SAFETY
FIRST

इस्पात मंत्रालय
MINISTRY OF
STEEL
सत्यमेव जयते

SAFETY GUIDELINES

FOR IRON & STEEL SECTOR

Foreword

Ministry of Steel in 2019 & 2020 undertook extensive interactions with the stakeholders viz. the steel industry, the industry associations and the academic institutions of repute and constituted a Working Group to evolve & formulate a set of safety guidelines to address specific activities/ hazards faced by the Indian steel industry. A Sub Group was also constituted under the Working Group to address the specific issues faced by the mini iron & steel producers. Working Group comprised of experts/ stakeholders from the large steel plants and the Sub Group comprised of experts/ stakeholders from the small steel plants, to facilitate formulation of these guidelines.

As an outcome of the valuable inputs & efforts of the stakeholders, twenty-five safety guidelines for the Iron & Steel Sector were formulated for the Indian steel industry (both large & small). These guidelines in the form of a book viz. "Safety Guidelines for the Iron & Steel Sector", was formally launched by the Hon'ble Steel Minister on 17th February 2020 and uploaded in Ministry of Steel's website. The stakeholders from the Indian steel industry and its associations were urged to adopt these guidelines wholeheartedly, to reinforce the safety ecosystem in the steel plants.

The adoption of these guidelines is voluntary as the legislation for Safety in the manufacturing sector in India, is under the jurisdiction of Ministry of Labour & Employment. However, Ministry of Steel has taken up the matter with Ministry of Labour & Employment to facilitate mandatory adoption of the Safety Guidelines by the Iron & Steel Industry. Ministry of Labour & Employment has informed that it is under consideration of the Expert Committee set up for framing standards under Section 18 of the Occupation Safety Health & Working Conditions (OSH&WC) Code 2020.

Subsequently, to move the initiative further, in 2022 it was decided to formulate Process Based Safety Guidelines for the Iron & Steel Sector, based on the specific processes adopted by the sector. Ministry of Steel reconstituted the aforementioned Working Group & Sub Group, to facilitate formulation of these process based safety guidelines.

To carry out the exercise, small teams of members were formed according to their areas of expertise to discuss and evolve each of the process based safety guidelines. Each of the guideline was prepared by the respective team leaders in consultation with the members of the group. Subsequently, these guidelines were reviewed in the meetings of the Working Group/ Sub Group under the Chairmanship of Joint Secretary, Ministry of Steel and given the final shape in the meeting held on 21st May 2024 under the chairmanship of Secretary, Ministry of Steel. These process based safety guidelines comprise of 16 guidelines, out of which 4 guidelines are on workplace safety and 12 guidelines are on specific iron & steel making processes.

Ministry of Steel would like to complement the stakeholders for their participation in the aforementioned exercise and offering their valuable contributions in developing the guidelines. Ministry of Steel would like to thank the Working Group/ Sub Group for their dedicated efforts in formulating the guidelines. As these guidelines have been developed by the stakeholders for the iron & steel industry themselves, Ministry of Steel would like to urge the iron & steel industry to also adopt these guidelines wholeheartedly to strengthen their safety ecosystem with an aim to eliminate accidents altogether.

एच. डी. कुमारस्वामी
H. D. Kumaraswamy

सत्यमेव जयते

मंत्री
भारी उद्योग एवं इस्पात मंत्रालय
भारत सरकार, नई दिल्ली

UNION MINISTER OF
HEAVY INDUSTRIES AND STEEL
GOVERNMENT OF INDIA
NEW DELHI

Message

I am happy to note that Ministry of Steel has undertaken an extensive exercise since 2019 in consultation with the stakeholders to proactively identify the hazards that prevails in the iron & steel making industry and measures that need to be adopted to eliminate accidents.

As outcome of the dedicated efforts of the stakeholders, the first set of safety guidelines which were based on specific hazards existing in iron & steel industry, was formulated & published in 2020.

I am happy to know that Ministry of Steel has continued the efforts in improving the safety eco-system of the Iron & Steel sector and has now come up with the second volume of the safety guidelines which are based on the specific processes adopted by the Iron & Steel sector.

I hope that these guidelines will be widely adopted by the iron & steel industry and help the industry to become world class in adopting safety standards/ guidelines and eliminating accidents.

(H. D. Kumaraswamy)

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భూపతిరాజు శ్రీనివాస వర్మ
BHUPATHIRAJU SRINIVASA VARMA

सत्यमेव जयते

राज्य मंत्री
भारी उद्योग एवं इस्पात मंत्रालय
भारत सरकार, नई दिल्ली – 110011

MINISTER OF STATE FOR STEEL AND HEAVY INDUSTRIES
GOVERNMENT OF INDIA
NEW DELHI-110011

Message

I am happy to note that Ministry of Steel is taking various initiatives in ensuring health & safety to the workforce of the iron & steel industry and one of the initiative is development of safety guidelines to identify the hazards prevailing in the industry and the required preventive measures required to be taken to address these hazards with an aim to eliminate accidents.

I am also happy to know that Ministry is now going to publish the second volume of the safety guidelines, which are based on the specific processes adopted by the iron & steel sector.

I hope that these proactive & dedicated efforts will also be continued in the future in eliminating accidents from the iron & steel industry. All the stakeholders need to monitor their performance both within their units and as a sector. A culture of sharing knowledge, reflecting upon the progress made and scope for further improvement including the way in which the facilities and services designed and organized.

(Bhupathiraju Srinivasa Verma)

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सचिव

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सत्यमेव जयते

भारत सरकार
इस्पात मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF STEEL

01st July, 2024

Message

Ensuring health & safety of the employees in the Iron & Steel Sector is of vital importance as it has social, moral, legal and economic consequences. Accordingly, the Indian Steel Industry needs to eliminate accident/fatalities in their operations.

Recognizing the need of framing uniform guidelines, Ministry of Steel, in the year 2020, had facilitated formulation of a set of 25 common minimum guidelines for safety based on specific activities/ hazards faced by the Indian Steel Industry. These guidelines were unveiled by the Hon'ble Steel Minister on 1"111 February 2020 in the form of a book, viz., ***"Safety Guidelines for the Iron & Steel Sector"***. I am happy to note that the stakeholders from the Indian Steel Industry and its Associations have enthusiastically adopted these guidelines. Ministry has now proposed their inclusion in the **Occupational Health and Safety Code**, being formulated by the Ministry of Labour and Employment.

Subsequently, Ministry of Steel has continued to expand the aforementioned initiative further and has now facilitated the formulation of 16 additional guidelines, which are based on the specific processes adopted by the Iron & Steel Industry. This will issue as the Second Volume of the aforementioned set of guidelines. These guidelines have been evolved by the dedicated efforts of the Working Group constituted by Ministry of Steel comprising members from the Steel Industry and its Associations.

I compliment the dedicated efforts of the stakeholders in formulation of these guidelines. I sincerely hope that large scale adoption of these guidelines by the Steel Industry including the Secondary Steel Producers shall help the industry in minimizing/eliminating accidents and making workplace more humane and pleasurable.

