

| RECOMMENDED GUIDELINES FOR IRON & STEEL SECTOR | | |
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| MINISTRY OF STEEL, GOVT. OF INDIA | STEEL MELTING SHOP | Doc. No: SG/39 |
| | | Rev no. : 00 Effective Date: |

1. OBJECTIVE:

Steel Melting Shop (SMS) receives Hot Metal (HM) from Iron-making units and converts it into various grades of Steel and casts them into Slabs, Blooms, Billets, Beam blanks, Rounds and thin slab- HR coils. Those are delivered as products to down-stream units (Long, Section & Flat Products). SMS is the first stage in the Steel manufacturing value chain where product differentiation and customization starts.

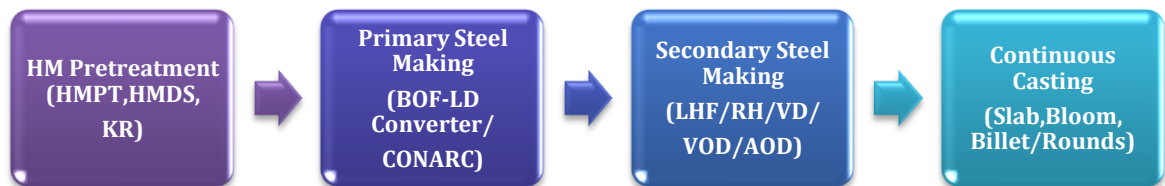
This entire process of steel making is associated with various safety hazards like exposure to excessive heat, dust, noise, fire and explosion, fall from height, confined space, electrical shock, gas & radioactive leakages related hazards etc. The objective of this document is to identify the hazards associated with steel melting shop process & to ensure accident free working.

2. SCOPE:

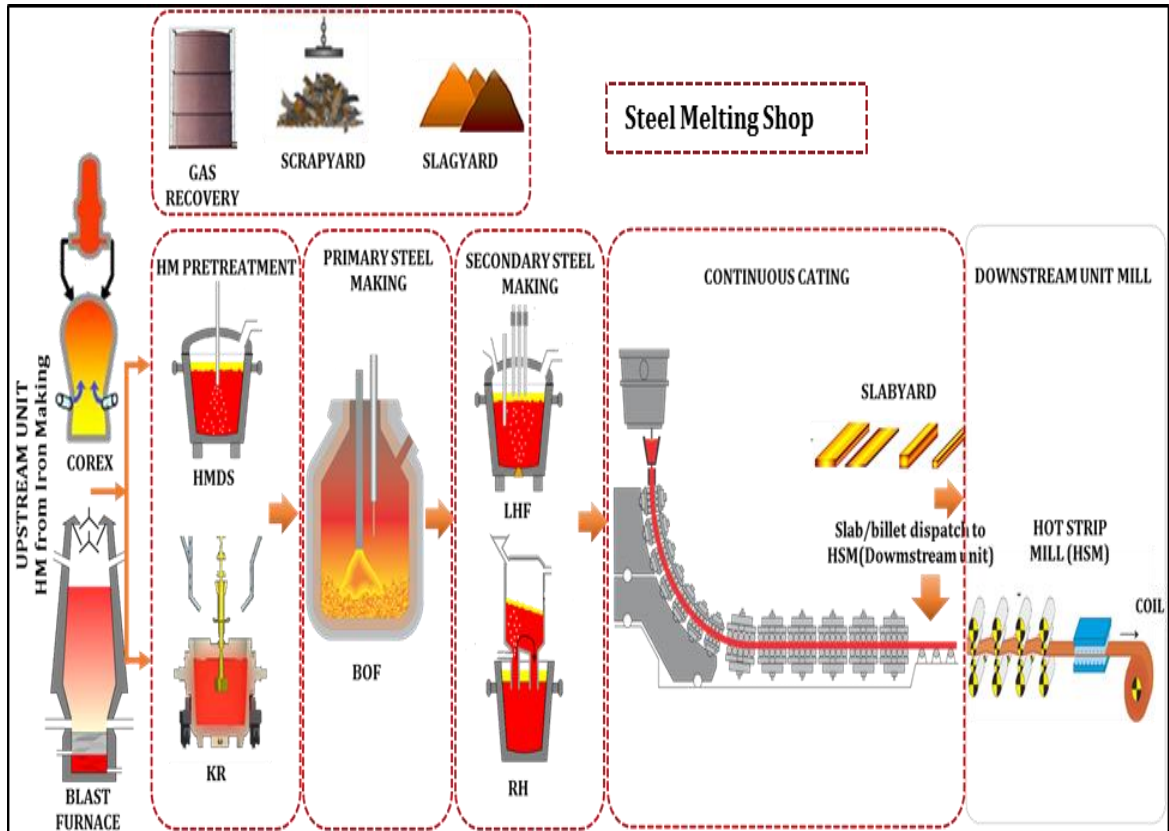
These guidelines are applicable to Steel Melting Shop department of an Integrated Steel Plant.

3. PROCESS BRIEF:

3.1 The Steel Melting Shop has following Units & Auxiliary Departments:



The hot metal from Iron making is transported by Open ladles/Torpedoes which are poured out into charging ladle into the furnaces. To convert iron into steel needs oxygen blowing or combination of oxygen / arcing to reduce carbon, silicon, manganese and phosphorous as main impurities. Typical flow chart is illustrated below.



3.2 Hot Metal (HM) Pre-treatment / Hot Metal Desulphurization:

During HM refining, impurity like Silicon, Phosphorous & Sulphur is removed by injection of reagents. In pre-treatment station desiliconization & dephosphorization by oxygen blowing along with iron ore/sinter is done into the ladle or torpedo with continuous deslagging. After the pre-treatment process, co-injection / mono-injection or stirring process is adopted for desulphurisation, slag skimming is done in Hot Metal ladles to ensure slag free metal for Primary steelmaking.

In some of the old steel melt shops, hot metal transferred in open top ladles are poured in Mixer units for temperature & composition homogenisation of hot metal received from different blast furnaces. The Mixer unit also acts as a buffer between the blast furnace & BOF units. However present day new steel melt shops do not have any mixer unit as hot metal is received in torpedo ladle cars.

3.3 Primary Steel Making (BOF Vessel / LD Converter / ConArc):

3.3.1 **LD Converter** : HM & Scrap are charged in one vessel after which O₂ is blown to remove impurities in HM. Fluxes are added to get desired quality product output.

3.3.2 The basic equipment of CONARC process consists of two identical refractory lined furnace shells, one slewable electrode structure with one set of electrodes serving both the furnace shells, one electric supply (transformer etc.) for both the shells, and one slewable water cooled top oxygen lance system serving both the shells. Alternatively two stationary top lances, one for each furnace shell for the blowing of oxygen can also be used. The basic concept of CONARC process is to carry out decarburization in one shell and electric melting in another vessel.

