

SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	BLAST FURNACE	Doc. No: SG / 30
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		Effective Date: --

1. OBJECTIVE:

Blast furnace produces Hot metal (Liquid Iron) using Iron ore, Coke, Sinter, Pellets and fluxes such as Lime-stone, Pyroxenite, Quartzite, Dolomite, & Mn Ore reacting with oxygen from pre heated air.

This entire process of production of hot metal is associated with various safety hazards like hit / entanglement with mobile equipment, burns, fire, slip & fall, falling objects, electrocution exposure to dust, smoke, noise, heat & gas etc.

2. SCOPE:

This guideline of safety is applicable to Blast furnace Dept. of an Integrated Steel Plant.

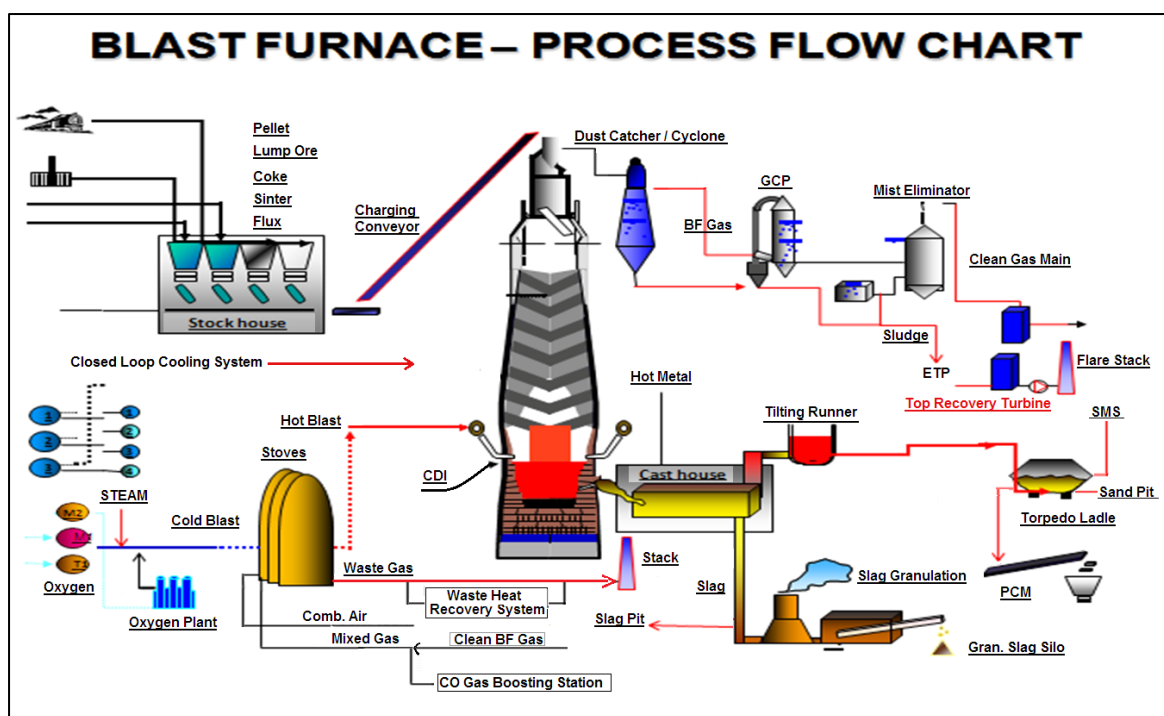
3. PROCESS:

In the Blast Furnaces (BF) liquid iron (popularly termed as 'Hot Metal') is produced by the process of reduction at high temperature from raw materials like iron ore, base mix, sinter, pellet, coke, fluxes (limestone, quartzite, Dolomite & Mn-ore), etc. & also pre heated air blast / O₂. In blast furnace the process is also known as "Counter current process" as solid raw material is being charged from the top and hot air is being blown from tuyeres installed in hearth area at the bottom. During the process the impurities are removed in the form of slag and hot metal is produced. Pulverized Coal is being injected to reduce consumption of main fuel coke which is a cost reduction measure.

Liquid metal and slag are being separated in the area known as cast house. The liquid Hot Metal is transported in Hot Metal Ladles / Torpedoes to the Steel Melting Shops (SMS) for the production of steel by the process of oxidation of the Hot Metal in specially designed Convertors.

Sometimes the Hot Metal is poured in the Pig Casting Machine (PCM) to produce Pig Iron. During commissioning when Si content of hot metal is very high, hot metal is taken to sand pit for dumping.

Slag produced is granulated by high pressure water jets in the Cast House itself or sent to Slag Dumping in the Slag Pots or into dry slag pit constructed adjacent to the cast house.

