GLOSSARY OF TERMS/ DEFINITIONS COMMONLY USED IN IRON & STEEL INDUSTRY

(i) Terms Related To 'IRON':

Iron :
Iron is a base metal extracted from iron ore. Pure iron has melting point of 1530 Degree Centigrade and density of 7.86 gm/cc.

Iron Making:
Iron making is the process of **Reduction of iron ore** using the relevant reducing agent (Reductant).

Hot Metal (Liquid Iron) :
It is the hot, liquid, metallic iron product obtained upon reduction of iron ore (normally in **Blast Furnace** or in **Corex Furnace)**.

It contains about 93-94% Iron (Fe) and other elements/impurities like Carbon (4%), Silicon (~1%), Manganese(+1%) Sulphur, Phosphorus etc.

Hot metal is the primary input for production of steel in the Integrated Steel Plants.

Pig Iron :
A product in solid (lumpy) form obtained upon solidification of Hot Metal in Pig Casting Machine.

It is called Pig or Pig Iron because of its typical humpy shape. It is produced in 2 broad categories/grades:

a) **Foundry Grade Pig Iron**:
Pig iron used in the Foundries for production of **Cast Iron (CI) Castings** using Cupola Furnace. This is the major use of pig iron.

b) **Basic/Steel Making Grade Pig Iron**:
Pig iron (including hot metal) used for production of Steel.

Sponge Iron/ Direct Reduced Iron(DRI)/ Hot Briquetted Iron(HBI):

- **Direct Reduced Iron(DRI):**
  Solid metallic iron product obtained upon **Direct Reduction** of high grade iron ore in solid state itself without being converted into liquid form like that in Blast Furnace.

- **Sponge Iron(SI):**
  DRI is also known as **Sponge Iron** because of its spongy micro structure.

- **Hot Briquetted Iron(HBI):**
  At times the DRI/SI coming out from the furnace is converted into a bigger compact mass i.e. **Briquettes** for ease in transportation/charging in steel making furnace, which are known as **Hot Briquetted Iron (HBI).**

- SI/ DRI/HBI is produced by reducing high **quality iron ore lumps or iron ore pellets** with the help **of non-coking coal** in **Rotary Kiln (in Coal based Plants**) or with the help of **Natural Gas** in **Shaft Furnace** (known as **Gas based plants**).

- SI/ DRI/HBI is primarily used for production of steel (as a substitute of steel melting scrap), in the Electric Furnaces like the Electric Arc Furnace (EAF) or the Induction Furnace (EIF). However, TISCO is using it in their blast furnace as substitute for iron ore or/sinter

(ii) Terms Related To 'STEEL' and 'STEEL PRODUCTS':

Steel

Steel is an iron based alloy containing Carbon, Silicon, Manganese etc.

Steel making:

Steel making is the process of **selective oxidation of impurities** present in the charge material (Hot metal/Scrap/DRI) in the presence of suitable fluxes in the **Steel Melting Shops (SMS).**

Steel/Steel Products as per Form/shape/size:

Liquid Steel :

The immediate hot molten steel product from Steel Melting Shop (LD Converter/Electric Arc Furnace/Electric Induction Furnace/Energy Optimising Furnace). It is further cast into ingots/Semis. The by-product from SMS is called SMS **slag.**

Ingot Steel (ingots):

- The primary solid product obtained upon solidification of liquid steel in conventional, vertical, Cast Iron Molds which are intended for rolling into intermediate/semi-finished products after re-heating.
- Ingots are normally very large and heavy weighing several tonnes (up to 15-20 tonnes).

Pencil Ingots: Small ingots in Kgs produced in mini-steel plants**.**

Semi-Finished Steel Products (Semis):

Intermediate solid steel products obtained by Hot rolling/Forging of ingots (in conventional process) or by Continuous casting of liquid steel are known as Semis. These are called so since they are intended for further rolling/forging to produce Finished steel products.

Various types of semis are as under:

- **Blooms**:
  A Semi-finished product, usually in square (at times in rectangular) section of cross sectional size exceeding 5”x5” (125mm X 125mm). In some of the modern mills, the term bloom is used to cover such products of cross sectional size exceeding 8”x8”.

  These are inputs for producing Heavy sections and Sheet piling section normally by hot rolling.

  At times, like in VSP, blooms are used to produce billets by hot rolling in the Billet Mill.