3.4 Secondary Steel Making (LHF / RH degasser / VD / VOD / AOD):

- 3.4.1 **LHF** : Ladle Heating Furnace (LHF) ensures reheating of Liquid Steel, coming from BOF Ladle Furnace utilizes electric energy& graphite electrode to raise & maintain Temperature. Homogenization of liquid steel temperature and chemistry of steel through inert gas stirring. Steel is refined & final composition is achieved.
- 3.3.2 **RH-OB** : RH-OB degasser is a secondary refining system that removes dissolved gases such as hydrogen, Nitrogen, reduction of Carbon present in molten steel to enable the production of high-grade steel. RH is used to make Ultra low carbon speciality steel products like IF steel and Electrical steels.
- 3.4.3 **VD** : Vacuum de-gassing (VD) is a secondary refining system that removes dissolved gases such as hydrogen, nitrogen present in molten steel by means of vacuum & argon purging in a tank. Minor composition adjustment is done with alloying as per the special steel chemistry requirement.
- 3.4.4 **VAD** : Vacuum Arc Degassing (VAD) unit is a secondary refining system comprising of a tank degasser with electrodes added for the purpose of reheating the liquid steel with provision of alloy trimming.It has an added advantage of superior desulphurisation potential & nitrogen control required for quality steel grades with ultra low sulphur levels.
- 3.4.5 **AOD**: Argon Oxygen Decarburization (AOD) is used during refining for stainless steel grades and other high grade alloys with oxidisable elements such as chromium and aluminium. Oxygen is blown from top lance & oxygen with argon is blown from the side tuyeres for preferential oxidation of carbon over chromium thereby leading to processing of high chromium stainless steels with lower carbon contents. However AOD is primarily used in conjunction with IF / EAF based route.

3.4 Caster:

- 3.4.1 Continuous Casting Machine: Caster converts liquid steel into solid shapes either slabs, bloom, billets, rounds and section of required dimensions as per downstream mill configuration. The liquid steel is poured in refractory lined tundish from the teeming ladle placed on the ladle turret arm. Thereafter the liquid steel is poured (controlled pouring through stopper rod arrangement / slide gate arrangement/ open stream through metered nozzles) into the water cooled copper mould and solidified & cast into relevant shapes in the continuous casting strand. The solidified strand is cut into requisite lengths in a torch cutting machine and the cut slabs/ billets/blooms are dispatched to the rolling mill for further processing into saleable steel.

3.5 Auxiliary units:

- 3.5.1 **Ladle preparation** of all steel &HM ladles minor, major repairs, Preheating & preparation activities done to smooth batch process of steel making
- 3.5.2 **Slag yard:** All BOF & Secondary steel slag handling in liquid condition
- 3.5.3 **Scrap yard:** Receiving & Preparing of various scrap kinds to feed BOF continuously.
- 3.5.4 **Slab Yard:** Slab Handling and transferring of slabs to downstream unit (Hot Strip Mill)
- 3.5.5 **Fuel gases/Mixed gasses are** used as source heating for heating purposes within the plant for meeting various refractory vessels.
- 3.5.6 **Gas Recovery and Export system / Gas Holder:** BOF process gas is recovered during O₂ blowing and collected in a gas holder and same is exported to gas network of the plant where in gases are fed to power plant and other utility consumers.
- 3.5.7 **EOT Cranes** are used to handle hot metal / steel ladles / equipment handling for casters and slab / bloom / billet handling
- 3.5.8 **Water Treatment Plant :** BOF and Casting process consumes lot of water for cooling equipment / slabs where in primary cooling is closed loop for which water treatment to required quality is maintained. Since these water are hot during process needs to be cooled down through cooling tower on continuous basis. Overhead emergency tanks are also maintained for power failure sustenance.
- 3.5.9 **Tundish preparation:** Tundish preparation & maintenance equipments comprises of lining stands, tundish cooler, tundish driers, tundish deskulling stands & tundish preheating stations (on casting platform). Depending on the type of casting requirement SEN & SES pre-heating stations are envisaged on casting platform.

Some of critical Equipment's/ facilities in Steel Melting Shop Department are as follows:

| Area | Major equipment's |
|-----------------------------|--|
| Steel Making/Melting Shop | BOF vessels, Refractory Ladles, RH vessels, Transfer cars Fork Lift, Gradall, Debricker, EOT Cranes, Mobile Cranes, Pay loaders, Bunkers, Gas holder, Gas cooling and cleaning system, ID fans, Transformers |
| Continuous Casting / Caster | Turret , Mould , Tundish Car , Segments, Run out table , Torch cutting machine, Deburring machine, Marking machine and product evacuation tables. Auxiliary equipment are water pumps for cooling system and scale flushing system |

4. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--|---|--|---|
| 4.1 Transferring HM from Torpedo to HM Ladles | | | |
| 4.1.1 | Movement of the HM ladle car and align the ladle properly underneath the Torpedo spout. | <ul style="list-style-type: none"> • Hot Metal Spillage • Fire | <ol style="list-style-type: none"> 1 Level sensors for free board measurement system to be in place (Laser/Radar/Camera based) to avoid overfilling 2 Fire hydrant and Extinguishers to be kept as standby, 3 Bunds are made to avoid metal flowing to vast areas <p><i>(Refer SG-16, Safety guidelines for Fire Safety, SG-23: Safe handling of liquid metal)</i></p> |
| 4.1.2 | Make the Electric plug connection | Electric shock | <ol style="list-style-type: none"> 1 Electric shock proof hand gloves to be used. 2 Regular maintenance of plug to be ensured. <p><i>(Refer SG-18: Personal Protective Equipment PPE Management)</i></p> |
| 4.1.3 | Pouring of Hot Metal from Torpedo ladles to hot metal Ladles | <ol style="list-style-type: none"> 1 Metal spillage due to over flow 2 Fire | <ol style="list-style-type: none"> 1 Proper Positioning of the torpedo and controlled tilting to be done prevent the spillage. Visibility to operator should be ensured 2 Functioning of Tilt in / out of torpedo to be checked once before pouring hot metal into ladle <p><i>(Ref SG-23 for safe handling of liquid metal)</i></p> |
| | | <ol style="list-style-type: none"> 1 Trickling/Puncture of ladle on transfer ladle car(TLC) 2 Fire hazard 3 Explosion | <ol style="list-style-type: none"> 1 Visual inspection of ladle refractory & Life monitoring / Thermography of refractories 2 Hydraulic tanks if any on transfer car to be protected suitably with proper design and use fire resistant oil. 3 Water accumulation in |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--|---|--|---|
| | | | pouring pits to be drained out/dried with slag <i>(Refer SG-10 for Hydraulic safety)</i> |
| 4.2 Transferring HM from Mixer to HM Ladles | | | |
| 4.2.1 | Movement of the HM ladle car and align the ladle properly underneath the Mixer spout. | <ul style="list-style-type: none"> • Hot Metal Spillage • Fire | <ol style="list-style-type: none"> 1 Level sensors for free board measurement system to be in place (Laser/Radar/Camera based) to avoid overfilling 2 Fire hydrant and Extinguishers to be kept as standby, 3 Bunds are made to avoid metal flowing to vast areas <i>(Refer SG-16: Safety guidelines for Fire Safety, SG-23: Safe handling of liquid metal)</i> |
| 4.2.3 | Pouring of Hot Metal from Mixer to hot metal Ladles | <ol style="list-style-type: none"> 1. Metal spillage due to over flow 2. Fire 3. Overturning of mixer 4. Mixer through | <ol style="list-style-type: none"> 1 Proper Positioning of the HM ladle and controlled mixer tilting to be ensured prevent the spillage / overturning of mixer. 2 Visibility to operator should be ensured 3 Functioning of Tilt in / out of mixer to be checked once before pouring hot metal 4 Mixer lining condition to be checked as per SOP. <i>(Ref SG-23 for safe handling of liquid metal)</i> |
| | | Trickling/Puncture of ladle on transfer ladle car(TLC) | Visual inspection of ladle refractory & Life monitoring / Thermography of refractories |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---|---|--|---|
| | | Fire hazard | 1 Hydraulic tanks if any on transfer car to be protected suitably with proper design and use fire resistant oil. (Ref SG-10 for Hydraulic safety) |
| | | Explosion | Water accumulation in pouring pits to be drained out/dried with slag. |
| 4.3 Unloading of DeS (De-Suplhurization) reagents into storage bunkers | | | |
| 4.3.1 | Connect Material Conveying Hose & Gas Hose to the Bulk Transport Vehicle. | Bursting of hose and fire catch due to Mg/CaC2 exposure to atmosphere | 1 Cam-lock coupling to be provided in the hose to prevent unlocking of hoses during conveying pressure operation. 2 Fire Extinguishers to be kept as standby, 3 Dry Sand in Buckets to be kept as standby (Refer SG-16: Safety Guidelines for Fire Safety) |
| | | <ul style="list-style-type: none"> Water logging in the area Fire catch, Explosion | Regular upkeep to be done & standby Fire Extinguishers to be made available, Ensure area is free from water (Ref SG-16 Safety Guidelines for Fire Safety) |
| | | <ul style="list-style-type: none"> Moisture entrapment in the silo Fire catch Explosion | 1 Periodical Calibration of Acetylene analyser, 2 Continuous monitoring of readings along with alarms 3 Dry Sand in Buckets & Fire Extinguishers (Refer SG-16 Safety Guidelines for Fire Safety) |
| 4.4 Hot Metal (HM) Pre-treatment | | | |
| 4.4.1 | Positioning of Ladle for Slag Raking (Pre raking / Post raking) | <ul style="list-style-type: none"> Splashing of Metal Fire hazard | 1 Operators Cabin to be provided to prevent splashes 2 Fire Extinguishers to be in standby (Ref SG-16 Safety Guidelines for Fire Safety) |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|--|---|--|
| | | <ul style="list-style-type: none"> Trickling/Puncture of HM Ladles Fire hazard | <ol style="list-style-type: none"> Ladle will not be moved till metal flow stops Fire extinguishers and water spray systems to be available to extinguish any fire breakout. Ladle to be moved to crane approach after clearing the tracks Ladle to be evacuated using EOT crane to pour the hot metal into other ladle <p><i>(Ref SG-16 Safety Guidelines for Fire Safety)</i></p> |
| | | Hitting of Loco to the transfer cars during operation | <p>Wheel stoppers to be provided for ladles cars, and camera displays at control rooms</p> <p><i>(Ref SG-25 for Loco operation guidelines)</i></p> |
| | | <ul style="list-style-type: none"> Ladle Tilting Hook Wire rope cut Spillage of Hot Metal/Fire hazard | <ol style="list-style-type: none"> Routine inspection Maintenance of wire rope condition and crane equipment to be done. Third party inspection. <p><i>(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)</i></p> |
| | | <ul style="list-style-type: none"> Fall of Raking machine boom/plate in to the ladle Spillage of Hot Metal/Fire hazard | <p>Routine inspection & Maintenance of raking machine to be done</p> |
| 4.4.2 | Injection of Desulphurizing agent for HM Pre-treatment | <ul style="list-style-type: none"> Fall of Jam from dedusting hood Spillage of metal/fire Damage to the Loco/Equipment | <p>Periodical Jam Clearing of dedusting hoods should be done.</p> |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--|---|---|--|
| | | Water Leakage from Splash Cover/Oxygen Lance, Explosion | Corrosion of pipes shall be monitored and Ladle should not be moved till water is completely drained out, if leaks. <i>(Ref SG-20 Safety Guidelines for Oxygen & Nitrogen Gas line)</i> |
| 4.5 Primary Steel making (BOF (Basic Oxygen Furnace)/ LD Converter) | | | |
| 4.5.1 Scrap Charging | | | |
| 4.5.1.1 | Lifting of scrap box from scrap car by semi portal/charging crane (EOT Crane) | Free falling of scrap box along with rope | 1 Movement of people should be restricted under the crane – Auto siren during movement to be incorporated 2 Periodic inspection & maintenance of crane to be done <i>(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)</i> |
| 4.5.1.2 | Scrap falling out from scrap box | Fall of object/loose scrap | 1 Movement of people should be restricted under the crane 2 Inspection of healthiness of emergency brakes of crane during P.M. 3 Continuous alerts like hooter sound while movement of crane to be provided <i>(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)</i> |
| 4.5.2 HM Ladle Charging to Converter | | | |
| 4.5.2.1 | Hot Metal ladle is lifted by charging crane. | Free fall of HM/Steel ladle from EOT crane | 1 Auto / manual Emergency breaks shall be made available in cranes and operators to be trained 2 Hooter shall be provided to alert persons 3 Unauthorised Movement of people should be restricted under the crane 4 lifted weight tracking facility w.r.t. Crane |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|------------------------------------|------------------------------------|---|--|
| | | | capacity shall be provided to avoid overload lifting 5 Hazard Sign Board Display at critical areas to be made |
| 4.5.2.2 | Charging of hot metal into furnace | Flame shoot up | <ol style="list-style-type: none"> 1 Emergency Preparedness shall be made available 2 N₂ sealing shall be used continuously in dedusting system 3 Rocking of converter to be done slowly before charging along with scrap 4 Ensuring proper communication systems between furnace operator and crane operator for slow charging 5 Unauthorised Movement of people should be restricted during this process <p><i>(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane, SG-23 for safe handling of liquid metal)</i></p> |
| 4.5.3 Oxygen blowing in BOF | | | |
| 4.5.3.1 | Blowing of oxygen | <ul style="list-style-type: none"> • Water leakage from lance tip • Blast inside vessel | <ol style="list-style-type: none"> 1 Condition monitoring and testing of weld in Blow tip fixing and method. 2 Blow stop interlocking due to due to differential water flow in lance to be made mandatory and water diversion bypass line shall be available 3 Lance positioning and facilitating converter tilt to be defined as standard procedures 4 Arrest the water leakage, Ensure that water isn't entrapped in hot metal. Do not tilt furnace till water evaporation is |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|---|--|---|