(Nagendra Nath Sinha)

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Joint Secretary

सत्यमेव जयते

इस्पात मंत्रालय
भारत सरकार
GOVERNMENT OF INDIA
MINISTRY OF STEEL

Message

Safety at work place has always been one of the important and high priority items. In this endeavour, Ministry of Steel undertook extensive interactions with the stakeholders viz. the steel industry, the industry associations & the academic institutions of repute, during 2019 & 2020 and constituted a Working Group/ Sub Group to evolve & formulate common minimum guidelines for safety on various activities/ hazards faced by the Indian steel industry. As an outcome of the valuable inputs & efforts of the stakeholders, twenty-five safety guidelines were formulated. These guidelines were aimed for specific activities/ hazards faced by the Indian steel industry (both large & small) and brought out in form of a book named "Safety Guidelines for the Iron & Steel Sector", which was unveiled by the then Hon'ble Steel Minister on 17th February 2020. The stakeholders from the Indian steel Industry and its associations have been urged to adopt these guidelines in letter and spirit for ensuring a safe working environment at workplaces.

To move the initiative further, it was further decided to formulate Process Based Safety Guidelines for the processes adopted by the Iron & Steel Sector, as second volume of the aforementioned book.

The preparation of these process-based guidelines was attempted for the first time and no global references were available for guidance. It was therefore, decided that guideline for each process be evolved by a team having members with expertise in that field. During the years 2023 & 2024, the stakeholders and experts again came together for evolving the aforementioned process-based safety guidelines. As outcome of the dedicated efforts of the stakeholders and experts, 16 guidelines have been developed. Out of which, 4 guidelines are on workplace safety and 12 guidelines are on specific processes.

The publication of these 16 Process Based Safety Guidelines in a booklet form shall go a long way in improving the safety.

(Vinod K. Tripathi)

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Introduction

1.0 Background:

Integrated Steel plants as well as secondary steel units involve many high hazardoperations considering amount of flammable gases, liquid fuel, hot metal and otherexplosive and toxic materials being handled and stored. Potential consequencesmay be very serious and can pose threat to business in particular and society ingeneral.Where a personal safety incident may affect only one individual or a smallgroup,processsafetyincidentscanresultinmultipleinjuries/fatalities,andsubstantialeconomic,property,andenvironmentaldamagebothintheplantandtheneighboringcommunity.

In view of above, many hazardous process industries like oil & gas, petroleum,fertilizeretc. includingfewintegratedsteel plantshavealreadyimplementedaformalProcess safetymanagement system.

It is with same objective, Ministry of Steel in Sept., 2022 decided to frame processbased safety guidelines for the Iron & Steel Sector to facilitate Plants in managingthehazards&risks associatedwiththeirprocessesina structuredmanner.

It is pertinent to mention here that Ministry of Steel, in 2019 & 2020, undertookextensive interactions with the stakeholders from the steel industry, the industryassociations and the academic institutions of repute to evolve & formulate a set of25 common minimum Guidelines (namely SG-01 to SG-25) for Safety, based ongeneralhazardsintheIndiansteelindustry. Theseguidelinesviz."SafetyGuidelines for the Iron & Steel Sector", was unveiled by the then Hon'ble SteelMinisteron 17th February2020.

2.0 Constitution of working group & subgroup:

TheconstitutionoftheWorkingGroupandSub Groupwas as follows:

SN	Representatives from	Status
A. Working Group		
1.	ED,SSOSAIL	Convener
2.	SAILSSO/SAILPlants	Member
3.	NMDC	Member
4.	MECON	Member
5.	RINL	Member
6.	Tata Steel	Member
7.	JSW	Member
8.	AMNS	Member
9.	JSPL	Member
10.	IndianSteelAssociation	Member
11.	IITKharagpur	Member
B. Sub Group		
1.	NISST	Convener
2.	AIIFA	Member

SN	Representatives from	Status
3.	SIMA	Member
4.	AISRA	Member
5.	ASPA	Member

3.0 List of Processbased safety guidelines (PBSG)

In the meeting held on3rd January 2023 in Steel Room, Ministry of Steel, it was decided to form smallteams of members according to their areas of expertise to further discuss andevolveeach guideline.The details aregiven below.

SN	Guideline No	Title of the Guideline	Team Leader	Members
1	SG-26	Guidelines for Classification & Investigation of Incidents	Tata Steel	SAIL, JSW, AM/NS, RINL, JSPL, NMDC, NISST
2	SG-27	Guidelines for Creation of Safety database & proactive data collection	Tata Steel	SAIL, Tata Steel, JSW, RINL, JSPL, NMDC, NISST
3	SG-28	Safety Guidelines for Coke Ovens (Recovery & Non-Recovery Type)	MECON	SAIL, Tata Steel, JSW, AM/NS, RINL, JSPL, NMDC
4	SG-29	Safety Guidelines for Asset Management	JSW	SAIL, Tata Steel, JSW, AM/NS, RINL, JSPL, NMDC, NISST
5	SG-30	Safety Guidelines for Blast Furnace	SAIL	SAIL, Tata Steel, JSW, AM/NS, RINL, JSPL, NMDC, MECON, NISST
6	SG-31	Safety Guidelines for Sinter Plant	NMDC	SAIL, Tata Steel, JSW, AM/NS, RINL, JSPL, MECON
7	SG-32	Safety Guidelines for Direct Reduced Iron (DRI) Plants (Coal Based)	JSPL	Tata Steel, JSW, JSPL, ASPA, SIMA
8	SG-33	Safety Guidelines for Direct Reduced Iron (DRI) Plants (GasBased)	JSW	AM/NS, JSPL
9	SG-34	Safety Guidelines for Electric Arc Furnace (EAF) Plants	JSPL	AM/NS, JSW, JSPL, Tata Steel, SAIL, JSL, ASPA, SFAI
10	SG-35	Safety Guidelines forInduction Furnace (IF) Plants	NISST	ASPA, AIIFA
11	SG-36	Safety Guidelines for Semi-Automatic rollingandRe-rollingMills	NISST	AISRA
12	SG-37	Safety Guidelines for Hot Rolling Mills (Automated)	AM/NS	SAIL, Tata Steel, JSW, RINL, JSPL, MECON
13	SG-38	Safety Guidelines for Cold RollingMills	JSW	SAIL, Tata Steel, AM/NS, MECON
14	SG-39	Safety Guidelines for Steel Melting Shop (BOF)	RINL	SAIL, Tata Steel, JSW, MECON

SN	Guideline No	Title of the Guideline	Team Leader	Members
15	SG-40	Safety Guidelines for Pellet Plants	JSW	AM/NS, PMAI
16	SG-41	Safety Guidelines for Contractor Safety Management	JSW	SAIL, Tata Steel, JSW, AM/NS, RINL, JSPL, NMDC

4.0 Methodology adopted

a. Team leaders of the respective Safety Guidelines (as decided in the meeting held on 3rd Jan 2023) revised the guidelines in consultation with the groupmembers/domainarea experts (Designated the guidelines as Rev 1.0).

b. Comments sought from all the members of the Working Group/ Sub Group (Designated the guidelines as Rev 2.0).

c. Each team leader revised the guidelines as per the comments received from allmembers (Designated the guidelines as Rev 3.0).

e. Convener finalised each guideline through VC (Designated the guidelines as Rev 4.0).

f. Subsequently, the finalized guidelines reviewed in the meetings of the Work Group/Sub-Group convened by MOS & necessary up-dationd one as per suggestions of MOS.

The working group & sub group unanimously decided to adopta standard format applicable to all process based safety guidelines asmentioned below.

