ships either through berth or through transshipers.

Almost all the public sector mines which include Kiruburu, Barsua, Gua, Bailadila, Donimalai, Kudremukh, Daitari & Dalli-Rajhara operated by various undertakings, such as, SAIL, NMDC, OMC & KIOCL are fully mechanised. In private sector, mines operated in Goa region and TISCO's captive mines in Jharkhand and Orissa are mechanised. Approximately, 90% iron ore production comes from mechanised mines.

The processing of iron ore in the country involves crushing, screening, washing and in some cases beneficiation and agglomeration. Crushing and screening are adopted mainly for sizing the ore and also for removing the adherent gangue minerals. Dry and wet grinding are also resorted to in some cases.

The lumps and fines of iron ore are marketed after washing, screening and beneficiation. The ores in the form of fines or blue dust generated in the mines are not subjected to washing, as there may be heavy slime losses. So for these fines washing & beneficiation are bypassed and they are routed to stockpile or for despatch in dry condition through separate belt conveyers provided for this purpose. Iron ore fines are converted into sinters for use in steel plants while pellets are made from concentrates/fines.

Mining Problems

Mining and beneficiation of ores carried out at large scale causes environmental problems. These activities cause a variety of environmental impacts which contribute towards degradation of environment as a whole. Environmental degradation starts with the extraction of minerals resulting in land degradation and addition of pollutants to air and water as a result of beneficiation and processing of minerals. A specific problem exclusive to iron ore mining is disposal of tailings and other deleterious silica minerals and phosphorus. Environmental management and pollution control activities are considered on top priority in most of the big mining companies. To keep the environment clean and for ecological protection, thrust on various aspects, such as, green belt development by plantation of trees on old waste dumps and unutilised area of the lease, solid waste management, monitoring of liquid & air effluents for various environmental parameters were mooted.

Goa region is prone to siltation of agricultural fields, nallahs, river beds and creeks due to wash off from iron ore dumps in rainy season. Loss of crop yield, reduction in fish population in streams and navigation difficulties are the problems due to silting. To overcome the problems, check dams and water filter beds at higher contours have been constructed. Tailing ponds are also being maintained at some mines. Afforestation is the main activity in reclaiming the mined areas in Goa. In a few cases, pits are used as water reservoir for pisciculture.

In Bellary-Hospet area in Karnataka, dust concentration (suspended particulate matters) pose huge environmental concerns. In Bailadila sector, Chhattisgarh, degradation of forest – which earlier was fairly widespread and dense with rich flora & fauna – is a major concern. These problems need to be addressed. Measures to compensate by afforestation at suitable slopes and township areas affected by deforestation due to mining and waste dumping need to be implemented and enforced. In Jharkhand sector, afforestation of land is the main strategy adopted for reclamation of degraded lands and its restoration.

The mining of iron ore in Orissa has triggered environmental concerns. The iron ore waste dumps washed out from dumping site of the mines in rainy season is the prime cause for siltation in agricultural land, nallahs and riverbeds. Siltation and pollution are threats to the environment, which affect life cycles of living organisms. The loss of flora & fauna due to mining in mine areas as well as downstream side of the mines has to be checked. Tailing dams have been constructed to overcome these problems. Plantation of trees in degraded land is one of the viable means to protect the environment.

BENEFICIATION

Beneficiation is a process in which iron ores are brought up to a desired level of improvement in their quality after removal of gangue materials (i.e., unwanted materials like SiO_2, Al_2O_3, S, P, etc.). The main purpose is to utilise low grade iron ore by upgrading it to the desirable level. This is very important with respect to conservation of minerals as the minerals are non-renewable. In most of the iron ore mines bulk and selective mining are done to obtain high-grade lumps. The low-grade ores are stacked separately. The mined-out high-grade ores are treated in beneficiation plants, in a dry or wet circuit, to obtain calibrated lumps, and to reduce alumina and silica. The dry circuit comprises, crushing and screening while the wet circuit consists of crushing, scrubbing, wet screening and classification (recovery of fine iron ore by classifier). The alumina and silica mostly contributed by lateritic and clayey matters are removed during beneficiation process. If SiO_2 and Al_2O_3 contents in iron ore are more than permissible limit, extra fuel will have to be expended for converting SiO_2 to slag, and similarly extra flux will be required for converting Al_2O_3 to slag in the blast furnace. The presence of high alumina in the blast furnace feed, results in highly viscous slag which requires high quantity of fluxes and in turn results in an increase in CO and coke consumption and decrease in blast furnace productivity due to generation of large quantity of slag volume. So upgradation of Fe content & reduction of SiO_2 and Al_2O_3 in iron ore through beneficiation are compulsory to optimise CO and coke requirements and curtail manufacturing cost of iron. Blending of iron ore obtained from a single source or homogenisation of the blended ores received from different sources are also carried out before feeding in the blast furnace.

The Indian iron ores (haematite ores) are relatively rich in iron content (about 58% Fe & above) but contain high impurities particularly alumina (varying from 1–7%) and silica. The beneficiated products obtained are:

1. Caliberated lumps generally of 16–40 mm size,
2. Classifier sand between 0.15 to 10 mm (as sinter feed),
3. Classifier fines and slimes (below 0.15 mm).

In order to improve the economics of iron and steel production only high quality iron ore with as low alumina as possible need to be used in the blast furnace and this can be achieved through beneficiation of iron ore.

The beneficiation process includes various activities like:

1. Washing & Wet Scrubbing
2. Gravity separation
   a) Heavy media separation
   b) Spiralling
   c) Jigging
   d) Reichert Cone Concentrator
   e) Multi-gravity Separator
3. Magnetic Separator
   a) Low intensity separator
   b) High intensity separator
4. Roasting followed by magnetic separation
5. Electrostatic separation
6. Froth floatation
7. Selective flocculation Desliming-cum-froth floatation
8. Column floatation
9. Agglomeration
10. Briquetting
11. Sintering
    a) Use of fine quartz & serpentine
    b) Addition of quick lime in the sinter mix
    c) Deep bed sintering

   d) Double layer sintering
   e) Improved ignition condition
   f) Heat recovery from exhaust gases
   g) Step-by-Step ore sintering process
12. Pelletisation
   a) Feed preparation
   b) Balling
   c) Hardening (induration)
   d) Vertical shaft furnace
   e) Travelling (straight Grate) furnace
   f) Grate kiln furnace.

Beneficiation actually involves the stages from washing & wet scrubbing to column floatation activities whereas agglomeration to pelletisation are stages carried out for preparation of blast furnace feed from iron ore fines. All these activities are briefly explained below:

1. Washing & Wet Scrubbing

Washing & wet scrubbing and screening are done to obtain coarse and clean iron ore concentrates. By washing & wet scrubbing, the silica (SiO_2) and alumina (Al_2O_3) percentage in the iron ore are reduced. Screen undersize is normally fed to mechanical classifiers. The processing of iron ores from many deposits of Jharkhand, Goa, Chhattisgarh, Orissa etc. in India comes under this category of treatment.

2. Gravity Separation

The common iron ore minerals have usually high specific gravity (haematite: 5.1, magnetite : 5.2, as compared to the most common associated gangue minerals like quartz and chert (2.65), and calcite or limestone (2.7 to 2.75). If iron minerals are associated with gangue minerals (waste rocks), they can be separated by various gravity methods. Proper feed preparation is an important step of gravity separation. The feed preparation may include (i) crushing and grinding of mineral up to a feed of proper size as specified for the particular machine, (ii) removal of slimes to increase the viscosity of the pulp and (iii) proper sizing of crude fractions before subsequent treatment. The important gravity separation methods are:

a) Heavy-media Separation

For coarse ore (-50 mm + 3 mm), heavy-media separators using ferro-silicon suspension in a rotary drum (spiral and drum-type vessels) are most commonly used. For fine ore (-3 mm + 28 mesh or up to 65 mesh), heavy media cyclones are used. The cyclone-type separator utilises centrifugal as well as gravitational force to make separation between ore and gangue minerals. Mostly material finer than 65 mesh size containing 50% (-200 mesh) is predominantly used in iron ore heavy-media separation. Ore in which iron mineral has a low apparent specific gravity is concentrated using a low specific gravity suspension 3- 3.1 for (–50 mm to +12 mm) feed and specific gravity of 2.7 to 2.8 for (–12 mm to + 3 mm) feed. When the iron mineral is hard haematite associated with non-porous high specific gravity gangue minerals, the specific gravity of suspension may be raised up to 3.45 for coarse fraction and 3.2 for fine fraction. When the ore feed contains both haematite and magnetite, it is necessary to separate magnetite prior to heavy-media separation.

b) Spiralling

Humphrey's spirals have wide range of applications in gravity treatment of iron ores. Since there are no moving parts in Humphrey's spirals and spirals of other make, the concentration is effected by water flow only. Feed to spirals should be in the range of (–20 to +150 mesh) and it is practically nil in case of 325 mesh feed. Spirals are normally operated at a pulp density of 25–30% solids and capacity of a spiral is in the range of 2–3.5 tph for a double start spiral depending upon fineness of the feed and nature of cleaning. Water requirement for treating one tonne of sample in roughing and cleaning stages is 5–10 gpm (gallon per minute) and 8–12 gpm, respectively.

c) Jigging

Jigging of iron ore is normally done at the feed size (-6 mm to + 65 mesh) suitable for treatment by HM cyclones. Iron ores are being processed by jigging at Barsua plant (India). The pulp density of the feed to the jig ranges between 25 and 35% solids, and jig loading is in the range of 0.6 to 0.8 tph per square feet of jig bed. Water requirements are 10–15 gpm per square feet of jig bed.

d) Reichert Cone Concentrator

It is a wet gravity-concentrating device designed for high capacity applications (60 to 100 tph). It accepts a high pulp density feed (35–70% solids) and can treat material from 3 mm to 30 microns and in no case finer than 20 microns.

e) Multi-gravity Separator (MGS)

The treatment of fines and ultra-fines poses problems in conventional gravity separators. A technique of gravity separator known as multi-gravity separator has been developed to recover very fine mineral particles up to 5 micron. This type of separator may be useful and favourable to Indian iron ore processing industry for the recovery of iron values from slimes and tailings in the coming years.

3. Magnetic Separation

Magnetic separators exploit the difference in magnetic properties of ore and gangue minerals and are used to separate valuable magnetic iron minerals from the non-magnetic associated gangue minerals. Magnetic separators are classified into low and high intensity machines which may be further subdivided into dry and wet separators. They are briefly discussed below:

a) *Low Intensity Separators*

When the economic iron ore mineral is magnetite, low intensity separators are almost invariably used. This is because the method is very cheap and effective. Rotary drum separators with permanent magnet or electromagnets are commonly used. The magnetic field in the concentration zone (50 mm from the shell of separator) is of the order of 1,000–2,000 gauss.

b) *High Intensity Separators*

High intensity magnetic separators are designed with a magnetic intensity of 7,000–20,000 gauss in the separation zone to recover feebly magnetic minerals like haematite. Wet high intensity magnetic separators (WHIMS) are generally used for treating haematitic and limonitic ores.

4. Roasting followed by Magnetic Separation

Non-magnetic iron ores (haematite, limonite and siderite) are rendered magnetic by roasting. Haematite and limonite when subjected to reduction by roasting to a temperature of 500-550 °C becomes strongly magnetic whereas siderite when roasted to a temperature of 700–775 °C in a neutral atmosphere becomes magnetic. To avoid reoxidation, such roasted ores are quenched in water. After roasting, the ore is ground to liberation size and subjected to low intensity magnetic separation. Roasting makes the ore very weak and therefore requires less energy for grinding. This technique is not employed nowadays to process iron ores in commercial scale.

5. Electrostatic Separation

This type of separation is generally employed to produce high-grade concentrates. It works best on dry crystalline non-magnetic iron oxide minerals finer than 10 mesh and coarser than 325 mesh. The mineral surface should be entirely free from slimes and moisture.

6. Froth Floatation

Froth floatation is now used in a number of major iron ore processing plants in the world. For effective floatation, the feed should be finer than 65 mesh. Anionic flotation, employing fatty acid or petroleum sulphonate collectors is adopted to float out most of the iron oxide minerals leaving behind the gangue minerals (quartz and chert) in the tailings. Crystalline haematite, such as, specularite can be effectively floated. Anionic floatation is also resorted for selective floatation of apatite from iron ore by depressing iron minerals with starch. Cationic floatation using amine as collector is adopted for selective floatation of quartz from magnetic iron ore. Cationic floatation is generally done on a deslimed feed. The ground ore is conditioned with anionic collector (fatty acids) at high pulp density (70% solids). The temperature during conditioning is maintained around 45–60 °C. The cleaner concentrates assay 65.4% Fe with 46% yield by weight. The ore is upgraded by anionic floatation of iron minerals (haematite) under acidic medium using sodium petroleum sulphonate and fatty acid as collector. Magnetite is recovered by magnetic separation. The final concentrate assayed 64.4% Fe and 6.3% SiO_2 with 42.2 % yield by weight.

7. Selective Flocculation-Desliming-cum-Froth Floatation

This method is applied with where the main iron minerals, such as martite, goethite and haematite are intimately associated with chert and quartz—the predominant gangue minerals. The minor gangue minerals are silicates and carbonates. The average size of iron ore mineral grains is in the range of 10–25 micron. The process adopted for treating this type of ore comprises fine grinding to liberation size, selective flocculation of iron minerals, desliming of fine cherty materials and cationic floatation of coarse cherty minerals from the deslimed material. By adopting this process, a high grade concentrate assaying 65.6% Fe from a low-grade ore (Fe: 35.9%), with 70.2% Fe recovery (wt. % yield: 38.4) can be obtained.

8. Column Floatation

Column floatation has gained wide acceptance in iron ore processing industries because of its advantage over conventional cells as they are capable of producing high-grade concentrate with low capital and operating costs and greater selectivity against silica rejects in iron ore industry. Columns are effectively used in treating fine-grained concentrate during final cleaning stages.

9. Agglomeration

The high-grade ore fines and fine beneficiated concentrates are agglomerated to make it suitable for iron and steel making. Sintering, pelletisation and briquetting are the different processes being adopted for agglomerating iron ore fines.

10. Briquetting

Briquetting is defined as compaction of fine particles by application of high pressure in a more or less close mould to produce agglomerates of suitable size. It can be done hot or cold and with/without binder depending upon the nature of material. Briquettes are produced in the shape of pillow, egg, peanut and cylinder. The different stages of briquetting are feed preparation, pressing/compaction, curing and evaluation of quality of briquettes. The cold briquetting process is generally applied to agglomerate (-3 mm) sponge iron particles, while hot briquetting process is applied for agglomerating the entire quantity of material emerging from the gas-based direct reduction furnaces without using any binder. Hot briquetting is particularly applicable where it is necessary to store or transport sponge iron otherwise they are susceptible to re-oxidation and self-combustion. Most of the gas-based direct reduction plants all over the world including the one in India employ briquetting for agglomerating sponge iron fines.

11. Sintering

Plantwise capacity and production of sinters in India with consumption of iron ore is given in Annexure-23. Sintering has been the traditional method for agglomerating iron ore fines (-10 mm + 100 mesh). In this method, ore fines after mixing properly with mill scale, blue dust, return fines, coke breeze (-3 mm), flux (-3 mm lime, dolomite, olivine, serpentine, etc.) and moisture are charged into a fixed/continuous horizontal travelling grate and the top of the bed is ignited at high temperature (1200 to 1300 °C) by oil, or gas burners for a few minutes (10–20% of total sintering time). After that burners are shut off, air is continuously drawn downwards throughout the length of grade by suction fan so that flame front gradually travels down through the bed of the sinter mix. This combustion raises the temperature inside the bed to 1250–1600 °C depending upon the amount of fuel and suction developed. The iron minerals are reduced to FeO and it in turn combines with silica to form faylite ($2FeO.SiO_2$). Faylite melts at 1290 °C in the bed and thus wets the solid particles resulting in their binding into the bed and forming a strong agglomerate. The quantity of flux depends upon the gangue content of the ore and usually proportioning of the flux material is regulated to obtain self-fluxed or super-fluxed sinter ($CaO/SiO_2>2.0$). The flux addition in the sinter mix improves the physical quality of sinter. It also reduces the iron content of blast furnaces slag due to the presence of iron in sinter in more reducible form (oxides and ferrites). Use of self-fluxing sinter in blast eliminates the need to include raw limestone in the burden, an undesirable constituent that consumes a lot of heat. Use of super-fluxed sinter markedly improves its reducibility without affecting its strength. This is due to the presence of easily reducible calcium ferrites in large quantity instead of less reducible ferrous silicate (faylite).

Sinters are porous and brittle and therefore they cannot be transported over a long distance, as they cannot withstand the rigors of handling, i.e., repeated loading, unloading etc. That is why sinter plants are located close to the iron blast furnaces.

Before oil crisis, more emphasis was laid on producing sinter with better cold strength (SI: shatter index) and less degradation during reduction when the blast furnaces were operated with high ore/coke ratio (less coke) and high oil injection. Now the scenario has changed and blast furnaces are being operated with high coke and low oil injection. This has led to the production of highly reducible sinter with better high-temperature-properties. Sintering with low heat input is considered the best method to achieve the objectives in the changed scenario, i.e., better reducibility, less slag volume, good high-temperature-properties (softening, melting and dropping characteristics) and optimum SI. The following developments in sintering have played a significant role in achieving the objectives.

a) Use of Fine Quartz and Serpentine

When fine quartz and serpentine (-1 mm size) are incorporated in the sinter mix, slag formation rate speeds up and productivity and strength (SI) of sinter are improved and slag volume in the blast furnace is reduced.

b) Addition of Quick Lime in the Sinter Mix

Quick lime addition in sinter mix plays a great role in production of sinter with increasing calcium ferrite concentration with improved Low Temperature Breakage (LTB) resistance. Fine lime particles fuse and coat nucleus (1–5 mm) and medium size particles (0.25 mm to 1 mm) to form pseudo-particles. Due to addition of quick lime, the amount of pseudo-particles increases up to 30% from as low as 2% in the feed.

c) Deep-bed Sintering

Increase in bed depth from 350–400 mm to 600–650 mm has led to improvement in sinter productivity rate with low heat input. Nippon Steel Sintering operation and Tabato Sinter Plants in Japan increased bed depth by 125–150 mm to produce sinter of better quality with reduced coke breeze requirement by 5–10 kg/t of sinter. TISCO (India) also got similar results.

d) Double Layer Sintering

The world biggest sintering machine (effective grate area: 600 m^2) at Wakamatsu (Japan) employs double layer sintering process. Double layer sintering ensures good bed permeability and uniform sintering reaction throughout the bed. This has helped in increased productivity of good quality sinter with less fuel (coke breeze less by 4 kg/t) and also reduced air consumption (0.5 Nm^3/t) . M/s Wakamatsu is also said to be operating with high sinter bed depth (630 mm).

e) Improved Ignition Conditions

Sintering process is initiated by ignition of coke breeze on or near sinter mix surface at about 250–650 °C. Lack of oxygen in the fuel gas delays this ignition. A rapid ignition is necessary for optimum utilisation of sinter strand area and it is possible only with full combustion of coke. Increase in length of furnace hood by 10% of the strand, use of coke oven gas and oxygen-rich fuel (15–18% O_2) reduce fuel consumption, improve sinter productivity and increase shatter strength.

f) Heat Recovery from Exhaust Gases

The sintering process accounts for about 10% energy consumption of an integrated iron & steel plant. About 50% of the heat required for sintering is discharged into atmosphere in the form of waste gases (30% from hot air or sinter cooler +20% from waste gas). Kokura Steel work of Sumitomo Metal Industries, Japan, has developed a technology to recover heat from waste gas by sending them to heat exchangers and hot air from exchanger is utilised to increase sintering temperature. The exhaust air from cooler is utilised as preheating air for coke oven gas which also enriches its oxygen content. This type of heat recovery from exhaust gases could also be implemented in Indian steel plants.

g) Step-by-step Box Sintering Process

Small double layer sintering machines are prone to the problems of excessive air leakage, high-energy consumption and poor quality sinter production.

The step-by-step box sintering process developed in China provides solution to these problems. In this process, ore fines are sintered in a box. The sintering takes place in four stages. A loaded box is ignited and sintered at Ignition Sinter Position (ISP), then driven to cooling position, then moderate cooling position (MCP) and finally to discharging stage and thereafter ready for next loading. The ISP box is pushed forward to cooling position, and another loaded box occupies the ignite in cooling position instantly. In this way, continuous sinter production goes on. This method of sintering reduces energy consumption. In addition, capital cost is only 50% of the conventional double layer machine and high quality sinter is produced. It is mainly suitable for low capacity sinter plants.

12. Pelletisation

Plantwise capacity and production of pelletisation plants in India with consumption of iron ore is given in Annexure-24. The pelletisation process is the formation of green balls (12–15 mm) by rolling fine ground ore or concentrate (generally 60 to 65% –32.5 mesh size) with very small quantity of bentonite (as binder) and 8–10% moisture and hardening the green balls by heat treatment (drying, pre-heating and firing) under oxidising conditions up to a temperature of 1250–1350 °C. As a result, oxide bridging grain growth and slag binding occur and sufficient pellet strength is developed. The pellets are then cooled in air. Pelletisation thus produces agglomerates in highly oxidised state as opposed to sinters which contain 5–10% ferrous iron. Different steps involved in pelletisation are as follows:

a) Feed Preparation

In pelletising process, the production of good quality green balls assumes paramount importance for making good quality fired pellets. The major binding forces in balling are those due to surface tension of water and mechanical interlocking of particles on rolling. Any impurity present in the ore or hydrophobic floatation reagents, which reduce the surface tension of water pose problems in balling. The moisture content is also critical for the production of good quality green balls. Haematite, magnetite and limonite require about 8%, 9% and 13% moisture, respectively. The feed for balling should be finer than –65 mesh size containing at least 65% material finer than 325 mesh size. Specular haematite grains require even fine grinding sometimes up to 100% -325 mesh. In balling process, it is desirable to have minimum porosity in the green balls (25–30%).

b) Balling

Balling normally starts when fine ground material mixed with binder is moistened and balled by rolling. First, small pellets (seeds) are formed. These seeds then grow layer by layer and get compacted by rolling action, which reduces the size of the balls. Drums, discs and cones of different designs are used for balling. Drums are claimed to be the best for magnetite fines of beneficiated concentrates obtained by floatation/magnetic separation. The pellets/balls produced, being different in sizes need screening to separate undersize for recirculation back to the drums.

c) *Hardening (Induration)*

Though hardening or induration of green balls is then carried out in one equipment, it consists of four operations, namely, drying, pre-heating, firing and cooling. In case of magnetite pellets, a recuperation period between firing and cooling is introduced to ensure completion of exothermic oxidation of magnetite. Drying of pellets removes moisture and hardens the pellets to such an extent that they do not develop cracks in the subsequent operation. The induration cycle is adjusted in such a way that pellets of maximum strength are obtained with minimum fuel requirements. The induration of green pellet is generally done in any of the three furnaces, namely, vertical shafts, travelling grate and grate kiln.

d) *Vertical Shaft Furnace*

The shaft furnace was the earliest device used for pellet hardening. The shafts had an effective height of 15 m with 4.3 m x 1.8 m rectangular cross-section. The shaft furnace operates on the counter current flow principle, i.e., heat extracted from cooling of pellets is used for high temperature heating of pellets. Thermal efficiency of shaft furnace is high.

e) *Travelling (Straight Grate) Furnace*

The green pellets are charged into a travelling grate and subjected to drying, pre-heating, firing and cooling as they travel along the strand. Grate bars and side walls of pellets are protected by covering with layers of fired pellets. The induration cycle is flexible and drying, pre-heating and firing periods can be adjusted with ease to suit the needs of a particular material which is being pelletised. The heat is supplied by oil/gas burners in the hood. The hot air drawn from under firing section of the grate and also from above cooling section is used both to dry the green pellets and as combustion air for firing purpose. On a typical strand, 25% of the air is used for drying, 40% for pre-heating & firing and 35% for cooling. It is claimed that this type of furnace is more suitable for very large output (5 million tonnes/year from a single unit).

f) *Grate Kiln Furnace*

In this system, the green pellets are dried and pre-heated to about 1,000 °C on a travelling grate and then fired in a rotary kiln and finally cooled in a separate cooler. Hot gas from the kiln are used first to pre-heat the dried pellets after which it is repassed through the strand to dry green pellets. The pre-heated pellets are charged into a rotary kiln inclined at certain angle. An oil/gas-fired burner is set at discharge end of the kiln and pellets travel down the kiln by counter current to the combustion gases. The air from the hotter end of cooler is used as secondary air for the rotary kiln burner. A single grate kiln furnace can produce 200 tph of fired pellet.

R &D ACTIVITIES

Several R&D laboratories in India like Indian Bureau of Mines (IBM), Nagpur; Regional Research Laboratory (RRL), Bhubaneswar; National Metallurgical Laboratory (NML), Jamshedpur; etc. have undertaken studies to improve the quality of iron ore feed and to recover values from low-grade ores, fines and slimes. Investigations are conducted both on the basis of sponsorship and as R&D Project by these organisations.

The R&D studies on various types of samples collected from different mining areas yielded encouraging results. These studies were conducted with the following major objectives:

1. To increase iron content in lumps, to meet the specifications for blast furnace and DR iron making process.
2. To remove alumina and other gangue from lumps and fines (for sinter feed)
3. Recovery of iron ore values from tailings to meet the specifications for sintering and SR process of iron making (Romelt).
4. Utilisation of low-grade and marginal-grade ores for iron making.

Some of the salient and encouraging results of the studies undertaken by these organisations are discussed below:

1. Indian Bureau of Mines (IBM), Nagpur

The IBM carried out beneficiation studies for upgradation/utilisation of low-grade fines of iron ore, removal of gangue minerals, such as, silica, alumina, etc. and recovery of iron from classifier overflow, hydrocyclone overflow, tailing ponds and slimes. Some of the important investigations are discussed below:

a) The tests carried out on sub-grade iron ores/mine wastes and slimes from the mines of M/s Bandodkar Mines, Goa yielded encouraging results—upgradation of iron from 54.34% to 64.40% and reduction of silica from 16.18% to 3.68% were achieved. The process adopted included, jigging, tabling and magnetic separation. Nearly 50% of the iron by weight could be recovered from the waste dumps, to prepare good pellet feed.

b) The pilot plant tests were conducted on fines, waste dumps of Dalli-Rajhara (Chhattisgarh) and Gua Mines (Jharkhand)—upgradation of Fe content from 58% to 64% and reduction of alumina and silica from 4.76% to 2.00% and 7.05% to 2.5%, respectively were achieved. The process included, jigging and spiralling. The concentrates thus produced were suitable as sinter feed. Salient results of some of the important investigations carried out by IBM on iron ore, mine wastes and slimes sample are summarised in Annexures 25 and 26.

2. National Metallurgical Laboratory (NML), Jamshedpur

The National Metallurgical Laboratory (NML), Jamshedpur has carried out extensive beneficiation studies on iron ores from different parts of the country and developed suitable flow sheets for setting up the beneficiation plants. The tests were carried out on lumpy and fine ores both by dry and wet beneficiation techniques. The tests were conducted using modern equipment like, duplex concentrator, multi-gravity separator (MGS), wet high intensity magnetic separator (WHIMS), Bartles-Mozley separator and cross belt concentrator.

Heavy media separator, jigging and tabling studies were conducted to treat lumpy and fine ores, particularly, on ores from Joda, Noamundi and Bolani. The Barsua iron ore has beneficiation plant with a capacity of 900 tph wherein Wemco Rimmer jigs for treating -8 to +0.15mm material are deployed. NML carried out several beneficiation/investigations on iron ore fines and rejects for their better utilisation. Sintering studies were conducted on two iron ore samples from Panjim, Goa, the results of which indicated basicity of 2.0 ($CaO + MgO + Al_2O_3 + SiO_2$) and above as acceptable grade for Sinter with Tumbler index >75% with utilisation of an optimum level of coke breeze, moisture and return fines for both the sample at 5.0%, 7.0%, 2.5% and 5.25%, 7.0% and 1.25% respectively. Some of the investigations carried out by NML Jamshedpur are listed in Annexure-27.