| | | | ensured |
| | | <ul style="list-style-type: none"> Skirt / lower /upper hood leakages Blast inside vessel | <ol style="list-style-type: none"> Process interlocks for blow stop shall be established Periodical change of hoods based on heat load and frequencies Do not tilt furnace till water evaporation is ensured |
| | | <ul style="list-style-type: none"> O₂ Lance free fall Blast inside vessel | <ol style="list-style-type: none"> Digital encoder for lance movement measurements Provision of Lance emergency Push button <p><i>(Ref SG-20 Safety Guidelines for Oxygen & Nitrogen Gas line)</i></p> |
| 4.5.3.2 | Slopping/Slag gush out of furnace/Boiling | <ul style="list-style-type: none"> Slag and metal coming out from furnace mouth Fire / Explosion | <ol style="list-style-type: none"> Lance height, O₂ flow rate and bulk materials feeding to be optimized to avoid slopping Gas analysis and gas flow rate shall be monitored to avoid explosive mixture Bath level to be monitored (Sub lance system can be used for every blow) Blow stop options and De slagging be done Acoustic slopping control mechanism to be adopted for avoiding slopping during blowing period. <p><i>(Ref SG-23 for Safe handling of liquid metal)</i></p> |
| 4.5.3.3 | BOF / Furnace vessel | Converter shell puncture | <ol style="list-style-type: none"> Deploy Scanning machine for refractory thickness measurement periodically (Portable or online scanning machine is recommended). Thermography measurement of shell can help to determine |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--|---------------------------------------|---|--|
| | | | critical zones 3 Tilt the converter such that metal is positioned away from the puncture area 4 Standby HM/steel ladle to empty out the converter <i>(Ref SG-23 for Safe handling of liquid metal)</i> |
| 4.5.3.4 | Sub lance measurement (if applicable) | 1 Water leakage from lance 2 Blast in vessel | Automatic Lance lift interlock with differential water flow / pressure to be provided |
| 4.5.3.5 | Blowing | CO leakage related hazards | 1. Access to bulk material handling system & bunkers should be avoided during blowing in converter because of CO leakage from converter off-gas. CO monitors with hooting / alarm arrangement to be put in place to eliminate CO poisoning related mishap. 2. Unauthorised movement of people should be restricted during blowing period. |
| 4.5.4 De-slagging | | | |
| 4.5.4.1 | De-slagging | 1 Slag overflow from pot 2 Fire 3 Blast in slag pot | 1 Salt/wood pieces to be used to suppress foaminess in slag & prevent overflow 2 Avoid wet jam falling inside pot during deslagging / avoid wet slag pot in usage |
| 4.5.5 Bulk Material Charging System(BMCS) Bunkers | | | |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---|--|--|--|
| 4.5.5.1 | Filling Lime and Calcined Dolomite into BMCS Bunkers From LCP | 1 Conveyor fire 2 Fall of idlers roll | 1 Closed conveyors to avoid hydration 2 Water sprinklers to be provided in entire gallery 3 Camera monitoring 4 Periodic maintenance practise of conveyors 5 Fire hydrant Systems for fire prevention 6 Nitrogen purging system in bunkers (Ref SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG-13 Safety Guideline for Material handling (manual and mechanized) & storage, SG-16 Safety Guidelines for Fire Safety) |
| 4.5.6 BOF Converter Tapping Start | | | |
| 4.5.6.1 | Tapping | 1 Spillage of slag/metal from the mouth 2 Fire 3 Blast | 1 De-slagging to be ensured before tapping 2 Dog house doors to be kept closed before tapping 3 Unauthorised Movement of people should be restricted 4 Water accumulation below the furnace to be avoided 5 In case water enters the ladle , do not move the ladle till it evaporates and boiling stops (Ref SG-16 Safety Guidelines for Fire Safety) |
| 4.5.6.2 | Manual addition of Ferro alloys | Ferro alloy chute jam | 1 Aluminium bar sizes are less than chute Diameter 2 Controlled additions to be done |
| 4.5 Secondary Steel making (LHF/RH/VD/VOD/AOD) | | | |
| 4.5.1 Ladle Preparation | | | |
| 4.5.1.1 | 1 Ladle Preparation 2 Lancing of Slide gate nozzle 3 Cleaning of Purging Plug surface with | 1 Exposure to Heat 2 Metal Splashes due to lancing | 1 Flashback Arrestor in oxygen line is mandatory 2 Proper PPE is to be worn (Fire proof hand gloves 3 Working platform to be |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--|---|---|---|
| | Oxygen 4 Slide Gate Plate / Nozzle Changing | 3 Burn injury due to lance backfire 4 Contact with hot ladle shell | designed for proper reach of each fixtures attached to ladle bottom (Ref SG-18: Personal Protective Equipment (PPE) Management, SG-20: Safety Guidelines for Oxygen & Nitrogen Gas line) |
| 4.5.2 LHF (Ladle Heating Furnace) | | | |
| 4.5. 2.1 | Positioning of Ladle in transfer car | 1 Metal spillage due to improper positioning. 2 Fire 3 Equipment stalling | 1 Focus lights to be provided for proper visualization for crane operators 2 Crane cabin glasses to be maintained for better visibility 3 Proper Operators signalling / marking systems for ladle handling (Ref SG-14: Safety Guidelines for work on Electrical Overhead Travelling EOT Crane) |
| 4.5. 2.2 | Positioning of the ladle below the LHF hood | <ul style="list-style-type: none"> • Water leakage from hood puncture • Blast | 1 Jam free ladle top to be ensured 2 Process interlock for car movement /collision between roof / electrode |
| 4.5. 2.3 | Heating by Electric Arc | 1 Electrode breakage 2 Metal Spillage 3 Fire | 1 Roof balance to be ensured (automatic LVDT control system can be adopted) 2 Ceramic ring to be provided for non-contact of electrode and steel hood 3 Solid free surface of steel bath to be ensured for arcing 4 Nippling of electrodes with torch wrench is mandatory as per vendor design (Ref SG-16 Safety Guidelines for Fire Safety) |
| 4.5. 2.4 | Trickling/Puncture of ladle on transfer ladle car | 1 Fire hazard 2 Explosion | Visual inspection of ladle refractory & Life monitoring / Thermography of |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---|---|--|--|
| | | | refractories (Ref SG-16 Safety Guidelines for Fire Safety) |
| 4.5.3 RH De-gasser (Ruhrstahl Heraeus Process) | | | |
| 4.5.3.1 | RH process | Slag and metal over flowing out of the ladle Fire | 1 Free board to be measured to ensure dipping 2 Depth of immersion to be measured 3 Establish O ₂ Blow chart as per process requirement |
| | | Sucking of slag and metal during vacuum treatment Fire | 1 Depth of immersion to be measured 2 Minimum 500 mm dipping of vessel inside the steel bath is essential. Measurement system to be incorporated |
| 4.5.3.2 | Trickling/Puncture of ladle on transfer ladle car | 1 Fire hazard 2 Explosion | Visual inspection of ladle refractory & Life monitoring / Thermography of refractories (Ref SG-16 Safety Guidelines for Fire Safety) |
| 4.5.3.3 | Gunning of Snorkel | 1 Spraying particle splinter 2 Eye Injury 3 Burn | 1 Area barrication during the process 2 Gunning suit with additional Head protection (Ref SG-18 Personal Protective Equipment (PPE) Management) |
| 4.5.3.4 | Vacuum Ejector System with Boiler & Boiler House | 1. Explosion 2. Fire 3. Gas/Steam leakage 4. High Noise 5. Exposure to high temperature 6. Rotating Machineries 7. Work in confined spaces 8. Falling out | 1. Use of PPEs 2. Guarding of all rotating parts of conveyor system 3. Pull chord in conveyors 4. Emergency switch 5. Display of Noise level at site 6. Adherence to electrical safety precautions (Refer: SG-03: Safety Guidelines for working in confined space, SG-16 Safety Guidelines for fire safety , SG- |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|--|--|---|
| | | from working platform | 18: Safety guidelines for Personal Protective Equipment (PPE) management |
| 4.5.4 | Vacuum Degasser (VD) | | |
| 4.5.4.1 | Metal treatment during degassing | Slag & metal overflowing from the treatment ladle may result in fire hazard and subsequent injury | 1 Adequate ladle freeboard to be ensured while tapping the heat. Ladle skull formation & mouth jams to be removed with better ladle management. 2 Adequate refractory lining to be provided in the tank for ensuring non occurrence of fire hazards in case of metal overflow & metal boiling. |
| 4.5.4.2 | | Accumulation of water inside the tank/pit may result in explosion because of slag/metal overflow | Water accumulation to be avoided |
| 4.5.4.3 | VD Vessel with Hood mounted on Trolley. | 1.Toxic/Poisonous Gas leakage 2.Dust exposure 3. Exposure to high temperature/fire 4. Working in confined space | 1 Use of PPEs 2 . Develop SOP and follow (Refer: SG-03: Safety Guidelines for working in confined space, SG-16 Safety Guidelines for fire safety , SG-18: Safety guidelines for Personal Protective Equipment (PPE) management) |
| 4.5.4.4 | Ladle and Ladle Preheater | 1. Handling of heavy equipment 2. Exposure to High temperature 3. FO leakage 4. Noise | 1. Use of PPEs 2. Display of Noise level at site (Refer: SG-16 Safety Guidelines for fire safety, SG-18: Safety guidelines for Personal Protective Equipment (PPE) management) |
| 4.5.4.5 | Vacuum Ejector System with Boiler & Boiler House | 1. Explosion 2. Fire 3. Gas/Steam leakage | 1. Use of PPEs 2. Guarding of all rotating parts of conveyor system |