1. Objective
2. Scope
3. Processde scription with flow chart
4. List of Critical equipment/facilities
5. Process Based Hazards & Necessary Risk Control Measures

Sl.No.	Area/ Section/Activity	Hazards	RiskControlMeasures
			1. Engg.controls 2. Administrativecontrols 3. PPEs

6. Cross referencing with 25 Safety Guidelines framed earlier to be done as required
7. PPE matrix (as shown below), list of abbreviations & list of instruments/ equipment required for detection/management of the hazards to be mentioned at the end of each guideline.

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body-Harness	Shin Guard	Breathing Apparatus

In this entire exercise, a number of online internal review meetings were held (between team leaders & members, team leaders & convener etc.) apart from five physical review by MOS at Steel room, Udyog Bhawan, New Delhi, two of which were chaired by Joint Secretary, Ministry of Steel & the final meeting chaired by Secretary, Ministry of Steel. Various decisions taken in these meetings to enrich the quality & content of these guidelines were implemented.

The process of formulation of these guidelines was essentially a joint exercise led by concerned team leaders and supported by other team members including domain experts of concerned area who posses necessary technical expertise & experience of the process under the close supervision & monitoring of Executive Director, SAIL Safety Organization, Convener of working group. The review of each guideline before finalization was done at convener level which provided final opportunity for bridging the gaps, if any, as well as adopting a uniform approach.

Conclusion:

These safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed / reviewed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants. Regarding implementation of these guidelines by both large & small units, necessary training programs & workshops needs to be organized at industry level for spreading awareness amongst the employees as well as contract workers for preventing any undesirable incidents.

SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	**CLASSIFICATION,REPORTING AND INVESTIGATION OF INCIDENTS**	Doc. No: SG/26 Rev no. : 00 Effective Date : 12.06.2024

1. OBJECTIVE

The purpose of this document is to provide guidance on the classification, reporting and investigation of incidents for standardizing it across organizations. It is also to ensure that all incidents are reported, investigated and recommendations are based on addressing the root cause of the incident.

2. SCOPE

The scope of the incident investigation process covers all incidents (injury incident, near miss, property damage, fire incident etc.) of steel industry. The personnel involved could be:

- Own employees (Executives and non-executives)
- Contract employees
- Others (Vocational & apprentice trainees, drivers, and all visitors)
- Stakeholders who may be affected by incident of plant & equipment

3. MANAGEMENT RESPONSIBILITIES

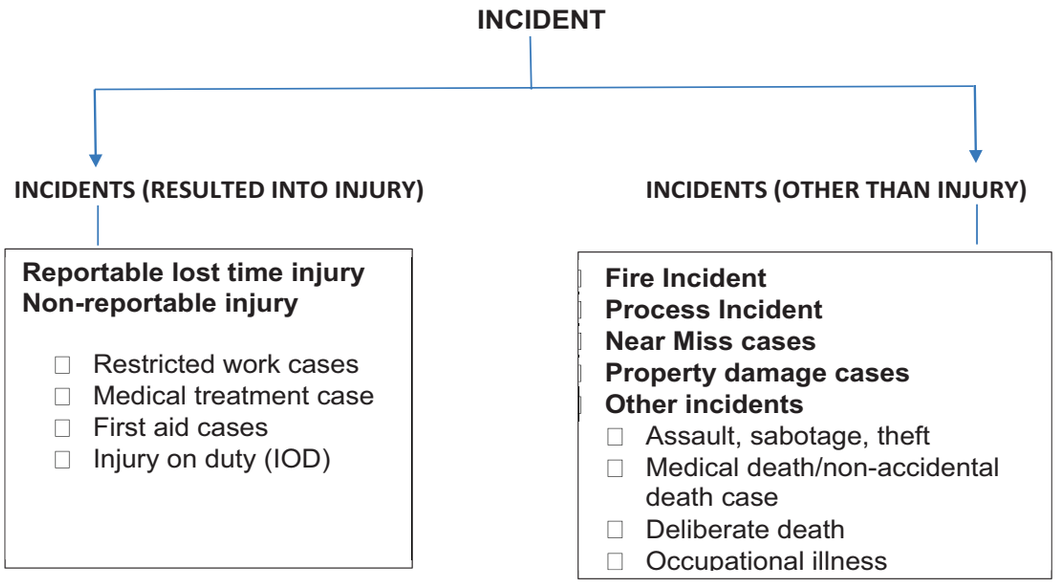
Management has the responsibility to implement incident investigation process. Management shall establish the foundation for an effective incident investigation process through leadership and commitment. Management has also the following specific responsibilities:

- Ensure that all incidents are reported. Create an atmosphere of trust and respect that leads to openness in the reporting and investigation of incidents.
- Establish systems and procedures to assure an effective and efficient incident investigation process. Communicate the value of incident investigation as a tool to continuously improve HSE systems and performance.
- Provide the resources and prioritize attention necessary for timely, thorough and comprehensive investigations.
- Implement systems to ensure that learning and recommendations of an investigation are acted on to prevent recurrence. This includes communicating the learning and findings to all who may benefit, including other sites.

4. INCIDENTS AND THEIR CLASSIFICATION

Incident: An incident is an event or a series of events that resulted or could have resulted in an adverse effect on Safety, Health and Environmental aspect of the organization and related stakeholders. Undesirable consequences related to safety incidents include, but are not limited to the following:

- Injuries/ illnesses
- Environmental impact
- Unfavorable impact on the public
- Property damage
- Business interruption
- Damage to company reputation



4.1. Incidents (resulted into injury):

4.1.1 **Reportable lost time injury:** A reportable lost time injury is a case in which an injury prevents the employee from reporting to duty within next two regular shifts (within next 48 hrs.) or fatality (Death occurred while performing duty).

4.1.2 **Non –reportable lost time injury**: A non- reportable incident is a case in which a person is not able to report for duty on the immediate next working day (but joins before 48 hrs.) of the incident.

4.1.3 **Non –reportable incidents are further classified as:**

- **Restricted work cases (RWC):** A RWC is a case in which an injury or illness prents the employee from working for a complete shift (or from doing any task that is part of his or her regularly scheduled job that may be performed or assigned) but does not result in lost workdays.
- **Medical treatment cases (MTC):** A MTC is a non-injury case happened within work premises where the person is referred to hospital due to medical illness only.
- **First-aid cases (FAC):** First-Aid cases are occupational injuries for which immediate aid provided to the injured person either at shop floor or at plant First Aid center/ OHS center as applicable and released afterwards as fit for Duty.
- **Injury on duty (IOD):** IOD is an occupational injury, preventing an employee from joining duty in the next scheduled shift, caused due to an incident occurred outside when the victim is engaged in company business.

4.2. Incidents (other than injury):

4.2.1 Fire incident: Fire incident is an unplanned ignition of flammable or combustible material either with an open flame or without flame. This includes smoldering, charring, smoking, singeing, scorching, carbonizing, uncontained electrical arcing / sparking, or evidence that any of these have occurred.