Blast Furnace Process Flow:**Different Sections of Blast Furnace:****i) Furnace Proper:**

In the Furnace, Hot Metal (along with slag) is processed from the raw material which gets collected in the hearth and blast furnace gases come out of blast furnace from the top.

ii) Cast House:

In the Cast House, Hot Metal & slag are tapped from the Furnace tap hole and Hot metal and slag are separated in the refractory lined main iron trough. Hot metal is led to hot metal ladles/torpedoes (placed below the cast house) through hot metal runners and slag is led to cast house slag granulation system or to dry slag pit (when granulation is not being carried out) through slag runners.

iii) Stoves and Hot Blast Supply System:

Hot Blast Stoves (normally 3 nos.) supply hot blast after heating cold air provided by turbo blowers/Fans to Blast furnace through hot blast main, bustle main, tuyere stocks and tuyeres. Stoves are also provided with Waste Heat Recovery System and Coke Oven gas enrichment facilities, if Coke Oven gas is available.

iv) Raw Material storage / Stock House and Raw Material charging system:

In this there are designated bunkers for raw materials transported from mines / Sintering Plant (SP) / Raw Materials Handling Plant (RMHP) / Coke Ovens (CO) by wagons / conveyors. Here batching of raw materials is done and sent to Blast Furnace top via conveyors/ Skips for charging into the blast furnace as per predetermined charging schedule.”

v) Gas Cleaning Plant (GCP):

The blast furnace gas (BFG) generated in the BF is cleaned through a series of steps (primary cleaning at Dust Catcher/Cyclone and secondary cleaning at Gas Cleaning Plant) before transporting it to the BFG Holder / Flare Stack after internal consumption.

vi) Slag Granulation Plant (SGP) / Slag Dumping Yard:

During the process of iron making, the impurities are fluxed and removed as slag. The hot liquid slag is made into slag granules by means of high pressure water jets in the Slag Granulation Plant in the Cast House itself (sometimes separate SGP is located at a distance from the furnace proper).

If the slag is not granulated in SGP, it is poured in the Slag Dumping Yard or sent to dry slag pit, normally provided adjacent to the cast house.

vii) Pig Casting Machine (PCM):

Sometimes when there is poor off take of Hot Metal by SMS or if the Hot Metal chemistry is very adverse, Hot Metal is taken to this section for casting into Pig Iron.

viii) Pulverised coal Injection:

In this section, coal Conveyed from RMHS (Raw Material Handling System) is pulverised to fine dust in mills and injected in the furnace through lances provided in blow pipe engaging with tuyeres.

ix) Sand Pit

During commissioning of Blast Furnace when Si content of hot metal is very high or in some emergency, hot metal is dumped into sand pit where it is water cooled, broken into small pieces and dispatched.

Some of critical Equipments/ facilities in Blast Furnace Department are as follows:

S.No.	Area	Major equipments / facilities
1.	Blast Furnace & auxiliary sections	Blast Furnace proper with top charging system, stoves & hot blast supply system, Stock House & conveyor/skip charging system, Fines handling system, Dust Catcher/Cyclone, (water, BF gas, Oxygen, skip car, yard equipments, conveyors, bunkers, Coal Dust Injection / Coal Tar Injection units, drill machine, mud gun, pusher cars, ladle/

		torpedo, TRT, Gas Cleaning Plant, Tilting/ Rocking Runner, Pig Casting Machine, Utility lines (Compressed air, Instrument air, Nitrogen, steam, etc.), EOT cranes, Cast House, Pump house, Cooling Towers, Water supply system, Electrical Sub-station, ETP, Filter press/Sludge pond, Flare Stack, Railway track, CO gas boosting station, Cast house De-fuming System, Stock House De-dusting System, Dry Slag pit, Sand Pit, LRS, Soft Water Plant, Fire fighting system etc.
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4. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

S.No.	Section	Hazard	Risk Control Measures
1.	Furnace Proper	Gas leakage	<ul style="list-style-type: none"> ❖ Installation of On-line Gas monitor at strategic locations & use of Portable "CO" monitors to detect gas leakage. ❖ Prohibition of people going above cast house level around the furnace, as there are chances of gas leakage. If at all, one needs to go, he should be accompanied by gas safety man with proper safety precautions under intimation to control room. <p><i>(Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) management, SG-16: Safety Guideline for Fire Safety, SG-21: Safety Guideline for Handling Fuel Gas)</i></p>
		Shell crack	Regular inspection & repair as per requirement
		Corroded structure	
		Fine Dust deposition	Installation of ESP /bag filter based cast house de-fuming system & regular cleaning
		Sound from Leakages etc.	Plug the leakage points, use Ear Plugs
Slip, Trip and fall hazards. Material falling from height.	<ul style="list-style-type: none"> ❖ Ensure proper housekeeping. ❖ Prevent materials or objects falling. ❖ Uses of appropriate PPEs, such as helmets, gloves, aprons and boots. <p><i>(Refer: SG-18: Safety Guideline for Personal Protective Equipment (PPEs) management).</i></p>		