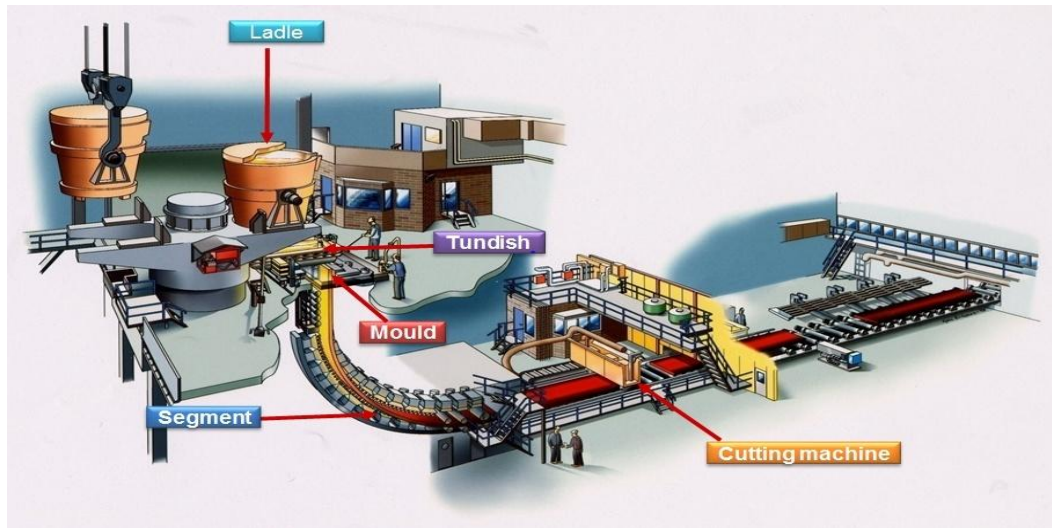
| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|--|---|--|
| | | 4. High Noise 5. Exposure to high temperature 6. Rotating Machineries 7. Work in confined spaces 8. Falling out from working platform | 3. Pull chord in conveyors 4. Emergency switch 5. Display of Noise level at site 6. Adherence to electrical safety precautions <i>(Refer: SG-03: Safety Guidelines for working in confined space, SG-16 Safety Guidelines for fire safety , SG-18: Safety guidelines for Personal Protective Equipment (PPE) management)</i> |
| 4.5.5 | Vacuum Arc Degasser (VAD) | | |
| 4.5.5.1 | Metal treatment during degassing | Slag & metal overflowing from the treatment ladle may result in fire hazard and subsequent injury | 1 Adequate ladle freeboard to be ensured while tapping the heat. Ladle skull formation & mouth jams to be removed with better ladle management. 2 Adequate refractory lining to be provided in the tank for ensuring non occurrence of fire hazards in case of metal overflow & metal boiling. |
| 4.5.5.2 | Positioning of Ladle in transfer car | Metal spillage due to improper positioning | Focus lights to be provided for proper visualization |
| 4.5.5.3 | Heating by electric arc | Electrode breakage may result in fire hazard and subsequent injury | Roof balance to be ensured by automatic LVDT control |
| | | Accumulation of water inside the tank/pit may result in explosion because of slag/metal overflow | Water accumulation to be avoided |
| 4.5.5.4 | VAD Vessel with Hood mounted on Trolley. | 1. Toxic/Poisonous Gas leakage 2. Dust exposure | 1. Use of PPEs 2. Develop SOP and follow <i>(Refer: SG-03: Safety Guidelines for working in</i> |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|--|--|--|
| | | 3. Exposure to high temperature/fire 4. Working in confined space | <i>confined space, SG-16 Safety Guidelines for fire safety, SG-18: Safety guidelines for Personal Protective Equipment (PPE) management)</i> |
| 4.5.5.5 | Ladle and Ladle Preheater | 1. Handling of heavy equipment 3. Exposure to High temperature 4. FO leakage 5. Noise | 1. Use of PPEs. 2. Display of Noise level at site. (Refer: SG-16 Safety Guidelines for fire safety SG-18: Safety guidelines for Personal Protective Equipment (PPE) management) |
| 4.5.5.6 | Vacuum Ejector System with Boiler & Boiler House | 1. Explosion 2. Fire 3. Gas/Steam leakage 4. High Noise 5. Exposure to high temperature 6. Rotating Machineries 7. Work in confined spaces 8. Falling out from working platform | 1. Use of PPEs 2. Guarding of all rotating parts of conveyor system 3. Pull chord in conveyors 4. Emergency switch 5. Display of Noise level at site 6. Adherence to electrical safety precautions (Refer: SG-03: Safety Guidelines for working in confined space, SG-16 Safety Guidelines for fire safety , SG-18: Safety guidelines for Personal Protective Equipment (PPE) management) |
| 4.5.6 | Argon Oxygen Decarburiser (AOD) | | |
| 4.5.6.1 | Treatment in AOD vessel | Water leakage from lance tip may result in explosion | 1 Condition monitoring and testing of weld in blow tip fixing to be ensured. 2 Blow stop interlocking due to differential water flow in lance to be made and water diversion bypass line shall be available. |
| 4.5.6.2 | Blowing of oxygen | Explosion | 1 Lance positioning and facilitating converter tilt to be defined as standard |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|-----------------------|--|---|
| | | | procedures 2 Arrest the water leakage, Ensure that water isn't entrapped in hot metal 3 Periodical change of hoods based on heat load and frequencies |
| | | Oxygen Lance free fall | 1 Digital encoder for lance movement measurements 2 Provision of lance emergency push button |
| | | Slag and metal coming out from converter | Lance height, oxygen flow rate and bulk materials feeding to be maintained to avoid slopping. |