3. Regional Research Laboratories (RRL), Bhubaneswar/ Bhopal

The Regional Research Laboratories at Bhubaneswar and Bhopal have carried out several beneficiation studies on iron ores to recover values from fines and lumps using latest gravity and magnetic separator methods.

Some iron ore samples were tested to remove alumina, using latest enhanced gravity methods, such as, Knelson Concentrator, Multi-gravity Separator and Kelsey Centrifugal Jig. These tests yielded encouraging results wherein upgradation of iron from 62.8% to 66% and reduction of alumina from 3.4% to 1.74% were achieved. These modern methods provide good scope for adoption in industrial applications.

In the recent past, Regional Research Laboratory, Bhubaneswar, had done extensive work on beneficiation of iron ore fines and slimes for their effective utilisation by reducing alumina and silica contents. A summary of the investigations carried out in the recent past by Regional Research Laboratory at Bhubaneswar is provided in Annexure-28.

Beneficiation Plants of Iron Ore

In order to meet the growing demands of iron ore lumps and fines, both for domestic consumption and export, there is a need for improving the economics of mines by adopting beneficiation methods to prepare a proper feed suitable for various iron-making processes. The Corex and sponge iron plants need ore in lumpy form with stringent chemical and metallurgical specifications. The specific requirement of iron ore for direct reduction process requires closely sized lumps, having good physical, chemical and metallurgical properties. Therefore, it is essential to beneficiate ore by cost-effective techniques, to remove silica and alumina from iron ores. There is also a need to conserve low-grade ores and recover values from slimes and fines to improve the economy of mines and become competitive globally.

It is observed that column floatation and high intensity magnetic separators are widely being deployed both on experimental and semi-commercial scale for producing concentrate from low-grade ores, iron ore fines and slimes. For instance, Iron beneficiation plants operated by M/s Fomento, Goa, adopt different beneficiation techniques including column floatation and deploy various equipment to treat the fine size material by magnetic and gravity separators. Recent studies and their encouraging results will enable recovery of iron ore from slimes particularly from tailing dams of various washing plants in the near future.

As already mentioned there are a number of beneficiation plants set up in the country. The present status and processes of beneficiation plants of iron ore of Kiriburu iron ore mines, M/s Jindal Vijaynagar Steel Ltd. and M/s V.M. Salgaocar Brothers Pvt. Ltd are briefly discussed as under:

Kiriburu Iron Ore Mines (SAIL), Keonjhar, Orissa

The Plant has two lines, each with a capacity of 750 tonnes/h with provision for both lines to be operated simultaneously. R.O.M. dumped in hoppers is conveyed by Apron Feeders to inclined stationary Grizzlies. Plus 200 mm material from Grizzlies is fed to Primary Jaw Crushers, one in each line (size 152 cm x 213 cm and setting 150 mm), and after being crushed, joins the undersize of Grizzlies and is conveyed to Scalping Screens which separate + 70 mm and -70 mm material. Plus 70 mm fraction goes to two Secondary Crushers one Gyratory Crusher (size 61 cm x 168 cm) in 'A' line and one Cone Crusher (size 220 cm setting 30–60 mm) in 'B' line. After being crushed in Secondary Crushers and after washing, passes on to Primary Screens (double-deck, 40 mm and 4 mm).

There are 2 nos. of Primary Screens in each line, one for secondary crushed material. Oversize of top decks of all the primary screens is conveyed to Tertiary Crusher (A cone crusher of size 220 cm, setting 10–30 mm) for further crushing to -40 mm. The undersize of the bottom decks goes to classifiers.

The middle product, i.e., undersize of top deck and oversize of the bottom deck of primary screens goes to Secondary Screens (double-deck, 10 mm and 3 mm) through Screen hoppers. There are 3 Secondary Screens in each line, one for the product coming from Secondary Crusher Circuit.

Out of the three products obtained from Secondary Screens oversize of the top deck forms the lump ore (- 40 mm to +10 mm) and the middle product i.e. (-10 mm to +3 mm) forms fine ore. The undersize material of bottom deck of Secondary Screens (-3 mm) goes to Classifiers.

Water Spraying arrangement has been provided in all the screens for washing and effective screening of ore and also for effective dust suppression.

Out of the -4 mm material from Primary Screens and -3 mm material from Secondary Screens, Classified sand (- 4 mm +100 mesh) is obtained after classification which joins fine ore product after being dewatered over Dewatering Screens. There are two Classifiers in each line—a Spiral Classifier and a Rake Classifier.

The crushed material from Tertiary Crusher is conveyed to Tertiary Screens double-deck, 40 mm and 10 mm which separates three products + 40 mm, - 40 mm to +10 mm and -10 mm. The product (40 mm to + 10 mm) joins lump ore from Secondary Screens and -10 mm product joins fine ore from Secondary Screens. The product (+ 40 mm) is conveyed to Quaternary Crushers (2 nos. size -220 cm, setting 5–7 mm) for further crushing to (-40 mm) in close circuit.

For blue dust, slime loss of iron ore is very high, so blue dust ore operated in dry circuit and it directly goes to stock pile or upto loading point.

Classifier overlow is taken to thickeners (2 nos. size 39 m dia) where clarified water is reclaimed for recirculation in the Plant and the slime is discharged in the tailing dam for disposal through a pipeline. The flow sheet of Kiriburu iron ore mines is depicted in Fig. 2.

Jindal Vijaynagar Steel Ltd, Bellary District, Karnataka

The incoming iron ore fines fed to the truck hoppers by trucks are fed to the storage bins (2 x 300 tonne capacity) through the conveyor system at the rate of 700 tph.

The ore is withdrawn from the bin Nos. 1 & 2 by belt feeder BF-01-02 (500 t/h) and then fed to the belt conveyor BC-03-1 (500 t/h). This conveyor feeds wet vibrating screen SW-01 (300 t/h) with 10 mm aperture. Water is sprayed over the screen at the rate of 0 - 600 m^3/h. The under size (-10 mm) fraction of vibrating screen reports to spiral classifier (CS01-04) through Launders (2 Nos.) as slurry of 30% solids. The +10 mm fractions from the wet screen is handled by front-end loader and further shifted to stacking yard.

The coarse fraction from the classifiers (+150 microns) is discharged to the belt conveyor BC - 04 (600 t/h) and then to BC-04A (600 t/h). The BC-04A feed the dewatering screen. The dewatered material falls over the BC-05A and then to the BC-05. From BC-05 dewatered material falls at staking conveyor STC 1 for stacking at yard.

The overflow fraction (-150 micron) of spiral classifier is collected in classifier over flow tank in the form of slurry (15% solid) in tank TKO-1-4 of 18 m ^{3}. Water is added to the tank at 200 m^3/h to bring down the solid content in the slurry from 15% to 10%.

Classifier launder slurry after dilution is pumped by slurry pumps PS 01-04 (650 m^3/h) to the primary cyclones (stub type-radial of 12 cyclones CY01-2) for separation of iron-bearing minerals based on the specific gravity differences. Each individual of 10" stub-cyclones is designed for 55 m^3/h flow rate. The underflow of the stub-cyclones is fed to the belt filter

Plate – 2

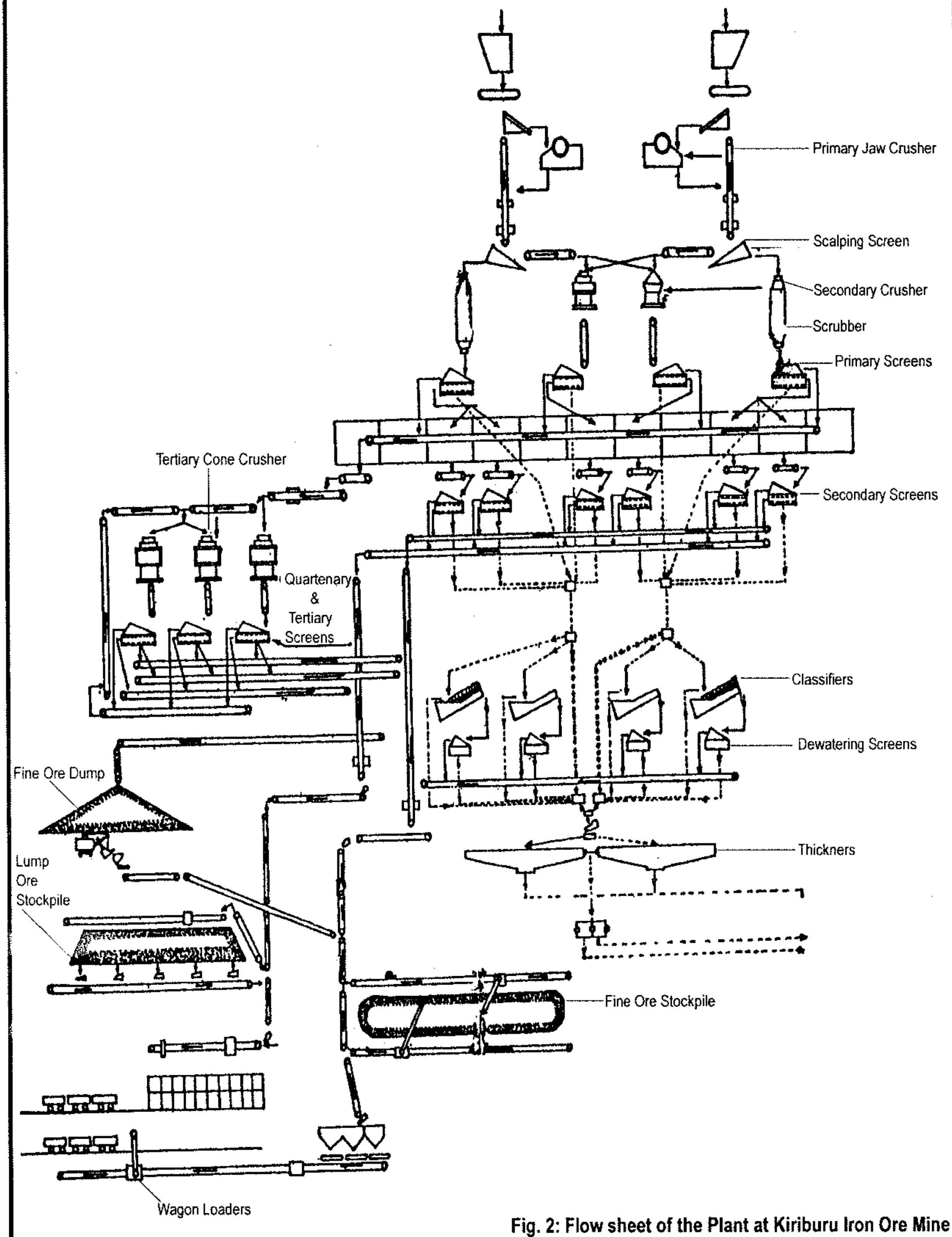

Fig. 2: Flow sheet of the Plant at Kiriburu Iron Ore Mine

for dewatering (12% moisture). The overflow of the primary cyclone is led to the tank TKO-2 of 80 m^3.

Water is added to the tank TKO-2 at the rate of 150 m^3/h to maintain solid content of 10 to 12%. Slurry pumps PSO2-1-4 (650 m^3/h) pump the slurry from the tank TKO-2 to 4 sets of hydrocyclones CYO-4. Each set of radial hydrocyclone battery includes a total of 40 hyrdrocyclones. The individual cyclones are designed for 18 m^3/h and 10 Nos. form a battery and four batteries are available with three in operation and one kept as standby. The three operating batteries cater to 650 m^3/h of slurry feed. These hydrocyclones separate out -25 micron fraction based on size difference. The overflow contained of higher levels of alumina and silica is treated as tailing. The underflow/coarser fraction of the secondary stage hydrocyclones distribute evenly across the cross-section of the Belt filter for dewater purpose along with primary stub cyclone underflow.

The overflow (-25 microns) is fed to the high rate thickener TR1 (HRT) of 35 mm diameter with a holding capacity of 4500 m^3. The overflow from the thickener is pumped to the tank TKO4 (process water sump) of capacity 325 m^3. The maximum make-up water required is estimated at 150m^3/h to maintain the process water sump level. The process water pumps PWO-1 to 4 (each of 650 m^3/h) pump water to different water consumers of the beneficiation unit. One or two of these run depending on the water required to meet the extent of dilution for better process operation.

The high rate thickener drive, driven hydraulically is also equipped with hydraulic rake—raise and lower systems. Thickener feed is thickened to a density of 1.7–1.8 g/cc which is monitored by the bed mass sensor, in turn it controls the speed of the underflow pump. Bed mass sensor dictates the flocculants dozing pump(s) to maintain the set bed level. Auxiliary unit named flocculants dozing system is equipped with the preparation tank, provided with screw feeder, discharges solid flocculants as per the set concentrations. The so prepared flocculant solution is transferred to a storage tank, then dozing pumps feed the solution to thickener based on the solid load as sensed by the bed mass sensor. The thickener underflow is pumped by pumps TUF 1-2 (Thickener underflow pump) each of capacity 150 m^3/h to tailing pond.

Instrumentation & Control

- A PLC system sequences the automatic operation of the plant.
- Group starts are provided for product and screen groups.
- Classifier drives are provided with current and speed monitoring system.
- Current pump output, bed mass and bed level controls for thickener are provided. Auto lifting and lowering option is available for thickener rake underflow pumps.
- Auto operation of flocculants dozing system exists linking to the bed level sensor.
- Weigh scales are provided in feeding conveyors & discharge conveyors for mass balancing. The flow sheet of the plant of Jindal Vijaynagar Steel Ltd. P.O. Vijaynagar, Dist. Bellary is depicted in Fig. 3.

V.M. Salgaoncar Brothers Pvt Ltd, Goa

The beneficiation process is basically a desliming process, wherein lighter & sticky aluminous material along with siliceous material adhered to ore particles is separated by scrubbing and cleaning. In the process, lighter deleterious constituents are also removed, segregating heavier & coarser particles of enriched ore.

There are four independent processing lines, with a capacity of 250 tonnes per hour each with a feed hopper, reciprocating feeder, single deck vibrating screen, scrubber, double deck vibrating screen, spiral classifier and two stages of hydrocyclones as the main equipment. Water is the media used for the purpose at the consumption rate of 1.5 cubic meter for every ton of ore processed.

In the existing process, R.O.M. passes through scalping grizzly of 150 mm separating +150 mm fraction of the ore. The said oversize fraction is crushed and re-fed to the plant as and when required. The -150 mm material is passed through a single deck screen with 75 mm aperture separating +75 mm fraction from the rest. If required +75 mm fraction is further crushed within-inline Jaw crusher and recycled or stacked separately for re-use whenever required.

The -75 mm material is fed to the scrubber along with water. The scrubber output passes through linear motion to double deck vibrating screen with 40 mm and 10 mm aperture screen mats with high pressure jets of water spray. At this stage + 40 mm, +10 mm - 40 mm and -10 mm size fractions get separated.

Both the fractions, +10 mm and +40 mm are collected together as lumpy ore product. The -10 mm portion thus separated, further passes through spiral classifier. The underflow of classifier of size - 10 mm / + 100 mm is collected as classifier product whereas; overflow is pumped into hydro cyclones. The underflow of cyclone (-100 mm / + 325 mm) is collected as a hydrocyclone product. Overflow of hydrocyclone which constitute only tailings (-325 mm) is taken into a thickener to recover and recycle of process water. Thus nearly 40–50 % of process water is recovered, prior to discharging thickened tailings into tailing pond. The flow sheet of the plant of V.M. Salgaoncar Brothers Pvt Ltd, Goa, is depicted in Fig. 4.

INFRASTRUCTURAL FACILITIES AND SUPPLY CONSTRAINTS

1. Railways

Loading station is a very important infrastructural facility in the transport of iron ore. The prices of iron ore are also affected by the mode of transport and distance of transportation. Cost of loading and unloading also affects the prices of iron ore. Obviously the loading material and the loading stations

S. No.	Description	S. No.	Description
1.	Belt Conveyor 1300 t/h	19.	Tank Classifier O/F
2.	Belt Conveyor 1200 t/h	20.	pump
3.	Ore Bin 300 t capacity	21.	High Rate Thickner
4.	Belt Weight Feeder 600 t/h	22.	Tank Thickner
5.	Belt Conveyor 600t/h	23.	Pump
6.	Wet	24.	Pump
7.	Loundern	25.	Sludge Dewatering Pond
8.	Spiral Classifier 200 t	26.	Pump Vertical 10 m
9.	Belt Conveyor	27.	Sump, Classifier Area Drainage
10.	Belt Conveyor 800 t/h	28.	Pump Vertical 10 m³/h
11.	Tank Classifier	29.	Sump, Cyclones Area Drainage
12.	pump, Slurry	30.	Pump Vertical 10 m³/h
13.	Primary Cyclones 8" size	31.	Belt Conveyor 600 t/h
14.	Tank Cyclone	32.	3 Position Flow Divider
15.	Pump, Slurry	33.	Dewatering Screen
16.	Secondary Cyclone	34.	Belt Conveyor 600 t/h
17.	Launder	35.	Belt Conveyor 600 t/h
18.	Belt Filter		

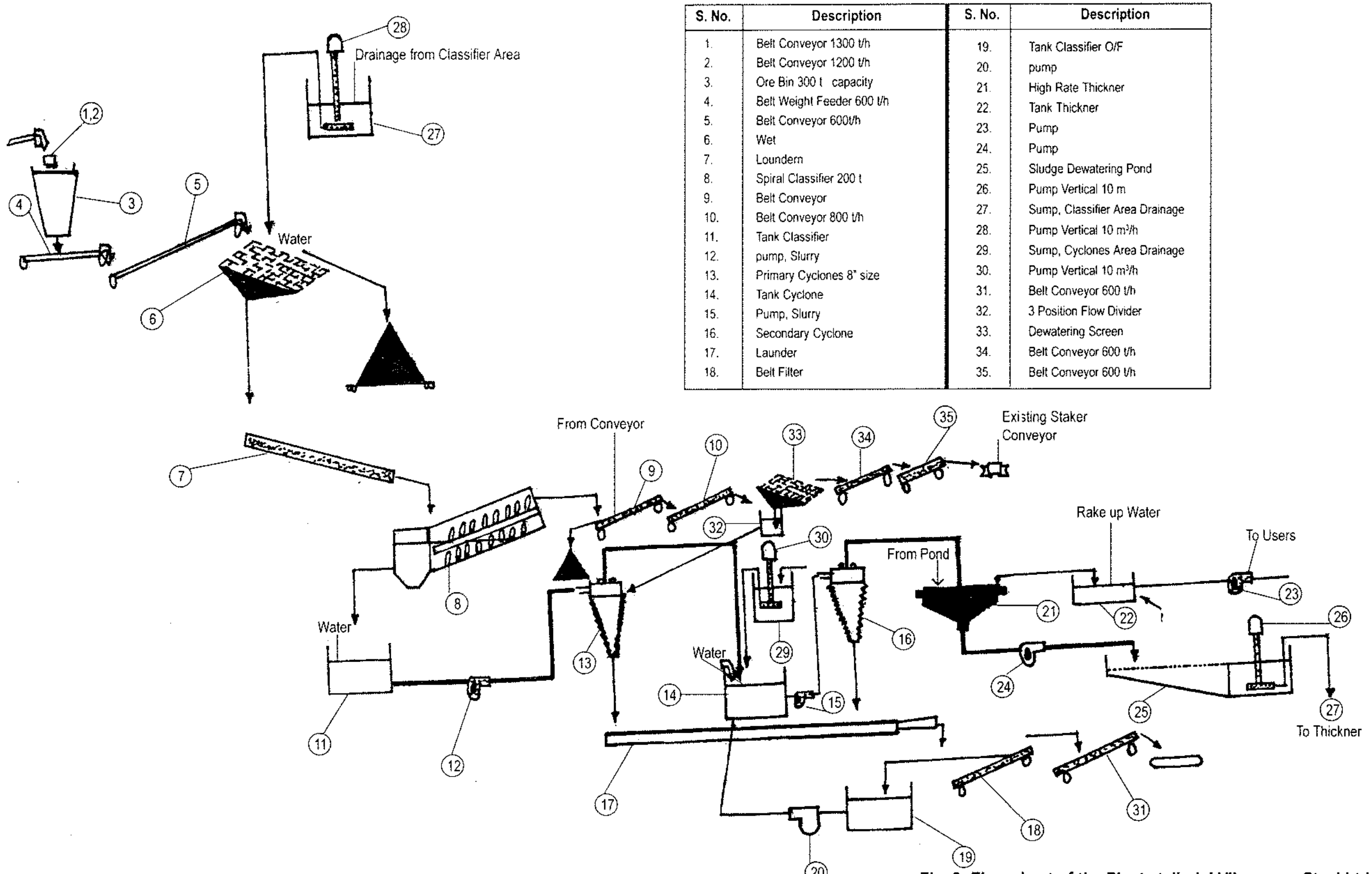

Fig. 3: Flow sheet of the Plant at Jindal Vijaynagar Steel Ltd

Plate – 4

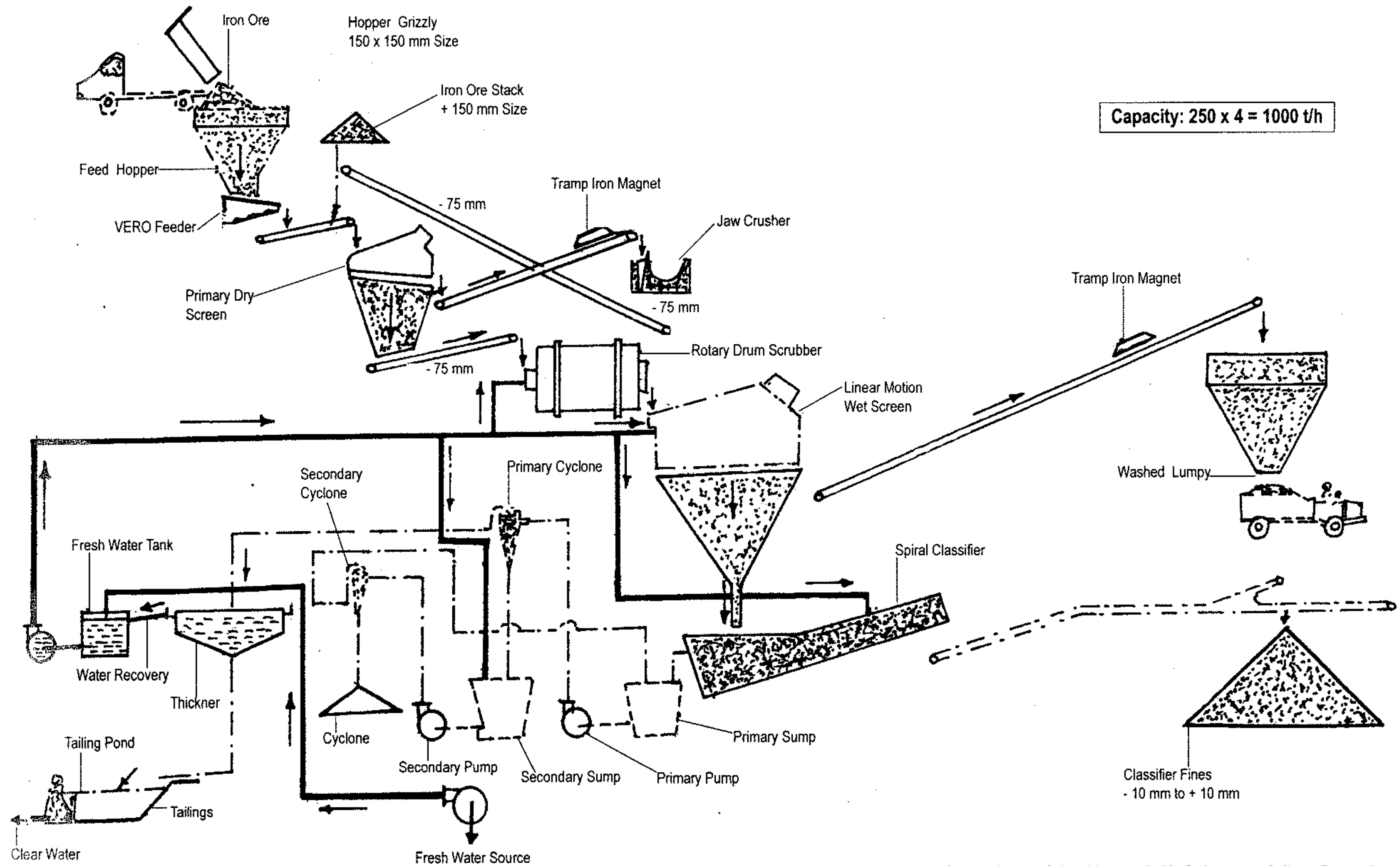

Fig. 4: Flow sheet of the Plant at V.M. Salgaocar & Bro. Pvt Ltd

should be situated at a suitable distance from the mine site so that the ore can be transported at the lowest cost to the harbour for export or to the plant where the ore is consumed. The important loading stations in India are discussed below:

Orissa

Orissa is the most important iron ore producing state in India. Almost all the iron ore produced in the state comes from Keonjhar district. There are two important railway sidings in the state viz., Barajamada and Barbil for private and small mines. All the important iron ore producing mines are situated in close vicinity of these two stations. The various captive mines of SAIL have their own mechanised loading stations at the mine sites. The loading of iron ore is carried out for these captive mines at their loading stations itself. The Paradip Port, which is an important port for export is situated at a distance of about 275 km and 300 km from Barbil and Barajamada railway stations respectively.

Jharkhand

The railway sidings for loading iron ore in this state are located in the West Singhbhum district, namely, Kiriburu, Meghahataburu, Noamundi and Manoharpur (for Chiria mines). The iron ore from Kiriburu and Meghahataburu mines of SAIL are loaded from the Kiriburu and Meghahataburu railway sidings, respectively. The iron ore from Noadmundi mines of TISCO is loaded from Noamundi siding. The iron ore is then transported to Jamshedpur. The iron ore from Chiria mines is loaded at Manoharpur railway siding. The iron ore is then transported to Bokaro and Rourkela steel plants. The distances between Manoharpur railway siding and Bokaro & Rourkela steel plants are 300 km and 375 km respectively.

Chhattisgarh

The major mines located in this state are in the districts of Dantewada and Durg. Major iron ore mines in Durg district, namely Dalli Rajahara and Mahamaya are the captive mines of SAIL for the Bhilai Steel plant and they are situated very near to the steel plant. The most important deposit in this state is Bailadila iron ore deposit presently worked by NMDC. The iron ore from this deposit is exported through Visakhapatnam Port. The railway siding for loading iron ore from this deposit is at Bhansi, which is located at a distance of about 10 km. The distance from the Visakhapatnam port to Bhansi railway station is 470 km.

Karnataka

The major iron ore mining sector is located in Bellary district. The iron ore from this sector is exported from Chennai port. Recently, a new port at Ennore is being developed for the export of iron ore from this mining sector. Iron ore from this sector is loaded into railway rakes, mainly at Tornagallu railway siding and then it is transported to Chennai or Ennore port. The distance is about 500 km. Another destination for the iron ore from this sector is Mormugao port situated at a distance of about 375 km by railway.

Another important railway siding in this sector is at Donimalai, which is situated near Donimalai iron ore mine of NMDC. Iron ore from this railway siding is also transported to the Chennai, Ennore and Mormugao port.

Iron ore pellets from KIOCL are exported from New Mangalore port, which is situated very near to the pelletisation plant. Hence the transportation cost is very less.

2. Ports

Embarkation of iron ores for exports was reported from 13 ports in India, namely, Mormugao, Panjim, Chennai, New Mangalore, Paradip, Vizag, Haldia, Belekeri, Kakinada, Karwar, Ennore, Redi and Mumbai. Mormugao registered embarkation figures of 24.61 million tonnes followed by New Mangalore (9.4 million tonnes), Paradip (9.05 million tonnes), Vizag (8.6 million tonnes), Panjim (7.98 million tonnes) and Haldia (4.97 million tonnes). The remaining was contributed by other six ports. Almost all the ports have recorded increased their embarkation figures in 2004-05 as compared to that in the previous year, except Panjim outer harbour where a marginal decrease of 0.11 million tonnes was reported (8.09 million tonnes in 2003-04 as compared to 7.98 million tonnes in 2004-05).