S.No.	Section	Hazard	Risk Control Measures
		Fire and explosion	<ul style="list-style-type: none"> ❖ Fire fighting. ❖ Engineering controls. ❖ Administrative (procedural) controls. ❖ Practicing controlled water spraying for burden cooling and meticulous checking of hydrogen content in the gas for avoiding explosion during shutdown. <p><i>(Refer SG-16: Safety Guideline for Fire Safety)</i></p>
2.	Cast House	Hot metal/slag over flow from runner	<ul style="list-style-type: none"> ❖ Use of PPEs. ❖ Maintaining Runner depth. ❖ Development & adherence to SOP (Standard Operating Procedure). ❖ Provision of water spraying system.
		Hot metal splinter during casting	<ul style="list-style-type: none"> ❖ Timely closing of Tap holes after blow, ❖ Regular inspection & checking of Mud gun machines and Drilling Machines. ❖ Development & adherence to SOP. ❖ Use of PPEs like fire retardant suits, helmet with face shield, ankle guards hand gloves and safety shoes. ❖ Prohibition of people working on cast house cranes and its walkways during tapping. ❖ Trial of rocking runner should be taken during tapping before the entire ladle is full. This will prevent overflow of hot metal from the ladle. <p><i>(Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) management).</i></p>
		High radiant heat, molten metal, dross or slag, fumes, dust.	<ul style="list-style-type: none"> ❖ Molten metal resistant jackets and trousers, face shields or vented goggles, Safety gloves, protective helmets; safety

S.No.	Section	Hazard	Risk Control Measures
			<p>footwear insulated against heat, Safety goggles.</p> <ul style="list-style-type: none"> ❖ Dust and fume collectors ESP /Bag filter system. ❖ Provision of covers on hot metal and slag runners. ❖ Provision of heat shield in cast house control pulpit/pulpits. <p><i>(Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) management).</i></p>
		Use of wet sand in runner	Use of dry sand.
		Water ingress in runner	Regular inspection.
		Gas leakage from surrounding area	<ul style="list-style-type: none"> ❖ Provision of Online Gas monitor & Portable "CO" (carbon Monoxide) monitors. ❖ Emergency Plan & mock drill. <p><i>(Refer SG-21: Safety Guideline for Handling Fuel Gas)</i></p>
		Fire in Elect panel/cable nearby	<ul style="list-style-type: none"> ❖ Portable fire extinguishers. ❖ Development & adherence to SOP (Safe Operating Procedure). <p><i>(Refer SG-16: Safety Guideline for Fire Safety)</i></p>
		Movement of Cranes	<ul style="list-style-type: none"> ❖ Use of PPEs. ❖ Keep away from moving Cranes. ❖ Effective audible and visual communication devices should be installed on a crane or hoist. ❖ Proper locking of crane hook as per SOP. ❖ Regular inspection of crane hook & ropes. <p><i>(Refer SG-14: Safety Guideline for work on Electric Overhead Travelling (EOT) Crane)</i></p>
		Failure/ Melting of tuyeres	<ul style="list-style-type: none"> ❖ Regular inspection to be done. ❖ Monitoring of cooling system at tuyere platform. ❖ Checking of refractory

S.No.	Section	Hazard	Risk Control Measures
			healthiness of tuyere.
3.	Hot Metal / Slag Handling including Ladle preparation & Ladle repair	Accumulation of water near rail track /Ladles	Regular inspection of tracks, Ladles & drainage facility. <i>(Refer SG-23: Safety Guideline for Safe handling of Liquid Metal)</i>
		Wrong placement of ladles	Proper coordination between BF & TRM by defining & following SOP
		Over flow of metal/slag	❖ Inspection to ensure proper filling of ladles. ❖ Provision of level sensors. ❖ Development & adherence to SOP.
		High radiant heat, fumes, hot metal splashes, high temperatures.	❖ Emergency measures. ❖ Fire fighting and fire prevention. ❖ First aid facility. ❖ PPE Management. <i>(Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) management)</i>
4.	Stoves	Gas leakage	❖ Provision of Online Gas monitor & Portable "CO" monitors to detect gas leakage. ❖ SOP & SMPs to be followed strictly to avoid gas leakage. ❖ Prohibition of people working on stove platform area when stove status is changed from isolation mode to heating mode. <i>(Refer SG-21: Safety Guideline for Handling Fuel Gas)</i>
		Sound from Leakages etc.	❖ Arrest the leakage points, ❖ Use Ear Plugs while on job.
		Hot spot development	Regular inspection of shell temperature and provision of water spray cooling.
5.	High lines /Stock House	Spillage accumulation	Regular cleaning to be ensured & Engineering controls to be applied to arrest the spillage points.
		Conveyor belt hazards	SOP (Standard Operating Procedures) for conveyor safety to be followed strictly.
		Cleaning running conveyors	<i>(Refer SG-19: Safety Guideline On Operation and Maintenance of conveyor belts).</i>
		Fall into raw	Railings are provided around the