4.6 Caster

Continuous casting is a process where liquid steel is converted into solid product by cooling intensively in primary and secondary cooling system. The semi finished products can be of different shapes namely Thick or Thin Slab / Bloom / Billets / Beam Blank / Rounds / Sections / Strips.



Potential hazards identified during caster operation are free flow of liquid metal from holding vessels like ladle, tundish. Mould Breakouts leading to metal spillage in caster machine causing fire hazard. Hot surface exposure are prone to burn injury caused during this operation

4.6.1 Casting Operation

| | | | |
|---------|------------------|---|---|
| 4.6.1.1 | Turret Operation | <ul style="list-style-type: none"> • Metal spillage during ladle placement • Fire and explosion | 1. Trained operator for EOT crane with proper guidance system (laser / marker) should be installed for vertical placement of Ladle |
|---------|------------------|---|---|

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|--|---|---|
| | | | <ol style="list-style-type: none"> 2. Overfilled Ladle with liquid steel should not be placed on turret 3. Any ladle having red spot on shell should be not placed on turret 4. Interlocks to be in place for turret rotation while placement of ladles on loading arm 5. Slide gate attachment of hydraulic hose to be ensured <p><i>(Ref SG-10 Safety Guideline for Hydraulic System, Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)</i></p> |
| 4.6.1.2 | Oxygen lancing while ladle not free open | <ul style="list-style-type: none"> • Metal Spillage • Fire of Hydraulic line | <ol style="list-style-type: none"> 1. In-built Flash back arrester in lancing system 2. Controlling of metal stream to avoid spillage 3. Shrouding of stream to be done immediately 4. Special High quality (chromite based) well sand usage for ensuring high ladle free open % <p><i>(Ref SG-18: Personal Protective Equipment (PPE) Management, SG-16 : Safety Guidelines for Fire Safety)</i></p> |
| 4.6.1.3 | Transfer of steel teeming ladle from secondary refining unit to Caster | <ul style="list-style-type: none"> • Metal spillage • Fire in hydraulic line & system | <ol style="list-style-type: none"> 1. Ladle is lifted slowly and very carefully to continuous casting machine (on ladle turret loading arm) 2. It is then positioned on the other side by lifting the arm and rotating the turret for pouring and casting. 3. Shop floor below the ladle movement and turret loading area shall be cleared of any personnel during operation. |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|-------------|--|--|---|
| | | | 4. The pathway for overhead filled ladle movement shall not have any facilities involving manual engagement. |
| 4.6. 1.4 | Casting operation related abnormalities & emergency situations | <ul style="list-style-type: none"> • Metal spillage • Fire hazard • Explosion • Radioactive hazard | <ol style="list-style-type: none"> 1. During start of continuous casting operations, Ladle Turret emergency rotation must be checked to ensure proper rotation & safety measures during casting ladle troughs / slide gate failure led slag /metal splashing. Emergency ladle to be positioned at the rear end of the ladle turret prior to start of casting for ensuring proper draining of the casting ladle during the above mentioned emergency situations. 2. Tundish shell condition to be monitored with infra red pyrometer for ensuring identification & elimination of hot spots for preventing tundish troughs & metal slag spillage during casting operation. 3. Proper safety clothing & precautions to be taken by mould operators for preventing fire related hazards during mould overflow, tundish stopper running, mould boil, radioactive hazards when using radiometric type automatic mould level control system. Proper maintenance related procedures to be adhered to while handling & maintenance of mould with radiometric system. 4. Slag boxes should be made available for metal |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---------|-------------------------------|--|---|
| | | | <p>& slag spillage / tundish drain out during stopper running.</p> <p>5. Casting platform & shop floor below the filled tundish movement (after casting abort / casting close situations) shall be cleared of personnel for preventing safety hazards.</p> <p>6. Ladle handling crane shall have inching speed for safe handling.</p> <p>7. Refractory encasing and plate heat shield shall be provided for protection of all structures.</p> <p>8. Availability of fire fighting system with fire detection and alarm system.</p> <p>9. Movement of filled tundish (after casting abort / break out) to be handled with crane over & along a free zone area.</p> |
| 4.6.1.5 | Tundish | <ul style="list-style-type: none"> • Free running of Steel from tundish , • Burn Injury | <p>1. Overflow bucket shall be in standby.</p> <p>2. Condition monitoring of refractory during preheating</p> <p>3. Tundish emergency bucket positioning at casting position is mandatory</p> <p><i>(Ref SG-18 Personal Protective Equipment (PPE) Management)</i></p> |
| 4.6.1.6 | Temperature and Sample taking | <ul style="list-style-type: none"> • Heat, • Dust, • splashes • Contact with hot materials | <p>1. Auto online temperature measurement is beneficial.</p> <p>2. Manual sampling with all protective PPE's</p> <p><i>(Ref SG-18: Personal Protective Equipment (PPE) Management)</i></p> |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|----------------------------------|---|---|---|
| 4.6.1.7 | End of Casting | <ul style="list-style-type: none"> Heat Explosion Burn Injury | <ol style="list-style-type: none"> Avoid spraying the water directly on the top of the liquid metal. Water to be sprayed on the mould wall outer face Face shield to be used by operator as additional safety Usage of PPE's to be ensured 100% <p><i>(Ref SG-18 Personal Protective Equipment (PPE) Management)</i></p> |
| 4.6.1.8 | Slab cutting with torch cutting machine | <ul style="list-style-type: none"> Torch back fire, Equipment damage due to back flash Fire in LPG / Oxygen line | <ol style="list-style-type: none"> Cutting speed with respect to casting speed. Nozzle cleaning based on Pressure feedback. Edge feelers to start auto cutting. <p><i>(Ref SG-07 Safety Guideline for Gas cutting & Gas Welding)</i></p> |
| 4.6.1.9 | Run Out area Slab/Bloom/Billet evacuation | <ul style="list-style-type: none"> Exposure to radiation heat Fire due to grease/hydraulic line leakage Burn Injury due to hot surface | <ol style="list-style-type: none"> Trespassing / crossing the ROT should be banned. Cross over bridge should be installed Fire hydrant support to be near ROT area <p><i>(Ref SG-16 Safety Guidelines for Fire Safety)</i></p> |
| 4.6.1.10 | Slag dumping after cast | <ul style="list-style-type: none"> Metal entry into pot / Red spot of slag pot Break out of slag pot and slag spillage Fire | <ol style="list-style-type: none"> Ensure steel is not drained into the slag pot. Steel if retained in ladle after casting should be poured in other steel ladle or separate refractory line dump container Foaming of slag should be avoided by adding salt <p><i>(Ref SG-16 Safety Guidelines for Fire Safety)</i></p> |
| 4.6.2 Tundish Preparation | | | |
| 4.6.2.1 | Tundish Spraying with the spray gun | <ul style="list-style-type: none"> Spray mass dust falling in eyes Exposure to spray mass jet (impingement) | <ol style="list-style-type: none"> Eye protection with goggle and face shield mandatory Jeans jacket and leather hand glove mandatory |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|----------------------------------|---|---|--|
| | | <ul style="list-style-type: none"> Radiation due to hot fumes – Burn | <i>(Ref SG-18 Personal Protective Equipment (PPE) Management)</i> |
| 4.6.2.2 | Flame adjustment & Ignite the burner by visual inspection | <ul style="list-style-type: none"> Heat Exposure to hazardous gas like CO | <ol style="list-style-type: none"> Ensure fixed CO monitor working on all preheaters Auto pilot ignitor should be installed <i>(Ref SG-21 Safety Guideline for Handling Fuel Gas)</i> |
| 4.6.2.3 | Deskulling of Tundish Skull on Tilter | <ul style="list-style-type: none"> Falling of debris dust in eyes Exposure to heat/dust | <ol style="list-style-type: none"> Tilt the Tilter slowly to check if any liquid metal still exists. During tilting the skull barrication of area to be followed <i>(Ref SG-18 Personal Protective Equipment (PPE) Management Ref SG-11 Safety Guideline for Barricading)</i> |
| 4.6.3 Machine Preparation | | | |
| 4.6.3.1 | Machine checking | <ul style="list-style-type: none"> Heat/Dehydration Struck with drive shaft Hydraulic leakages | <ol style="list-style-type: none"> Ventilation by opening all doors of cooling chamber Illumination to be ensured before entering the cooling chamber Steam fan should be in operation Drive isolated in system with local locking Hydraulic pump off and locked out (LOTO must be ensured) <i>(Ref SG-05 Safety Guideline for Illumination at workplace, SG-15 Safety Guideline for Electrical safety, SG-10 Safety Guideline for Hydraulic System)</i> |
| 4.6.3.2 | Metallic jam cutting/slab/Bloom/billet cutting inside cooling chamber | <ul style="list-style-type: none"> Contact with hot materials Burn injury with contact of hot object or steam | <ol style="list-style-type: none"> Illumination to be ensured before entering the cooling chamber Lance with back flash arrestor to be used only. Wire braided Hoses used for lance to be of rated pressure > 20 bar. |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--|---|--|--|
| | | | 4. Ensure steam fan is run while people are inside <i>(Ref SG-06 Safety Guideline for Lance cutting, SG-05 Safety Guideline for Illumination at workplace, SG-18 Personal Protective Equipment (PPE) Management)</i> |