4.2.2 Process safety incident: An unplanned or uncontrolled loss of containment (primary) of any hazardous material / release of energy including non-toxic and non-flammable materials (e.g. steam, hot condensate, nitrogen, compressed CO2 or compressed

air, hydraulic oil, water etc.) from a process or an undesired event or condition that under slightly different circumstances either resulted in or could have resulted in a loss of containment (LOC) of hazardous material/release of energy. For example: Chemical fire, gas release, explosion etc. Incidents like actuation of safety relief valve, tripping due to operation outside operating parameters, activation of critical alarms, interlock failure, small fires due to leakage of chemicals, hydraulic oil, grease and hot metal (not fire in bins, conveyors, buildings etc.) but have not resulted in injury / property / environment damage should also be considered as process incident. All such incidents shall be reported, no matter the quantity.

4.2.3 **Near Miss Case (NMC):** A near miss is an incident in which no property damage happened, or no personal injury was sustained, but where, given a slight shift in time or position, damage or injury could have occurred.

Generally, the following events are some examples of near miss when:

- A person trips over an object but injury was averted.
- A person had to dive or jump out of the way to avoid a collision with a motorized vehicle or from an uncontrolled suspended load.
- Any emergency equipment (fire extinguisher, air pack, oxygen sensor, eye wash etc.) fails to operate properly when tested randomly or called upon in an emergency.
- Any actuation of safety relief valve, tripping due to operation outside operating range, activation of critical alarms, interlock failure etc.

4.2.4 **Property Damage: Any incident that results in loss of equipment/property of the organization.**

4.2.5 **Assault, Sabotage, Theft: All on-site fatalities and injuries resulting from assault, sabotage and property loss due to theft inside the factory premises shall be reported and to be dealt as per individual plant protocol.**

4.2.6 **Non-accidental Death /Medical Death Case: Non-accidental death of employee/ contractor employee shall be notified and investigated to:**

4.2.6.1 Decide whether there is a causal relationship between work and the death, if it is so, the death should be classified as work related and recorded in statistics.

4.2.6.2 Identify work related causes or contributing factors that may provide the ground for corrective actions and improvement.

4.2.6.3 Establish whether management systems were in place to ensure that fitness of personnel was in line with the requirements of the job.

4.2.6.4 Address the following questions:

- Was there any work related exposure to hazardous agents, e.g., contacts with hazardous substances, poor working environment, which could have contributed to the death?
- Was there any pre-existing medical condition?
- Has the individual been declared fit to carry out his normal duties in compliance with company standards?
- Did the individual exhibit any sign or symptom associated with the cause of death before or during his recent work period?
- Was the individual recently referred to a doctor or hospital?
- Were the company medical emergency response procedures, including provision

of first aid and treatment, suitable and complied with?

Examples:

Work related:

- Evidence that an individual has been exposed to high levels of a hazardous substance during his work.zby work related stress factors.

Non-work related:

- Investigation has shown that an individual, who was previously found medically fit for his duties, has died from the consequences of a heart attack or due to some medical ailment.

4.2.7 **Deliberate death: Suicides and homicides should be notified as soon as practicable. If the initial investigation indicates a work relationship, they should be investigated in the same way as an accidental death.**

4.2.8 **Occupational illnesses: Occupational illness is any abnormal condition or disorder, other than the ones resulting from an injury that is mainly caused by exposures at work. All the occupational illness cases need to be reported and investigated for recurrence prevention.**

5. INCIDENT/ NEAR MISS CLASSIFICATION MATRIX

Though there is intent to investigate all incidents, matrix given below shall be used to capture serious near miss cases/ incidents to facilitate quality investigation.

Nature of incident/ Near miss: (Score: 4 to 1)		Consequences / Potential consequences: (Score: 5 to 1)	
Work related repeat incident (W-R)	4	Fatality or permanent disability, or Severe property damage or affecting legal compliance / environment / community.	5
Work related first-time incident (W-FT)	3	Lost time injury, significant property damage to plant, potential of fire and explosion, impact on health.	4
Non-Work related repeat incident (NW-R)	2	MTC, Restricted work cases, Property damage to department / section	3
Non-Work related first-time incident (NW-FT)	1	FAC, Minor property damage	2
		Minor bruise, No property damage	1

X Axis – Nature of near miss / Incident

Y Axis – Consequence

		W-R	W-FT	NW-R	NW-FT
Consequence		4	3	2	1
	5	20	15	10	5
	4	16	12	8	4
	3	12	9	6	3
	2	8	6	4	2
	1	4	3	2	1
	Nature of near miss/ incident				

Risk score (Nature of near miss / incident X maximum potential consequence)		
Score range (15–20)	High potential	Investigation required by HOD& assigning it to cross functional team
Score range (5–12)	Medium potential	Investigation required by middle level management / Section In-charge
Score range (1–4)	Low Potential	Investigation not required, Concerned Head of department will assign the recommendation and ensure closure

The above risk matrix is indicative, and plant may use their own risk matrix also for prioritizing & management of incident investigation.

6. Accident Reporting

6.1. Statutory requirement of accident reporting

- As per Factories Act Section 88, notice of certain accidents: Where in any factory an accident occurs which causes death, or which causes any bodily injury by reason of which the person injured is prevented from working for a period of forty-eight hours or more immediately following the accident, or which is of such nature as may be prescribed in this behalf, the manager of the factory shall send notice thereof to such authorities, and in such form and within such time, as may be prescribed.
- As per Factories Act Section 88A, notice of certain dangerous occurrences: Where in a factory any dangerous occurrence of such nature as may be prescribed occurs, whether causing any bodily injury or disability or not, the manager of the factory shall send notice thereof to such authorities, and in such form and within such time, as may be prescribed.
- Duly filled up form as applicable to the work location to be sent to Inspector of factory/ DGMS or other statutory authority (like Electrical Inspector in case of electrical incidents) for the applicable incidents within specified time.

6.2. Internal reporting of incidents

All the business, functional and operational units under the control of a company/organization are required to report the incidents as given below:

- Front line management, under whose jurisdiction incident has happened, should immediately notify the Chief/ Head of the department and the safety person concerned about the occurrence of the incident.
- The Safety person concerned should report to Chief/ Head Safety immediately.
- Chief / Head shall report Fatality/Lost time injury/ Dangerous occurrence to the designated senior persons of the company within 1 hour followed by a detailed report. For other incidents, the reporting guidelines of the respective organization are to be followed.
- Government agencies shall be notified within stipulated time as per local legal requirement as applicable.
- Respective line manager shall log preliminary incident report (PIR) in IT based safety system for investigation within the same shift of work during which the incident has

occurred. Wherever IT based safety system is not available, organization should decide a methodology to create the incident reporting repository.

- Format of Incident investigation report & one page report may be used for standardizing the reports (Annexure 1& 2).

Summary: Reporting of incident

Type of incidents	Reporting responsibility	To whom
Any incident	Respective line manager	Chief/Head of the dept & safety personnel
Reportable lost time injury (fatality /lost time injury) or **High potential incident** (process incident / near miss/dangerous occurrence)	Respective Chief/ Head of the department	Designated senior persons within one hour
Reportable lost time injury (statutory)	Factory manager/Mine manager	Factory inspector/ DGMS/Other statutory authority

7. Incident Investigation

Incident investigation is to be conducted within the stipulated time by the competent incident investigation team through the standardized steps & procedures. It consists of following steps:

7.1. Incident recording:

All the incidents including near miss must be recorded in the system within 24 hrs of occurrence by the respective line manager with basic information like:

- Classification/category of incident
- Details of injured person(s)
- Place of incident
- Date, shift &time of occurrence
- Brief description of the incident
- Potential of incident etc.