Prices

Chapter 6

The prices of iron ore depend upon various factors, such as, domestic and foreign demand, grade, degree of sizing (lumps and fines), cost of mining, beneficiation & processing (briquetting/sintering & pelletisation), freight rate, distance of transportation, mode of transportation (rail, truck or ship), tariff & tax as well as supply position from the various sources. The prices are generally negotiated or contracted between buyer and seller and are generally quoted on F.O.R. or ex-mine basis for domestic markets and on F.O.B. basis for export market. The predominant influence on the price of iron ore is the relationship between demand-supply and general economic condition. The demand of iron ore has a direct relationship with steel production. Some times due to unavoidable situations like strike in mine, interruption in transportation, non-clearance of lease etc. the iron ore supply is interrupted. Such situation leads to increase in prices of iron ore. The over supply as compared to low demand of iron ore, leads to decrease in prices.

India is a major producer and exporter of iron ore in the world. During 2005-06, exports of iron ore were mainly to China, Peoples Republic of (76%); Japan (14%); Korea, Republic of (2.75%), Taiwan (0.77%); European Countries (3.64%) and others (2.44%).

DOMESTIC MARKETS

The prices of iron ore in domestic market during 2001-02 to 2005-06 are reflected in Annexure-29.

On analysis of Annexure-6.1 it reveals that the F.O.B. prices of iron ore lumps are higher than iron ore fines. It is also observed that the prices of iron ore in the year 2002-03 decreased as compared to those in the year 2001-02. However, during the last three years, the iron ore export prices from Mormugao, Vizag and Chennai showed an increasing trend. Bailadila lumps with 65% Fe and Donimalai lumps with 65% Fe were quoted at US$ 49.64 and US$ 49.97 per tonne, respectively, during 2005-06 as against US$ 29.41 & US$ 23.10 per tonne during 2003-04. Bailadila fines with 65% Fe and Donimalai fines with 65% Fe were quoted at US $ 38.51 and US $ 38.51 per tonne, respectively, during 2005-06 as against US$ 18.93 and US$ 17.99 per tonne during 2003-04.

Year 2005-06 witnessed substantial rise in prices of iron ore. F.O.B.T. Mormugao price of iron ore lumps were quoted at US $ 35.88, US $ 34.14, US $ 32.57, US $ 31.31 and US $29.84 per tonne for 63% Fe, 62% Fe, 61% Fe, 60% Fe and 59% Fe respectively during 2005-06. Similarly the F.O.B.T.

Mormugao prices of iron ore fines were quoted at US $ 30.88, US $ 29.99, US $ 29.11 and US $ 28.50 per tonne for 63% Fe, 62% Fe, 61% Fe and 60% Fe respectively. The F.O.B Vizag price of Bailadila lumps with 65% Fe was quoted at US $ 49.64 and Bailadila fines with 65% Fe was quoted at US $ 38.51 per tonne in 2005-06. The F.O.B. Chennai price of Donimalai lumps with 65% Fe was quoted at US $ 47.97 per tonne and Donimalai fines were quoted at US $ 38.51 per tonne during 2005-06.

The ex-mine MML (Karnataka) prices per tonne for iron ore fines were quoted at Rs 2200 for 67% Fe, Rs 2000 for +66 to 67% Fe, Rs 1600 for +65 to 66 % Fe, Rs 1200 for +60 to 65% Fe, Rs 600 for -60% Fe and Rs 375 for iron ore mud during 2004-05 and 2005-06.

The F.O.B. prices for May–June 2004 and February–April 2007 as available and published in Minerals and Metal Review are included as Annexures 30 and 31 respectively. On close examination of the Annexures, it is noticed that the F.O.B. prices for the same grade in the same month show substantial variations. This apparent variations in prices could be attributed to trade on the basis of long-term agreed prices and spot prices between the supplier and client.

The ex-mine prices as quoted by Orissa Mining Coprporation for the period between July and September 2007 are reflected in Annexure-32.

Based on the data on prices of iron ore received from iron ore producers (Annexure-33) regionwise analysis is discussed as below:

Goa Region

In Goa region, the F.O.R. prices of iron ore lumps in 2001-02 varied between Rs133 to Rs 346 per tonne and that of fines between Rs 189 to Rs 551 per tonne. In 2002-03 prices of lumps showed variation in the range of Rs133 to Rs 450 per tonne and fines between Rs 162 and Rs 595 per tonne. A sudden spurt in the prices of iron ore (both lumps and fines) was observed in 2003-04. The prices of lumps in 2003-04 fluctuated between Rs 277 and Rs 475 and those of fines between Rs 291 and Rs 513 per tonne. The F.O.B. prices of iron ore lumps in Goa were Rs 800 per tonne (US$ 16.80) and fines was Rs 1200 per tonne (US$ 17.48) during 2003-04.

Karnataka Region

In this region, the F.O.R. prices of iron ore lumps in the year 2001-02 varied in the range of Rs 135 to Rs 395 per tonne and those of fines between Rs 185 and Rs 200 per tonne. In the year 2002-03 also no significant change in the prices could be observed. The variation was restricted between Rs 178 and Rs 393 per tonne for lumps and Rs 185 and Rs 300 per tonne for fines. Prices increased substantially in the year 2003-04 and ranged between Rs 272 and Rs 531 per tonne for lumps and between Rs 375 and Rs 650 per tonne for fines.

The F.O.B. prices of iron ore showed a significant change in the year 2003-04 and the price range was observed to be Rs 800 to Rs 1800 per tonne for lumps and Rs 900 to Rs 1200 per tonne for fines.

Orissa Region

In Orissa region, prices of lumps varied in the range of Rs 190 to Rs 474 per tonne and those for fines from Rs 51 to Rs 140 per tonne during 2001-02. In the year 2002-03, the variation in prices was observed in the range of Rs 250 to Rs 525 per tonne for lumps and for fines in the range of Rs 99 to Rs 170 per tonne. In this region also boom in prices of iron ore was experienced which showed range between Rs 400 and Rs 880 per tonne in case of lumps and between Rs 100 and Rs 400 per tonne in case of fines in the year 2003-04.

Jharkhand Region

In Jharkhand region, there are many captive mines therefore the supply of iron ore in domestic market is comparatively low. Prices of lumps and fines ranged between Rs 290 and Rs 360 per tonne in 2001-02 and 2002-03. In the year 2003-04, a spurt in the iron ore prices of lumps and fines was observed and it ranged between Rs 360 and Rs 550 per tonne.

Chhattisgarh Region

In Chhattisgarh region, the F.O.B. prices of iron ore for lumps were US $23.59 per tonne and those of fines were US $17.28 per tonne during 2001-02. In the year 2002-03, it decreased slightly to US $22.41 per tonne in case of lumps and remained almost static at US $17.37 per tonne in case of fines. The year 2003-04 reflected a boom in prices which were US $24.47 per tonne and US $ 18.93 per tonne for lumps and fines respectively. The year 2004-05 witnessed further increase in the F.O.B. prices which shot up to US $28.95 per tonne for lumps and US $22.46 per tonne for fines.

The overall inference that could be drawn from the above is that the year 2003-04 showed a real boom in both domestic and international iron ore market. This sudden spurt in prices could be attributed to the demand for both iron ore and steel mainly from China and other important international markets.

INTERNATIONAL MARKET

The prices of iron ore experienced an increasing trend in the last few years. This upsurge was as a result of the imbalance in demand and supply in the overseas markets. The trend in prices of iron ore in a few foreign markets is discussed in the following paragraphs.

United States of America

The prices of iron ore in the US market like other world markets have been on a rise since the last five years. In 2005 the price of iron ore was US $ 44.00 per tonne, an increase of 84.33% when compared to US $ 23.87 per tonne in 2001. The price of iron ore which was US $ 37.92 per tonne in 2004 increased by 16% to US $ 44.00 per tonne in 2005. The iron ore prices in US market for the years between 2001 and 2005 are given in the following Table:

(In US $ per metric tonne)

Particular	2001	2002	2003	2004	2005
Prices of iron ore	23.87	26.04	32.70	37.92	44.00

Canada

The prices of iron ore in Canada began to show an upward trend in 2004. The price in 2004 was up by 22% from US $31.9/Fe unit in 2003 to US $38.9 /Fe unit for concentrates and for acid pellets it increased by 21% from US $ 53.3 /Fe unit to US $ 64.5 /Fe unit. This upsurge continued in 2005 as well. The price of iron ore (concentrates) increased from US $ 38.9/Fe unit in 2004 to US $ 66.7/Fe unit in 2005 registering an increase of 72 percent. Similarly, the price of acid pellets increased to US$ 120.77 /Fe unit in 2005 from US $ 64.5 /Fe unit thereby registering an increase of 87 percent. The prices of iron ore in US $/ Fe unit in Canadian market are reflected in the following Table:

(In US $/Fe Unit)

Grade	2003	2004	2005
Concentrates	31.9	38.9	66.7
Acid Pellets	53.3	64.5	120.7

Source: *Canadian Minerals Yearbook, 2004*

Brazil

The Brazilian iron ore market also showed an upward trend in iron ore prices. The increase in iron ore prices began in 2004 and the real boom was observed in 2005. The price of iron ore fines in 2004 which was US$ 37.30 per tonne increased to US$ 64.00 per tonne in 2005, and further to $76.2 per tonne in 2006. The price of iron ore lumps which was US$ 44.40 per tonne in 2004 increased to US$ 79.00 per tonne in 2005 and further to $94.00 per tonne in 2006. Iron ore pellets too registered an increase. The price of pellets which was US$ 61.80 per tonne in 2004 rose to US$ 115.50 per tonne in 2005 and declined to $112.00 per tonne in 2006. The prices of iron ore in Brazilian market are reflected in the following Table:

(US $ per tonne)

Grade	2003	2004	2005	2006
Lumps	37.30	44.40	79.00	94.00
Fines	31.40	37.30	64.00	76.20
Pellets	52.00	61.80	115.50	112.00

Source: *CVRD, Wall Street Journal, quoted from www.econstat.com, dt. 30.04.2007*

ROYALTY & OTHER TAXES

Royalty

In exercise of the powers conferred by Sub-section (3) of Section 9 of the Mines and Mineral Development & Regulation Act, (67 of 1957), the Government of India notifies rates of royalty in respect of minerals applicable in all States and Union Territories (except in the State of West Bengal). The holder of mining lease is liable to pay royalty in respect of all minerals removed or consumed from the leased areas at the rates specified in the second schedule of MMDR Act, 1957. The Central Government is empowered to increase or reduce the rate of royalty, but it cannot increase the rate in respect of a mineral more than once during a three years period. The royalty is to be paid at such a time and in such a manner as the State Government may prescribe.

The rates of royalty of iron ore lumps, fines & concentrates are furnished below:

Lumps

a) with 65% Fe content or more	:	Rs 24.25/ tonne
b) with 62 % Fe content or more but less than 65% Fe content	:	Rs 14.50/ tonne
c) with 60% Fe content or more but less than 62% Fe content	:	Rs 10.00/ tonne
d) less than 60% Fe content	:	Rs 7.00/ tonne

Fines

(including inter alia natural fines produced incidental to mining & sizing of lump ore)

a) with 65% Fe content or more	:	Rs 17.00/ tonne
b) with 62 % Fe content or more but less than 65% Fe content	:	Rs 10.00/ tonne
c) with less than 62% Fe content	:	Rs 7.00/ tonne

Concentrates : Rs 3.00/ tonne

(prepared by beneficiation
and /or concentration of low grade ore
containing 40% Fe or less)

Dead Rent

The holder of a mining lease must pay to the State Government dead rent annually at such a rate as may be specified in MMDR Act, 1957, for all areas included in the mining lease.

Surface Rent

The lessee is required to pay surface rent for the surface area used for mining operations at a rate not exceeding the land revenue as may be specified by the State Government in the mining lease.

Demand-Supply Analysis

Chapter 7

Iron ore is an important basic raw material produced in the country for iron & steel and other industries. India is in a position to meet the growing demand of its domestic industry and also sustain the demands of external trade. In this Chapter, an attempt has been made to examine the present and future demand-supply position of iron ore on the basis of the information available.

HISTORICAL SCENARIO

The study of demand-supply position of iron ore of earlier years is quite vital to understand the past trends in production, consumption and trade of iron ore. These trends provide a basis to formulate the present demand and supply position and also help to arrive at a reasonably accurate projection of demand and supply of iron ore in the future.

The total demand of iron ore is calculated as a sum of total internal consumption and exports of iron ore, while supply of iron ore, on the other hand, is the sum of production and imports of iron ore. Imports of iron ore in India are very meagre since last so many years. The demand-supply position of iron ore for the years 1995-96 to 2003-04 is given in Table 7.1.

Table 7.1: Demand-Supply of Iron Ore from 1995-96 to 2003-04

(In '000 tonnes)

Year	Demand			Supply		
	Internal (Consumption)	External (Export)	Total	Production	Imports	Ratio [1/]
1995-96	31986	31713	63699	64507	879	1.03
1996-97	34068	27627	61695	66576	853	1.09
1997-98	34576	29496	64072	68161	372	1.07
1998-99	32520	22274	54794	72230	149	1.25
1999-2000	33912	15717	49629	74946	644	1.52
2000-01	37168	20162	57330	80587	487	1.42
2001-02	38185	23086	61271	86226	395	1.41
2002-03	41882	57094	98976	99072	520	1.01
2003-04	51259	63000*	114259	122838	1587	1.09

* *Data supplied by Goa Mineral Exporters' Association.*

1/ *Demand-supply ratio*

From the above Table, it is observed that during 1995-96 to 2003-04, iron ore for both domestic as well as exports on the whole showed an increasing trend except for a few years wherein there were some fluctuations. Production of iron ore in the period between 1995-96 and 2003-04 registered an increase every year mainly as a result of export compulsions. The production which was 64 million tonnes in 1995-96 gradually increased up to 81 million tonnes in 2000-01. Thereafter it gathered momentum and reached a whopping 123 million tonnes in 2003-04. Orissa was the major producing State in respect of both quality and quantity. Other producing States were Karnataka, Chhattisgarh, Goa, Jharkhand, etc.

There was a world wide recession in the demand of iron ore in the year 1998-99. As a result of which India's internal and external demand also came down marginally, which again showed an increasing trend from 1999-2000. The internal demand increased gradually from 32 million tonnes in 1995-96 to 51 million tonnes in 2003-04.

The exports of iron ore also increased considerably from 31.71 million tonnes in 1995-96 to 63.00 million tonnes in 2003-04. The recent past has seen China become the main export destination of Indian iron ore. Traditionally, iron ore from India is usually exported to Japan, Korea, Hong Kong, etc. Imports, on the other hand, were negligible and showed a fluctuating trend.

From the above analysis, it is but evident that India is surplus in its iron ore reserves and has been progressing stride for stride in all fronts especially production, internal consumption and exports.

PRESENT DEMAND-SUPPLY POSITION

Internal Demand

The internal demand of iron ore in the year 2004-05 was 62.82 million tonnes. The contribution of iron & steel industry in the consumption of iron ore was 69.1%. Sponge iron (27.9%) and cement (2.8%) are other major consuming industries. The consumption in other industries which included coal washery, ferro-alloys, foundry, chemical, glass and refractories was 0.2%. Industrywise internal demand of iron ore during 2004-05 is highlighted in Table 7.2.

Table 7.2: Industrywise Internal Demand/Consumption of Iron Ore during 2004-05

(In tonnes)

Name of Industry	Industrywise Consumption	% Share
All Industries	**62,817,500**	**100**
Cement	1,768,700	2.8
Coal washery	92,000	0.2
Ferro-alloys	5,800	++
Iron & steel	43,440,000	69.1
Sponge iron	17,510,000	27.9
Other (Foundry, Chemical, Glass & Refractory)	1,000	++

++ *Negligible*

External Demand

During 2004-05, India exported 83.07 million tonnes of iron ore, an increase of 31.85% when compared to 63.00 million tonnes of exports during 2003-04. Earlier in 2002-03, the exports of iron ore were 57.09 million tonnes. In 2004-05, China was the main destination accounting for 57.26 million tonnes (68.9%) followed by Japan 10.55 million tonnes (12.7%), Saudi Arabia 5.30 million tonnes (6.38%) and Korea, Republic of 2.44 million tonnes (2.94%). The remaining 7.57 million tonnes (9.11%) was accounted for by Chinese Taipei, Netherlands, Romania and other countries.

Total Present Demand

Total demand of iron ore as in 2004-05 was 145.89 million tonnes out of which 62.82 million tonnes was for internal consumption and 83.07 million tonnes was for exports.

SUPPLY

The production of iron ore in 2004-05 was 145.94 million tonnes. The iron ore was produced in the form of lumps, fines and concentrates. Out of the total 145.94 million tonnes, the production of lumps was 58.15 million tonnes (i.e., 40%), production of fines was 82.54 million tonnes (56%) and that of concentrates was 5.25 million tonnes (4%). Karnataka and Goa were the only two States where production of concentrates was reported. Orissa, Karnataka, Chhattisgarh, Goa and Jharkhand were the other major iron ore producing States.

FUTURE DEMAND- SUPPLY POSITION

Future Internal Demand

It is expected that iron & steel and sponge iron industries will continue to be the major consumers of iron ore in the future. Some of the integrated steel plants are increasing their production capacity and several new steel and sponge iron plants are also expected to come into operation soon. As discussed in the Chapter on 'Internal Demand', the total projected future internal demand of iron ore is likely to be 78 million tonnes, 112 million tonnes and 199 million tonnes by 2006-07, 2011-12 and 2019-20, respectively (Table 7.3).

Table 7.3: Future Internal Demand of Iron Ore

(In million tonnes)

Year	Internal consumption
2006-07	78
2011-12	112
2019-20	199

Future External Demand

As discussed in the Chapter on 'Foreign Markets', the estimated future external demand of iron ore is expected to hover around 85 million tonnes, 91 million tonnes and 100 million tonnes by 2006-07, 2011-12 and 2019-20, respectively (Table 7.4).

Table 7.4: Future External Demand of Iron Ore

(In million tonnes)

Year	External demand
2006-07	85.26
2011-12	90.91
2019-20	100.00

Total Future Demand

The total future demand of iron ore including internal as well as external demand for the years 2006-07, 2011-12 and 2019-20 is projected in Table 7.5.

Table 7.5: Total Future Demand of Iron Ore

(In million tonnes)

Year	Future Internal Demand	Future External Demand	Total Future Demand
2006-07	78	85.26	163.26
2011-12	112	90.91	202.91
2019-20	199	100.00	299.00

Future Supply

As per the National Mineral Inventory of Iron ore as on 1.4.2005, the total resources of iron ore was placed at 25,250 million tonnes which include 7,063 million tonnes of reserves and 18,187 million tonnes of remaining resources. The total production of iron ore for the period between 2000-01 and 2004-05 was 535 million tonnes. The production for the years 2005-06 and 2006-07 was 154 million tonnes and 172 million tonnes respectively.

Analysis of demand-supply of iron ore during the last five years has revealed that the iron ore mining industry has been able to cope with the demand both from the domestic and foreign markets. The resource position of iron ore is comfortable and no problems are envisaged in meeting the demand of iron ore for targetted production of steel at 110 million tonnes by 2020.

However, looking at the resources of iron ore of high-grade, it is necessary to restrict exports of high-grade iron ore. Further, there is also a need to carry out beneficiation studies to upgrade the low-grade ore.

Chapter 8

Iron & Steel

INTRODUCTION

Steel is considered as the backbone of human civilisation. It is essential for the development of any modern industry & infrastructure in any country.

The first high quality steel was produced in India around 300 BC. The famous iron pillar in Delhi was erected around 375–414 AD.

USES

Depending upon strength, ductility and weldability the finished steel is classified into two segments— Long products and Flat products.

1. *Long products:* Long products consist of rounds, bars, wire rods, structural, such as, angles, channels, beams and railway material in the shape of rails.
2. *Flat products:* The flat steel products consist of light and heavy plates, hot-rolled coils and sheets, cold-rolled coils and sheets, galvanised & coated sheets, tin plates, electrical steels etc. Flat products are used in automobiles, railways, tube makers, cold rolled units, power sector, heavy industries, machinery manufacturers, galvanised/coated steels, consumer durables, electrical manufacturers, house buildings, manufacturers of LPG cylinders etc.

The domestic consumption of steel during 2004-05 was 33.35 million tonnes. Some of the major steel consumers are discussed below:

Construction

Heavy investment in infrastructure (National Highways and Housing), surge in construction activities and increase in steel intensive construction have escalated the demand of steel in construction and this demand is bound to grow many folds in the coming years.

1. National Highways and Urban Transport

There are large prospects in this areas like

a) The proposed golden quadrilateral
b) North-South and East-West Carriers
c) Projects for Port-connectivity
d) Construction of railway level crossing—under this 75 railway over-bridges are being considered,
e) Laying four-lane National Highways and other projects for connecting State capitals and important tourist centres. Huge investments are planned for urban transport developments. All these programmes will require huge quantity of steel.

2. *Housing*

With spurt in housing construction and increasing adoption of steel intensive option in buildings, the demand for steel in building construction is bound to rise in the coming years.

Automobile

With increase in automobile production, there is substantial rise in demand of both flat and long products in the automobile manufacturing industry.

Pipes & Tubes

Pipes and tubes consume more than 25% of the total hot rolled coil production. The end-use products of steel pipes & tubes find major applications in water supply & drainage system, housing appliances, irrigation, industrial applications and for oil & natural gas transportation.

Consumer Durables

The consumer durables sector is a major end-use for cold rolled flats. The outer panel of most of the white goods is made of cold rolled (CR) or galvanised steel sheets and colour-coated sheets. Consumption of steel in consumer durables sector is bound to rise with increase in demand for consumer durables.

Railways

Railways is one of the major consumers of steel. The important areas of steel consumption are in the manufacture of locomotive (65 tonnes), coaches (15.5 tonnes flat products), wagons (3.2 tonnes flat products), rails, wheels and axles, structural steel for bridges and steel for maintenance. Railways is reportedly consuming 1.5 million tonnes of steel per year.

Industrial Machinery & Equipment

This Sector's consumption depends on the growth in the industrial sector of the country. It accounts for around 7 percent of the total consumption of flat steel, with the anticipated growth in the power sector, cement industry, sugar industry, metallurgical & mining machinery, petrochemical and textile industries. The demand of steel is most likely to increase in this sector with the ambitious growth prospects as foreseen for the Industrial Sector.

Port

Currently, the facilities at Indian ports are not fully adequate to meet the country's exports & imports requirements. There is massive plans for arrangements of the ports withprogrammes to raise each of them to international standards. It is envisaged that huge quantities of steel will be required for construction to enhance the capacities of Indian Ports.

DEMAND

Present Demand

Although, India is one of the major producers of steel in the world, its per capita consumption is only 30 kg which is very low as compared to the developed and several developing countries.

The categorywise apparent consumptions during the period 2001-02 to 2003-04 as worked out by JPC are presented in Annexure-34.

The industrywise and categorywise consumption of finished steel in India during 2002-03 and 2003-04 is presented in Annexure-35. From Annexure-35, it is evident that the major consuming sectors of finished steel in India during 2002-03 and 2003-04 were the railways, housing constructions, public building & hotels construction, industrial construction, tube makers, CR units, auto/tractor/cycle and other engineering units. These eight sectors accounted for 56 percent of India's total finished steel consumption in 2003-04 as compared to 54 percent in 2002-03.

The consumption of finished steel by Government sector has increased by about 7.89 percent in 2003-04 as compared to that of the previous year while in private sector it has gone up by 7.85 percent.

The apparent consumption of finished steel in India with breakup of long and flat products is given in Table 8.1.

Table 8.1: Apparent Consumption of Finished Steel in India, 2000-01 to 2004-05

(Unit in '000 tonnes)

Year	Long products	Flat products	Total fin. steel	% Share of		% growth in finished steel consumption
				Long	Flat	
2000-01	12,196	14,330	26,526	46.0	54.0	-
2001-02	12,726	14,792	27,518	46.2	53.8	3.73
2002-03	13,639	15,258	28,897	47.2	52.8	5.01
2003-04	14,658	16,511	31,169	47.0	53.0	7.86
2004-05(P)	15,695	17,659	33,354	47.1	52.9	7.01

***Data Source:** JPC; (P) Provisional*

Future Demand

The abundant availability of raw material like iron ore and cheap man power in India provide tremendous potential for the Iron & Steel Sector to grow. The production of iron & steel has been increasing steadily. Growth is originating more from private sector. Incentive like 100% foreign equity and lowering of import duties on capital goods raw materials are positive factors of growth.

The anticipated total steel demand in India as per National Steel Policy, 2005 is expected to double at the end of 11th Five Year Plan period. At a conservative growth rate of 7.3 percent, steel demand in 2012 is likely to be about 62 million tonnes and by 2020 it is expected to touch 110 million tonnes.

SUPPLY

Steel in India is produced by primary as well as secondary sectors. The primary sector consists of integrated steel plants while the secondary sector consists of Electric Arc Furnace (EAF), Induction Furnace (IF), Pig iron, Sponge iron, HR Mill for long products, CR Mills (sheets & strips), Steel wire drawing units, GP/GC/PVC-coated sheets and Tin plate units. The total production of finished carbon steel was 42.33 million tonnes in 2004-05.

STRUCTURE AND ROLE OF INDIAN STEEL INDUSTRY

Steel sector represents around Rs 90,000 crore capital. The Indian Steel sector was the first core sector to be completely freed from the licensing regime and the pricing & distribution controls. This was done primarily because of the inherent strengths and capabilities demonstrated by the Indian Iron & Steel Industry.

India is the eighth largest producer of crude steel in the world. In the Indian Steel industry, steel is produced in the Primary and Secondary sectors. In the Primary Sector, there are 11 integrated steel plants in the public and private sectors. The structure of the Indian Steel Industry (Primary and Secondary sectors) is reflected in Annexure-36. The details on capacity and production of pig iron and steel ingots/crude steel are furnished in Annexure-37. Products manufactured by various steel plants are summarised in Annexure-38. Domestic Production of finished steel is furnished in Table 8.2.

Table 8.2: Domestic Production of Finished Steel

Year	Main producers	Secondary producers	Total
1994-95	9.57 (53.8%)	8.25 (46.2%)	17.82
1995-96	10.59 (49.5%)	10.81(50.5%)	21.40
1996-97	10.54 (46.4%)	12.18 (53.6%)	22.72
1997-98	10.44 (44.6%)	12.93 (55.4%)	23.37
1998-99	9.91 (41.6%)	13.91 (58.4%)	23.82
1999-2000	11.482 (40.34%)	16.980 (59.66%)	28.46
2000-01	12.686 (41.84%)	17.636 (58.16%)	30.32
2001-02	13.198 (41.73%)	18.427 (58.27%)	31.62
2002-03	19.675 (55.72%)	15.632 (44.27%)	35.30
2003-04	21.272 (54.06%)	18.028 (45.53%)	39.30
2004-05	-	-	42.33

Figures in parentheses indicate percentage share

Source: *Annual Report, Ministry of Steel, 2004-05 for the period from 1993-94 to 1998-99. JPC for the period from 1999-2000 to 2005-06*

Primary Sector

The Indian Steel Industry comprises integrated steel plants in the Primary Sector. All the plants in the Primary Sector use BF-BOF route of iron & steel production except Jindal Vijaynagar Steel Limited which use Corex-BOF-CCP-HSM route for iron & steel production.

Secondary Sector (Mini-steel Plants)

The secondary Sector consists of Electric Arc Furnace (EAF), Induction Furnace (IF), Pig Iron, sponge Iron, HR Mill for long products, CR Mills (sheets &

strips) Steel Wire Drawing Units, GP/GC/PVC-coated Sheets and Tin Plates units. Scrap and sponge iron are used as raw feed in Induction Furnace and Electric Arc furnace while HR Mill for long products, CR Mills (sheets & strips), Steel wire drawing units, GP/GC/PVC-coated Sheets and Tin Plate units use ingots/ slabs/bars etc. as raw feed.