- **Billets** : A semi-finished product which are similar to blooms but of smaller cross sectional size (usually less than or 5''x5''/7''x7''. These are used as input material for production of Finished Steel long products viz bars & rods, light sections etc.

- **Slabs** : A semi-finished Rectangular, wide, semi-finished steel product intended for production of finished Hot Rolled Flat products viz Plates, sheets, Strips etc. They are normally of width 150-250mm wherein width is at-least 3 or 4 times of thickness.

- **Thin Slabs** : In modern thin slab casting machine, liquid steel is continuously cast into much thinner slabs of 35-50mm directly which are used for production of Finished Hot Rolled Flat products upon heating on-line.

Finished Steel :
Products obtained upon hot rolling/forging of Semi-finished steel (blooms/billets/slabs) .
These cover 2 broad categories of products, namely **Long Products** and **Flat Products**:

a) Long Products:
Finished steel products produced normally by hot rolling/forging of Bloom/billets/pencil ingots into useable shape/sizes.

These are normally supplied in straight length/ cut length except Wire rods which are supplied in ir-regularly wound coils.

Different types of long products are :

- **Bars & Rods** : Long steel products obtained normally by hot rolling/forging of billets/blooms. They include **Rounds**, **Flats** (flat bars), **Squares**, **Hexagons**, **Octagons** etc. which find direct use in in a wide variety of products in Engg, & Agricultural, House hold, Furniture sector etc. with/without further processing.

- **CTD (Cold-worked Twisted & Deformed)/ TMT (Thermo Mechanically Treated)Bar & Rods:**
  Hot rolled round bars/rods with indentations/ribs normally supplied in straight length or in folded bundles. Used directly in civil construction.

- **Wire Rod** : Hot rolled plain bar/rods (i.e without indentation) **in Coil Form**, normally used to produce **Steel Wires** and at times **Steel Bright Bars**.
- **Angles, Shapes & Section** : Hot rolled Structural Sections obtained by hot rolling of blooms/billets. They include Angles, Channels, Girders, Joist, I Beams, H Beams etc used in civil/mechanical construction.
- **Rails** : Hot rolled Rail Sections obtained upon hot rolling of Blooms/Billets. Used in rail ways/tram ways, on which rail/tram moves .
- **Wires**: Wires are produced by **cold drawing** of wire rod through a die. They are normally supplied in coils.
- **Bright Bars** : There are cold drawn/ ground/ Peeled plain bars produced from hot rolled plain bars/wire rods. **(Does not fall under the purview of MOS but under D/o IP&P).**

Flat Products (Flat Rolled Products) :

Finished steel thin flat products, produced from slabs/thin slabs in rolling mills using flat rolls. These are supplied in **Hot Rolled (HR**), **Cold Rolled (CR)** or in **Coated** condition depending upon the requirement.

Different types of flat products are :

- **Plate** : Thick flat finished product of width: +500mm & Thickness: (+)5mm which are supplied in cut/straight length. Plates are normally produced/supplied in as hot rolled condition with or without specific heat treatments.

- **Sheet** : Thin flat finished steel products, Width: +500MM, Thickness: (-) 5mm, Supplied in cut/straight length. Sheets are produced/ supplied in hot rolled /cold rolled/coated condition and accordingly, known as **Hot Rolled (HR) Sheets or Cold Rolled (CR) Sheets** or **Coated Sheets**.
- **Strips** : Hot/cold/coated Flat rolled products, supplied in regularly wound coils of super imposed layers. Accordingly, known **as HR Strips** or **CR Strips** or **Coated Strips**. Depending upon width, strips are sub-classified as **wide strip** or **narrow strip** as under :

  a) **Wide Strips** : Strips of widths 600mm & above. Also known as **Coils** in India and **Wide Coils** in Europe etc. Accordingly, the terms

HR Coils/Wide Coils or CR Coils/ Wide Coils etc. are commonly used.

b)**Narrow Strips** : Strips of widths less than 600mm.

Hot Rolled (HR) flat products are produced by re-rolling of slabs/thin slabs at high temperature (above 1000 Degree C) in **Plate Mills** (which produce plates) or in **Hot Strip Mills** (which produce strips) . Hot Rolled Strips are cut into straight length to produce **HR Sheets** or **Thin Plates.**

Cold Rolled(CR) Strips are produced by cold rolling of HR Strips in **Cold Rolling Mills** (normally at room temperature). CR Strips are cut to produce CR sheet. CR Strips/sheets are characterised by lower thickness, better/bright finish, closer dimensional tolerance and specific mechanical/metallurgical properties. They are directly used in automobiles (cars/ scooters, motorcycles etc.), white goods, consumer durable etc. or for production of coated sheet products.