7.2. Investigation team formation:

As per the category & potential of incidents, HOD must form an investigation team, which should necessarily be cross functional including expert(s) from same and/or outside department, safety representative and/or employee's representative as applicable. At least one member of the team should be experienced / trained in incident investigation process. The Incident investigation team is needed to be formed within maximum two days from the date of incident. The low potential near miss incident (where cause of incident is already known) may be closed by head of the department directly by assigning the recommendations with intimation to safety departments.

7.3. Investigation process:

The team needs to investigate and ensure the following as mandate:

7.3.1. Visit to the workplace to collect details of the Injured person(s).

7.3.2. Find out whether similar incidents happened in the past.

7.3.3. Risk level as per HSE risk matrix or any other suitable risk matrix followed by the organization.

7.3.4. Additional safeguards provided to prevent recurrence of the incident until the investigation is completed.

7.3.5. Incident analysis – Using proper incident investigation tools like root cause analysis, bow tie analysis etc. to identify the root cause & gap(s) in the system.

Gap identification is to be done with respect to the following factors:

- **Physical factor**-It refers to any object or environmental circumstances that may have contributed to the incident. These factors may include the condition of equipment, machinery, or tools involved in the incident, as well as the layout and design of the workspace. Physical factors may also include weather conditions, illumination and other environmental factors.
- **Human factor**- It refers to the influence of individual and group behaviors, actions, and decisions in investigation. These factors include factors such as communication failures, inadequate training, supervision, poor decision making, fatigue, stress, and inappropriate behaviors such as drug or alcohol use.
- **System factor**- It refers to the larger organizational, management, and regulatory structures that influence incidents in incident investigation. These factors include things like policies, procedures, training system, communication system, job safety analysis, reporting structures, and organizational culture etc.

7.3.6. Team shall give specific recommendation with respect to each root cause, which shall be provided in system.

7.4. Investigation reporting & communication:

The reports of Incident investigation shall cover the following points:

- Classification of incident
- Details of injured person(s)
- Nature of injury
- Body part injured
- Place of incident
- Date, shift &time of occurrence
- Brief description of the incident
- Additional safeguard (introduced immediately after an incident till investigation is complete and recommendations are compiled)
- Chronology of events
- Evidence tendered
- Actual observation of the incident site and other details by the members of the committee
- Primary cause and root cause of the incident by using appropriate investigation tool (e.g.: why- why analysis)
- Gap analysis (Key factor Identified)

- Remedial measures to prevent recurrence (Recommendation with responsibility and target Date)
- Fixing of responsibilities/administrative action: As decided by the enquiry committee in line with the consequence management system of the plant
- Investigation team details
- Statements of eyewitness, site photographs & layout, medical treatment reports & fitness certificate of the injured person if applicable and any other report etc. shall be annexed as evidence.

The report is to be shared with different stakeholders by the investigation team leader in the investigation format attached in **Annexure-1.**

Recommendation generated to be categorized as follows and mentioned actions to be ensured:

7.4.1. **Generic recommendation**: If team recommends that the recommendation shall be implemented in all the locations, it should be given as "Generic recommendation". It would be shared with Chief/Head Safety for horizontal deployment.

7.4.2. **Own Department**: If the recommendation is to be implemented by the department in which incident has happened, it should be given as ''Own department''.

7.4.3. **Specific Department**: If recommendation to be implemented by the department other than incident occurring department, applicable department can be mentioned.

7.5. Review & follow up:

The entire incident investigation process should be followed by the investigation team and recommendation implementation should be done by assigned line managers. Both are to be reviewed by respective Chief/ head of the department and Chief Safety. To ensure prompt follow up and closure of recommendations from incident investigation report, a system must be provided for sending periodic status report to higher management until all recommendations are acted on and closed out. The frequency of review may be decided by the departments. The incident investigation report shall be shared and discussed with appropriate personal of the affected area as well as those whose jobs are related to the incident findings. Consideration should be given to communicate findings to other facilities / units of the company for horizontal deployment.

Rehabilitation requirement, if any arises as per medical board recommendation for the injured person after treatment, should be decided by departmental management team & HRM or existing departmental protocol to be followed.

Annexure- 1

Incident Investigation Report (sample format)	
Incident Title:	
Document No:	Division/Department/Type of injury/Serial number
Type of incident:	Workplace Safety /Process Safety:

Classification	FATAL	LTI	MTC	RWC	FAC Minor	NEAR MISS		PROPERTY DAMAGE	
						High Potential	Minor	High Potential	
Numbers									

Injury Details	**Company Employee**	**Contractor Employee**	**Third Party**
Number of injured persons			
Name of Injured Person(s) (IP)			
Age & Sex of IP			
Personal No. / Gate Pass No : Department:			
Service- High risk or Low risk			
Service or Supply			
Last date of incident of contractor organization (incident free days)			
Nature of injury:			
Name of organ injured/ effected			
Incident reported by:			
Location of incident:		Incident number:	
Date of incident:		Time of incident:	
Incident investigation initiated: (Date / Time)		Incident investigation Report submission: (Date / Time)	
List of Records reviewed during incident investigation:	1. 2. 3. 4.	List of persons interacted during incident investigation process:	1. 2. 3. 4.
Any similar incident happened in organization:			
Summary of Incident:(Report as fact only what you are clear is fact. Specify the status of anything else you report, e.g. estimate / belief)			
Risk level as per incident classification risk matrix at the time of incident:			

Classification	FATAL	LTI	MTC	RWC	FAC Minor	NEAR MISS		PROPERTY DAMAGE	
						High Potential	Minor	High Potential	

Additional safeguard (introduced immediately after an incident till investigation is complete and recommendations are complied):

Chronology of Events

Sl. No.	Time	Activity	Remarks
1			
2			
3			
4			
5			

Incident Site Layout: (Photograph / Sketch etc)

List of facts collected during investigation:							

Evidence	Key findings of the investigation

Root cause analysis of incident:

Conclusion:

Classification	FATAL	LTI	MTC	RWC	FAC Minor	NEAR MISS		PROPERTY DAMAGE	
						High Potential	Minor	High Potential	

Key Factors Identified:

PHYSICAL FACTORS:

1.
2.
3.
4.

HUMAN FACTORS:

1.
2.
3.
4

SYSTEM FACTORS:

1.
2.
3.
4

Recommendations:

Sl. No.	Recommendation	Responsibility	Target Date	Implementation to be Verified by
1				
2				
3				
4				
5				

Investigation Team:

1	
2	
3	
4	
5	

Supporting Photographs & Documents:

Annexure-2

Health & Safety : One page incident report (sample format)

State:

Company:

Location :

Incident title:

Incident category: (LTI / FAC/Property damage etc.)