Sponge Iron

India is the largest producer of sponge iron in the world. Sponge iron is produced from iron ore either by using non-coking coal or gas. Big rotary kilns are used where the iron ore, non-coking coal and limestone/dolomite are fed. The hot air is injected in to the kiln from various zones to heat the raw materials at a temperature that reduces the iron ore leaving behind solid contents along with gangue material. The hot reduced material discharged from the other end of the kiln is cooled and utilised afterwards as sponge iron (DRI/HBI). The production of sponge iron (Direct Reduced Iron—DRI) for the years between 1994-95 and 2004-05 is given in Table 8.3. The installed capacity of sponge iron has increased from 1.52 million tonnes in 1990-91 to 18.65 million tonnes in 2004-05 (207 units of which 204 are coal-based units and 3 are gas-based units). Out of 18.65 million tonnes, the capacity of coal-based units is 12.55 million tonnes and gas-based units is 6.10 million tonnes respectively. The production of sponge iron has risen from 0.9 million tonnes in 1990-91 to about 10.30 million tonnes in 2004-05.

Table 8.3: Domestic Production of Sponge Iron

(In million tonnes)

Year	Production	% increase
1994-95	3.39	41.3
1995-96	4.40	29.8
1996-97	5.01	13.8
1997-98	5.33	6.39
1998-99	5.17	-3.00
1999-2000	5.33	3.10
2000-01	5.48	2.81
2001-02	5.44	-0.73
2002-03	6.91	27.02
2003-04	8.08	17.00
2004-05	10.30	27.47

Source: *Annual Report, Ministry of Steel, 2005-06*

The data on annual production capacity of sponge iron units located in various States is furnished in Annexure-39.

Iron & Steel Scrap for Secondary Sector (Mini-steel Plants)

One of the essential requirements for manufacture of steel in Induction Furnaces and Electric Arc Furnace (mini-steel plants) is scrap. Iron scrap is available in the country in the form of pressed bundles, a mixture of used steel components (called as commercial scrap), turnings & borings and heavy melting scrap.

These are generated by industries under many sectors like automobile, railways and engineering workshops.

The collection & processing of scrap in an organised manner is done by a few units in the country. In the local market, scrap is supplied by dealers who in turn arrange to have scrap collected manually or through a few sub-dealers.

Ship Breaking

Ship breaking has become a major source for scrap generation. Ship breaking activities are carried at various places on the Indian coast, the largest concentration is at Alang on the west coast of Gujarat. Today, there are about 80 active yards along the 10 km coastline.

The life of an average sailing ship is about 20 years. About 60% of the ships broken are dry cargo ships, while the remaining 40% of the ships broken are wet cargo tankers and specialised ships. Ship breaking generates about 2.3 million tonnes of scrap every year.

Iron & Steel scraps are mainly used in steel melting shop (SMS) for steel making, in Induction Furnaces (IF) & Electric Arc Furnaces (EAF) for manufacture of pig iron, in alloy steel plants for alloy steel manufacture and in foundry industries. Iron & steel scraps are also imported to fulfil the domestic demand of these industries.

Imports of iron & steel scrap by India recorded a fluctuating trend during the years between 1990-91 and 2005-06. The iron & steel scraps imported during 1990-91 to 2005-06 are furnished in Table 8.4.

Table: 8.4 Import of Iron & Steel Scraps from 1990-91 to 2005-06

(Unit in million tonnes)

Years	Imports of iron & steel scrap
1990-91	3.152
1991-92	1.515
1992-93	3.039
1993-94	1.178
1994-95	2.212
1995-96	1.964
1996-97	1.953
1997-98	1.658
1998-99	1.494
1999-2000	1.924
2000-01	1.698
2001-02	2.879
2002-03	2.397
2003-04	2.567
2004-05	3.506
2005-06	4.803

Source: *DGCIS, Kolkata*

The consumption of scrap is mainly reported by Induction Furnaces, Electric Arc Furnaces, Integrated Steel Plants, Alloy Steel and Foundry Industries. Recycling of scrap plays an important role in the conservation of energy because remelting of scrap requires much less energy than the production of steel from iron ore. The consumption of scrap by various industries is furnished in Table 8.5.

Table: 8.5 Consumption of Scrap during 2003-04 to 2005-06

(Units in tonnes)

Industries	2003-04	2004-05	2005-06
Induction Furnace1/	3500000	1700000	3900000
Inte. Steel plants2/	1214253	491486	432473
Alloy Steel2/	103448	104772	40028
Foundry2/	7230	14114	13780
Total	**4824931**	**2310372**	**4386281**

Source: 1_/ Information supplied by IIFFA

2_/ Return reviewed by IBM on non-statutory basis

Scrap Trading

Metal Scrap Trading Corporation Ltd (MSTC Ltd): The Company has two operational divisions, Foreign Trade and Domestic Trade.

In Domestic Trade, the Company undertakes disposal of ferrous/ non-ferrous scrap and other secondary scrap arising from integrated steel plants under SAIL, Rashtriya Ispat Nigam Ltd, etc. and disposal of scrap and surplus stores from other public sector units and government departments including Ministry of Defence.

Ferro Scrap Nigam Ltd. (FSNL) has become a fully-owned subsidiary of MSTC Ltd under the Ministry of Steel. The Company undertakes recovery and processing of scrap slag and refuse dumps through its eight field units situated at Bhilai, Bokaro, Burnpur, Durgapur, Rourkela, Visakhapatnam, Dolvi and Duburi. The scrap so recovered is returned to the steel plants for recycling or disposal and the Company is paid processing charges on the quantity recovered at varying rates depending on the category of scrap. In addition, the company also provides steel mill services, such as, scaring of slabs and handling of BOF slag.

Steel Plants in India

Several new steel projects are in the pipeline and capacity addition and expansion of existing plants are seriously pursued for implementation.

Projects aiming to add capacity of over 120 million tpy are under various stages of implementation. Memorandum of Understanding (MoUs) signed with steel producers and State Government of Jharkhand, Orissa, Chhattisgarh and West Bengal are highlighted in Annexure-40.

In view of the rising demand, all major steel companies have planned phasewise expansion of their capacities which are briefly discussed below:

Steel Authority of India Ltd (SAIL)

SAIL has five subsidaries, namely, Bokaro Steel Plant (Jharkhand), Bhilai Steel Plant (Chhattisgarh), Rourkela Steel Plant (Orissa), Durgapur Steel Plant (West Bengal) and Indian Iron & Steel Company (West Bengal). These plants have a total of 14.41 million tonnes capacity of Hot Metal. The Company has plans to add new capacity in these plants. The plant capacity of Hot Metal and capacity addition of SAIL are given in Table 8.6.

Table 8.6: Capacity Addition of Hot Metal in the Steel Plant of SAIL

(Unit in million tonnes)

S.No.	Unit of SAIL	Capacity of Hot Metal by 2004-05*	Capacity of Hot Metal by 2012 **	Capacity addition
1.	Bokaro Steel Plant	4.58	6.5	1.92
2.	Bhilai Steel Plant	4.90	7.0	2.10
3.	Rourkela Steel Plant	2.00	3.0	1.00
4.	Durgapur Steel Plant	2.08	3.2	1.12
5.	IISCO Steel Plant	0.85	2.5	1.65
	Total	**14. 41**	**22.2**	**7.79**

Source: * *Replies received from the party by Indian Bureau of Mines*
** *www.sail.co.in*

Rashtriya Ispat Nigam Ltd (RINL)

Vishakhapatnam Steel Plant of RINL is the first shore-based integrated steel plant located at Vishakhapatnam in Andhra Pradesh, with the capacity to produce 3 million tonnes per annum of liquid steel. The Plant's futuristic layout is well-designed so to allow expansion of its capacity to over 10 million tpy. The Plant's first phase of expansion to a level of 6.5 million tpy is slated to be over by 2007-08 after which the next phase to achieve 10 million tpy – targeted for 2018 – would be taken up for completion.

NMDC

NMDC has set up 2.6 lakh tonnes capacity pig iron plant at Nagarnar near Jagdalpur in Chhattisgarh. It has further plans to set up 50,000 tonnes per year of Ductile Iron Spun Pipe (DISP) at Mangalore.

JSW Steel Limited (Jindal Vijayanagar Steel Plant)

The Plant is situated at Tornagallu, Bellary district, Karnataka with a capacity of 1.6 million tpy hot rolled flat steel products. The operation is based on Corex Process. The production facility includes 1.5 million tonnes iron ore beneficiation unit, 4.2 million tpy pellet plant, two corex units of 0.8 million tpy each, 2x130 tonnes convertors, two slab caters & hot strip mill. JVSL has tied up with Euro Ikon Iran & Steel Pvt Ltd (EII SPL) for setting up of 0.9 million tpy blast furnace. Earlier the Company tied up with Euro Coke and Energy Pvt Ltd for 0.62 million tpy coke oven, which became operational in 2004.

Essar Steel Ltd

Essar's expansion of its steel making capacity from 2.4 million tonnes to 4.6 million tonnes at Hazira, Gujarat is underway. A cold rolling (CR) complex of 1.2 million tonnes has also been commissioned at an investment of Rs 1000 crore.

Essar Steel Limited (ESL) has expansion programme in the States of Orissa and Chhattisgarh. Statewise capacity addition and investment for their expansion activities are summarised in Table 8.7.

Table 8.7: ESL's Statewise Capacity Addition & Investment Plan for Expansion Activities

Location/States	Existing capacity	Capacity addition of Hot Metal	Investment
Paradip, Orissa	–	4.0 million tpy	The company plans to set up a steel complex at an estimated cost of Rs 10,000 crore. The scheme also includes installation of pellet plant and iron ore beneficiation plant.
Bastar,Chhattisgarh	–	3.2 million tpy	The company plans to set up a steel plant at Bastar at an estimated cost of Rs 60 billion. In the first phase 1.6 million tonne steel plant with a captive power plant will be set up at an investment of Rs 40 billion.
Hazira, Gujarat	2.4 million tpy	2.2 million tpy	The capacity is expected to expand from 2.40 million tonnes to 4.60 million tonnes at an estimated cost of Rs. 28 billion.
Total	**2.4 million tpy**	**9.40 million tpy**	–

Ispat Industries Ltd

It is one of the largest integrated steel plants in the private sector with a Plant at Dolvi in Raigad district, Maharashtra. The Company plans to expand its hot rolled coils (HRC) capacity at Dolvi from 2.4 million tonnes to 3.4 million tonnes at an investment of Rs 11 billion. The Company also manufactures sponge iron & pig iron at their Dolvi complex. The Company has a DRI plant of 1.6 million tpy capacity and an ultra-modern blast furnace of 2 million tpy capacity to produce hot metal/pig iron. It will also build a 2 million tpy sinter plant which will use iron ore fines for sinter making. A oxygen plant of 1,260 tonnes per day capacity, an Electric Arc Furnace (EAF) and a gas cleaning plant are also in the pipeline. The Company has combined the use of Hot metal and DRI (Sponge Iron) in the Electric Arc Furnace for production of liquid steel for the first time in India. Statewise existing capacity & capacity addition of Ispat Industries Ltd are furnished in Table 8.8.

Table 8.8 : Statewise Existing Capacity and Capacity Addition of Ispat Industries Ltd

Location/State	Existing capacity of Hot Metal	Capacity addition	Investment
Dolvi, Raigad, Maharashtra	2.0 million tpy	-	Hot Rolled coil capacity is to be expanded from 2.4 million tpy to 3.4 million tpy; 2 million tpy Sinter Plant and 1,260 tonnes per day capacity Oxygen Plant are to be set up with an investment of Rs 11 billion.
Paradip, Orissa	-	5.0 million tpy	The company plans to set up a 5 million tpy integrated steel plant with an investment of Rs 12000 crore.

Neelachal Ispat Nigam Limited (NINL)

Neelachal Ispat Nigam Ltd has 1.1 million tonnes per annum capacity of iron & steel plant located at Duburi, Orissa. The NINL along with Government of Orissa have proposals to set up 1 million tonnes steel plant at Kalinganagar, Jajpur, Orissa with an investment of Rs 1,000 crore.

TISCO

TISCO has an integrated steel plant located at Jamshedpur, Jharkhand with an annual crude steel making capacity of 5 million tonnes. TISCO has expansion plans for its existing plant at Jamshedpur and also has plans to set up plants at Kalinganagar (Orissa) and Bastar (Chhattisgarh). The expansion plans of TISCO are furnished in Table 8.9.

Table 8.9: TISCO's Statewise Existing Capacity and Proposed Capacity Addition Plans

(Unit in million tonnes)

Location/State/Unit	Existing capacity of Hot Metal	Capacity addition	Completion tenure/Investment
1. Jamshedpur, Jharkhand	5.0	5.00	The capacity of the Plant will be raised to 7.4 million tonnes by 2009 and further to 10 million tonnes at an investment of Rs 11,000 crore
		12.00	Installation of a 12 million tonnes per year mega unit near the existing plant is to be taken up in two phases. a) In the first phase, 6.0 million tonnes per annum capacity will be installed at a cost of Rs 23,000 crore. b) After completion of the 1st phase another 6.0 million tpy capacity is slated to be added at an investment of Rs 19,000 crore.
2. Kalinganagar, District: Jajpur (Orissa)	–	6.00	Capacity addition is scheduled to be completed in two phases of 3 million tpy each. The first phase is likely to be completed by 2009 at an investment of Rs.15,400 crore.
3. Bastar, Chhattisgarh	-	5.00	5 million tonnes capacity integrated steel plant is to be set up at a cost of Rs 15,000 crore.
Total	**5.0**	**28.0**	-

Bhushan Steel and Strips Limited

New Delhi based Bhushan Steel and Strips Limited has undertaken setting up of steel mill at Dhenkanal district, Orissa. Initial capacity of the Mill will be 3.0 million tonnes which is likely to be raised to 9 million tonnes in the future.

Arcelor Mittal

Arcelor Mittal has plans to set up 12 million tonnes steel mill in Orissa at an investment of Rs 40,000 crores.

The capacity addition of the various steel plants along with the existing capacity are furnished in Table 8.10.

Table 8.10: Installed Capacity & Capacity Additions at Existing Steel Plants

Company	Installed Capacity (million tonnes)	Capacity additions (million tonnes)	Capital Outlay (Rs Crores)
SAIL	14.41	7.19	25,000
Tata Steel	5	28	83,400
Vedanta Resources	-	5	12,500
RINL	3.5	10	8,500
JSW Steel Ltd	-	1.5	2,000
JVS Ltd	1.6	-	-
Visa Steel	-	1.5	1,600
Ispat	2	5	12,000
Essar Steel	2.4	9.4	18,000
NINL	1.1	1.0	1,000
NMDC	-	2.55	NA

Source: *Iron & Steel Review, Dec. 2005*

National Steel Policy (NSP)

The National Steel Policy was announced in 2005. The salient features of the NSP are as follows:

1. The NSP has set a target of 110 million tonnes of domestic steel production by 2019-20. This would require about 190 million tonnes of iron ore.
2. The NSP assumes that 60% of the new steel capacity would come up through blast furnace route, 33% through sponge iron & EAF route and 7% through other routes. Sponge iron units are expected to increase capacity from13 million tonnes at present to 38 million tonnes by 2020, especially in Jharkhand & Orissa. The NSP envisages a judicious blend of exports and domestic supply of steel.

FOREIGN TRADE

Exports

The total exports of iron & steel in 2003-04 steeply increased to 5.15 million tonnes from 4.95 million tonnes in the previous year. Out of the total steel exports in 2003-04 which comprised finished steel including C.R. sheets, semi-finished steel including ingots steel wire, sponge iron, steel scrap and pig iron, major share of the exports were to USA, China and UAE. The exports of iron & steel during the years between 2001-02 and 2003-04 are furnished in Annexure-41. During 2004-05 and 2005-06, the exports of iron & steel were 6.75 million tonnes and 6.73 million tonnes respectively.

Imports

The imports of iron & steel increased from 4.12 million tonnes in 2002-03 to 4.86 million tonnes in 2003-04. Imports were mainly from U.K., Russia, Ukraine, Japan and UAE. Imports of finished steel including CR sheets were mainly from Japan and those of steel wire were from Nepal. However, semi-finished steel including ingots were mainly imported from Ukraine and Russia. The imports of iron & steel for the years between 2001-02 and 2003-04 are furnished in Annexure-42. During 2004-05 and 2005-06, the imports were 6.78 million tonnes and 10.57 million tonnes respectively.

Chapter 9

Summary

Steel axiomatically is the backbone of any country's economy. Iron ore being the main raw material for manufacture of steel assumes a status of a vital mineral commodity that is significant to the development of an economy especially of a developing country like India. Iron ore is one of the important metallic minerals in which India is self-sufficient. India has substantial resources of good quality iron ore. The present production of iron ore in India is not only sufficient for domestic consumption, but also adequate enough for export purposes. India earns considerable amount of foreign exchange through export of iron ore. An attempt has been made in this Report to suggest some remedial measures on the problems related to mining as well as domestic and foreign demand of iron ore. An attempt has also been made to evaluate the demand-supply relationship. The future demand – both domestic and foreign – has been projected up to 2011-12 and further up to the year 2019-20. Besides, the Report also provides information on Uses & Specifications, Prices, Foreign Markets, etc. of iron ore.

USES AND SPECIFICATIONS

Uses

Haematite and magnetite varieties of iron ore are used as principal raw material for the manufacture of iron & steel and sponge iron. About 98% of the total consumption of iron ore is by Iron & Steel and Sponge Iron industries. Iron ore lumps are directly used in the furnaces whereas the fines are converted into pellets or sinters before being used in Iron & Steel and Sponge Iron industries. The other industries in which iron ore is used are cement, coal washery, alloy steel, ferro-alloys, etc. In cement industry, iron ore is used to improve burning properties to balance the composition of the mix so as to impart colour to the cement. In coal washery, magnetite is used as heavy media for separation of impurities from coal.

Specifications

Iron ore is consumed by different industries for different purposes. The physical properties and chemical constituents are taken into consideration while deciding the end-use grade. The Expert Group on "Classification of minerals with regard to their possible optimum industrial uses" September 2004, has prescribed some specifications for iron contents and other impurities. Accordingly the preferred grade of iron ore for use in Steel Industry is the ore with more than 62% Fe. Similarly, the Indian Iron and Steel industries prefer iron ore with 62% Fe on an average. The lowest grade of iron ore consumed is 60.3% Fe by Rourkela Steel Plant and the highest grade of iron ore consumed is 66.6% Fe by Vishakhapatnam Steel Plant.

Silica is an important gangue component associated with iron ore. It is the major constituent of slag produced while smelting. Variation of silica content has direct effect on volume of slag. Silica should be restricted to control the volume of slag. Besides, increased volume of slag results in larger fuel consumption and in turn will result in increase in the cost of production of steel.

In India, silica content in iron ore consumed by steel industries varies from 1% (TISCO) to 6%(RSP). Alumina content which is another important gangue component controls the fluidity of the slag. It is easy to remove sulphur from more fluid slag. The alumina content of iron ore consumed by the Indian Iron & Steel industry varies from 2% (TISCO) to 10% (RSP).

In the case of blast furnaces where coke is used, alumina-silica ratio is an important factor. It should be 1:1 to 1:1.5 with predominant silica.

Sponge iron industry consumes iron ore lumps. The specifications of the feed grade iron ore have been prescribed by the Bureau of Indian Standards (BIS) vide BIS Specification No. IS : 11093 – 1984. According to BIS specifications, iron ore to be consumed in sponge iron industries should be of - 5 mm to + 40 mm size with a tumbler index between 85 to 92. The Fe contents should be + 62 %, $SiO_2 + Al_2O_3$ - 7% maximum, CaO+ MgO - 2% maximum, sulphur 0.03% maximum and P - 0.08% maximum.

In cement industry, the requisite Fe content of iron ore is + 58%. Another important factor is Al_2O_3 content. The Al_2O_3 content in the iron ore used in cement industry largely depends upon the Al_2O_3 content of the limestone in the flux used by particular cement plant. Therefore, the specifications of iron ore in cement industry vary from plant to plant.

The specifications of magnetite consumed in the coal washery have been prescribed vide BIS Specification No. 11894-1986. According to which the specifications of magnetite used in coal washery are Fe 64% minimum and $SiO_2 + Al_2O_3$ - 10-12% minimum, Size (-) 53 micron, 100 percent.

INTERNAL DEMAND

The total consumption of iron ore during 2004-05 in the country was reported as 62.818 million tonnes. The Iron & Steel and Sponge Iron industries accounted for 97% of consumption. The remaining 2.9% was consumed by cement, coal washery, ferro-alloys, and other industries, such as, refractory, chemicals, glass, etc.

Iron ore is consumed in three different forms, i.e., lumps, fines and concentrates. Lumps are consumed directly in the blast furnace, whereas fines are converted into sinters before being consumed in the blast furnace. Concentrates are consumed after conversion into pellets. Coal washeries consume magnetite as heavy media for separating impurities from coal.

The future internal demand of iron ore was calculated by different statistical methods, such as, Arithmetic averaging, Moving average and Trend line methods. The internal demand was also estimated by End-use method, Economical (GDP) projections and Judgemental analysis. The results of estimation of demand projection and judgemental analysis appeared to be more realistic and hence accepted in this Report. The future demands of iron ore for the years 2006-07, 2011-12 and 2019-20, as estimated by the above mentioned method are78 million tonnes, 112 million tonnes and 199 million tonnes respectively.

SUPPLY

Resources

India is endowed with substantial resources of iron ore. Deposits of iron ore are reported from 12 States. Out of which 9 States produce iron ore. The total resources of haematite is 14,630 million tonnes and that of magnetite is 10,620 million tonnes which adds up to 25,250 million tonnes, i.e., the total resources of iron ore.

Haematite

Out of 14,630 million tonnes of total resources of haematite, the reserves are 7,004 million tonnes (47.87%) and the remaining resources are 7,626 million tonnes (52.13%). Out of the 7,004 million tonnes of reserves of haematite, 4, 945 million tonnes is in proved category and 2,059 million tonnes is in probable category. Out of 7,626 million tonnes of remaining resources, feasibility resources, prefeasibility resources, measured resources, indicated resources and inferred resources are placed at 178 million tonnes, 369 million tonnes, 491 million tonnes, 1,032 million tonnes and 4,022 million tonnes respectively. Besides, there is 1,534 million tonnes of reconnaissance resources.

Statewise, Orissa with 4,761 million tonnes (32.5%) of resources of haematite is the highest which is followed by Jharkhand 4,036 million tonnes (27.5%), Chhattisgarh 2,731 million tonnes (19%), Karnataka 1,676 million tonnes (11%) and Goa 713 million tonnes (5%). The remaining 713 million tonnes (5%) is contributed by Maharashtra, Madhya Pradesh, Uttar Pradesh, Rajasthan, etc.

Magnetite

Out of the total 10,619 million tonnes resources of magnetite, total reserves is placed at 58.50 million tonnes (0.6%) and the remaining resources are 10,561 million tonnes (99.4%). Out of the total reserves of 58.50 million tonnes, 14.34 million tonnes is under proved category and 44.16 million tonnes is under possible category. Out of 10,561 million tonnes of remaining resources, feasibility resources is 173 million tonnes, prefeasibility resources is 35.6 million tonnes, measured resources is 1,625.8 million tonnes, indicated resources is 1,878 million tonnes, inferred resources is 6,281 million tonnes and reconnaissance resources is 569 million tonnes.

Statewise, Karnataka with 7,812 million tonnes (74%) of resources is the top most State in the resource tally followed by Andhra Pradesh with 1,464 million tonnes (14%). The remaining 1,344 million tonnes (12%) is contributed by Goa, Rajasthan, Tamil Nadu, Assam, Jharkhand, etc.

PRODUCTION

The production of iron ore since 1993-94 recorded an increasing trend. The production of iron ore which was 59.64 million tonnes in 1993-94 increased by 145% to 154.4 million tonnes in 2005-06. Orissa was the major producing State accounting for 32% of the total production in 2004-05. This was followed by Karnataka (22%), Chhattisgarh (16%), Goa (15.4%) and Jharkhand (11.3%). The remaining 2% was contributed by Andhra Pradesh, Maharashtra, Madhya Pradesh and Rajasthan.

Gradewise, the production of iron ore in 2005-06 was— lumps 62.6 million tonnes (40.54%), fines 87.9 million tonnes (56.93%) and concentrates 3.9 million tonnes (2.52%).

BENEFICIATION

Though India is endowed with substantial resources of iron ore, the reserves of high-grade iron ore are comparatively less. Therefore to conserve these high-grade iron ore reserves, it was felt necessary to upgrade the low-grade iron ore by suitable beneficiation technique and utilise the same to fulfil the market demands.

Research & Development Agencies—Indian Bureau of Mines (IBM), Nagpur; Regional Research Laboratory (RRL), Bhubaneshwar; National Metallurgical Laboratory (NML), Jamshedpur; etc. have carried out beneficiation studies and have developed suitable techniques for upgradation of low-grade iron ore. Various beneficiation methods like—Washing and Wet Scrubbing, Gravity Separation, Magnetic Separation, Electrostatic Separation, Froth & Column Floatation, Agglomeration have been developed and are now adopted for beneficiation of low-grade iron ore. Some modern techniques like Duplex Concentrates, Multi-Gravity Separators (MGS), Wet High Intensity Magnetic Separators (WHIMS), Bartles–Mozley Separator and Cross Belt Concentrator are also used for beneficiation of iron ore.

There are a number of beneficiation plants set up in the country. Major beneficiation plants are owned by M/s SAIL, NMDC, TISCO, OMC, JSW Steel Ltd (formerly Jindal Vijaynagar Steel Ltd), M/s V.M. Salgaonkar Pvt Ltd etc. The beneficiation and processing of iron ore also involves crushing, screening washing, magnetic separation, etc. Almost all the integrated steel plants in the country have their own sintering plants, which make sinters by using iron ore fines. The pelletisation plants that are currently in operation are M/s KIOCL, JSW Steel Ltd, Mandovi Pellets Ltd, High Grade Pellets Ltd of Essar Group, etc.

FOREIGN MARKETS

The world's major resources of iron ore are located in Ukraine, Russia, China, Australia, Kazakhstan, Brazil and India. There are about 370 billion tonnes of iron ore resources in the world. India with 3% share of the world's resources stands presently at eighth position in the world. World production of iron ore at 1,486 million tonnes in 2005 recorded an increasing trend since 2001. India's production of iron ore in 2004-05 was 146 million tonnes.

The iron ore market across the world is experiencing hectic activities especially since 2001. This recent boom in iron ore trade is chiefly attributed to China's heavy demand. The total world exports of iron ore in 2004 was 668 million tonnes. When compared to the 481 million tonnes in the year 2001 the increase is about 39%. Brazil was the leading exporter in 2004 with an export of 218 million tonnes of iron ore followed by Australia 210 million tonnes. India exported 83.07 million tonnes of iron ore in 2004. The world imports of iron ore also showed a similar increasing trend. The total imports which were 497 million tonnes in 2001 increased to 632 million tonnes in 2004. China was the leading importer with imports of 208 million tonnes followed by Japan with 135 million tonnes and Korea with 44.00 million tonnes. India's imports were negligible as compared to other countries.

As far as Indian exports are concerned, an increasing trend has been recorded since 2000-01. The Indian exports which were 20.16 million tonnes in 2000-01 increased to 87.28 million tonnes in 2004-05. Exports of all grades of iron ore and concentrates recorded an increasing trend. The exports of iron ore fines with + 62% Fe was highest at 46.87 million tonnes. The major export destination was China followed by Japan, Korea and European countries.

India is the major exporter of iron ore in Asia. Although there are prospects for increasing exports of Indian iron ore in the world, there is a need to review our export policy keeping in view the recent surge in consumption of iron ore by the domestic steel sector. The National Steel Policy has estimated that exports of iron ore would be 91 million tonnes by 2011-12 and 100 million tonnes by 2020. However, recent trends have indicated that estimates of 2011-12 will be achieved even before 2011-12. However for long haul requirement for export markets, the following steps are necessary:

1. Entering into long-term contracts;
2. Maintenance of strict delivery schedules;
3. Development of infrastructural facilities like Road, Rail and Ports;
4. Rigorous exploration activities to discover new deposits of iron ore;
5. Maintenance of quality standards;
6. Beneficiation of low-grade ores.

It is recommended that exports of high-grade iron ore be restricted in view of its conservation and instead low-grade iron ore after beneficiation should be substituted for utilisation and for fulfilment market demands.