Cold Rolled Sheets/Strips are supplied in **as rolled** condition (**CRFH**- Cold Rolled Full Hard) or in **closed annealed** (**CRCA** –Cold Rolled Close Annealed) condition or in **closed annealed & skin passed/temper passed** condition, depending upon the requirement of the end users.

D/DD/IF Steel:

Specific variety of Cold Rolled Sheets / Strips with specific chemical composition used in Tn Mills are known as **Tin Mill Black Plate (TMBP)**.

- **Coated Products** : There are cold rolled products coated with metals or organic chemicals as under :

  i)Galvanised Plain/ Corrugated (GP/GC) Sheets: These are Cold Rolled Sheets/Strips coated with **zinc** metal. Process is known as **Galvanising**. Used in roofing, paneling etc.

  GP sheets are normally produced by Hot Deep Galvanising of CR Sheets/Strips in liquid zinc bath. GC sheets are obtained upon corrugating of GP sheets in corrugating machine.

Although not practiced in India, GP sheets are also produced by electroplating of zinc on CR sheets/strips when the process is known as **Electro-Galvanising**.

Galvanised sheets are used mainly in roofing, paneling, automobile bodies, Trunks/Boxes etc.

ii)Tinplate: TMBP coated with **tin** metal. Used for manufacture of containers.

iii)Tin Free Steel : TMBP sheet/strips coated with **chromium metal and chromium oxide**.

iv)Colour coated products : Cold Rolled/ galvanised steel sheets/strips coated with **PVC/ plastics or any other organic material**. Process known as **Colour Coating**. Used for mfr. of furniture, auto bodies, roofing, paneling etc.

v)Terni plate : Cold rolled steel sheets/strips coated with an alloy of tin and lead, used in manufacture of Petrol Tanks for automobiles. Not produced in India.

Galfan alloy coated sheets : These are CR Sheets/Strips coated with an Zinc- Aluminium alloy comprising of 95% zinc and 5% aluminium. Uses are similar to GP/GC sheets but it has better life and better corrosion properties.

Galvalume alloy coated sheets : These are CR Sheets/ Strips coated with an alloy comprising of approx. 55% aluminium and approx. 45% zinc with nominal amount of silicon. Uses are similar to that of GP/GC sheets but it has better life and much better high temperature performance.

Crude Steel :

The term is internationally used to mean the 1st solid steel product upon solidification of liquid steel. In other words, it includes Ingots (in conventional mills) and Semis (in modern mills with continuous casting facility).

According to International Iron & Steel Institute (IISI), for statistical purpose, crude steel also includes liquid steel which goes into production of steel castings.

Saleable Steel :

The term is used to designate various types of solid steel products, which are sold to outside customers for further processing or for direct use/consumption. Therefore, it includes ingots and/or semis and/or finished steel products. (Liquid steel is normally not traded).

Steel as per Composition :

1. Alloy Steel :

Steel which is produced with intended amount of one or more alloying elements in specified proportions to impart specific physical, mechanical, metallurgical and electrical properties.

Common alloying elements are manganese, silicon, nickel, lead, copper, chromium, tungsten, molybdenum, niobium, vanadium etc.

Some of the common examples of alloy steels are:

(a) Stainless Steel: which essentially contains chromium (normally more than 10.5% with/without nickel or other alloying elements. As the name implies, stainless Steel resist staining/corrosion and maintains strength at high temperatures.

Used widely in Utensils, architectures and in Industrial applications viz automotive & food processing products as well as medical & health equipment.

Commonly used grades of stainless steels (SS) are:

- **Type 304**: Chrome –Nickel Austenitic S S accounting for more than half of SS produced in the world. 18:8 SS used for utensils are the most common example.
- **Type 316**: Chrome –Nickel (Austenitic) SS containing 2-3% Molybdenum , intended for specific industrial use.

- **Type 410**: Plain Chromium (Martensitic) S S with exeptional strength. It is a low cost, heat treatable grade suitable for non-corrosive applications.
- **Type 430**: Plain Chrome (Ferritic) S S, offering general purpose corrosion resistance, often in decorative applications.
- **Type 201/202** etc.: Low Nickel Austenitic S S containing 2-5% Nickel . Used as cheaper substitute of Type 304 grade for production of utensils.