Division : **Department:** **Section:**

Date of incident: **Time:**

Place of incident:

(In case of injury give further information as below, otherwise omit this)

Name: **P. No. /Gate Pass No:**

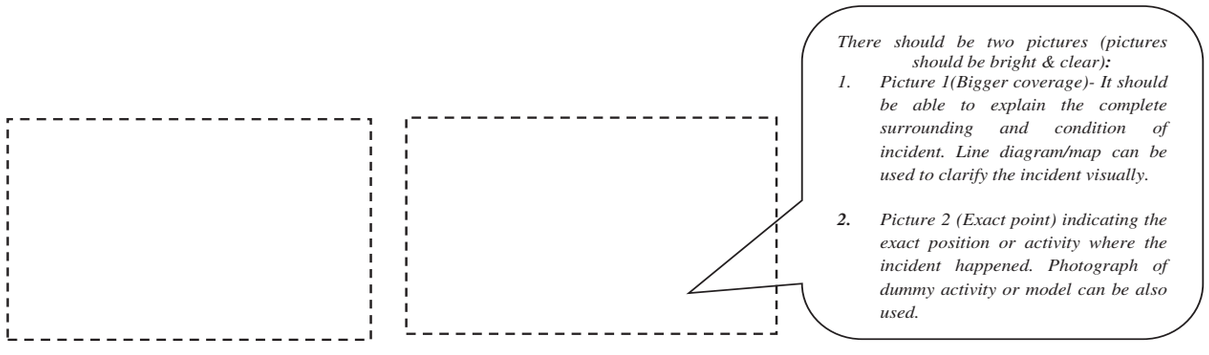
Age: **Designation:**

Vendor Name: If applicable **Injury details:**

- **Hazard Identification and Risk assessment (HIRA) for this job is available : (Yes / No)**
- **Incident scenarios was identified in the HIRA : (Yes / No/ NA)**

What happened: (Brief of incident):

Preliminary findings: *(considering human, physical and system factors- facts should be revealing and informative- Start with 'what went right' then write 'what went wrong'- specially in terms of failure of safeguard (if risk is already assessed). In case of injury, mention the profile of injured person. Example: experience, technical expertise, knowledge, skill certification etc.)*



1. ...
2. ...

PICTURE:

Mention in 5–10 words what you want to convey through these pictures by indicating the points with red arrow/ circle

Immediate actions/Recommendations:

1. ....
2. ....

SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	CREATION OF SAFETY DATABASE & PROACTIVE DATA COLLECTION	Doc. No: SG/27
		Rev no.: 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this document is to develop standard guideline for creation of safety database & proactive data collection for the Iron & Steel sector.

2. SCOPE:

This document covers the guidelines that apply to the integrated steel plant from receiving of the raw materials, production and dispatch of the final product or may be applicable to standalone plants as well. Evaluating performance is essential to uphold and enhance the effectiveness of Safety & Health Management System, necessitating a blend of proactive and reactive measures (leading and lagging indicators). Constant monitoring, review, and evaluation of Safety &Health Management system ensure its effectiveness and drive continuous improvement.

3. Purpose

The objective of this guideline is to establish uniform terminologies and safety statistics measurement systems across all Iron and Steel sectors, promoting a common language and understanding of Safety & Health practices. The classification of incidents & injuries described here aligns with the existing nomenclature used by various Indian & International companies. An effort has been made to simplify the process and language, ensuring easy comprehension.

Furthermore, adopting these standardized categories is essential if we aspire to benchmark our performance against the best-in-class organizations, both nationally and internationally. Standardizing our data in these categories is crucial for accurate performance comparison.

4. Safety Nomenclature

4.1. Fatality in the context of this guideline refers to the unfortunate event of an employee's death resulting from an accident that occurred during the performance of work-related activities.

It is important to note that the following categories are not included in the definition of fatality:

- **Death** arising from Medical Causes (e.g., Heart Attack): Deaths caused by medical conditions unrelated to work activities are not considered as fatalities under this guideline. However, if the medical cause is directly related to or significantly aggravated by work (as determined by a doctor's opinion), it will be considered a work-related case.
- **Suicide**: Incidents of suicide are not considered as fatalities within the scope of this guideline.
- **Personal Behaviour of the Employee** (Death during violence, murder, etc.): Fatalities resulting from personal behaviour, such as deaths occurring during acts of violence or murder, are not accounted for in this guideline.

The primary focus of this definition is to provide clarity and ensure accurate reporting of work-related fatalities, excluding incidents not directly linked to work-related activities or those arising from personal circumstances.

4.2. **LTI**, which stands for Lost Time Injury, refers to a work-related injury sustained by an employee that prevents them from resuming their duties in the next scheduled shift. This category also includes fatalities, as every fatality is considered an LTI. In essence, any injury that causes a loss of work time beyond the current shift or results in a fatality falls under the classification of Lost Time Injury (LTI).

4.3. **RWC**, which stands for Restricted Work Case, refers to a work-related injury where the employee is able to return to work from the next scheduled shift. However, due to the injury, the individual is unable to perform their regular assigned activities and is given light duty or restricted tasks that are within their capabilities.

In summary, a Restricted Work Case involves an employee resuming work after an injury, but due to the injury's limitations, they are assigned lighter duties or restricted tasks instead of their regular responsibilities.

4.4. **FAC**, which stands for First Aid Case, refers to a minor work-related injury in which the employee can return to their regular duties within the same shift. In some instances, the employee may seek medical assistance from the dispensary for the injury, while in other cases; they may not require such aid but can still resume their work without significant disruption. The key characteristic of a First Aid Case is that the injury is minor and does not lead to any prolonged absence from work, allowing the employee to continue their duties during the same shift.

4.5. **HIPO** (High Potential) Incident: A HIPO (High Potential) incident may be a near-miss, property damage or any other dangerous occurrence such as collapse/ fall of any equipment or structure, fire, bursting/explosion of vessel or tank, large spills which does not result in injury to person(s) but which poses a risk to life of people in vicinity and has potential to cause serious injury / fatality if circumstances had been slightly different.

4.6. **Road Related Incident** is defined as any incident that occurs outside the factory during business travel, such as when an employee is on their way to a customer site or any other work-related destination. This type of incident is considered work-related and should be reported and investigated.

However, it is important to note that if an injury or fatality occurs to a third party (i.e., someone not employed by the company) in the context of the Road Related Incident, it should still be reported and thoroughly investigated. However, these third party injuries or fatalities typically will not be included in the company's internal statistics. Instead, they are handled separately as part of the reporting and investigation process, ensuring transparency and accountability even in cases involving external individuals.

4.7. **Safety Database Repository**

A safety database for an Iron and Steel sector industry should contain comprehensive and organized information related to various safety aspects within the organization. This database plays a crucial role in recording, analyzing, and monitoring incidents, hazards, and other safety-related data to improve safety performance and prevent future accidents. Here are some essential components that a safety database for an Iron and Steel sector industry

should contain:

4.1.1. **Incident Reports:** Detailed records of all safety incidents, including near-misses, injuries, illnesses, property damage. This should include information about the date, time, location, description of the incident, contributing factors, and severity.

4.1.2. **Injury Records:** Specific records of all work-related injuries along with data on the injured employee, the nature of the injury, medical treatment provided, and the recovery process.

4.1.3. **Hazard Identification and Risk Assessment (HIRA):** Documentation of identified hazards and potential risks, including details about the hazard's location, description, and corrective actions taken or planned to mitigate the risk.

4.1.4. **Safety Inspections and Audits**: Reports from regular safety inspections and audits, with findings, observations, and corrective actions taken to address safety deficiencies.

4.1.5. **Training Records**: Records of safety training sessions attended by employees, along with information about the type of training, date, and employees' participation.

4.1.6. **Safety Meetings**: Minutes and action items from safety committee meetings or other safety-related meetings held within the organization.

4.1.7. **Safety Performance Indicators**: Data on leading and lagging safety indicators, such as Lost Time Injury Frequency rate (LTIFR), Reportable lost time injury frequency rate (RLTIFR), Total Reportable Injury Rate (TRIR), and other relevant metrics to assess safety performance.