PRICES

The prices of iron ore experienced an increasing trend since 2000-01. The prices of iron ore continuously increased during 2001-02 and 2005-06 and ranged between Rs 133 to Rs 474 in 2001-02 and Rs 375 to Rs 2200 in 2005-06.

The F.O.R. prices of iron ore varied between Rs 375/- and Rs 2200/- for various grades in the year 2005-06. The F.O.B.T. prices of iron ore varied between US $ 28.50 and US $ 49.64.

In the international market more or less the same scenario prevailed. The prices of iron ore showed a steady increasing trend since 2001. In the US market, the price of iron ore which was US $ 23.87 in 2001 increased steadily and reached US $ 44.00 in the year 2005.

DEMAND-SUPPLY

The present domestic mine capacity is sufficient to meet both domestic and export demands.

The internal demand of iron ore projected for the years 2006-07, 2011-12 and 2019-20 are 78 million tonnes, 112 million tonnes and 199 million tonnes respectively. The future exports as estimated by Steel Policy, 2005 for 2006-07, 2011-12, and 2019-20 are 85.26 million tonnes, 90.91 million tonnes and 100 million tonnes respectively.

Against the above estimated demand, the supply of iron ore in the future is likely to be adequate. This is substantiated by the past trend of production, the total resources and the increasing trend in mining capacities. No constraints in the supply of iron ore are foreseen even after 2019-20.

IRON & STEEL

India ranks quite high among the world's largest crude steel producing countries. Steel is used in various industries, such as, Building & construction. Bridges, Highways, Automobile, Pipes & tubes, Consumer durables, Railways and Industrial machinery & equipment, etc. This vast usage of steel makes it the most important industrial commodity. The Steel Industry globally has been on a high witnessing extraordinary and rapid growth. This trend is likely to continue even in the near future.

The per capita consumption of steel in India is only 33 kg which is very low as compared to several developed and many developing countries. India's rapidly expanding economy is expected to boost up the demand of steel in the country. The apparent demand of steel in the year 2004-05 was 33.35 million tonnes registering an increase of 7.01% as compared to 31.17 million tonnes in the preceding year.

In view of the rising demand for steel, all major steel companies have planned phasewise expansion of their capacities. In addition, many new steel plants are likely to come up in the near future. The new economic policies pursued by the Government of India since 1991 have opened opportunities for expansion in the steel industry. Recently, the Government of India has announced National Steel Policy (NSP) 2005. According to NSP, a target of 110 million tonnes of domestic steel production has been set by 2019-20. To achieve this target, the Government has planned some important steps, namely—

1. Additional investment of Rs 20,000 crore.
2. Additional mining capacity of 200 million tonnes of iron ore.
3. Renewal of existing leases against credible mining plans.
4. Grant of fresh leases to capable agencies.
5. Restriction of long term export of iron ore to a maximum of 5 years contracts.
6. Encourage use of fines by way of sintering and pelletisation, etc.

The inherent strength and capabilities of the Iron & Steel Industry of India led to it becoming free from licensing regime, pricing and distribution controls. Iron & Steel Industry of India represents around Rs 90,000 crore capital and provides employment to over 5 lakh people in the country. Steel, in India, is produced in the Primary and Secondary sectors.

In the Primary Sector, there are 11 integrated steel plants. Seven in Public and four in Private Sector with some new projects which have already been commissioned. Units with overall capacity of 34 million tonnes of crude steel are under operation in the country in the Primary Sector.

India is the largest producer of sponge iron in the world. Sponge iron is directly used by the secondary producers in steel making. The installed capacity of sponge iron in India has increased from 1.52 million tonnes in 1990-91 to 10.30 million tonnes in 2004-05. There are about 227 sponge iron units in India. Out of these 227 units, 3 sponge iron units are gas-based and the remaining 224 units are coal-based.

Iron & Steel scrap is one of the essential requirements for manufacture of steel in Induction Furnaces and Electric Arc Furnaces (mini-steel plants). The scrap generated by the industrial sectors like, automobile, railways and engineering workshops is used as an important raw material for production of iron and steel products. Ship-breaking has become the major source of iron & steel scrap. Besides, about 4.8 million tonnes of scrap was reportedly imported in 2005-06.

Iron & steel is a highly traded commodity in the world. India exported 6.73 million tonnes of iron & steel in 2005-06 which included C.R. sheets, semi-finished steel ingots, wires, sponge iron, etc. India's exports were mainly to USA, China and UAE. India also imported 10.57 million tonnes of iron & steel in 2005-06. The imports were mainly from UK, Russia, Ukraine, Japan, UAE, etc.

Annexures

Annexure –1

Specifications of Iron Ore Consumed in Blast Furnace by Major Steel Plants

S. No.	Name of the Plant	Specifications					
		Size	Fe	Al_2O_3	SiO_2	P	S
1.	Bhilai Steel Plant	10–40 mm	62.4–64% min.	-	0.9%	0.1%	N.A.
2.	Bokaro Steel Plant	10–40 mm	62.5–63.5%	2.15% max.	2.23% max.	N.A.	N.A.
3.	Rourkela Steel Plant	10–50 mm	63.2%	3.01%	1.69%	0.15%	N.A.
4.	Durgapur Steel Plant	10–50 mm	63.0%	2.24%	1.8%	0.15%	N.A.
5.	Indian Iron & Steel Co.	8–10 mm	62.5–63.5%	4.5% max	2.5%	N.A.	N.A.
6.	Visakhapatnam Steel Plant	10–25 mm	66.9%	1.6%	0.9%	N.A.	N.A.
7.	Kalinga Iron Works	10–30 mm	65%	Al_2O_3+ SiO_2 – 5% max.		N.A.	N.A.
8.	Visveswaraya Steel Plant	10–30 mm	62–63%	1.5 –5%	2-5%	N.A.	N.A.
9.	Tata Iron & Steel Co. Ltd	10–50 mm	64–67%	2.0–3.9%	0.8 to 1.7%	0.15%	0.01%
10.	Essar Steel Ltd	10–40 mm	67%	Al_2O_3+ SiO_2– 2.60%		0.05%	0.01%
11.	JSW Steel Ltd	10–30 mm	64.5%	Al_2O_3+ SiO_2– 4.5% max.		0.1%	0.02%

Data supplied by different plants

Annexure – 2

Specifications of Iron Ore Consumed by Major Sponge Iron Plants

S.No.	Name of the Plant	Specifications					
		Size	Fe	Al_2O_3	SiO_2	P	S
1.	Orissa Sponge Iron Plant	5–10 mm	65% min	Al_2O_3+ SiO_2– 4.5% max.		0.03	N.A.
2.	Vikram Ispat	9–16 mm	66%	Al_2O_3+ SiO_2– 2.6% max.		0.05	0.01
3.	HEG Ltd	5–18 mm	65% min	Al_2O_3+ SiO_2– 5% max.		0.06	0.03
4.	Sunflag Iron & Steel Ltd	5–20 mm	67.5%	N.A.	N.A.	N.A.	N.A.
5.	Sponge Iron India Ltd	6–18 mm	62%	N.A.	N.A.	N.A.	N.A.
6.	Essar Steel Ltd	10–40 mm	67%	Al_2O_3+SiO_2– 2.60% max.		0.05	0.01
7.	Jindal Steel & Power Ltd	10–30 mm	65% min	N.A.	3% max.	0.05	N.A.
8.	Tata Sponge Iron Ltd	5–18 mm	65–67%	Al_2O_3+SiO_2– 5.6%		N.A.	N.A.
9.	GSAL India Ltd	10–40 mm	62%	N.A.	N.A.	N.A.	N.A.
10.	Raipur Alloys & Steel Ltd	5–18 mm	65–66%	N.A.	N.A.	N.A.	N.A.

Data supplied by different plants

Annexure – 3

Total Consumption of Iron Ore in India during 1991-92 to 2003-04

(In '000 tonnes)

Year	Total consumption
1991-92	24,389
1992-93	25,785
1993-94	27,148
1994-95	29,623
1995-96	31,986
1996-97	34,068
1997-98	34,576
1998-99	32,520
1999-2000	33,912
2000-01	37,168
2001-02	38,185
2002-03	45,987
2003-04	51,259

Source : *Replies received from consumers of iron ore on non-statutory basis*

Annexure – 4

Consumption Pattern of Iron Ore, 1999-2000 to 2003-04

(In tonnes)

Industry	1999-2000	2000-01	2001-02	2002-03	2003-04(p)
All industries	**33,911,700**	**37,167,800**	**38,184,600**	**45,987,098**	**51,259,000**
Alloy steel	160,000	72,200	297,700	360,400	360,400
Cement	750,000	726,400	701,200	887,800	824,900
Coal washery	59,700	59,100	59,100	59,100	47,900
Ferro-alloys	5,600	5,500	5,600	5,400	5,800
Iron and steel	27,862,900	31,263,500	32,223,500	33,617,398	37,091,000
Sponge iron	5,072,300	5,040,100	4,896,600	11,056,000	12,928,000
Others (Chemical, Foundry, Glass & Refractory	1,200	1,000	900	1,000	1,000

P: provisional
Source: *Replies received from consumers of iron ore on non-statutory basis*

Annexure – 5

Internal Demand of Iron Ore during the Year 2004-05

(Unit in tonnes)

Name of Plant	Iron ore consumed	Hot metal produced	Ratio*
1. Electrosteel Casting Kolkata Ltd, Stephen House, 4B. B.D Bag (East), Kolkata (WB)	271,246 1/	176,134 4/	-
2. JSW Steel Limited Jindal Vijaynagar Steel Ltd., P.O. Vidyanagar-583275 Toranagallu, Bellary, Karnataka	2,644,676 1/	1,717,322 4/	-
3. Kirloskar Ferrous Industries Ltd, Laxman Rao Kirloskar Road, Pune, Maharashtra	463,085 1/	300,704 4/	-
4. Industrial Developoment Corporation of Orissa Ltd, P.O. Jajpur Road,-755020, Cuttack, Orissa	170,973 1/	96,906	1.76
5. Visvesvaraya Iron & Steel Ltd, Bhadravati – 577301, Karnataka	246,263 2/	167,919	1.47
6. Indian Iron & Steel Co.Ltd, Burnpur Works, Burnpur – 713325, Burdwan, W.B	997,438 2/	683,553	1.59
7. Rourkela Steel Plant P.O. Rourkela – 769011,Orissa	2,696,251 2/	1,690,744	1.59
8. Durgapur Steel Plant, Durgapur – 713203, Dist. Burdwan, West Bengal	320,900 2/	2,017,000	1.59
9. Bokaro Steel Plant, Bokaro Steel City, Jharkhand – 827 001	6,233,987 2/	4,131,792	1.51
10. Bhilai Steel Plant, Bhilai – 490001, Chhattisgarh	7,463,905 2/	4,511,179	1.65
11. Rashtriya Ispat Nigam Ltd, Vishakhapatnam Steel Plant (VSP) Project Office Complex, Vishakhapatnam – 530031 Andhra Pradesh	6,136,000 2/	3,920,000	1.57
12. Tata Iron & Steel Co. Ltd, Bombay House, 24, I, Modi Street, Mumbai – 400001, Maharshtra	5,986,753 3/	4,347,000	1.38
13. Jindal Steel & Power Ltd, P.B. No. 16, Kharsia Road, Raigarh, Chhattisgarh-496001	324,243 2/	220,023	1.47
14. ISPAT Industries Ltd, Dolvi, Geetapuram, Taluka Pen, Dist. Raigad, (Maharashtra) Dolvi – 402 109	2,065,000 5/	1,340,909 4/	1.04
15. Lanco Industries Limited, Rachagunneri – 517641 Srikalahasti Mandal, Chittor Dist. (A.P.)	166,856	88,887 1/	1.88*
16. Others	-	2,797,720 6/	-
Total	**43,440,000 7/**	**28,207,792**	**Av. 1.54**

Ratio (1.54) per tonne required iron ore for production of hot metal. Due to higher consumption ratio of Lanco Industries Ltd, it has not been taken into calculation of average ratio of iron ore.

1/ **Source :** *Industrywise consumption from Indian Minerals Yearbook*

2/ *Reply received from various plants*

3/ *98th Annual Report of TISCO, 2004-05.*

4/ *Estimated by applying a ratio of 1.54 to the iron ore consumed for production of hot metal.*

5/ *Production of hot metal for the year 2004-05. Source: www.ispatind.com/Blast Furnace. As per Annual Report 2004-05.*

6/ *Production of pig iron other than integrated steel plant. Data compiled from different sources.*

7/ *Estimated by applying a ratio of 1.54 to the hot metal for iron ore.*

Annexure – 6

Plantwise Norm of Consumption of Iron Ore Per Tonne of Sponge Iron Produced

Company name	Location	Norm of consumption of iron ore
M/s Tata Sponge Iron limited, PO - Joda, Keonjhar- 750038 (Orissa)	Bileipada, Keonjhar, Orissa	1.6 tonnes per tonne of sponge iron
Sponge Iron India Ltd., Khanij Bhavan (6th floor), 10-3-311/A Castle Hills, Masab Tank, Hydrabad-500025	Paloncha, Khammam, Andhra Pradesh	1.70 tonnes of iron ore/ tonne of sponge iron
GSAL (India) Limited, 104, Sai Dharani Castle, Gopalapatnam Main Road, Visakhapatnam-530027	Sreerampuram, Vizianagram, Andhra Pradesh	N.A.
Essar Steel Limited, Flat No.1002, 10th Floor, Srinivasa Tower, 6-3-1187, Begumpet, Hyderabad-500016.	Hazira, Dist.Surat (Gujarat)	1.85
HEG Limited, Mandideep (Near Bhopal) Dist. Raisen (M.P.)-462046	Rasmada,Durg, Chhattisgarh	1.6 tonnes of iron ore
Vikram Ispat, Ahura Centre, 1st Floor, 82, Mahakali Caves Road, Andheri(E), Mumbai-400018.	Salav, Raigad, Maharashtra	1.5 tonnes per tonne of sponge iron
		Av. 1.6 Av. 1.65 or say (1.7)

Source: *Replies received from sponge iron Plants*

Annexure – 7

World Resources of Iron Ore (By Principal Countries)

(In million tonnes of Crude Ore)

S. No.	Name of the country	Reserve base
	World Total	**370,000**
1.	Australia	40,000
2.	Brazil	61,000
3.	Canada	3,900
4.	China	46,000
5.	India	9,800*
6.	Iran	2,500
7.	Kazakhstan	19,000
8.	Mauritania	1,500
9.	Mexico	1,500
10.	Russia	56,000
11.	South Africa	2,300
12.	Sweden	7,800
13.	Ukraine	68,000
14.	USA	15,000
15.	Venezuela	6,000
16.	Other Countries	30,000

Source: *Mineral Commodity Summaries, 2006; Figures rounded off*

* *India's total resources of magnetite and haematite as per NMI as on 1.4.2005 are estimated at 10,620 million tonnes and 14,630 million tonnes respectively and total resources of magnetite & haematite are 25,250 million tonnes.*

Annexure – 8

World Production of Iron Ore (By Principal Countries)

(Unit in million tonnes)

S. No	Name of the country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	World Total	**1018**	**1063**	**1050**	**1015**	**1085**	**1049**	**1118**	**1238**	**1370**	**1544**
1.	Australia	152	156	160	152	171	181	189	213	234	262
2.	Brazil	174	184	199	199	212	201	215	235	262	281
3.	Canada	35	37	37	32	36	29	29	33	29	28
4.	China	252	268	246	237	223	217	231	261	310	420
5.	India	68	75	72	75	80	86	99	121	146	154
6.	Kazakhstan	7	13	9	10	16	16	18	19	20	19
7.	Russia	72	70	72	82	87	83	84	92	95	97
8.	South Africa (a)	30	33	32	30	33	35	36	38	39	40
9.	Sweden	21	20	21	19	19	19	20	21	22	23
10.	Ukraine	47	52	51	48	55	55	59	63	66	69
11.	USA	62	62	63	58	63	46	52	50	55	55
12.	Venezuela	18	18	17	14	17	17	17	18	19	20
13	Other Countries	80	75	71	59	73	64	69	74	73	76

Source: *1. World Mineral Production, 2001-2003.*
2. USGS Mineral Commodity Summaries January, 2006
(a) Including by-products of magnetite

Annexure – 9

World Exports of Iron Ore (By Principal Countries)

(Unit in million tonnes)

S .No.	Country	1995	1996	1997	1998	1999	2000	2001	2002	2003*	2004*
	World Total	**441**	**423**	**457**	**459**	**433**	**485**	**481**	**548**	**583**	**668**
1.	Australia	130	128	146	136	146	158	157	166	187	210
2.	Brazil	130	128	134	150	140	157	156	167	175	218
3.	Canada	28	28	33	30	27	27	22	26	27	23
4.	Chile	6	6	6	7	6	6	6	6	6	6.(e)
5.	India	31	17	19@	22	16	20	23	57	63@	83@
6.	Kazakhstan	-	3	8	7	3	5	5(e)	5.(e)	11	10
7.	Russia	11	13	11	13	11	19	14	13	13	13(e)
8.	South Africa	21	19	20	22	21	21	24	24	25	25(e)
9.	Sweden	16	15	17	14	14	16	14	14	16	17
10.	Ukraine	19	19	20	17	13	19	24	24	25	27
11.	USA	5	6	6	6	6	6	6	7	7	8
12.	Venzuela	10	9	9	8	7	7	7	7	7	7(e)
13.	Other Countries	34	32	28	27	23	24	23	32	21	21(e)

e : *estimated*
* : *Data collected from internet sites of USGS, March 2003 and March 2004*
@: *As per DGCIS, exports were 29 million tonnes in 1997, 51 million tonnes in 2003 and 87 million tonnes in 2004*

Annexure – 10

World Imports of Iron Ore
(By Principal Countries)

(Unit in million tonnes)

S. No.	Country	1995	1996	1997	1998	1999	2000	2001	2002	2003*	2004*
	World Total	**444**	**423**	**476**	**475**	**473**	**508**	**497**	**524**	**562**	**632**
1.	Austria	5	4	5	5	4	5	5(e)	5.(e)	6	6
2.	Belgium	15	13	11	13	12	12	11	12	12	11
3.	Bulgaria	1	1	2	2	1	2	1	1	2	2
4.	Canada	6	7	7	7	7	7	5	7	7	8
5.	China	41	44	55	52	55	70	92	111	148	208
6.	Czech. Rep.	9	8	7	7	5	7	7	7	8	8
7.	France	20	18	20	20	20	20	17	19	19	21
8.	Finland	3	3	4	4	34	4	4	4	4	4
9.	Germany	43	39	42	54	39	48	40	44	34	43
10.	Hungary	2	2	1	2	2	2	2	2	2	1
11.	Italy	18	16	17	16	16	18	16	15	15	17
12.	Japan	120	119	127	121	120	132	126	129	132	135
13.	South Korea	35	23	39	34	35	39	46	43	59	44
14.	Netherlands	9	8	9	9	78	8	6	7	9	13
15.	Poland	11	10	11	10	7	10	8	7	9	11
16.	Romania	6	6	7	67	4	5	4	7	7	7
17.	Russia	4	4	5	67	3	9	9	9	9	10
18.	Slovakia	5	4	4	4	4	5	3	5	6	3
19.	Spain	7	6	6	7	6	6	7	6	6	6
20.	Taiwan	9	10	14	14	13	15	16	15	15(e)	15(e)
21.	Turkey	3	3	3	34	3	4	3	5	5	5
22.	UK	21	20	21	21	17	17	15	13	16	15
23.	USA (a)	17	18	19	17	14	16	11	12	13	12
24.	Other Countries	34	37	40	38	44	47	42	39	19	27

Note: *(a) = Including burnt pyrite*

* *Data collected from internet sites of USGS, Mining Annual Review, 2004 and Mining Annual Review, 2005*

Annexure – 11

Gradewise Exports of Iron Ore from India from 2002-03 to 2005-06

(In '000 tonnes)

S. No.	Grade	2002-03	2003-04*	2004-05	2005-06
1.	Iron ore conc. (Non-agglomerated)	2201	3168	8377	1940
2.	Iron ore fines 62% Fe and above	37770	31398	46872	52444
3.	Iron ore below 62%	2175	2642	4698	6383
4.	Iron ore lumps 60% Fe and above	12351	10864	19767	16812
5.	Iron ore lumps below 60%	1345	960	2138	2919
6.	Iron ore pellets	1253	2465	5332	3548
7.	Iron ore pyrites roasted/un-roasted	-	-	-	-
	Total of all grades	**57095**	**51495**	**87184**	**84066**

* *The data on exports were supplied by DGCIS and the data supplied by the Goa Mineral Exporters' Association do not match with DGCIS data. For gradewise and countrywise export from India Annexures 12-A, 12-B and 12-C may be referred*

Source: *DGCIS, Kolkata*

Annexure 12–A

Countrywise & Gradewise Exports of Iron Ore from India in 2002-03

(In '000 tonnes)

Name of Country	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Australia	-	158	-	-	-	-	158
Bangladesh	1	63	-	-	-	-	64
Belgium	-	285	-	-	-	-	285
China	1601	16923	204	5211	-	1217	25156
Chinese Taipei	-	370	-	493	-	-	863
France	-	18	299	-	-	-	317
Germany	-	62	-	72	-	-	134
Hong Kong	69	190	-	127	-	-	386
Iran	77	17	-	-	-	-	94
Italy	-	94	72	-	-	-	166
Japan	372	13691	1221	5033	1300	36	21653
Kenya	-	6	8	-	-	-	14
Korea, Republic of	81	2143	-	767	-	-	2991
Korea, Dem. Rep. of	-	279	-	-	-	-	279
Kuwait	-	65	37	-	-	-	102
Mauritius	++	-	-	-	-	-	++
Nepal	-	-	-	1	-	-	1
Netherlands	-	1300	-	51	45	-	1396
Oman	-	4	4	++	-	-	8
Pakistan	-	537	55	372	-	-	964
Qatar	-	1	-	-	-	-	1
Romania	-	913	226	-	-	-	1139
Russia	-	263	-	-	-	-	263
Singapore	-	-	-	203	-	-	203
Sweden	++	-	-	-	-	-	++
Thailand	-	13	-	-	-	-	13
Turkey	-	143	-	-	-	-	143
UAE	-	146	49	-	-	-	195
USA	-	86	-	21	-	-	107
Total	**2201**	**37770**	**2175**	**12351**	**1345**	**1253**	**57095**

++: *Negligible*

Source: *DGCIS, Kolkata*

Annexure 12–B

Countrywise & Gradewise Exports of Iron Ore from India in 2003-04

(In '000 tonnes)

Name of Country	Conc.	Fines		Lumps		Pellets	Total
	Non-agglomerated	+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Australia	-	81	-	-	-	-	81
Bangladesh	++	-	-	-	-	-	++
Belgium	-	192	-	-	-	-	192
China	1844	23410	1386	6362	150	2073	35225
Chinese Taipei	-	121	-	239	-	245	605
Hong Kong	270	479	288	234	57	-	1328
Iran	176	-	-	-	-	-	176
Italy	-	-	270	1	-	-	271
Japan	766	5456	541	3109	636	59	10567
Korea RP	71	757	-	573	-	-	1401
Korea DR RP	-	31	-	-	-	-	31
Nepal	++	-	-	-	-	-	++
Netherlands	-	305	-	-	117	-	422
Oman	-	4	-	-	-	-	4
Pakistan	40	273	-	169	-	-	482
Romania	-	203	136	-	-	-	339
Saudi Arabia	-	41	-	-	-	-	41
Singapore	-	-	-	-	-	44	44
Sri Lanka	++	-	-	-	-	-	++
UAE	++	45	21	111	-	44	221
USA	1	-	-	-	-	-	1
Unspecified	-	-	-	66	-	-	66
Total	**3168**	**31398**	**2642**	**10864**	**960**	**2465**	**51497**

++ : Negligible
Source : DGCIS, Kolkata

Annexure 12–C

Countrywise & Gradewise Exports of Iron Ore from India in 2004-05

(In '000 tonnes)

Name of Country	Conc.	Fines		Lumps		Pellets	Total
	Non-agglomerated	+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Australia	-	-	-	44	-	-	44
Bangladesh	-	63	-	-	-	-	63
Belgium	-	319	-	-	-	-	319
China	2449	37586	3310	12452	1297	3157	60251
Chinese Taipei	-	166	-	34	-	361	561
France	-	59	-	-	-	-	59

contd...

Annexure 12–C (concld)

(In '000 tonnes)

Name of Country	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Germany	++	-	-	-	-	-	++
Hong Kong	93	20	140	209	-	-	462
Iran	78	-	-	-	-	-	78
Indonesia	-	-	-	-	-	439	439
Italy	-	-	-	9	-	474	483
Japan	404	5852	92	4258	639	-	11245
Kenya	++	-	-	-	-	-	++
Korea, Rep. of	-	648	-	2052	-	-	2700
Kuwait	-	26	58	-	41	-	125
Myanmar	++	-	-	-	-	-	++
Nepal	++	-	-	-	-	-	++
Netherlands	-	740	-	86	102	-	928
Pakistan	-	644	-	279	46	-	969
Romania	-	425	909	-	-	110	1444
Saudi Arabia	5300	-	-	-	-	-	5300
Singapore	-	73	-	266	-	45	384
South Africa	-	-	-	-	++	++	++
Spain	-	-	-	-	-	++	++
Sri Lanka	-	++	++	-	-	-	++
Sweden	++	-	-	-	-	22	22
Switzerland	-	-	-	77	-	680	757
Thailand	++	-	-	-	-	-	++
Turkey	-	176	-	-	-	-	176
UAE	-	-	65	-	13	44	122
UK	-	75	124	-	-	-	199
USA	53	-	-	1	-	-	54
Total	**8377**	**46872**	**4698**	**19767**	**2138**	**5332**	**87184**

++: *Negligible*
Source: *DGCIS, Kolkata*

Annexure 12–D

Countrywise & Gradewise Exports of Iron from India in 2005-06

(In '000 tonnes)

Name of Country	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Bangladesh	21	1	-	4	-	-	26
Belgium	-	190	-	-	-	-	190
Canada	++	-	-	-	-	-	++
China	1549	45333	5569	12008	1773	3520	69752
Chinese Taipei	-	131	-	-	-	-	131
Cyprus	++	-	-	-	-	-	++

contd...