(b) Silicon-Electrical steel: which usually contains 0.6 – 6% silicon and exhibit certain magnetic properties, which make it suitable for use in transformers, power generators, and electric motors. They are normally supplied in 2 categories:

i)**CRGO:** Cold Rolled Grain Oriented Silicon-electrical steel sheets/strips, normally recommended for use in transformers and generators.

ii)**CRNO/CRNGO:** Cold Rolled Non-Grain Oriented Silicon-electrical steel sheets/strips, normally recommended for use in rotating machines such as electric motors.

(c) High Speed Steel: Alloy steel containing tungsten, vanadium, chromium, cobalt and other metals. Depending upon composition, they are classified as Cobalt Grade abd Non-Cobalt Grade. Used for manufacture of cutting tools.

2. Non-alloy /Carbon Steel/Plain carbon /Un-alloyed Steel :

These steels by definition do not contain any alloying element in specified proportions (i.e beyond those normally present in commercially produced steel in industry).

Non- alloy steel is divided into 3 categories namely

(i) **Low carbon steel or Mild steel** (normally containing upto 0.3% carbon

(ii) **Medium carbon steel** (normally containing 0.3 – 0.6% carbon) and

(iii) **High carbon steel** (normally containing more than 0.6% carbon).

Non-alloy steel constitutes approx. 90% of total steel production, of which, mild steel takes the lion’s share.

3. Special Steel :

Steel, in production of which special care has to be taken so as to attain the special/desired properties, such as, cleanliness, surface qualities and mechanical/ metallurgical properties.

In layman's language, all steel other than mild steel fall under the category of special steel. But metallurgically, even mild steel/low carbon steel i.e containing less than 0.25%/0.30% carbon, may still fall under the category of special steel if any special properties is specified in the steel. Examples are **DD / EDD** steel, **Forging Quality** steel, **Free Cutting** steel etc.

Classifications of Steel based on end use :
In terms of uses, steels are often classified as **Structural steels, Construction steel**, **Deep Drawing Steel**, **Forging quality**, **Rail steel** and the like.

iii). Terms Related To 'IRON ORE':

Iron Ore :

Definition: A naturally occurring mineral from which iron (Fe) metal is extracted in various forms viz Hot metal/ DRI etc.

Types of Ore: Two major varieties used for iron making are **Haematite Ore(Containing Ferric Oxide - Fe_2O_3)** and **Magnetite Ore (containing Ferro-Ferric Oxide – Fe_3O_4)**. When chemically pure, Haematite contains apprx 70% and Magnetite 72.4% iron . But usually iron content of ores ranges between 50-65/67% (rich ores) and 30-35% (lean ores); the remains being impurities known as **Gangue** (such as Alumina, silica etc.) and Moisture.

Grades of Ore: Iron ore is typically classified as **High grade** (+65% Fe), **Medium grade** (+62 – 65% Fe) and **Low grade** (-62% Fe).

Typically, the Integrated Steel Plants(ISPs) use medium/High grade Iron Ore whereas the Sponge Iron plants require only High Grade iron ore, preferably, with +67% Fe.

Lumpy/Fine Ore: Iron Ore is traded in **lumps** (i.e. **sized ore**) or in **fines**. Production/availability of lumps is limited by virtue of the natural occurrence and also because of generation of lot of fines during crushing of large lumps present in the run-of -mines.

Natural pellet: **It** is a term coined by producers like NMDC to designate sized iron ore used directly in Sponge Iron production.

Blue Dust: **Blue Dust** is the name given to naturally occurring, extremely friable, high grade Haematite Iron Ore powder.

Beneficiation of Ore: Very low grade Iron ore cannot be used in metallurgical plants and needs to be upgraded to increase the iron content and reduce the Gauge content. Processes adopted to upgrade ore is called Beneficiation.

Indian ores are: Indian ore is generally rich in iron (Fe) content but the Alumina content is very high which call for special adjustments/techniques for production of iron/steel at the cost of productivity and quality and hence money.

Beneficiation at KIOCL: KIOCL has set up a Beneficiation plant to beneficiate Magnetite ore with approximately 35% Fe to high grade **Iron Ore Concentrates**, part of which is also used for production of **pellets** in-house, and part is exported.