| 4.6.3.3 | Lifting of cut slabs / Billets / Blooms | <ul style="list-style-type: none"> • Contact with hot materials. • Fall from height Injury | 1. Area barricading to avoid tress passing. 2. Usage of tested lifting tools and tackles of required capacity. <i>(Ref SG-11 Safety Guideline for Barricading)</i> |
| 4.7 Auxiliary Units | | | |
| 4.7.1 Scap yard | | | |
| 4.7.1.1 | Unloading of scrap in pits | <ul style="list-style-type: none"> • Dust • Noise • Fire | 1. Slag / muck /oil to be avoided while transporting scrap from inside or outside 2. Hot DRI should not be stored in pits 3. No cutting / welding should be carried out in scrap yard 4. Dusk mask and ear muffs mandatory <i>(Ref SG-18 Personal Protective Equipment (PPE) Management)</i> |
| 4.7.1.2 | Free fall of scrap from magnet / grab | Fall of object | 1. No trespassing of human manpower in loading area 2. Unloading trucks to be parked in designated place 3. Driver / helpers should use PPE & move out from the vehicle and wait outside the shop <i>(Ref SG-18 Personal Protective Equipment (PPE) Management)</i> |
| 4.7.2 Slag Yard - Slag Handling | | | |
| 4.7.2.1 | Dumping the slag pot into the slag pit | Explosion due to water accumulation in | Controlled Water Spray system and proper water drainage systems in the area |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---|--|---|---|
| | | pits during slag cooling for digging | |
| 4.7.2.2 | Slag Cooling and evacuation | <ul style="list-style-type: none"> • Explosion • Fire catch of equipment | <ol style="list-style-type: none"> 1. Ensure cooling of hot slag properly before digging with mobile equipment & 2. Loading with pay loaders to dumper 3. Equipment healthiness checklist should be maintained for oil / diesel leak 4. Maintenance of Mobile equipment records should be maintained <p><i>(Ref SG-17 Safety Guideline during Excavation)</i></p> |
| 4.7.2.3 | Slag transportation to processing yard | <ul style="list-style-type: none"> • Spillage on road can cause slip & fall for 2-wheelers • Fire catch of tippers | <ol style="list-style-type: none"> 1. Forming of cold slag bed in the vehicle before loading hot slag 2. Shifting dumpers should not be overloaded 3. Back side of dumpers should have closing door 4. Slag shifting special dumpers should be used to avoid spillage during movement 5. Speed restriction to 16km/hr or as per rules |
| 4.7.3 Slag processing & metal recovery plant | | | |
| 4.7.3.1 | Slag processing & metal recovery plant | <ul style="list-style-type: none"> • Emission of Heat & dust fine particles • Struck in conveyor • Electric shock • Illumination Hazard • Fire of mobile equipment • Burn injury to drivers • Skid and fall of people • Health of operators | <ol style="list-style-type: none"> 1. Water sprinkling on slag heaps continuous basis 2. Fog Machine for dust suppression during dumping 3. Enclosed yard for fine dust slag (Pre-treatment / Secondary Steel making Slag) 4. Slow dumping on slag piles 5. Dedicated routes for in - out of dumpers 6. Speed restriction 7. Healthiness of mobile equipment |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|---|---|---|--|
| | | | <p>8. Metal Processing conveyor safety</p> <p>(Ref SG-05: Safety Guideline for Illumination at workplace, SG-09 Safety Guideline in Equipment & machine Guarding, SG-13: Safety Guideline for Material handling (manual and mechanized) & storage, SG-15: Safety Guideline for Electrical safety, SG-16 Safety Guideline for Fire Safety, SG-17: Safety Guideline during Excavation, SG-18: Personal Protective Equipment (PPE) Management, SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts)</p> |
| 4.7.3.2 | Drop balling of steel skull lancing | <ul style="list-style-type: none"> Scattering of metallic pieces Burn injury Piercing of metal | <ol style="list-style-type: none"> Designated area with proper fencing Oxygen Bullets to be located at safe distance and fenced <p>(Ref SG-07 Safety Guideline for Gas cutting & Gas Welding, SG-06 Safety Guideline for Lance cutting)</p> |
| 4.7.4 Slab yard (Slab Handling & Inspection) | | | |
| 4.7.4.1 | Moving of overhead crane along with slabs | Free falling of slab / Billet / Bloom may cause Injury Equipment damage | <p>Preventive maintenance of EOT cranes and provision of emergency brakes</p> <p>Inspection by a competent person as per statutory requirement</p> <p>Inspection of Lifting Tong/Magnet. Frequency of changing to be written document</p> <p>(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)</p> |
| 4.7.4.2 | Storage of Slabs and handling | <ul style="list-style-type: none"> Unsafe Stacking/piling height may lead to Collapse Radiation | <ol style="list-style-type: none"> Bend slab/Bloom/Billet should be separately stored. Uniform Ground Bed should be made Stacking height to be 3- |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--------------------------|----------------------------------|---|---|
| | | <ul style="list-style-type: none"> Heat | <p>3.5 m depending on Bay height</p> <p>4. Uniform width should be stacked in each pile.</p> <p>5. Restricted man entry should be signaged (Slab yard management system should be used for locating the slabs/billet/bloom pile)</p> <p>6. Fenced for no tress passing zone</p> <p><i>(Ref SG-13: Safety Guideline for Material handling (manual and mechanized) & storage)</i></p> |
| 4.7. 4.3 | Slab/Bloom/Billet transportation | <ul style="list-style-type: none"> Run over if people movement Fire Explosion | <p>1. Transfer movement area to be barricaded</p> <p>2. Hot Slab should be despatched on brick line car / trucks</p> <p><i>(Ref SG-11 Safety Guideline for Barricading)</i></p> |
| 4.7. 4.4 | Scarfig / Grinding | <ul style="list-style-type: none"> High Noise level Burn Fire in gas line Flying Splinter Burn due exposure to hot slab Radiation Heat / dehydration | <p>1. Trespassing in work is strictly prohibited</p> <p>2. Auto scarfig / Grinding machine are in enclosed chamber</p> <p>3. Manual scarfig / grinding should be carried out by trained operators</p> <p>4. All Gas safety precaution and fail proof system for auto closing of valves to be installed in Gas Valve station</p> <p><i>(Ref SG-07: Safety Guideline for Gas cutting & Gas Welding, SG-06: Safety Guideline for Lance cutting, SG-11: Safety Guideline for Barricading, SG-18 : Personal Protective Equipment (PPE) Management)</i></p> |
| 4.7.5 Gas Hazards | | | |
| 4.7. 5.1 | ID fan | <ul style="list-style-type: none"> Exposure to CO gas Injury due to exposure to | <p>1. Fixed CO monitors to be installed in ID fan area</p> <p>2. Machine Guarding is mandatory</p> |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|-------------------------------------|-----------------------|---|--|
| | | rotating equipment <ul style="list-style-type: none"> • Slip & fall due to slippery floor • Fire | 3. Lubrication system to ensured leak proof 4. Water drainage system to be adequate to avoid accumulation on floor/platform (Ref SG-09: Safety Guideline in Equipment & machine Guarding , SG-21: Safety Guideline for Handling Fuel Gas) |
| 4.7.5.2 | Gas Line Leakages | Exposure to CO gas | Pipes corrosion study, U seals/Water seals, Checking of feedback of fixed CO monitors readings to control rooms |
| 4.7.5.3 | Gas Holder Leakage | Explosion due to Oxygen ingress | Proper Gas recovery system with all safety interlock for restricting O ₂ ingress in gas holder Inspected & Certified by Boiler & Safety competent authority (Ref SG-21 Safety Guideline for Handling Fuel Gas) |
| 4.7.5.4 | Gas Holder Overfill | Explosion due to pressure build up | 1. Gas holder level to be maintained within 80% of the capacity and monitoring round the clock in main control room 2. Gas directing Dampers should be in healthy condition for flaring excessive gas 3. Gas holder level sensors (manual / laser) should be functioning all the time. Redundancy system to be installed (Ref SG-21 Safety Guideline for Handling Fuel Gas) |
| 4.7.6 Water Circulation Unit | | | |
| 4.7.6.1 | Plant pump room | <ul style="list-style-type: none"> • Injury due to exposure to rotating equipment • Slip & fall due | 1. Water drainage system to be adequate to avoid accumulation on floor/platform 2. Pump leakages to be |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|-------------------------|---|--|--|
| | | to slippery floor • Fire | eliminated 3. Illumination 4. Machine guarding is mandatory (Ref SG-05 Safety Guideline for Illumination at workplace, SG-09 Safety Guideline in Equipment & machine Guarding) |
| 4.7. 6.2 | Compressor room | Noise | 1. Proper sound proof rooms to be made 2. Ear Muffs mandatory for entry (Ref SG-18 : Personal Protective Equipment (PPE) Management) |
| 4.7.7 EOT Cranes | | | |
| 4.7. 7.1 | Free Fall of Ladle due to wire rope cut / rope drum failure / Brake failure | <ul style="list-style-type: none"> • Hot Metal Spillage • Fire • Explosion • Burn injury • Equipment damage | <ol style="list-style-type: none"> 1. Standard wire rope should be used 2. Frequency of wire rope changing based on cyclic load to be documented 3. 4 fall wire rope system in all Hot Metal crane should be followed 4. Speed Encoder to be installed with interlock 5. PLC based cranes is safe for usage 6. Emergency brake system should be available in all EOT cranes 7. Strict Maintenance schedule/matrix to be adhered for all cranes (Ref SG-14 : Safety Guideline for work on Electric Overhead Travelling (EOT) Crane) |
| 4.7. 7.2 | Collision of two crane | Hot Metal Spillage | Anti collision device is mandatory for all crane if 2 or more cranes operating in same bay |
| 4.7. 7.3 | Crush of people between column on crane girder walkway | Fatal / Major Injury | Entry / Exit system to be introduced in all cranes where people wanting to climb in or out, push button is pressed to stop the crane. Until acknowledged by other |