4.1.8. **Safety Policies and Procedures:** Documentation of safety policies, procedures, and standard operating guidelines established by the company.

4.1.9. **Emergency Response Plans**: Information about emergency response plans, evacuation procedures, and incident management protocols.

4.1.10. **Safety Improvement Projects**: Records of ongoing or completed safety improvement initiatives, including project descriptions, objectives, timelines, and outcomes.

4.1.11. **Safety Training Materials**: Digital copies of safety training materials, presentations, videos, or other resources used during safety training sessions.

4.1.12. **Safety Alerts and Communications**: Records of safety alerts, bulletins, and other safety-related communications sent to employees.

4.1.13. **Root Cause Analysis**: Reports from investigations into significant incidents, outlining the root causes and corrective actions implemented to prevent recurrence.

4.1.14. **Contractors Safety Performance**: Data on safety performance and incidents involving contractors working on-site.

4.1.15. **Vehicle Safety Records**: Information on safety-related aspects of vehicles used in the organization, including maintenance records, inspection reports, and incidents involving company vehicles.

Having a comprehensive safety database allows the organization to analyze trends, identify patterns, and make data-driven decisions to continuously improve safety performance and

prevent accidents in the iron and steel sector industry.

5. Lead & Lag KPIs Monitoring

Key Performance Indicators (KPIs) play a vital role in monitoring safety performance in the Iron and Steel sector industry. Lead and lag KPIs are used to assess both proactive (lead) and reactive (lag) safety measures.Here are some suggested lead and lag KPIs to be monitored:

Lead KPIs (Proactive Measures):

The indicators should be those with the highest predictive ability and those that provide actionable information. The following list of performance indicators may be considered:

- Compliance to Safety training plan- Percentage of required safety training sessions completed as per plan.
- Completion to Emergency Response Mock Drills- Percentage of emergency response drills completed as scheduled.
- Safety Audit Compliance: The percentage of safety audits completed as scheduled, indicating the organization's commitment to regular safety assessments.
- Near-Miss Reporting: The number of near-miss incidents reported per month or quarter, reflecting a proactive safety culture.
- Safety Participation: The percentage of employees actively engaged in safety-related activities, such as safety committees or safety improvement projects.
- Safety Communication Effectiveness: Feedback and surveys on the effectiveness of safety communications and awareness campaigns.

Lag KPIs (Reactive Measures):

- Lost Time Injury Frequency Rate (LTIFR): The number of lost time injuries per 1,000,000 man work hours worked.
- Reportable Lost Time Injury Frequency Rate (RLTIFR): The number of Reportable injuries (including fatal) per 1,000,000 man work hours worked.
- Severity Rate: The total number of days lost due to injuries (per 1,000,000 work hours), indicating the severity of injuries and their impact on work. Number of lost days to be calculated as per Appendix- A (IS:3786).
- Fatality Rate: The number of work-related fatalities (per 1000 employees) during a specific period, reflecting the most severe safety incidents.
- Total Reportable Injury Rate (TRIR): The number of reportable injuries (per 1000 employees) during a specific period, indicating the overall safety performance.
- Accident Investigation Timeliness: The average time taken to complete accident investigations from the time of the incident.
- Recommendation Completion Rate: The percentage of recommendations implemented within the specified timeframe after incident investigations.
- Compliance with Safety Regulations: The rate of compliance with safety regulations, both internal and external (e.g., regulatory authorities).
- KPIs may vary based on the organization's safety goals and focus areas. It is essential to align KPIs with the company's safety strategy and continuously review and update them to drive continuous improvement in safety performance.

6. Sample Monthly Reporting Format

1. Key Performance Indicators					
	a. Leading Indicators				
S.No.	KPI	April	May	June	July
1	No. Of Safety Training Sessions				
2	No. of Participants in Safety Tranining				
3	No. of Unsafe Situations (behaviour, conditions & near misses) observed				
4	No. of Unsafe Sitauations Rectified				
5	No. of Health Awarness sessions conducted				
	b. Lagging Indicators				
1	No. of Fatalities				
2	No. of Major Fires				
3	No. of LTIs				
4	No. of RWCs				
5	No. of MTCs				
6	No. of FAC				
7	Total Number of Manhours				
8	Total TRC	0.00	0.00	0.00	0.00
9	LTI-FR	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
10	TRC-FR	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
11	No. of HIPO (High Potential) Incidents				
12	No. of Road Related Incidents (inside + outside premisis)				
8	Number of Occcupational Diseases				

Reference:

IS: 3786: 2002- Method for Computation of Frequency and Severity Rates for Industrial Injuries and Classification of Industrial Accidents.

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	COKE OVEN BATTERY (RECOVERY & NON-RECOVERY), COKE DRY COOLING PLANT AND BY PRODUCT PLANT	Doc. No: SG/28
		Rev no.: 00 Effective Date: 12.06.2024

1.0 OBJECTIVE

The main objective of these guidelines is to safeguard workmen, shift in-charges and other working personnel from accidents/incidents, major & minor injuries, damage to the plant & machineries, prevention of fire, intoxication, health hazards by systematically following the step by step guidelines in running and maintenance.

2.0 SCOPE

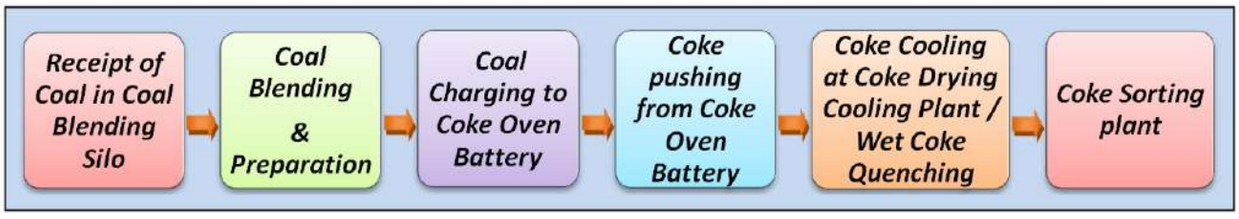
This recommended guideline is applicable to

- Coke Ovens(Recovery & Non-recovery),
- Coke Dry Cooling Plant,
- Coal & Coke Sorting/Handling Plant,
- By-product plant of an Integrated Steel Plant.

2.1 Coke Oven Battery (Recovery & Non-recovery type)

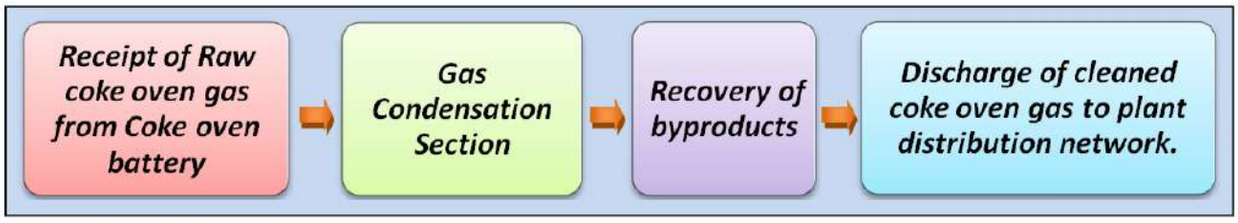
The main function of Coke Ovens is to convert coal into coke which is used as a fuel and reducing agent in the Blast Furnace.