Agglomeration of Iron Ore: Iron Ore Fines/blue dust cannot be charged in the blast furnace directly since they block the passage for ascending gas inside the fee. So, they are **agglomerated** (by igniting at lower temperature causing only interfacial fusion) into larger lumpy pieces with/without addition of additives like limestone, dolomite etc.

Two types of agglomerated products are commonly produced/used in the industry namely **Sinter** and **Pellet**. Accordingly the processes are known as **Sintering** and **Pelletising** respectively:

(a) **Sinter** : Sinter is a clinker like aggregate which is normally produced from relatively coarser fine iron ore (normally –3mm) mixed with coke breeze (-3mm), limestone dolomite fines (-3mm) and other metallurgical return wastes from the plant.

Sinter is a much preferred input/raw material in blast furnaces. It improves BF operation and productivity and reduces coke consumption in blast furnace. Presently, more than 70% hot metal in the world (in India 50%) is produced through the sinter.

(b) **Pellet**: Pellets are normally produced in the form of Globules from very fine iron ore (normally –100 mesh) and mostly used for production of Sponge Iron in gas based plants, though they are also used in blast furnaces in some countries in place of sized iron ore.

(iv.) Terms Related To 'COAL/COKE':

Coal:

Definition: Coal is a naturally occurring combustible rock containing 70% (by Vol) carbonaceous material including moisture.

Classification based on level of Maturity: Depending upon the level of maturity/metamorphism**,** coal is classified under 3 main categories namely, **Lignite/Brown Coal, Bituminous Coal, Anthracite Coal.**

Grouping based on Property: Coals are grouped according to particular properties as defined by their Rank (which is a measure of degree of maturity/metamorphism), Type (Vitrinite, Liptinite and Inertinite which are the 3 main groups of materials that constitute coal) and Grade ((depending on Impurities and Calorific Value).

Use of Coal: Natural coal in general is too dense and/or fragile and has limited use as a fuel/reductant in metallurgical plants like Blast Furnace. However, some specific varieties of natural coal (crushed and screened in specified size ranges) find direct application in other metallurgical operations (such as Corex Plant, Coal Dust Injection/Pulverised Coal Injection in Blast Furnace etc.).

Coking/Non-coiking Coal: Based on coking property, coals are broadly classified into two categories namely, **Coking Coal** and **Non-coking Coal**. **Steam coal** used for steam/power generation falls under the broad group of Non-coking coal.

Coking Coal :

Definition: Coking coals are those varieties of coal which on heating in the absence of air (process known as **Carbonisation**) undergo transformation into plastic state, swell and then re-solidify to give a Cake. On quenching the cake results in a strong and porous mass called coke.

Primary/Medium/Semi/Week Coking Coal: Coking coal is divided into 3 sub-categories namely, **Primary Coking Coal** (Low ash , low Volatile, High Coking property) **Medium Coking Coal** (low ash, medium volatile, low caking index) and **Semi/Weak Coking Coal** (low ash, high volatile, very low caking index).

Characteristics of Coking coal for BF Coke: Coking coal for production of BF Coke (which is the right type of fuel/reductant needed for a BF) is characterised by certain specific properties in terms of appropriate composition (viz low Ash (10% max), Volatile Matter (20-26%), and very low sulphur and phosphorous content, appropriate Rank of coal (1—1.3), good rheological properties, wide range of fluidity , low inert content etc.

Indian Coking Coal: Indian Coking Coal found in Gondwana belt (Bihar &West Bengal region) has very high ash (17% or more) and poor rank and other properties, which results in lower productivity and higher coke consumption in blast furnace. **Assam coking coals** though, are low in ash have very high sulphur which limits their use in iron making in blast furnace.

Washing of Coal: Since ash content in Indian coal is very high, washing is resorted to to lower the ash content to some extent. However, Indian coals are notorious with respect to its Washability because the ash /inerts are fairly and finely distributed in the coal matrix thereby rendering washing difficult.

Blending of coal: Because of limited availability of good quality coking coal, the Indian Steel plants use a optimal **Blend** of the 3 or more varieties of coking coal to compensate for the lack of individual coals with the necessary properties. Another important consideration in selecting a coal blend is that it should not exert a high coke oven wall pressure and should contract sufficiently to allow the cake/coke to be pushed out from the oven.

Coke:

Coke is the residual solid product obtained upon carbonisation of coking coal. Depending upon property, coke is known as Hard Coke, Soft Coke and Metallurgical Coke.

Metallurgical Coke: Not all coke can be used in metallurgical operations for which good quality coke made from specific blend of coking coal is essential. Such coke is classified as Met. Coke.