S.No.	Section	Hazard	Risk Control Measures
		material bins	bins.
		Materials falling, Releases of dust	<ul style="list-style-type: none"> ❖ Open-mesh walkways to prevent objects from falling through and causing injury to people below. ❖ Respiratory protection dusk mask. ❖ Dust and fume collectors ESP /Bag filter system.
6.	Gas Cleaning Plant (GCP)	Gas leakage	Provision of Online Gas monitor & Portable "CO" (Carbon Monoxide) monitors to detect gas leakage. <i>(Refer SG-21: Safety Guideline for Handling Fuel Gas)</i>
Hot flue dust dumping		<ul style="list-style-type: none"> ❖ Development & Adherence to SOP. ❖ Usage of proper PPEs (Personal Protective Equipment) while working. 	
Water seal breakage due to pressure fluctuation and damaged water seal		<ul style="list-style-type: none"> ❖ Regular inspection to be done & Process parameters to be monitored continuously to avoid any deviations. <i>(Refer SG-21: Safety Guideline for Handling Fuel Gas)</i>	
7.	Slag Granulation Plant (SGP) / Slag Dumping Yard	Spillage accumulation	<ul style="list-style-type: none"> ❖ Regular cleaning of settling tanks of cooling towers.
Water accumulation in slag pit		<ul style="list-style-type: none"> ❖ Water draining system to be maintained. Regular inspection to be done. 	
Conveyor belt hazards		Development & adherence to SOP on Conveyor Safety. <i>(Refer SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts)</i>	
Presence of hot metal in slag		Proper segregation of hot metal & slag at cast house in main iron trough.	
Overflow of Hot water from drains		Regular cleaning of Drains.	
8.	Pig Casting Machine (PCM)	Overflow of hot metal from runner & machine	Development & adherence to SOP.
Handling hot liquid, dust, heat.		<ul style="list-style-type: none"> ❖ Safety footwear and other leg protection guard. 	

S.No.	Section	Hazard	Risk Control Measures
			<ul style="list-style-type: none"> ❖ Effective audible and visual communication devices. ❖ Hand railing near PCM pouring end.
9.	Pulverised Coal Injection (PCI)	Inhalable agents (gases, vapours, dusts and fumes); gases containing concentrations of carbon monoxide, moving machinery, conveyors	<ul style="list-style-type: none"> ❖ Work-related training programmes to cover all workers including contractors. ❖ CO-gas (Carbon Monoxide) detector, trained in to recognize the symptoms of carbon monoxide poisoning. ❖ Guarding of moving machineries and conveyors. ❖ During cleaning of bunkers, precaution for confined space working shall be taken. <p><i>(Refer SG-09: Safety Guideline in Equipment & machine Guarding, SG-21: Safety Guideline for Handling Fuel Gas, SG-03: Safety Guideline for Working in a Confined Space.)</i></p>
10.	Sand Pit	Falling into hot metal pit	<ul style="list-style-type: none"> ❖ Provision of proper hand rails all around the pit. ❖ Unauthorized entry in the area should be prohibited.
11	CO gas boosting Station	Exposure to gas leakage	<ul style="list-style-type: none"> ❖ Provision of online gas monitor and portable gas monitors to detect gas leakage. ❖ Provision of proper ventilation. <p><i>(Refer SG-21: Safety Guideline for Handling Fuel Gas)</i></p>
12.	Repair work in Gas lines, GCP, TRT & Flare Stack	Explosion	<ul style="list-style-type: none"> ❖ Preparation of proper protocol. ❖ Adherence to SOP& Protocol. ❖ Taking shut down and complete purging of the system. ❖ Blanking of the area as per requirements. ❖ Cordoning of repair area and prohibition of any unauthorized entry.

Note:

- 1) The operating procedure as given in the write-up may vary from shop to shop due to different equipment disposition and type. Safety precautions under each head may be separately identified.
- 2) Other standard plant safety procedures shall be followed.
- 3) Signages and emergency escape route shall be shown covering the entire shop.
- 4) Provision & operability of safety fences should be ensured covering the entire shop.
- 5) The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs (Standard Operating Procedures) & SMPs (Standard Maintenance Procedures) are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.