Annexure 12–D (concld)

(In '000 tonnes)

Name of country	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	-62% Fe	+60% Fe	-60% Fe		
France	6	-	-	-	-	-	6
Hong Kong	89	94	-	182	-	-	365
Iran	-	-	-	-	-	-	-
Indonesia	-	-	-	++	-	-	++
Japan	255	5010	213	3532	971	-	9981
Kenya	-	-	-	-	-	-	-
Korea, Republic of	-	548	-	744	-	-	1292
Kuwait	-	-	59	-	57	-	116
Nepal	-	-	-	-	1	-	1
Netherlands	-	549	-	-	117	-	666
Oman	-	12	-	-	-	-	12
Pakistan	-	99	97	341	-	-	537
Romania	-	160	378	-	-	-	538
Saudi Arabia	-	++	-	-	-	-	++
Singapore	-	10	-	-	-	-	10
Sri Lanka	-	-	++	1	-	-	1
Switzerland	-	-	-	-	-	28	28
Thailand	-	-	-	-	-	-	-
Turkey	-	140	67	-	-	-	207
UAE	20	140	-	-	-	-	160
USA	++	-	-	-	-	-	++
Venezuela	-	-	-	++	-	-	++
Unspecified	-	27	-	-	-	-	27
Total	**1940**	**52444**	**6383**	**16812**	**2919**	**3548**	**84046**

++: *Negligible*

Source: *DGCIS, Kolkata*

Annexure – 13

Gradewise Imports of Iron Ore into India from 2002-03 to 2005-06

(In'000 tonnes)

S.No.	Grade	2002-03	2003-04	2004-05	2005-06
1.	Iron ore conc. (Non-agglomerated)	++	++	++	-
2.	Iron ore fines 62% Fe and above	Nil	890	Nil	-
3.	Iron ore below 62%	Nil	Nil	Nil	-
4.	Iron ore lumps 60% Fe and above	119	330	140	323
5.	Iron ore lumps below 60%	Nil	Nil	Nil	-
6.	Iron ore pellets	401	347	345	288
	Total of all grades	**520**	**1567**	**485**	**611**

Source: *DGCIS, Kolkata*

++: *Negligible*

Annexure 13–A

Countrywise & Gradewise Imports of Iron Ore into India in 2002-03

(In '000 tonnes)

Name of country	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Bahrain	-	-	-	-	-	255	255
Brazil	-	-	-	119	-	146	265
Germany	++	-	-	-	-	-	++
Saudi Arabia	++	=	=	=	=	=	++
USA	++	=	=	=	=	=	++
Total	**-**	**-**	**-**	**119**	**-**	**401**	**520**

++: *Negligible*
Source: *DGCIS, Kolkata*

Annexure 13–B

Countrywise & Gradewise Imports of Iron Ore into India in 2003-04

(In '000 tonnes)

Name of country	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Bahrain	-	-	-	-	-	239	239
Brazil	-	-	-	329	-	108	437
China	-	822	-	-	-	-	822
Germany	++	-	-	-	-	-	++
Hong Kong	-	-	-	1	-	-	1
Iran	-	-	-	1	-	-	1
Japan	-	68	-	-	-	-	68
Total	**-**	**890**	**-**	**331**	**-**	**347**	**1568**

++: *Negligible*
Source: *DGCIS, Kolkata*

Annexure 13–C

Countrywise & Gradewise Imports of Iron Ore into India in 2004-05

(In '000 tonnes)

Name of country	Conc. Non-agglomerated	Fines		Lumps		Pellets	Total
		+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Bahrain	-	-	-	-	-	146	146
Brazil	-	-	-	140	-	199	339
Iran	++	-	-	++	++	-	++
Total	**-**	**-**	**-**	**140**	**-**	**345**	**485**

++: *Negligible*
Source: *DGCIS, Kolkata*

Annexure 13–D

Countrywise & Gradewise Imports of Iron Ore into India in 2005-06

(In '000 tonnes)

Name of country	Conc.	Fines		Lumps		Pellets	Total
	Non-agglomerated	+62% Fe	-62% Fe	+60% Fe	-60% Fe		
Bahrain	-	-	-	-	-	288	288
Brazil	-	-	-	322	-	-	322
Hong Kong	-	-	-	++	++	-	++
Indonesia	-	-	-	++	-	-	++
Iran	-	-	-	1	++	-	1
UAE	-	-	-	++	-	-	++
USA	++	-	-	-	-	-	++
Total	-	-	-	323	-	288	611

++: *Negligible*

Source: *DGCIS, Kolkata*

Annexure – 14

United Nations Framework Classification (UNFC)

The UNFC consists of a three dimensional system with the following three axes—Geological Assessment, Feasibility Assessment and Economic Viability. The process of geological assessment is generally conducted in stages of increasing details. The typical successive stages of geological investigation, i.e., reconnaissance, prospecting, general exploration and detailed exploration generate resource data with a clearly defined degree of geological assurance. These four stages are, therefore, used as geological assessment categories in the classification. Feasibility assessment studies form an essential part of the process of assessing a mining project. The typical successive stages of feasibility assessment, i.e., geological study as initial stage, followed by pre-feasibility study and feasibility study/mining report are used. The degree of economic viability including economic or sub-economic is assessed in the course of pre-feasibility and feasibility studies. A pre-feasibility study provides a preliminary assessment with a lower level of accuracy than that of a feasibility study by which economic viability is assessed in detail.

It is a three-digit-code based system, the economic viability axis representing the first digit, the feasibility axis the second digit and the geologic axis the third digit. The three categories of economic viability have codes 1, 2 and 3 in decreasing order. Similarly, the three categories of feasibility study have codes 1, 2 and 3 while the four stages of geological assessment are represented by 4 codes, i.e., 1 (detailed exploration), 2 (general exploration), 3 (prospecting) and 4 (reconnaissance). Thus, the highest category of resources under UNFC system will have the code (111) and lowest category the code (334). The various terms used in this classification and their definitions are as follows:

Total Mineral Resources

Reserve plus Additional or Remaining Resource comprises the Total Resource, or Total Resource minus Reserve gives the Remaining Resource.

A. *Mineral Reserve*

Economically mineable part of measured and/or indicated mineral resource.

(i) Proved Mineral Reserves (111)
Economically mineable part of Measured Mineral Resource

(ii) Probable Mineral Reserves (121 and 122)
Economically mineable part of indicated or in some cases, a measured mineral resource.

B. *Mineral Resource*

A Mineral Resource (Remaining or Additional Resource) is the balance of the Total Mineral Resources that has not been identified as a Mineral Reserve.

(i) Measured Mineral Resource (331)
That part of mineral resource for which tonnage, density, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence, i.e., based on detailed exploration.

(ii) Indicated Mineral Resource (332)
Tonnage, density, shape, physical characteristics grade and mineral content can be estimated with reasonable level of confidence based on exploration, sampling and testing information, location of borehole, pits, etc., too widely spaced.

(iii) Inferred Mineral Resource (333)
Tonnage, grade and mineral content can be estimated with low level of confidence inferred from geological evidence.

(iv) Reconnaissance Mineral Resource (334)
Estimates based on regional geological studies and mapping, airborne and indirect methods, preliminary field inspections as well as geological inference and extrapolation.

(v) Pre-feasibility Mineral Resource (221 and 222)
That part of an indicated and in some circumstances, measured mineral resource that has been shown by pre-feasibility study to be not economically mineable.
Possibly economically viable subject to changes in technological, economic, environmental and/or other relevant conditions.

(vi) Feasibility Mineral Resource (211)
That part of measured mineral resource, which after feasibility study has been found to be economically not mineable.

C. *Uneconomic Occurrence*

Materials of estimated quantity that are too low in grade or for other reasons are not considered potentially economical. Thus, Uneconomic Occurrence is not part of a mineral resource. If quantity and quality are considered worthy of reporting, it should be recognised that an Uneconomic Occurrence cannot be exploited without major technological and/or economic changes, which are not currently predictable.

D. *Mineral Occurrence*

A mineral occurrence is an indication of mineralisation that is worthy of further investigation. The term mineral occurrence does not imply any measure of volume/tonnage or grade/quality and is thus not part of a mineral resource.

Annexure – 15

Reserves/Resources of Iron Ore (Haematite) as on 1.4.2005 (By Grades/States)

(In '000 tonnes)

Grade/State	Reserves				Remaining resources								Total
	Proved STD111	Probable STD121	Probable STD122	Total (A)	Feasibility STD211	Pre-feasibility STD221	Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	resources (A+B)
All India : Total	**4945329**	**995556**	**1063283**	**7004168**	**178449**	**101713**	**267013**	**491631**	**1031763**	**4021763**	**1533887**	**7626219**	**14630387**
By Grades													
Lump, high grade	537663	167697	108732	814092	51957	6433	3785	38419	32251	260525	1680	395050	1209142
Lump, medium grade	1183120	206967	282719	1672806	10862	37215	149835	154117	528826	997268	7932	1886055	3558861
Lump, low grade	471383	24548	43199	539130	6733	9073	25823	13392	70502	773926	103	899552	1438682
Lump, unclassified grade	8153	3309	6146	17608	63860	0	0	16768	32934	180257	0	293819	311427
Fines, high grade	146524	80538	17100	244162	4500	0	4500	45336	8676	43559	0	106571	350733
Fines, medium grade	1071378	400526	39430	1511334	900	11243	11839	177185	269655	612470	443	1083735	2595069
Fines, low grade	965434	66555	64349	1096338	13730	22844	18867	14020	72535	396927	4	538927	1635265
Fines, unclassified grade	16692	2364	3004	22060	268	1529	0	8452	12908	141181	0	164338	186398
Lumps & fines, high grade	213190	20308	12548	246046	24990	0	47000	0	0	47132	8285	127407	373453
Lumps & fines, medium grade	171128	12463	176304	359895	0	984	433	176	0	77513	13122	92228	452123
Lumps & fines, low grade	118088	6634	229556	354278	649	3951	0	17087	2400	204759	19619	248465	602743
Lumps & fines, unclassified	39853	2015	77693	119561	0	73	4755	6647	0	271340	2700	285514	405075
Black iron ore	0	746	1775	2521	0	2788	158	0	1059	8716	0	12721	15242
Others	715	887	17	1619	0	4440	18	34	0	562	0	5054	6673
Unclassified	1983	0	0	1983	0	0	0	0	0	0	0	0	1983
Not-known	25	0	710	735	0	1140	0	0	18	5630	1480000	1486788	1487523
By States													
Andhra Pradesh	24961	7377	7258	39596	205	0	0	377	1054	121807	0	123443	163039
Assam	0	0	0	0	0	0	0	8600	2400	1600	0	12600	12600
Bihar	0	0	0	0	0	0	0	0	0	55	0	55	55
Chhattisgarh	570227	190285	0	760512	101548	0	656	81555	526906	779609	480000	1970274	2730786
Goa	268126	93658	96919	458703	25018	33010	48403	3327	7906	136581	0	254245	712948
Jharkhand	2237629	35730	221065	2494424	0	343	328	30000	50000	460651	1000000	1541322	4035746
Karnataka	465677	190168	284584	940429	939	5524	1034	274600	43380	400813	9502	735792	1676221
Madhya Pradesh	21093	2355	10469	33917	8280	451	4500	4710	1760	151310	10	171021	204938
Maharashtra	9816	3520	661	13997	0	4852	0	79793	71806	62566	32343	251359	265356
Meghalaya	0	0	0	0	0	0	0	0	0	225	0	225	225
Orissa	1341025	470129	440623	2251777	42459	55443	211673	8668	315042	1863531	12032	2508848	4760625
Rajasthan	6774	2334	1705	10813	0	2090	419	0	11510	5016	0	19035	29848
Uttar Pradesh	0	0	0	0	0	0	0	0	0	38000	0	38000	38000

Figures rounded off. Hence, total may not tally.

Annexure – 16

Reserves/Resources of Iron Ore (Magnetite) as on 1.4.2005 (By Grades/States)

(In '000 tonnes)

Grade/State	Reserves				Remaining resources								Total
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	resources (A+B)
		STD121	STD122			STD221	STD222						
All India : Total	**14339**	**38767**	**5397**	**58503**	**173273**	**9120**	**25460**	**1624796**	**1878483**	**6280882**	**568964**	**10560978**	**10619481**
By Grades													
Metallurgical	424	102	162	688	173096	840	25449	694836	338764	952024	45	2185054	2185742
Coal washery	14	816	2498	3328	0	5	11	411	318	4256	0	5001	8329
Foundry	329	125	0	454	0	0	0	0	0	303	0	303	757
Others	220	0	750	970	0	0	0	0	0	24158	0	24158	25128
Unclassified	13053	37595	1988	52636	177	8274	0	929549	1539401	5014051	568887	8060339	8112975
Not-known	299	130	0	429	0	0	0	0	0	286089	32	286121	286550
By States													
Andhra Pradesh	0	0	0	0	43034	0	0	13800	1266666	140027	14	1463541	1463541
Assam	0	0	0	0	0	0	0	4240	1600	9540	0	15380	15380
Bihar	0	0	0	0	0	0	0	0	0	2659	0	2659	2659
Goa	10738	37583	1791	50112	0	9071	0	0	3046	149943	1997	164057	214169
Jharkhand	14	836	2540	3390	0	5	11	411	3948	2472	32	6879	10269
Karnataka	0	0	0	0	130062	0	18375	1498957	479372	5345018	340000	7811784	7811784
Kerala	0	0	0	0	0	0	7074	0	56571	19790	0	83435	83435
Maharashtra	513	0	108	621	0	0	0	0	0	0	0	0	621
Meghalaya	0	0	0	0	0	0	0	0	0	3380	0	3380	3380
Nagaland	0	0	0	0	0	0	0	0	5280	0	0	5280	5280
Orissa	0	102	54	156	0	0	0	0	0	54	0	54	210
Rajasthan	3074	247	904	4225	177	43	0	0	0	522431	0	522651	526876
Tamil Nadu	0	0	0	0	0	0	0	107388	62000	85567	226921	481876	481876

Figures rounded off. Hence, total may not tally.

Annexure – 17

All India Production of Iron Ore from 1993-94 to 2005-06

(Qty in '000 tonnes, Value in Rs 000)

Year	Quantity				Value
	Lumps	Fines	Concentrates	Total	
1993-94	24042	29038	6565	59645	10393941
1994-95	26666	31683	6158	64507	11862407
1995-96	28956	31296	6326	66578	12867310
1996-97	30341	31630	6202	68161	14795556
1997-98	32753	35789	7181	75723	18197018
1998-99	31022	35073	6135	72230	18559498
1999-2000	32090	36138	6718	74946	19236584
2000-01	33567	41189	6006	80762	21267382
2001-02	34572	45224	6430	86226	24969189
2002-03	39581	52994	6497	99072	29648653
2003-04	48959	67680	6199	122838	46497470
2004-05	58152	82537	5253	145942	74029029
2005-06	62643	87900	3893	154436	86905259

Annexure – 18

All India Production of Iron Ore and Concentrates, 2000-01 to 2005-06

(In '000 tonnes)

Year	State	No. of mines	Production by Grades: Fe content										Concentrate	Total (Lumps & Fines + Concentrate)
			Lumps					Fines						
			Below 60%Fe	60–62% Fe	62–65% Fe	65% Fe & above	Total	Below 62%Fe	62–65% Fe	65%Fe & above	Total		Total	
2000-01	**India**	**208**	**1871**	**4070**	**11309**	**16317**	**33567**	**7083**	**19262**	**14844**	**41189**		**6006**	**80762**
	Public Sector	38	34	2806	7092	8477	18409	1662	10277	8143	20082		5000	43491
	Private Sector	170	1837	1264	4217	7840	15158	5421	8985	6701	21107		1006	37271
	Andhra Pradesh	2	-	-	64	48	112	-	145	79	224		-	336
	Chhattisgarh	9	-	1161	2520	6153	9834	1169	3719	5294	10182		-	20016
	Goa	46	1739	1145	390	6	3280	5064	5168	46	10278		1006	14564
	Jharkhand	14	1	1331	2197	2034	5563	2	4343	2495	6840		-	12403
	Karnataka	49	24	198	3133	2477	5832	197	3719	4154	8070		5000	18902
	Madhya Pradesh	7	37	19	-	-	56	63	7	-	70		-	126
	Maharashtra	4	1	21	-	-	22	-	-	-	-		-	22
	Orissa	73	58	195	3005	5599	8857	588	2161	2776	5525		-	14382
	Rajasthan	3	11	-	-	-	11	-	-	-	-		-	11
2001-02	**India**	**221**	**2327**	**3015**	**9532**	**19698**	**34572**	**9204**	**20060**	**15960**	**45224**		**6430**	**86226**
	Public Sector	38	40	2518	5380	10170	18108	2129	11003	8385	21580		5410	45098
	Private Sector	183	2287	497	4152	9528	16464	7012	9057	7575	23644		1020	41128
	Andhra Pradesh	3	++	-	56	40	96	-	185	93	278		-	374
	Chhattisgarh	9	-	814	645	7090	8549	633	3412	6060	10111		-	18660
	Goa	52	2218	407	374	-	2999	6729	3973	-	10765		1020	14784
	Jharkhand	15	1	1315	2330	2217	5863	4	4667	2534	7205		-	13068
	Karnataka	57	6	186	2800	3263	6255	171	5707	5052	10930		5410	22595
	Madhya Pradesh	6	26	23	-	-	49	53	-	-	53		-	102
	Maharashtra	4	13	20	-	-	33	-	-	-	-		-	33
	Orissa	73	55	250	3327	7088	10720	1551	2116	2215	5882		-	16602
	Rajasthan	2	8	-	-	-	8	-	-	-	-		-	8

contd...

Annexure – 18 (contd...)

(In '000 tonnes)

Year	State	No. of mines	Production by Grades: Fe content									Concentrate	Total (Lumps & Fines + Concentrate)
			Lumps					Fines					
			Below 60%Fe	60–62% Fe	62–65% Fe	65% Fe & above	Total	Below 62%Fe	62–65% Fe	65%Fe & above	Total	Total	
2002-03	**India**	**242**	**2110**	**3226**	**11909**	**22336**	**39581**	**10192**	**23960**	**18842**	**52994**	**6497**	**99072**
	Public Sector	40	20	2320	7564	10079	19983	2018	11844	10319	24181	5532	49696
	Private Sector	202	2090	906	4354	12257	19598	8174	12116	8523	28813	965	49376
	Andhra Pradesh	4	1	-	29	103	133	-	229	295	524	-	657
	Chhattisgarh	8	-	784	2486	5420	8690	673	3436	6982	11091	-	19781
	Goa	56	2055	806	527	103	3491	7636	5797	-	13433	965	17889
	Jharkhand	18	-	1206	2546	2364	6116	4	5035	2547	7586	-	13702
	Karnataka	67	15	158	2804	3782	6759	139	6373	5994	12506	5532	24797
	Madhya Pradesh	6	13	19	-	-	32	96	-	-	96	-	128
	Maharashtra	4	6	30	-	-	36	-	-	-	-	-	36
	Orissa	77	15	223	3517	10564	14319	1644	3090	3024	7758	-	22077
	Rajasthan	2	5	-	-	-	5	-	-	-	-	-	5
2003-04	**India**	**266**	**2736**	**3228**	**16564**	**26431**	**48959**	**13742**	**31420**	**22518**	**67680**	**6199**	**122838**
	Public sector	43	20	2359	8917	12499	23795	1978	15244	11435	28657	5090	57543
	Private sector	223	2716	869	7647	13932	25164	11764	16176	11083	39023	1109	65295
	Andhra Pradesh	5	48	-	209	50	307	-	626	469	1095	-	1402
	Chhattisgarh	11	-	847	3337	6523	10707	1084	5013	6557	12654	-	23361
	Goa	59	2513	425	952	-	3890	9478	5750	19	15247	1109	20246
	Jharkhand	19	++	1246	3121	2119	6486	21	5852	2323	8196	-	14682
	Karnataka	71	60	463	4682	3697	8902	1402	8324	7917	17643	5090	31635
	Madhya Pradesh	6	17	14	-	-	31	11	-	52	63	-	94
	Maharashtra	10	20	31	-	-	51	67	-	-	67	-	118
	Orissa	82	66	202	4263	14042	18573	1679	5855	5181	12715	-	31288
	Rajasthan	3	12	-	-	-	12	-	-	-	-	-	12

Annexure – 18 (contd)

(In '000 tonnes)

Year	State	No. of mines	Production by Grades: Fe content										Concentrate	Total (Lumps & Fines + Concentrate)
			Lumps					Fines						
			Below 60%Fe	60–62% Fe	62–65% Fe	65% Fe & above	Total	Below 62%Fe	62–65% Fe	65%Fe & above	Total		Total	
2004-05	**India**	**281(16)**	**3834**	**4448**	**19775**	**30095**	**58152**	**19392**	**37375**	**25770**	**82537**		**5253**	**145942**
	Public Sector	44	182	2303	8312	12263	23060	2531	16344	10743	29618		4350	57028
	Private Sector	237	3652	2145	11462	17833	35092	16861	21032	15026	52919		903	88914
	Andhra Pradesh	6(1)	87	-	479	3	569	84	2055	100	2239		-	2808
	Chhattisgarh	12	31	786	2883	6642	10342	1303	5264	6209	12776		-	23118
	Goa	65	2929	949	365	-	4243	11594	5891	41	17526		903	22672
	Jharkhand	21(1)	1	1370	3467	2700	7538	25	6755	2401	9181		-	16719
	Karnataka	76(3)	341	964	6522	4461	12288	3291	10849	7184	21324		4350	37962
	Madhya Pradesh	6(2)	23	10	-	-	33	183	-	-	183		-	216
	Maharashtra	8	198	29	-	-	227	442	-	-	442		-	669
	Orissa	84(7)	196	340	6059	16289	22884	2470	6561	9835	18866		-	41750
	Rajasthan	3(1)	28	-	-	-	28	-	-	-	-		-	28
2005-06	**India**	**261(17)**	**4013**	**4019**	**22243**	**31868**	**62643**	**19446**	**47234**	**21220**	**87900**		**3893**	**154436**
	Public Sector	41	40	1639	10637	12125	24441	3335	19726	8389	31450		2922	58813
	Private Sector	220	3973	2380	12106	19743	38202	16111	27508	12831	56450		971	95623
	Andhra Pradesh	5(1)	130	-	769	1	900	134	2877	47	3058		-	3958
	Chhattisgarh	12	19	91	3573	7618	11301	922	7333	5194	13449		-	24750
	Goa	63	3194	780	354	-	4328	12740	5519	186	18445		971	23744
	Jharkhand	15(1)	3	1464	3444	1764	6675	1664	5862	3234	10760		-	17435
	Karnataka	72(5)	368	856	5301	4807	11332	984	12660	5771	19415		2922	33669
	Madhya Pradesh	5(3)	55	21	-	-	76	389	-	-	389		-	465
	Maharashtra	7	109	78	49	-	236	281	-	-	281		-	517
	Orissa	81(7)	119	727	9253	17678	27777	2332	12983	6788	22103		-	49880
	Rajasthan	1	16	2	-	-	18	-	-	-	-		-	18

Annexure – 19

Production of Iron Ore, 2003-04 (By Sectors / States / Districts/ Grades)

(Quantity in '000 tonnes; Value in Rs '000)

State/District	No. of mines	Production by Grades: Fe content														
		Lumps						Fines					Concentrate		Total	
		Below 60%Fe	60–62 % Fe	62–65 % Fe	65% Fe & above	Total	Value	Below 62% Fe	62–65 % Fe	65% Fe & above	Total	Value	Qty	Value	Qty	Value
India	**266**	**2736**	**3228**	**16564**	**26431**	**48959**	**20758746**	**13742**	**31420**	**22518**	**67680**	**20370219**	**6199**	**5368505**	**122838**	**46497470**
Public sector	43	20	2359	8917	12499	23795	9792758	1978	15244	11435	28657	8368709	5090	4975475	57543	23136942
Private sector	223	2716	869	7647	13932	25164	10965988	11764	16176	11083	39023	12001510	1109	393030	65295	23360528
Andhra Pradesh	**5**	**48**	-	**209**	**50**	**307**	**111260**	-	**626**	**469**	**1095**	**332286**	-	-	**1402**	**443496**
Anantapur	3	-	-	209	50	259	105980	-	626	469	1095	332286	-	-	1354	438216
Kurnool	1	48	-	-	-	48	5247	-	-	-	-	-	-	-	48	5247
Nellore	1	-	-	++	-	-	33	-	-	-	-	-	-	-	-	33
Chhattisgarh	**11**	-	**847**	**3337**	**6523**	**10707**	**4624289**	**1084**	**5013**	**6557**	**12654**	**3791916**	-	-	**23361**	**8416205**
Dantewada	3	-	-	50	6496	6546	3720038	296	1690	6557	8543	2904844	-	-	15089	6624882
Durg	5	-	847	3242	-	4089	888098	757	3323	-	4080	883307	-	-	8169	1771405
Kanker	2	-	-	39	27	66	11494	30	-	-	30	3000	-	-	96	14494
Rajnandgaon	1	-	-	6	-	6	4659	1	-	-	1	765	-	-	7	5424
Goa	**59**	**2513**	**425**	**952**	-	**3890**	**1403405**	**9478**	**5750**	**19**	**15247**	**4881260**	**1109**	**393030**	**20246**	**6677695**
North Goa	22	1564	179	151	-	1894	544895	6679	2663	-	9342	2681529	22	4699	11258	3231123
South Goa	37	949	246	801	-	1986	858510	2799	3087	19	5905	2199731	1087	388331	8978	3446572
Jharkhand	**19**	**++**	**1246**	**3121**	**2119**	**6486**	**1818963**	**21**	**5852**	**2323**	**8196**	**1996769**	-	-	**14682**	**3815732**
Palamau	1	-	++	-	-	++	113	1	-	-	1	600	-	-	1	713
Singhbhum West	18	++	1246	3121	2119	6486	1818850	20	5852	2323	8195	1996169	-	-	14681	3815019

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Annexure – 19 (concld)

(Quantity in '000 tonnes; Value in Rs '000)

State/District	No. of mines	Production by Grades: Fe content														
		Lumps						Fines					Concentrate		Total	
		Below 60%Fe	60–62 % Fe	62–65 % Fe	65% Fe & above	Total	Value	Below 62% Fe	62–65 % Fe	65% Fe & above	Total	Value	Qty	Value	Qty	Value
Karnataka	**71**	**60**	**463**	**4682**	**3697**	**8902**	**2460277**	**1402**	**8324**	**7917**	**17643**	**4420157**	**5090**	**4975475**	**31635**	**11855909**
Bagalkote	2	-	-	264	-	264	31744	533	-	-	533	21349	-	-	797	53093
Bellary	52	51	149	3926	3585	7711	2193836	259	7264	7627	15150	3939187	-	-	22861	6133023
Chikmagalur	2	-	103	-	-	103	27911	38	-	-	38	10354	5090	4975475	5231	5013740
Chitradurga	6	-	188	261	112	561	159987	549	766	281	1596	415572	-	-	2157	575559
Tumkur	9	9	23	231	-	263	46799	23	294	9	326	33695	-	-	589	80494
Madhya Pradesh	**6**	**17**	**14**	**-**	**-**	**31**	**1987**	**11**	**-**	**52**	**63**	**4101**	**-**	**-**	**94**	**6088**
Gwalior	2	2	-	-	-	2	118	++	-	-	++	12	-	-	2	130
Jabalpur	4	15	14	-	-	29	1869	11	-	52	63	4089	-	-	92	5858
Maharashtra	**10**	**20**	**31**	**-**	**-**	**51**	**7862**	**67**	**-**	**-**	**67**	**10042**	**-**	**-**	**118**	**17904**
Chandrapur	2	-	30	-	-	30	4270	-	-	-	-	-	-	-	30	4270
Gadchiroli	1	-	1	-	-	1	199	-	-	-	-	-	-	-	1	199
Gondia	2	4	-	-	-	4	982	-	-	-	-	-	-	-	4	982
Sindhudurg	5	16	-	-	-	16	2411	67	-	-	67	10042	-	-	83	12453
Orissa	**82**	**66**	**202**	**4263**	**14042**	**18573**	**10329012**	**1679**	**5855**	**5181**	**12715**	**4933736**	**-**	**-**	**31288**	**15262748**
Keonjhar	46	17	144	2193	13270	15624	9134902	755	4621	5049	10425	4095992	-	-	26049	13230894
Mayurbhanj	8	4	-	74	128	206	63738	12	4	4	20	5428	-	-	226	69166
Sundergarh	28	45	58	1996	644	2743	1130372	912	1230	128	2270	832316	-	-	5013	1962688
Rajasthan	**3**	**12**	**-**	**-**	**-**	**12**	**1693**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**12**	**1693**
Jaipur	1	10	-	-	-	10	1428	-	-	-	-	-	-	-	10	1428
Jhunjhunu	2	2	-	-	-	2	265	-	-	-	-	-	-	-	2	265

Annexure – 20

Production of Iron Ore, 2004-05 (By Sectors/States/Districts/Grades)

(Quantity in '000 tonnes; Value in Rs '000)