Blast Furnace (BF) Coke: The term is used to refer to such Met Coke which are used for iron making in BF. BF coke fulfills 3 main functions in the blast furnace operation:

i) It acts as a **fuel** providing heat for all reactions
ii) It acts as a **reductant** provicing Carbon dioxide gas anc carbon for readuction of iron ore ,and
iii) It provides the required **permeability** for movement of gases through the bed of iron ore, coke and limestone inside the blast furnace.

BF Coke is characterised by the following parameters:

i) Specified Size Range (25/40-80mm),
ii) High Fixed Carbon (80-85%),
iii) Low Ash (10- 15% ash),
iv) Low Volatile Matter (2% Max),
v) Low Alkalies,
vi) Low Sulpher(0.7%Max),
vii) Low Phosphorous(0.3% max),
viii) High Strength/Abrasion Resistance(measured in terms of Micum Index(namely M10 value 10% Max and M40 value 75/80% Min),
ix) Reasonable Coke Strength after Reaction (CSR : 55-60), and
x) Appropriate Reactivity (CRI: below 25).

These characteristics depends not only on the coal properties but also on the coking technology/parameters as well as pre-carbonisation & post-carbonisation techniques adopted thereof.

Adverse effects of Ash : Ash has highly adverse effect on the productivity of BF and on consumption of coke in the BF. An increase in ash content by 1% over a critical limit results in increase in coke consumption by about 4-5% and decrease in BF productivity about 3-6%.

Indian Integrated Steel Plants **normally** use high ash coke produced in-house, at the cost of productivity, energy consumption etc. The Mini Blast Furnace units however use mainly imported low ash Met coke from China and other sources.

Non-Coking Coal (NCC)

These are coal of poor coking properties i.e. does not soften and form cake like coking coal during carbonization in the coke oven. Such coals with relatively lower ash and higher fixed carbon are used in metallurgical applications viz. COREX technology based iron (pig iron) plants, Coal based DRI Plant etc, while those with higher ash are normally used in thermal Power Plants as steam coal.

NCCs are classified into A,B,C,D,E and F grades depending upon its heat value which is a fraction of carbon and volatile matter and ash content in the coal.

Coke Ovens/Coke Oven Battery: Coking Coal is converted into Coke in coke ovens which are silica refractory lined ovens/ chambers. Coke Oven battery comprises of a large number of ovens, 50-70 in tandem. Such batteries are normally attached with By-product plant where in valuable constituents are recovered from the volatile /gaseous content of coal driven out during carbonisation. Accordingly, such coke ovens are known as By-product coke oven battery vis-a-vis Non-recovery type coke ovens, also known as Bee-hive type coke ovens.

Coking time : Coking time is defined as the time required for conversion of coal to coke in the coke oven which varies in the range of 15-20 hrs.

Yield of different varieties of coke: Typical yield from one tonne of dry coal charge to coke is 75%. Depending upon size ranges, coke is classified into the following categories:-

Category	Yield	Use
BF Coke (25/40-80mm)	85%	Blast Furnace

Nut Coke (15-25mm)	5%	Sinter Plant /Ferro Alloy/Pig Iron Industry
Coke breeze (0-15mm)	10%	Sinter Plant /Cement Industry.

Coal Dust Injection(CDI)/
Pulverised Coal Injection(PCI): These are technologies wherein pulverised/ granulated/ dust coal is injected into the blast furnace through the tuyers along with the Blast to replace part of the coke requirement..

(v). Terms Related TO 'TECHNO-ECONOMIC PARAMETERS' :

These are parameters which are normally used to judge the operational efficiency/effectiveness of iron & steel making processes in the steel plants. Most commonly used parameters are :

i) **BF Productivity** : which is measured in terms of tonnes of hot metal produced, per cubic meter of blast furnace volume, per day (T/cubic met/day).

ii) **Coke Rate** : This is measured in Kgs. of BF Coke consumed per tonne of Hot Metal produced in the Blast Furnace(Kg/THM). By convention, this excludes coke (nut/pearl coke) mixed with sinter etc.

iii) **Energy Consumption** : This is measured in Giga Calorie (i.e. 1000 million calorie) per tonne of Crude Steel produced(Gcal/TCS).

iv) **Power Consumption** : This is measured in terms of Number of units of electrical power consumed in KWH per tonne of crude steel produced (KWH/TCS).

v) **Refractory Consumption** : This is measured in terms of total refractory consumed per tonne of crude steel(Kg/TC.