| Sl. No. | Area/Section/Activity | Hazards | Risk Control Measures |
|--|------------------------------------|---|--|
| | | | side push button crane movement will not start. <i>(Ref SG-14 : Safety Guideline for work on Electric Overhead Travelling (EOT) Crane)</i> |
| 4.7.8 Rooms (Control Room , MCC room , Drive Room, Electrical/ Cable premises) | | | |
| 4.7.8.1 | All Operating and Electrical rooms | 1. Fire 2. Electrical shock | 1. Fire proof panel to be used for interior works 2. Double Toughened Glass to be used in such rooms exposed directly to Liquid steel handling 3. Smoke detection should be installed and common alarm system to be monitored 4. AC or Ventilation system should be installed 5. Proper means for access/ exit to be made for emergency situations <i>(Refer: SG-15 Safety Guideline for Electrical safety)</i> |
| 4.7.9 Oil / Lubrication / Hydraulic System | | | |
| 4.7.9.1 | Hydraulic Systems | 1.Failure of safety devices 2.Fire 3.Explosion 4.Oil leakage 5.Slippage 6.Rotating Machineries 7.High Noise | 1. Regular inspection of Safety Devices 2. Use of PPEs 3. Guarding of all rotating parts 4. Display of Noise level at site 5. Adherence to electrical safety precautions <i>(Refer: SG-03: Safety Guidelines for working in confined space, SG-16 Safety Guidelines for fire safety , SG-18: Safety guidelines for Personal Protective Equipment (PPE) management</i> |

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 steel melt shop.
- 5) Provision & operatability of safety fences should be ensured covering the entire steel melt shop.
- 6) All fuel & oxygen lines shall have proper colour coding as per the existing practice of the plant so as to identify the respective gas lines. Proper pre-conditions should be followed while purging & charging of gas lines with compliance of safety guidelines of EMD / Safety Department for eliminating explosion & fire related hazards.
- 7) 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.