State/District	No. of mines	Lumps						Fines					Concentrate		Total	
		Below 60%Fe	60–62 % Fe	62–65 % Fe	65% Fe & above	Total	Value	Below 62% Fe	62–65 % Fe	65% Fe & above	Total	Value	Qty	Value	Qty	Value
India	**281(16)**	**3834**	**4448**	**19775**	**30095**	**58152**	**32999793**	**19392**	**37375**	**25770**	**82537**	**35136558**	**5253**	**5892678**	**145942**	**74029029**
Public Sector	44	182	2303	8312	12263	23060	15396908	2531	16344	10743	29618	13036781	4350	5559300	57028	33992989
Private Sector	237	3652	2145	11462	17833	35092	17602885	16861	21032	15026	52919	22099777	903	333378	88914	40036040
Andhra Pradesh	**6(1)**	**87**	**-**	**479**	**3**	**569**	**157051**	**84**	**2055**	**100**	**2239**	**539926**	**-**	**-**	**2808**	**696977**
Ananthapur	3	-	-	479	3	482	135536	-	2055	100	2155	532378	-	-	2637	667915
Cuddapah	2	51	-	-	-	51	17181	84	-	-	84	7548	-	-	135	24728
Kurnool	1(1)	36	-	-	-	36	4334	-	-	-	-	-	-	-	36	4334
Chhattisgarh	**12**	**31**	**786**	**2883**	**6642**	**10342**	**6567470**	**1303**	**5264**	**6209**	**12776**	**6546379**	**-**	**-**	**23118**	**13113849**
Dantewada	3	-	2	203	6608	6813	5965470	441	2566	6209	9216	5959783	-	-	16029	11925253
Durg	5	-	778	2619	-	3397	542010	851	2696	-	3547	581351	-	-	6944	1123361
Kanker	3	-	-	36	34	70	29212	-	-	-	-	-	-	-	70	29212
Rajnandgaon	1	31	6	25	-	62	30778	11	2	-	13	5245	-	-	75	36023
Goa	**65(1)**	**2929**	**949**	**365**	**-**	**4243**	**1783714**	**11594**	**5891**	**41**	**17526**	**7169046**	**903**	**333378**	**22672**	**9286138**
North Goa	28	1517	424	22	-	1963	604150	7593	2720	17	10330	3271158	-	-	12293	3875308
South Goa	37(1)	1412	525	343	-	2280	1179564	4001	3171	24	7196	3897888	903	333378	10379	5410830
Jharkhand	**21(1)**	**1**	**1370**	**3467**	**2700**	**7538**	**2232486**	**25**	**6755**	**2401**	**9181**	**2553443**	**-**	**-**	**16719**	**4785929**
Palamau	1	-	-	++	-	++	53	-	2	-	2	1395	-	-	2	1448
Singhbhum West	20(1)	1	1370	3467	2700	7538	2232433	25	6753	2401	9179	2552048	-	-	16717	4784481

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Annexure – 20 (concld)

(Quantity in '000 tonnes; Value in Rs '000)

State/District	No. of mines	Lumps						Fines					Concentrate		Total	
		Below 60%Fe	60–62 % Fe	62–65 % Fe	65% Fe & above	Total	Value	Below 62% Fe	62–65 % Fe	65% Fe & above	Total	Value	Qty	Value	Qty	Value
Karnataka	**76(3)**	**341**	**964**	**6522**	**4461**	**12288**	**6158955**	**3291**	**10849**	**7184**	**21324**	**10869045**	**4350**	**5559300**	**37962**	**22587300**
Bagalkote	2	-	-	300	-	300	121944	582	-	-	582	240960	-	-	882	362904
Bellary	55(2)	241	630	5737	4177	10785	5312712	2334	8611	7184	18129	9560734	-	-	28914	14873446
Chikmagalur	2	-	25	-	-	25	6690	14	-	-	14	13713	4350	5559300	4389	5579703
Chitradurga	6	-	136	196	284	616	567593	290	1658	-	1948	955528	-	-	2564	1523121
Tumkur	11(1)	100	173	289	-	562	150016	71	580	-	651	98110	-	-	1213	248126
Madhya Pradesh	**6(2)**	**23**	**10**	**-**	**-**	**33**	**2080**	**183**	**-**	**-**	**183**	**20585**	**-**	**-**	**216**	**22665**
Gwalior	2	22	-	-	-	22	1067	-	-	-	-	-	-	-	22	1067
Jabalpur	4(2)	1	10	-	-	11	1013	183	-	-	183	20585	-	-	194	21598
Maharashtra	**8**	**198**	**29**	**-**	**-**	227	**20819**	**442**	**-**	**-**	**442**	**29864**	**-**	**-**	**669**	**50683**
Chandrapur	2	47	-	-	-	47	6631	-	-	-	-	-	-	-	47	6631
Gadchiroli	1	1	-	-	-	1	322	-	-	-	-	-	-	-	1	322
Gondiya	2	5	-	-	-	5	2262	-	-	-	-	-	-	-	5	2262
Sindhudurg	3	145	29	-	-	174	11604	442	-	-	442	29864	-	-	616	41468
Orissa	**84(7)**	**196**	**340**	**6059**	**16289**	**22884**	**16072379**	**2470**	**6561**	**9835**	**18866**	**7408270**	**-**	**-**	**41750**	**23480649**
Keonjhar	50(5)	179	131	3474	15000	18784	13766515	849	4820	9301	14970	5784008	-	-	33754	19550523
Mayurbhanj	7	17	-	74	209	300	162030	28	33	12	73	24966	-	-	373	186996
Sundargarh	27(2)	-	209	2511	1080	3800	2143834	1593	1708	522	3823	1599296	-	-	7623	3743130
Rajasthan	**3(1)**	**28**	**-**	**-**	**-**	**28**	**4839**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**28**	**4839**
Alwar	(1)	1	-	-	-	1	204	-	-	-	-	-	-	-	1	204
Jaipur	1	16	-	-	-	16	3235	-	-	-	-	-	-		16	3235
Jhunjhunu	2	11	-	-	-	11	1400	-	-	-	-	-	-	-	11	1400

Annexure – 21

Production of Iron Ore, 2005-06
(By Sectors/States/Districts/Grades)

(Quantity in '000 tonnes; Value in Rs '000)

State/District	No. of mines	Lumps						Fines					Concentrate		Total	
		Below 60%Fe	60–62 % Fe	62–65 % Fe	65% Fe & above	Total	Value	Below 62% Fe	62–65 % Fe	65% Fe & above	Total	Value	Qty	Value	Qty	Value
India	**261(17)**	**4013**	**4019**	**22743**	**31868**	**62643**	**41514395**	**19446**	**47234**	**21220**	**87900**	**40781456**	**3893**	**4609408**	**154436**	**86905259**
Public Sector	41	40	1639	10637	12125	24441	16443762	3335	19726	8389	31450	14929419	2922	4219741	58813	35592922
Private Sector	220	3973	2380	12106	19743	38202	25070633	16111	27508	12831	56450	25852037	971	389667	95623	51312337
Andhra Pradesh	**5(1)**	**130**	**-**	**769**	**1**	**900**	**205168**	**134**	**2877**	**47**	**3058**	**779672**	**-**	**-**	**3958**	**984840**
Ananthapur	3	-	-	769	1	770	175150	-	2877	47	2924	767580	-	-	3694	942730
Cuddapah	2	80	-	-	-	80	24017	134	-	-	134	12092	-	-	214	36109
Kurnool	(1)	50	-	-	-	50	6001	-	-	-	-	-	-	-	50	6001
Chhattisgarh	**12**	**19**	**91**	**3573**	**7618**	**11301**	**7634744**	**922**	**7333**	**5194**	**13449**	**7227068**	**-**	**-**	**24750**	**14861812**
Dantewada	3	-	4	113	7556	7673	6896069	891	3763	5194	9848	6569407	-	-	17521	13465476
Durg	5	-	-	3389	-	3389	635579	-	3570	-	3570	645203	-	-	6959	1280782
Kanker	3	-	-	18	62	80	25754	-	-	-	-	-	-	-	80	25754
Rajnandgaon	1	19	87	53	-	159	77342	31	-	-	31	12458	-	-	190	89800
Goa	**63**	**3194**	**780**	**354**	**-**	**4328**	**1995647**	**12740**	**5519**	**186**	**18445**	**7975006**	**971**	**389667**	**23744**	**10360320**
North Goa	29	1995	245	163	-	2403	700933	8011	3058	161	11230	3433995	-	-	13633	4134928
South Goa	34	1199	535	191	-	1925	1294714	4729	2461	25	7215	4541011	971	389667	1 0111	6225392
Jharkhand	**15(1)**	**3**	**1464**	**3444**	**1764**	**6675**	**2133278**	**1664**	**5862**	**3234**	**10760**	**3087447**	**-**	**-**	**17435**	**5220725**
Singhbhum West	15(1)	3	1464	3444	1764	6675	2133276	1664	5862	3234	10760	3087447	-	-	17435	5220725

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Annexure – 21 (concld)

(Quantity in '000 tonnes; Value in Rs '000)

State/District	No. of mines	Lumps						Fines					Concentrate		Total	
		Below 60%Fe	60–62 % Fe	62–65 % Fe	65% Fe & above	Total	Value	Below 62% Fe	62–65 % Fe	65% Fe & above	Total	Value	Qty	Value	Qty	Value
Karnataka	**72(5)**	**368**	**856**	**5301**	**4807**	**11332**	**8158982**	**984**	**12660**	**5771**	**19415**	**12299562**	**2922**	**4219741**	**33669**	**24678285**
Bagalkote	2	-	-	409	-	409	188335	212	530	-	742	278668	-	-	1151	467003
Bellary	54(4)	364	629	4468	4470	9931	7262274	577	9789	5771	16137	10503321	-	-	26068	17765597
Chikmagalur	1	-	-	-	-	-	-	-	-	-	-	-	2922	-4219741	2922	4219741
Chitradurga	6	-	166	275	337	778	639466	133	1544	-	1677	1128062	-	-	2455	1767528
Tumkur	9(1)	4	61	149	-	214	68907	62	797	-	859	389509	-	-	1073	458416
Madhya Pradesh	**5(3)**	**55**	**21**	-	-	76	**5464**	**389**	-	-	**389**	**33769**	-	-	**465**	**39233**
Gwalior	1	9	-	-	-	9	589	-	-	-	-	-	-	-	9	589
Jabalpur	4(3)	46	21	-	-	67	4875	389	-	-	389	33769	-	-	456	38644
Maharashtra	**7**	**109**	**78**	**49**	-	**236**	**58199**	**281**	-	-	**281**	**19664**	-	-	**517**	**77863**
Chandrapur	2	-	33	22	-	55	33264	-	-	-	-	-	-	-	55	33264
Gadchiroli	1	2	1	-	-	3	887	-	-	-	-	-	-	-	3	887
Gondiya	2	++	12	-	-	12	9554	3	-	-	3	1069	-	-	15	10623
Sindhudurg	2	107	32	27	-	166	14494	278	-	-	278	18595	-	-	444	33089
Orissa	**81(7)**	**119**	**727**	**9253**	**17678**	**27777**	**21321468**	**2332**	**12983**	**6788**	**22103**	**9359268**	-	-	**49880**	**30680736**
Keonjhar	50(5)	72	354	4815	16390	21631	17501692	849	10463	6267	17579	7281159	-	-	39210	24782851
Mayurbhanj	7	-	-	77	195	272	145394	-	12	10	22	7490	-	-	294	152884
Sundargarh	24(2)	47	373	4361	1093	5874	3674382	1483	2508	511	4502	2070619	-	-	10376	5745001
Rajasthan	**1**	**16**	**2**	-	-	**18**	**1445**	-	-	-	-	-	-	-	**18**	**1445**
Jaipur	1	16	2	-	-	18	1445	-	-	-	-	-	-	-	18	1445
Jhunjhunu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Annexure – 22

Major Producers of Iron Ore

S.No.	Name of the company	Production in 2004-05 (in million tonnes)
	Public Sector	
1.	National Mineral Development Corporation Ltd	21.15
2.	Steel Authority of India Ltd	19.89
3.	Kudremukh Iron Ore Company Ltd	4.35
4.	Orissa Mining Corporation Ltd	3.32
5.	Mysore Minerals Ltd	3.26
6.	Indian Iron & Steel Company Ltd	1.99
7.	Orissa Mineral Development Corporation Ltd	1.00
	Private Sector	
8.	Tata Iron & Steel Company Ltd	10.78
9.	Essel Mining & Industries Ltd	6.16
10.	Sunderlal Sarda & Mohanlal Sarda	3.51
11.	Rungta Mines Pvt. Ltd	3.49
12.	Sesa Goa Ltd	4.35
13.	Dempo Mining Corporation Ltd	2.73
14.	V.M.Salgaoncar & Brothers Pvt. Ltd	2.23
15.	Bharat Process & Mechanical Engg. Ltd	2.21
16.	Laxmi Narayana Mining Co.	2.11
17.	Chowgule & Co. Pvt Ltd	2.00
18.	M.S.P.L. Ltd	1.98
19.	V.S.Lad & Sons	1.89
20.	Jindal Steel & Power Ltd	1.88
21.	Obulapuram Mining Company Pvt. Ltd	1.53
22.	Cosme Costa & Sons	1.24
23.	Hothur Traders	1.16
24.	R.S.Shetye & Bros	1.12
25.	V.D.Chowgule	1.00

Annexure – 23

Capacity and Production of Sintering Plants in India with Consumption of Iron Ore

(In'000 tonnes)

S. No.	Plant	Capacity	Production		Consumption of iron ore	
			2003-04	2004-05	2003-04	2004-05
1.	Bokaro Steel Plant, Jharkhand	6200	5227	5349	4240	4126
2.	Bhilai Steel Plant, Chhattisgarh	6550	5802	6933	4832	4836
3.	Durgapur Steel Plant, West Bengal	3009	2640	2728	2076(e)	2226
4.	Rourkela Steel Plant, Orissa	3067	2624	2564	1444	1873
5.	Visakhapatnam Steel Plant, Andhra Pradesh	5256	5840	5520	4370	4184
6.	TISCO Steel Plant, Jharkhand	4500	NA	NA	2952(e)	NA
7.	Kalinga Steel Plant, Orissa	8.00	NA	NA	NA	NA

N.A = Not Available; e = Estimated

Annexure – 24

Capacity and Production of Pelletisation Plants in India with Consumption of Iron Ore

(In'000 tonnes)

S. No.	Plant	Capacity	Production		Consumption of iron ore	
			2003-04	2004-05	2003-04	2004-05
1.	Kudremukh Iron Ore Co. Ltd, Kudremukh district, Mangalore, Karnataka	4000	3671	3795	3359	3577
2.	Mandovi Pellets Ltd, Shiroda, Goa	1800**	Nil	707	174	Nil
3.	Jindal Vijayanagar Steel Ltd, District-Bellary, Karnataka	3000	NA	NA	2295(e)	2295(e)
4.	TISCO Noamundi, Jharkhand *	800*	Nil	Nil	Nil	Nil
5.	Chowgule & Co. Ltd, Pale, Goa	550*	Nil	Nil	Nil	Nil
6.	Essar Steel Ltd, Vishakhapatnam, Andhra Pradesh	8000	N.A.	NA	NA	NA

Note: The consumption for 2004-05 is not available.
N.A = Not Available. e = Estimated
* *Plants not working*
** *Plant closed*

Annexure – 25

Salient Data Pertaining to Important Beneficiation Studies Conducted on Iron Ore Samples by Indian Bureau of Mines

S.No.	Deposit	Feed grade (Assay %)	Minerals present	Concentrate Grade (Assay%)	Concentrate Wt% yield	Concentrate % Fe recovery	Process adopted
1.	Bonai (Orissa)	Fe : 59.16 Al_2O_3 : 3.22 SiO_2 : 2.43 LOI : 7.08	Goethite, limonite, haematite, quartz, clay & mica	Fe : 63.0	81.15	86.86	Trommel washing
2.	Kudremukh (Karnataka)	Fe : 39.46 Al_2O_3 : 2.44 SiO_2 : 43.82 LOI : 2.09	Magnetite, goethite, haematite, quartz, amphibole	i) Fe: 67.82 ii)Fe:70.89	40.81 37.24	70.85 66.38	Low intensity wet magnetic separation at 96% -28 mesh size. Low intensity wet magnetic separation at 93% -48 mesh size.
3.	Goa (M/s Salgaoncar)	Fe : 59.18 Al_2O_3 : 6.55 SiO_2 : 1.50 LOI : 6.35	Haematite, magnetite, gibbsite, quartz, felspar	Fe: 65.45 Al_2O_3:2.41	64.83	70.44	Low intensity wet magnetic separation followed by gravity separation at -48 mesh size.
4.	Goa (M/s EMCO Pvt Ltd)	Fe : 48.90 Al_2O_3 : 1.23 SiO_2 : 28.80	Haematite, magnetite, quartz, LOI : 0.74	Fe: 65.09 Al_2O_3:0.59 SiO_2 :4.67 chlorite, clay.	53.50	72.65	Hydroclassification at -100 mesh size followed by magnetic separation of fine fraction.
5.	Eleyttlmala (Kerala)	Fe : 42.72 Al_2O_3 : 1.09 SiO_2 : 35.50 LOI : 3.21	Magnetite, goethite, quartz.	Fe: 65.09 SiO_2 :3.65	61.53	90.12	Low intensity wet magnetic separation at - 100 mesh size followed by gravity separation on non-magnetic after regrinding to -48 mesh size.
6.	Sindhudurg (Maharashtra)	Fe : 55.03 Al_2O_3 : 4.52 SiO_2 : 8.83	Magnetite, goethite, quartz, gibbsite and clay	Fe: 61.04 Al_2O_3 2.80 SiO_2 :3.26	68.64	76.14	Scrubbing, hydroclassification and spiralling
7.	Tailing of Jaduguda Plant (Jharkhand)	Fe : 59.74 Al_2O_3 : 2.27 SiO_2 : 11.67	Magnetite, quartz, chlorite.	Fe: 70.65 SiO_2 :2.16	80.5	96.40	Low intensity wet magnetic separation

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Annexure – 25 (concld)

S.No.	Deposit	Feed grade (Assay %)	Minerals present	Concentrate			Process adopted
				Grade (Assay%)	Wt% yield	% Fe recovery	
8.	Iron ore fines from Dalli Mines (Chhattisgarh)	Fe : 62.21 Al_2O_3 : 4.28 SiO_2 : 2.87 LOI : 2.89	Haematite, quartz, clay	Fe: 64.62	81.7	84.3	Jigging
9.	Iron ore fines from Codli Mines, Goa	Fe : 56.97 Al_2O_3 : 7.49 SiO_2 : 2.36 LOI : 2.32	Haematite, quartz, gibbsite, clay	Fe: 60.49	62.3	66.1	Jigging
10.	Iron ore fines from Mayurpani Chhattisgarh	Fe : 58.45 Al_2O_3 : 5.91 SiO_2 : 6.75 LOI : 3.7	Haematite, quartz, mica, clay and amphibole	Fe: 62.90 Al_2O_3 4.05 SiO_2: 3.40	74.1	79.7	Jigging
11.	Iron ore slimes M/s Sociadade De Fomento Goa	Fe : 57.00 Al_2O_3 : 5.40 SiO_2 : 7.36 LOI : 5.99	Goethite, limonite, Haematite, martite, clay, mica, quartz.	Fe : 64.74 Al_2O_3:2.54 SiO_2: 2.20 LOI : 2.40	69.2 (+9 Micron product)	77.60	Cyclosizing
12.	Iron ore slimes M/s Sociadade De Fomento Goa	Fe : 56.35 Al_2O_3 : 5.40 SiO_2 : 7.36 LOI : 5.99	Goethite, limonite, Haematite, martite, clay, mica, quartz.	Fe : 64.74 Al_2O_3: 2.30 SiO_2: 2.16 LOI : 2.88	56.60	64.40	Wet high intensity magnetic separation
13.	Iron ore fines from Dalli Mines, Chhattisgarh	Fe : 59.70 Al_2O_3 : 5.23 SiO_2 : 7.52	Haematite, goethite, martite, quartz and clay.	Fe : 63.75 Al_2O_3:2.10 SiO_2: 2.65	66.7	73.2	Hydroclassification Jigging and spiraling

Annexure – 26

Important Beneficiation Studies conducted by Indian Bureau of Mines on Classifier Overflow, Hydrocyclone Overflow, Slime of Tailing Ponds and Scrubber Feed

S. No	Deposit	Type of Feed	Feed Grade			Concentrate			Yield (%)	Recovery	Process adopted
			Fe Content	SiO_2	Al_2O_3	Fe Content	SiO_2	Al_2O_3			
1.	Codely iron ore mine, M/s Sessa Goa	Classifier Overflow	53.65	7.387	6.23	65.19	2.87	1.32	16.1	-	Hydrocyclone and High & Low intensity magnetic separation
2.	M/s Socio dade De formento Industries Ltd Goa	Hydocyclone Overflow	47.37	13.52	7.65	65.11	4.18	3.14	20	-	Gravity seperation
3.	Dalli mechanised mines	Slime Sample of Tailing Pond	52.46	16.52	3.57	64.0	5.23	1.43	50.5	-	Direct tabling
4.	Dalli mechanised mines	Sample of Scrubber Feed	62.7	6.3	1.56	65	3.52 to 4.5	1.1 to 1.2	81.2	-	Wet screening
5.	Dalli mechanised mines	Classifier Overflow	51.0	16.55	5.05	64.65	3.56	1.05	57.5	72.2	2 stages Hydrocyclone and High & Low intensity magnetic separation

Annexure – 27

Salient Data Pertaining to the Important Beneficiation Studies Conducted on Iron Ore Sample by NML, Jamshedpur

S. No	Deposit	Type of Feed	Feed Grade			Concentrate			Yield (%)	Recovery	Process adopted
			Fe Content	SiO_2	Al_2O_3	Fe Content	SiO_2	Al_2O_3			
1.	Chitradurga, M/s Mineral Enterprises Ltd.,Kamataka	Iron ore	56.16	5.60	4.56	63.4	-	-	67.5	-	Washing & Scrubbing
1 A	Chitradurga, M/s Mineral Enterprises Ltd, Karnataka	Classifier Fines	-	-	-	61	-	-	-	-	Jigging
1 B	Chitradurga, M/s Mineral Enterprises Ltd., Karnataka	Jig Middling & Tailings	-	-	-	> 62	-	-	-	-	Tabling
1 C	Chitradurga, M/s Mineral Enterprises Ltd., Karnataka	Slime	-	-	-	> 62	-	-	-	-	Hydrocyclone and High & Low intensity magnetic separation.
2.	Kudremukh Iron Ore Co. Ltd., Bangalore, Karnataka	Iron Ore Fines	33 to 38%	-	-	63.47 to 69.30	0.80	-	85.7 Mechanical Floating Feed	-	Scrubbing & Screening
2A.	Kudremukh Iron Ore Co. Ltd, Bangalore, Karnataka	Iron Ore Fines	33 to 38%	-	-	63.47 to 69.3	0.27	-	86.5 Secondary Magnetic Concentrate		Scrubbing & Screening
2B.	Kudremukh Iron Ore Co. Ltd, Bangalore, Karnataka	Iron Ore Fines	33 to 38%	-	-	63.47 to 69.3	0.15	-	76 to 80 %	-	Chemical Beneficiation through Alkali Pressure Leaching.
3.	M/s Mineral Sales Pvt Ltd, Karnataka	Iron Ore Fines	62.86	4.16	3.5	62.86	0.97	3.5	73	-	Multigravity separation
3A.	M/s Mineral Sales Pvt Ltd, Karnataka	Iron Ore Fines	-	-	-	62.86	1.40	-	73.6	-	Three stages hydrocyclone
3B.	M/s Mineral Sales Pvt.Ltd., Karnataka		-	-	-	62.86	1.14	-	53.8	-	Wet High intensity magnetic
3C.	M/s Mineral Sales Pvt Ltd, Karnataka				-	62.86	0.54	-	77.6	-	Direct Floatation
3D.	M/s Mineral Sales Pvt Ltd, Karnataka				-	62.86	0.31	-	40.7	-	WHIMS & magnetic separation
3E.	M/s Mineral Sales Pvt Ltd, Karnataka					62.86	.40	-	45.4	-	Cyclone under floatation

Annexure – 28

Salient Data Pertaining to the Important Beneficiation Studies Conducted on Iron Ore Fines by RRL, Bhubaneshwar

S. No	Deposit	Type of Feed	Feed Grade			Concentrate			Yield (%)	Recovery	Process adopted
			Fe Content	SiO_2	Al_2O_3	Fe Content	SiO_2	Al_2O_3			
1.	Barsua (SAIL) Bolani (SAIL) Joda (TISCO)	Iron Ore Fine	60.3	4.74	3.88	65 to 67.2	1.12 to 1.79	1.22 to 2.31	-	-	Scrubbing
1A.	Barsua (SAIL) Bolani (SAIL) Joda (TISCO)	Iron Ore Fine	-	-	-	66.2 to 66.23	1.30 to 1.36	1.65	-	-	Jigging
1B.	Barsua (SAIL) Bolani (SAIL) Joda (TISCO)	Iron Ore Fine	51.8	7.32	9.2	55.7	4.66	6.58	-	-	Hydrocyclone
1C.	Barsua (SAIL) Bolani (SAIL) Joda (TISCO)	Iron Ore Fine	55.7	4.66	6.58	61.1	3.29	3.52	-	-	Magnetic Separation
2.	Barsua (SAIL)	Iron Ore Slime	52.7	7.1	9.35	63	2.2	3.5	-	-	Hydrocyclone Magnetic Separation Gravity Separation
2A.	Bolani (SAIL)	Iron Ore Slime	57.5	5.8	6.7	65.1	1.2	1.7	-	-	Hydrocyclone Magnetic Separation Gravity Separation
2B.	Joda (TISCO)	Iron Ore Slime	58.8	4.1	6.4	65.9	1.0	1.56	-	-	Hydrocyclone Magnetic Separation Gravity Separation
3.	Sponge Iron Plant, Orissa	Solid Waste generated in Sponge Iron Plant	-	-	-5 mm size fine upto 65 % Fe	-	-	-	-	-	Scrubbing followed by classification, Magnetic Separation, Gravity Separation & Floatation.
4.	Jindal Vijay Nagar Steel Ltd	Ultra Fine generated during process of beneficiation	50 to 60	4 to 7	2.5 to 5.5	61 to 64	-	-	-	-	Hydroclone & Magnetic Separation
5.	Thakurani Barbil, Orissa M.L Sarda	Iron Ore Fine	64	2.88	3.55	(-30 to 5mm) 67.16	-	-	57.1	60	Washing, Scrubbing Classification & Hydroclone
6.	Jindal Vijay Nagar Steel Ltd & Power Ltd, Barbil, Keonjhar	Iron Ore	-	-	-	66 to 67	-	-	-	-	Washing, Jigging, Magnetic Separation & Classification

Annexure – 29

Prices of Iron Ore, 2001-02 to 2005-06

Grade	Market	2001-02	2002-03	2003-04	2004-05	2005-06
Lump 63/63% Fe	f.o.b.t. Mormugao	$ 16.81	$15.97	$17.39	$20.63	$ 35.88
Lump 62/62% Fe	f.o.b.t. Mormugao	$ 16.22	$15.41	$16.78	$19.90	$ 34.14
Lump 61/61% Fe	f.o.b.t. Mormugao	$ 15.47	$14.70	$16.01	$18.99	$ 32.57
Lump 60/60% Fe	f.o.b.t. Mormugao	$ 14.87	$14.13	$15.39	$18.26	$ 31.31
Lump 60/59% Fe	f.o.b.t. Mormugao	$ 14.18	$13.47	$14.67	$17.40	$ 29.84
Fines 63/63% Fe	f.o.b.t. Mormugao	$ 14.27	$13.93	$15.18	$18.01	$ 30.88
Fines 62/62% Fe	f.o.b.t. Mormugao	$ 13.85	$13.52	$14.74	$17.48	$ 29.99
Fines 61/61% Fe	f.o.b.t. Mormugao	$ 13.45	$13.13	$14.31	$16.97	$ 29.11
Fines 60/60% Fe	f.o.b.t. Mormugao	$ 13.17	$12.85	$14.01	$16.62	$ 28.50
Baila Lump 65% Fe *	f.o.b. Vizag (Andhra Pradesh)	-	$22.41	$24.41	$28.95	$ 49.64
Baila Fines 65% Fe *	f.o.b. Vizag (Andhra Pradesh)	-	$17.37	$18.93	$22.46	$ 38.51
Doni Lump 65% Fe *	f.o.b. Chennai (Tamil Nadu)	-	$21.22	$23.10	$27.40	$ 47.97
Doni Fines 65% Fe *	f.o.b. Chennai (Tamil Nadu)	-	$16.51	$17.99	$21.34	$ 38.51
Lumps**	f.o.r. Noamundi Jharkhand	313	-	-	-	-
Fines +67% Fe **	Ex-mine MML (Karnataka)	-	-	700–2200	2200	2200
Fines +66-67% Fe **	Ex-mine MML (Karnataka)	-	-	110–2000	2000	2000
Fines +65-66% Fe **	Ex-mine MML (Karnataka)	-	-	97–1600	1600	1600
Fines +60-65% Fe **	Ex-mine MML (Karnataka)	-	-	70–1200	1200	1200
Fines –60% Fe **	Ex-mine MML (Karnataka)	-	-	120–600	600	600
Iron Ore Mud**	Ex-mine MML (Karnataka)	-	-	20-375	375	375