A comparative indicative picture of above parameters in Indian plants vis-a-vis the international level (during 2002-03) are given below:

Parameters	**World Norm**	**SAIL (BSP/DSP/RSP/BSL)**	**IISCO**	**VSP**	**TISCO**
BF Productivity (T/M3/Day)	**2 - 3**	**1.51 (1.72/1.36/1.11/1.60)**	**0.75**	**1.95**	**1.82**
Coke Rate (Kg/THM)	**350-400**	**538 (498/573/611/536)**	**798**	**474**	**528**
Energy	**4 – 5**	**7.5**	**9.19**	**6.32**	**5.28**

Consumption (Gcal/TCS)		**(6.84/7.36/8.88/7.77)**			
Power Consumption (Kwh/T Sal Steel)	400-500	498 (460/430/602/505)	500	540	430
Refractory Consumption (Kg/Tcs)	15	18.2 (20/16/23.8.14.9)	NA	18.5	13.6

(vi). MISCELLANEOUS TERMS :

Fluxes : Limestone, Dolomite, etc. used in Iron/ Steel making which react with the undesirable gangue material/ impurities and removed ash **slag**.

Ferro Alloys : Master alloys used for de-gassing/ de-oxidising/alloying in steel making. Common varieties are ferro silicon, ferro manganese, silico manganese, ferro chrome, ferro nickel etc.

Refractories : Heat resistant bricks/ shapes/ monolithic mass used for construction/ lining of reaction vessels/ furnaces. Common varieties are Silica, Magnesite, Dolomite, Alumina, Fire-clay, Mag-carbon, Mag-chrome etc.

Steel Melting Scrap: Steel waste/scrap not usable as such in its existing form which are further re-melted to produce liquid steel to produce various products. Depending on their form/type, they are classified as Heavy Melting Scrap, Light Melting Scrap, Turnings/borings etc.

Re-rollable Scrap: Seconds & defective products, Cuttings/end cuttings, Used steel products like used rails etc which could be directly used for re-rolling (without resorting to re-melting) into finished products for specified applications. These are substitutes of steel billets /pencil ingots. Ship breaking generates substantial quantity of re-rollable steel scrap.

Integrated Steel Plants: Steel plants using iron ore as the basic raw material for production of crude steel which is further rolled into finished shapes in-house. Conventionally, these plants have captive coke ovens also and the sensible heat of the outgoing gases from iron/coke making are utilised as fuel for various applications.

It therefore, includes units with in-house coke making (optional), iron making followed by production of liquid steel & crude steel and finished steel. So all ISPs adopting BF- BOF route and Major producers adopting Corex-BOF or DRI-EAFor MBF-EOF technology would technically, fall under this category.

Mini Steel Plants: Conventionally, EAF/IF based steel plants with/ without captive rolling mills were covered under this category. However, now all steel plants (based on any technology) of capacity upto 5 lakh tpa are covered under this category.

Primary Steel Producers: Steel (crude and/or finished steel) producers using iron ore as the basic raw material/input. It therefore, includes in-house iron making followed by production of liquid steel & crude steel with/without in-house rolling. So all ISPs adopting BF- BOF route and Major producers adopting Corex - BOF or DRI-EAF or MBF-EOF technology would fall under this category.

Hot Rolling : Rolling of Steel at above the recrystallisation temperature of steel (normally above 1000 C) to produce Hot Rolled Long products/Flat Products from semis. Ingots are also hot rolled to get semis. At times blloms are also hot rolled to produce Billets. Rolling Mills used for hot rolling are known as **Hot Rolling Mills**.

Cold Rolling: Rolling of steel (normally flat products) below the recrystallisation temperature of steel (normally at Room Temperature) to produce cold rolled sheets /strips /coils. Mills used for the purpose are called **Cold Rolling Mills**.

2Hi/4 Hi/6 Hi/20 Hi Mills: Rolling Mills are classified as 2-High / 2 Hi, 4 Hi and so on depending on Number of Rolls used in the arrangement/configuration of rolls in single stand. For example, a 2 Hi mill consist of 2 rolls one above the other known as Upper roll and the Lower roll. In a 4 Hi mill, there are 4 rolls in a stand—2 upper rolls one above the other and 2 lower rolls one above the other. A typical configuration of 4 Hi mill is shown below:

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