Source: *Indian Minerals Yearbook*

* *Prices are in US $/DMT* ** *Prices are in Rs/DMT*

Annexure – 30

F.O.B. Prices of Different Grades of Iron Ore during May to June 2004

Date	Grade	Exporter	Port	Country	Rs/t
07.05.2004	I.O.F. (+) 62% Fe	Feegrade & Co. Ltd	Viz.–S	China	2370
07.05.2004	I.O.F. (+) 62% Fe	Rungta Mines Ltd	Viz.–S	China	1450
19.05.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	China	3520
19.05.2004	I.O.L (+) 60% Fe	MMTC Ltd	Viz.–S	Japan	1270
19.05.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	Japan	990
25.05.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	Japan	990
25.05.2004	I.O.L. (+) 60% Fe	MMTC Ltd	Viz.–S	Japan	1270
29.05.2004	Iron Ore Pellets	Hy-grade Pellets Ltd	Viz.–S	China	2450
02.06.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	Japan	1010
02.06.2004	I.O.F. (+) 60% Fe	MMTC Ltd	Viz.–S	Japan	1310
07.06.2004	I.O.F. (+) 62% Fe	Essel Mining & Industries Ltd	Viz.–S	China	1620
07.06.2004	I.O.F. (+) 62% Fe	Swarup Gr. of Industries	Viz.–S	China	3340
08.06.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	China	3160
08.06.2004	I.O.F. (+) 60% Fe	MMTC Ltd	Viz.–S	China	1310
10.06.2004	I.O.F. (+) 62% Fe	Rungta Mines Ltd	Viz.–S	China	1170
10.06.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	China	1710
11.06.2004	I.O.F. (+) 62% Fe	Swarup Gr. of Industries	Viz.–S	China	3340
14.06.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	Japan	1310
14.06.2004	Iron Ore Pellets	Hy-grade Pellets Ltd	Viz.–S	Italy	2090
15.06.2004	I.O.F. (+) 62% Fe	Bellary Iron Ore (P) Ltd	Viz.–S	China	1580
18.06.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	Japan	1010
18.06.2004	I.O.F. (+) 62% Fe	MMTC Ltd	Viz.–S	Japan	1310
19.06.2004	I.O.F. (+) 62% Fe	Feegrade & Co. Ltd	Viz.–S	China	990
21.06.2004	I.O.F. (+) 62% Fe	Swarup Gr. of Industries	Viz.–S	China	1920
22.06.2004	I.O.F. (+) 62% Fe	Essel Mining & Industries Ltd	Viz.–S	China	1560
22.06.2004	Iron Ore Pellets	Hy-grade Pellets Ltd	Viz.–S	Indonesia	2140
25.06.2004	I.O.F. (+) 62% Fe	Bharat Mines Minerals	Viz.–S	China	1580
28.06.2004	I.O.F. (+) 62% Fe	NMDC Ltd	Viz.–S	China	930
28.06.2004	I.O.L. (+) 60% Fe	Sri Varalakshmi Jute Twine Mills Ltd	Viz.–S	Japan	1310
29.06.2004	I.O.L (+) 62% Fe	MMTC Ltd	Viz.–S	Japan	1010
29.06.2004	I.O.L (+) 60% Fe	MMTC Ltd	Viz.–S	Japan	1310
30.06.2004	I.O.F. (+) 62% Fe	Swarup Gr. Of Industries	Viz.–S	China	1920
30.06.2004	I.O.F. (+) 62% Fe	PEC Ltd.	Viz.–S	China	1310

***Source:** Weekly Minerals & Metals, October 2004*
I.O.F.: Iron ore fines; I.O.L.: Iron ore lumps

Annexure – 31

FOB Prices of Different Grades of Iron Ore during February and April 2007

Date	Grade	Port	Country	Rs/t
February 2007				
01.02.2007	High-grade calibrated sinter fine	CHN–S	China	3060
01.02.2007	High-grade calibrated sinter fine	CHN–S	China	3060
01.02.2007	H.G.I.O.F. (+ 65% Fe)	CHN–S	Hong Kong	3060
02.02.2007	I.O.F. (64% to 64.5% Fe)	CHN–S	China	2500
02.02.2007	I.O.L. (63% to 63.5% Fe)	CHN–S	China	2350
06.02.2007	I.O.F. (64% to 64.5% Fe)	CHN–S	China	2570
06.02.2007	Calibrated I.O.L (63.50% Fe)	CHN–S	China	2600
06.02.2007	Calibrated I.O.L (63.50% Fe)	CHN–S	China	2550
06.02.2007	I.O.F (64% to 64.5% Fe)	CHN–S	China	2570
April 2007				
03.04.2007	I.O.L. (60% Fe or more)	Viz.–S	Japan	2810
03. 04.2007	I.O.F. (62% Fe or more)	Viz.–S	Japan	2180
04.04.2007	Iron Ore Pellets	Viz.–S	China	3920
07.04.2007	I.O.F. (62% Fe or more)	Viz.–S	Japan	2180
07.04.2007	I.O.L. (60% Fe or more)	Viz.–S	Japan	2810
09.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	3090
13.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2640
13.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	1800
13.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2680
13.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	1800
14.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2600
16.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2450
16.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	3000
16.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2620
18.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2720
19.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2350
20.04.2007	I.O.L. (60% Fe or more)	Viz.–S	Japan	2180
20.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2750
20.04.2007	I.O.F. (62% Fe or more)	Viz.–S	Japan	2810
23.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2720
24.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2750
24.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	3000
27.04.2007	I.O.F. (62% Fe or more)	Viz.–S	China	2630

Source: *Weekly Minerals & Metals Reviews, May–July 2007*
I.O.F.: Iron ore fines; I.O.L.: Iron ore lumps

Annexure – 32

Price for Sale of Different Grade/Size of Iron Ore & Iron Ore Fines in the Domestic Market for July–September 2007 (As Quoted by Orissa Mining Corporation)

S.No.	Grade & Size	Basis	Price for July–September 07
A. BARBIL REGION			
1.	Sized iron ore (Fe-65% min.) Size: 5–18 mm +/-10%	65% Fe	Rs 2710/t
2.	Sponge grade lumpy ore (Fe-65% min.) Size: 10–180 mm +/-10%	65% Fe	Rs 1816/t Rs 1836/t (Crushing Units)
3.	BF grade lumpy ore 10–180 mm +/-10%, +62% Fe	62% Fe	Rs 1288/t Rs1308/t (Crushing Units)
4.	Sized iron ore (10–30/40% Fe) Fe-62% min.	62% Fe	Rs 1525/t Rs 1545/t (Crushing Units)
5.	Iron ore fines (Grade : 60– 58% Fe)	60% Fe	Rs 211/t
6.	Iron ore fines (Grade : 62– 60% Fe)	62% Fe	Rs. 341/t
7.	Iron ore fines (Grade : 64– 62% Fe)	64% Fe	R. 426/t
B. GANDHAMARDAN SECTOR			
1.	Sponge grade lumpy ore (Fe-65% min.) Size: 10–180 mm +/-10%	65% Fe	Rs 1672/t Rs 1692/t (Crushing Units)
2.	BF grade CLO 10– 40 mm +/-10% Fe : +62%	62% Fe	Rs 1709/t Rs 1729/t (Crushing Units)
3.	BF grade lump 10–180 mm +/-10% Fe : +63%	63% Fe	Rs 1251/t Rs 1271/t (Crushing Units)
4.	Soft grade lump (Puthulpani) 10–180 mm +/-10%; Fe : 66.5%	66.5% Fe	Rs 1851/t (Crushing Units) Rs 1831/t
5.	5–18 mm +/-10%; Basis : 64% Fe	64% Fe	Rs 2651/t
6.	Iron ore fines (Grade : 62– 60% Fe)	62% Fe	Rs 495/t
C. KOIRA SECTOR			
1.	Khandadhar/Kurmitar Fe+62% min.; Size: 10–40 mm +/-10%	62% Fe	Rs 1709/t Rs 1729/t (Crushing Units)
2.	BF grade lumpy iron ore Fe-62% Min. Size: 10–180 mm +/-10%	62% Fe	Rs 1414/t Rs 1434/t (Crushing Units)
3.	Iron ore fines (Grade: 62– 60% Fe)	62% Fe	Rs 516/t
4.	Sponge grade lumpy iron ore KHANDADHAR Fe: +65% min. Size: 10–180 mm +/-10%	65% Fe	Rs 1722/t Rs 1742/t (Crushing Units)
D. DAITARI SECTOR			
1.	BF grade CLO 10–40 mm +/-10% Fe : +62%	62% Fe	Rs 2068/t
2.	Iron ore fines (Grade: 64–62% Fe)	62% Fe	Rs 808/t

Note : *The above prices are on ex-mines basis, excluding royalty, taxes, other Govt. duties and 50% analysis charges which are to be borne by the buyer.*

Annexure – 33

Prices of Iron Ore as Reported by Producers from 2001-02 to 2003-04

(In Rs per tonne, unless otherwise stated)

Region		2001-02		2002-03		2003-04	
		Lumps	Fines	Lumps	Fines	Lumps	Fines
Goa	FOR	133-346	189-551	133-450	162-595	277-475	291-513
	FOB	NA	NA	NA	NA	US$16.80	US$17.48
Karnataka	FOR	135-395	185-200	178-393	185-300	272-531	375-650
	FOB	NA	NA	NA	NA	800-1800	900-1200
Orissa	FOR	190-474	51-140	250-525	99-170	400-880	100-400
	FOB	NA	NA	NA	NA	NA	NA
Jharkhand	FOR	290-360	290-360	290-360	290-360	360-550	360-550
	FOB	NA	NA	NA	NA	NA	NA
Chhattisgarh	FOR	NA	NA	NA	NA	NA	NA
	FOB	US$23.59	US$17.28	US$22.41	US$17.37	US$24.47	US$18.93

F.O.R. – Free on Rail; F.O.B. – Free on Board

Source : *Compiled from the correspondence with various producers.*

Note: *The data was received from the producers, up to 2003-04. Hence data for the year 2004-05 is not available, except FOB prices of Chhattisgarh region, i.e., US$ 28.95 for lumps and US$ 22.46 for fines.*

Annexure – 34

Categorywise Estimated Demand and Apparent Consumption of Finished Steel in India 2001-02 to 2003-04

(Unit in '000 tonnes)

Company	2001-02	2002-03	2003-04
	App. Cons.	App. Cons	App. Cons.
Bars & rods	9683	10337	10713
Structurals	2329	2420	3015
Rly Materials	714	882	930
Total long products	**12726**	**13639**	**14658**
Plates	1934	1961	2289
HR Coils/Skelp	6261	7320	7657
HR sheets	689	570	897
CR sheets/coils	3101	3202	3012
GP sheets/coils	1750	1265	1691
Elec. sheets	176	192	184
Tin plates (incl. W/W)	282	189	189
TMBP	15	10	12
Pipes (Large Dia)	519	497	551
Tin Free Steel	65	52	29
Total flat products	**14792**	**15258**	**16511**
Total finished steel	**27518**	**28897**	**31169**

Source : *Joint Plant Committee*

Annexure – 35

Industrywise and Categorywise Consumption of Finished Steel in India, 2002-03 and 2003-04

(Unit '000 tonnes)

Industry	Consumption (2002-03)			Consumption (2003-04)			% growth in 2003-04 with respect to 2002-03
	Longs	Flat Prod.	Total Fined Steel	Longs	Flat Prod.	Total Finished Steel	
Defence	198	123	321	212	133	345	7.4
Railways	1215	350	1565	1286	414	1700	8.6
Power Sector	575	136	711	629	171	800	12.5
Irrigation	74	67	141	93	75	168	(-) 19.1
Steel Industries	524	417	941	567	351	918	2.1
Coal Sector	72	39	111	84	41	125	12.6
Oil	132	1076	1208	121	1084	1205	(-)-0.2
PSU/Hy.Inds.	134	145	279	157	169	326	16.8
PWD/CPWD	600	115	715	731	129	860	20.2
P & T	78	62	140	83	72	155	10.7
Port/ Shipyards	138	38	176	146	49	195	10.7
Other Govt. Deptts	489	152	641	513	187	700	9.2
House Buildings	1751	229	1980	1921	125	2046	3.33
Public Building/Hotels	2017	138	2155	2362	158	2520	16.9
Industrial Construction	987	293	1280	1260	210	1470	14.9
Elec. Manufactuters	37	1089	1126	44	806	850	(-)24.5
Tube Makers	42	2664	2706	34	2816	2850	5.3
CR Units	33	2325	2358	30	2760	2790	18.3
Galvan./Coated Units	-	1047	1047	-	1257	1257	21.7
Auto/Tractor/Cycle	91	1279	1370	105	1541	1646	20.1
LPG Cylinder Mnf.	4	172	176	5	220	225	27.8
Wire Drawing Units	762	102	864	706	126	832	(-)3.70
Bright Bar Units	352	3	355	367	3	370	4.22
Drum/Barrel/ Container	1	754	755	2	768	770	1.98
Furniture Makers	8	393	401	7	408	415	3.49
Consumer Durables	14	404	418	14	446	460	10.04
Hardware	253	238	276	256	29	285	3.26
Agriculture Implements	44	287	331	45	305	350	5.7
Other Engg. Units.	1675	525	2200	1863	572	2435	10.6
Machinery Manufactuters	200	539	739	211	760	971	31.39
Miscellaneous	1139	272	1411	804	326	1130	(-)19.91
Grand Total	**13639**	**15258**	**28897**	**14658**	**16511**	**31169**	**7.86**

Source : *1. Joint Plant Committee 2. Iron & Steel Review, June, 2005*

Annexure – 36

Structure of the Indian Steel Industry

(Capacity in million tonnes per annum)

Sector	Type of Units	Working		Non-working		Total	
		No. of units	Capacity	No. of Units	Capacity	No. of units	Capacity
Primary	Integrated steel plant	11	26.04*	-	-	11	26.04*
Secondary	Electric Arc Furnace (EAF)	38	8.15	13	0.33	51	8.48
	Induction Furnace (IF)	719	12.35	241	-	960	12.50
	Pig iron	19	4.83	-	-	19	4.83
	Sponge iron	207	18.65	20	-	227	18.65
	HR Steel, (Sheets, strips, plate,) units	1250	18.80	670	6.08	1920	24.89
	CR Mills (sheets & strips)	54	3.89	31	0.70	85	4.59
	Steel wire drawing units	33	0.44	61	0.77	94	1.21
	GP/GC/PVC-coated sheets	17	3.79	1	0.04	18	4.23
	Tin plate	1	0.14	1	0.03	2	0.17

Source : *Annual Report of Ministry of Steel, 2003-04, 2004-05 and 2005-06*

* *Besides, new plants with a total capacity of 7.95 million tonnes have been commissioned. Thus the total capacity of primary sector is 34 million tonnes.*

Annexure – 37

Capacity and Production of Pig Iron and Steel Ingots/Crude Steel 2003-04 and 2004-05 (By Main Producers)

(In '000 tonnes)

Unit	Installed capacity		Production			
	Pig iron/ Hot metal	Steel ingots/ Crude steel	Pig iron/ Hot metal		Steel ingots/ Crude steel	
	2004-05	2004-05	2003-04	2004-05	2003-04	2004-05
Public Sector						
Bokaro Steel Plant (Jharkhand)	4585	4360	4108	4132	3754	3835
Bhilai Steel Plant (Chhattisgarh)	4080	3925	4932	4511	4091	4582
Rourkela Steel Plant (Orissa)	2000	1840	1727	1691	1571	1556
Durgapur Steel Plant (West Bengal)	2088	1802	1982	2017	-	1807
IISCO Burnpur Steel Plant (West Bengal)	850	520	684	642	301	356
Visvesvaraya Iron Steel Ltd (Karnataka)	205	180	173	168	114	126
Visakhapatnam Steel Plant (Andhra Pradesh)	3400	3000	4055	3920	3508	3360
IDCOL Kalinga Iron Works Ltd (Govt. of Orissa Undertaking)	180	-	136	97	-	-
Salem Steel Plant (Tamil Nadu)	-	175 (carbon steel/stainless steel)				83
Private Sector						
Tata Iron & Steel Co. Ltd (Jharkhand)	4808	4000	4466	4347	4221	4102
Jindal Vijaynagar Steel Ltd (Karnataka)	800	1600	NA	1460	NA	1420
Ispat Industries Ltd (Maharashtra)	2000	3000	NA	NA	NA	NA
Essar Steel Ltd (Gujarat)	2400	2400	NA	NA	NA	NA

Source: *Annual Report of Ministry of Steel, 2003-04*

Annexure – 38

Various Products Manufactured by Steel Plants

Plant	Products
Public Sector	
Bokaro Steel Plant (Jharkhand)	H R coil, H R plate, H R sheet, C R coil, C R plate, G P sheet
Bhilai Steel Plant (Chhattisgarh)	Billets, slabs, rails structural, plates, merchant product, wire rod and blooms.
Rourkela Steel Plant (Orissa)	Flat products, plate, H R coil, H R sheets, C R coil, C R sheets, Galvanised sheet, electrical steel sheets, electrolytic tin plates, SPI rally welded large dimension pipes
Durgapur Steel Plant (W.B.)	Railway materials, wheels and axels, fish plates, sleeper Structurals, Bars, rods , TMT, Skelps.
IISCO Burnpur Steel Plant (W.B.)	Foundry & pipes and structural steel
Visvesvaraya Iron Steel Ltd. (Karnataka)	Stainless steel, tool steel, other alloys & steel, bearing steel, spring steel, free cutting steel, constructional steel (a) carbon steel, b) case hardening steel and c) heat treatable steel)
Visakhapatnam Steel Plant (Andhra Pradesh)	Product of steel in long categories, finished steel (round . square), wire rods, re-bars., angles (equal & unequal), sections, channels, beams, saleable billets, flat products, light & medium merchant products (bars), medium merchant products (structural)
IDCOL Kalinga Iron Works Ltd (Govt. of Orissa U/T)	Pig iron/Hot metal
Salem Steel Plant Tamil Nadu	Stainless steel, carbon steel
Private Sector	
Tata Iron & Steel Co. Ltd, (Jharkhand)	H R coil, C R coil, flats, longs, tubes bearing, rings, Hand tools & implement for agriculture and industrial application
Jindal Vijaynagar Steel Ltd (Karnataka)	H R coil,
Ispat Industries Ltd (Maharashtra)	DRI, H R coil, cold rolled coils, galvanized steel coils/sheets
Essar Steel Ltd (Gujarat)	HBI, H R coil, CR coil Plates and sheets.

Source: *Annual Report of Ministry of Steel, 2003-04 and information from individual plants*

Annexure – 39

Annual Production Capacity of Some Sponge Iron (DRI) Plants

(In lakh tonnes)

Unit	Location	Installed capacity	Production	
			2003-04	2004-05
Gas-based				
Essar Steel Ltd	Hazira, Gujarat	36.00	22.32	28.04
Vikram Ispat	Salav, Raigad, Maharashtra	9.00	6.87	7.83
Ispat Industries Ltd	Geetapuram, Dolvi, Raigad, Maharashtra	16.00	10.56	10.50
Coal-based				
Kumar Metallurgical Corporation Ltd	Chityal Mandal, Nalgonda, Andhra Pradesh	0.60	NA	-
Sponge Iron India Ltd	Paloncha, Khammam, Andhra Pradesh	0.60	0.69	0.57
Goldstar Steel & Alloys Ltd	Srirampuram, Vizianagaram, Andhra Pradesh	2.20	NA	-
Bihar Sponge Iron Ltd	Chandil, Singhbhum, Jharkhand	1.86	1.54	1.40
Bellary Steel & Alloys Ltd	Bellary , Karnataka	0.60	0.76	0.66
HEG Ltd.	Borai, Durg, Chhattisgarh	1.20	0.67	0.87
Jindal Steel & Power Ltd	Kharsia Road, Raigarh, Chhattisgarh	6.50	5.79	6.88
Monnet Ispat Ltd	Chandhuri Marg, Hasaud, Raipur, Chhattisgarh	3.00	2.04	2.40
Prakash Industrties Ltd	Champa, Jangir Champa, Chhattisgarh	4.00	2.80	3.11
Raipur Steel & Alloys Ltd	Siltara, Raipur, Chhattisgarh	0.60	0.64	0.62
Sunflag Iron & Steel Co. Ltd	Bhandara, Maharashtra	1.50	NA	-
Lloyds Metals & Engineering Ltd	Chuggus, Chandrapur, Maharashtra	1.50	1.23	1.54
Orissa Sponge Iron Ltd	Palasapanga, Keonjhar, Orissa	1.50	1.20	0.91
Tata Sponge Iron (Ispat Sponge)	Joda, Keonjhar, Orissa			1.08
Deepak Mineral Industries Pvt Ltd	Topadihi, Keonjhar, Orissa	2.40	2.16	2.23
Sree Metalikes Ltd	Loidapada, Keonjhar, Orissa	1.44	1.4	
Rexon Strips Ltd	Kumakola, Rourkela, Orissa	0.60	0.45	0.60
Tamil Nadu Sponge Iron ltd	Mehta Nagar, Chollapilaikuttai, Salem, Tamil Nadu	0.30	NA	
Surya Sponge Iron Ltd	NA	0.54	0.28	0.47
Deepak Stel & Power Ltd	NA	NA	0.64	0.65
Ispat Godavari Ltd	NA	NA	0.70	0.69
Nalwa Sponge Iron Ltd	NA	NA	1.53	0.66
Singhal Enterplrises	NA	NA	1.02	0.57
Vandana Global Pvt Ltd	NA	NA	0.63	0.59
Twelve operating mini-plants@1500 tpy	NA	NA	NA	-

Annexure – 40

New Projects (Integrated Steel Plants) Under Various Stages of Implementation

Entity	Location	State	Capacity (min. tpy)	Cost (Rs Crore)	Remarks
LN Mittal	—	Jharkhand	12.0	40,000	MoU signed in October 2005
Tata Steel	Manoharpur	Jharkhand	12.0	42,000	MoU signed in September2 005
Posco	Jatadhari	Orissa	12.0	51,000	MoU signed in June 2005, construction work by April 2006
JSW	Saraikela	Jharkhand	10	35,000	MoU signed in November 2005
JSW*	Vijaynagar	Karnataka	7.5	18,000	Phase 1 adding 1.5 million tpa by March, 2006
SAIL	—	Multiple**	7.0	25,000	Under implementation
Tata Steel	Kalinganagar	Orissa	6.0	18,000	MoU signed in late 2004
JSPL	Angul	Orissa	6.0	13,135	Revised MoU signed in November 2005
Tata Steel*	W.Singhbhum	Jharkhand	5.0	11,000	Under implementation
Tata Steel	Bastar	Chhattisgarh	5.0	15,000	MoU signed in June 2005
JSPL	W.Singhbhum	Jharkhand	5.0	11,500	MoU signed in June 2005
MSPL	Koppal	Karnataka	5.0	12,000	—
Essar	Kakinada	Andhra Pradesh	5.0	15,000	—
Ispat	Paradip	Orissa	5.0	15,000	Feasibility studies in progress
Sterlite	Keonjhar	Orissa	5.0	12,500	MoU signed in October 2004
Essar	Paradip	Orissa	4.0	6,000	MoU signed in April 2005
Essar	Bastar	Chhattisgarh	3.2	8,000	—
Bhushan	Dhenkanal	Orissa	3.0	5,828	Under implementation
Bhushan Steel[L2] & Strips Ltd	Dhenkanal	Orissa	6.0	15,000	—
TI Group	Kalinganagar	Orissa	3.0	7,000	MoU signed in April 2005
NINL[L2] Jajpur	-	Orissa	1.0	1000	—
Rathi Udyog[L2] Ltd.	-	Orissa	-	210	—
Tube Investment[L2] of India Ltd.	-	Orissa	-	3480	-
Jindal Stainless[L2] Steel Ltd	Dhenkanal	Orissa	1.6	6628	-

* *Under Execution;* ** *Spread over Jharkhand, Orissa, Chhattisgarh & West Bengal*

Source : [L2] *Minerals & Metals Review — January, 2005*
[L2] *Iron & Steel September, 2006*

Annexure – 41

Exports (Incld. Re-exports) of Iron & Steel : Total (By Countries)

Country	2001-02		2002-03		2003-04	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs '000)	Qty (t)	Value (Rs '000)
All Countries	**2566599**	**512713978**	**4959341**	**99402202**	**5157941**	**24580239**
China, People's Rep. of	545415	11267354	1045983	2376308	1116075	27254886
United States of America	165261	3999797	1101513	1815152	363128	12026317
United Arab Emirates	230687	5509007	288521	7086788		
Iran	91905	1529485	72858	1840825	264120	4965227
Italy	127245	3003140	153762	2816358	230104	4916092
Sri Lanka	156860	2450075	153983	2600139	248995	4823986
Thailand	75996	1039332	113609	1680833	187463	4171316
Nepal	141565	1981499		227870	3732917	
Bangladesh	76122	1331196	180320	3500509	194647	3491381
Indonesia	71898	972479	154540	2330638	192020	3469133
Nigeria	28129	716560				
Spain	48773	851460				
Saudi Arabia	66167	915306				
Iraq	2415	65598				
Korea, Rep. of	12157		71089	1117074	180077	3452912
Chinese Taipei	44920	729264	102441	3101875	119296	3325808
Japan	18528	241785				
Hong Kong	25301	1028852	71449	2514803	62596	2529057
South Africa	19198	1585476	21705	644310	84507	2052137
Vietnam, Socialist Rep. of	82246	1472510		62820	1922740	
Germany, Federal Rep. of	42475	1218439	17577	1076695	27384	1817255
Belgium	42388	1102688	62450	1392311	63027	1788225
Djibouti	6667	147593		70572	1751001	
United Kingdom	69548	1660252	38192	1055593	47978	1720885
Singapore	72446	1033832	184788	1127309	68312	1668499
Myanmar	23798	348622	75296	922713	83884	1495398
Philippines			71217	950893	127775	1484478
Malaysia			39231	868660	43399	1404017
Other countries	580677	13296527	766173	56558595	803371	22229784

***Source**: Indian Bureau of Mines*

Annexure – 42

Imports of Iron & Steel : Total (By Countries)

Country	2001-02		2002-03		2003-04	
	Qty (t)	Value (Rs '000)	Qty (t)	Value (Rs '000)	Qty (t)	Value (Rs '000)
All Countries	**4273699**	**57436253**	**4116451**	**59334086**	**4861552**	**89781191**
Germany, Federal Rep. of	173472	3614721	161812	4155219	340133	9284730
Russia	149550	2560754	342346	5176979	502377	8951452
Japan	315855	6912222	228898	6889805	250365	8883710
United Kingdom	1018095	7839424	897882	5343511	499679	7156719
Ukraine	197213	4549762	292964	4387000	334344	5718846
Korea, Rep. of	197081	4120465	160991	3702071	185445	5618793
United States of America	312736	4716913	163168	3792651	160196	4373763
United Arab Emirates	318498	2122622	347443	2531052	509328	4186587
Belgium	42678	1126984	129014	1816640	126866	2624443
France	94883	2116714	69382	2798544	61799	2606347
Singapore	204132	1745386	123566	1745991	197908	2582373
Sweden	14900	976191	20913	1293384	109796	2254848
Nepal	35240	595419	84489	1823602	68505	2161601
Italy	37354	1024805	25264	949397	44043	1720407
Spain	40325	1369714	9977	689973	25148	1624242
South Africa	195850	1693734	106509	1057698	131737	1619139
China, People's Rep. of	26837	722952	8786	459999	33746	1608524
Romania	81306	1020640	73347	1362652	85676	1545359
Thailand	15967	730754	18025	751646	28054	1169709
Kuwait	97654	630092	122282	743670	155400	1132159
Australia	72015	935754	40239	826960	41630	981759
Nigeria	-	-	77220	453829	142018	962078
Netherlands	47263	753596	58380	833146	37665	920016
Canada	61377	713398	-	-	-	-
Other countries	523418	4843237	553554	5748667	789694	10093587

Source: *Indian Bureau of Mines*