The battery limits for implementation of safety guidelines for Coke Oven Battery will be as follows:



2.2 COAL CHEMICALS / BY-PRODUCT SECTION:

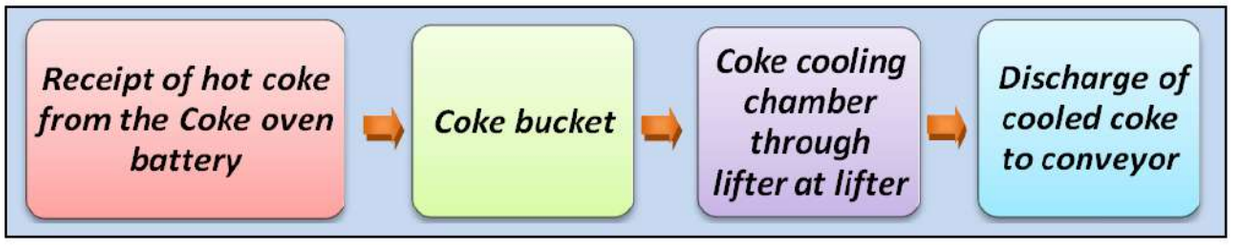
The coke oven gas coming out from batteries contains valuable chemicals like tar, ammonia and benzol. The battery limits for implementation of safety guidelines for By Product Plant will be as follows:



2.3 COKE DRY COOLING PLANT

The battery limits for implementation of safety guidelines for Coke Dry Cooling Plant will be as follows:

Receipt of hot coke from the Coke oven battery ➡ Coke bucket ➡ Coke cooling chamber through lifter at lifter Discharge of cooled coke to conveyor



3.0 PROCESS BRIEF

The Coke Ovens, By-Product Plant & Coke Dry Cooling Plant (CDCP) has following main sections:

3.1. COKE OVENS (Recovery/Non-Recovery Type)

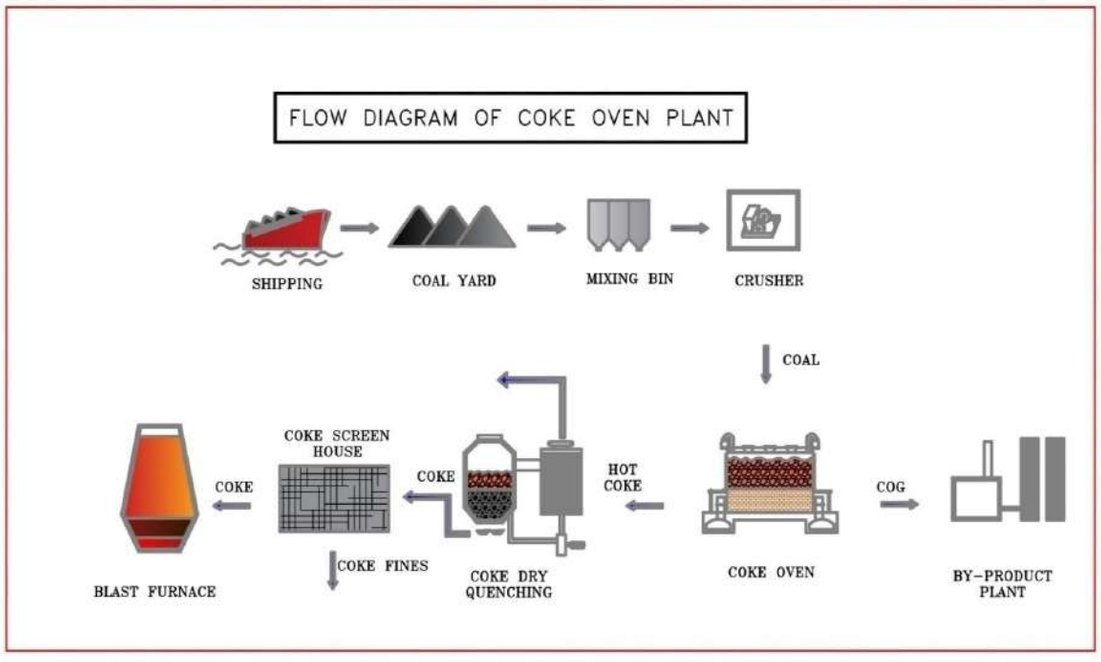
Various sub-sections of Coke Ovens complex and their functions are as follows:

3.1.1. Coal Handling Plant: To prepare coal blend suitable for carbonization in Coke Ovens batteries to produce BF coke. Coal Blending is referred to as mixing of coals of different grades in desired proportion as per techno-economic optimization which are subsequently crushed to desired fineness and moisture addition.

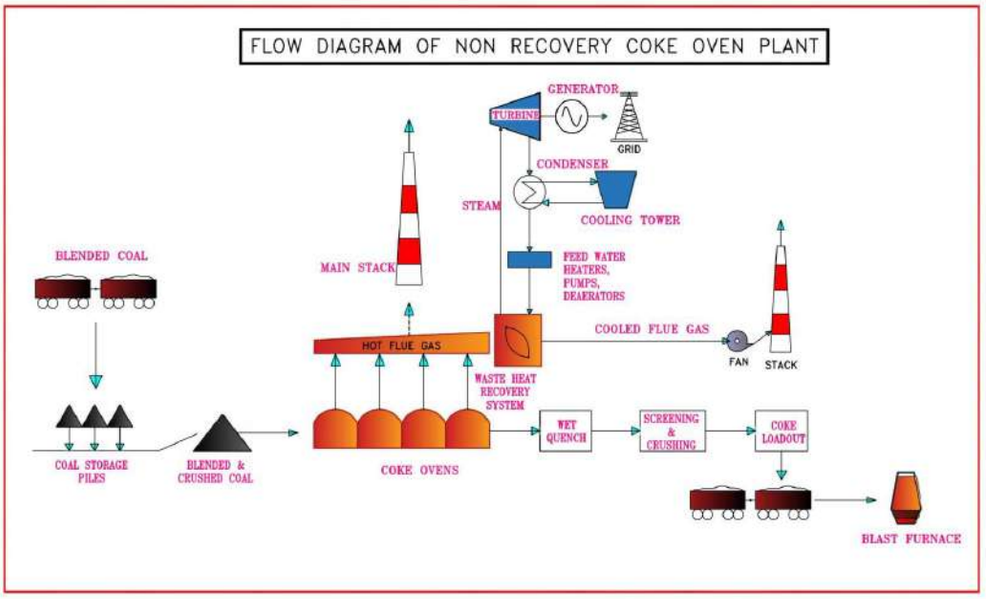
3.1.2. Coke Oven Batteries: To convert coal into coke by carbonizing coal in absence of air and thereby distilling the volatile matter out of coal. In Recovery type, the resultant coke oven gas is treated in By Product Plant for recovery of chemicals and thereby cleans the gas.

3.1.3. Coke Sorting Plant: To crush and screen coke to 25–80 mm size required by blast furnaces. The 0–10 mm fraction (coke breeze) is used in sinter making and 10–25 mm fraction (nut coke) is added along with sinter supplied to Blast Furnace.

The above process is narrated below schematically in a simplified way



The coking process through Non-Recovery type Coke Oven is indicated below schematically in a simplified way.



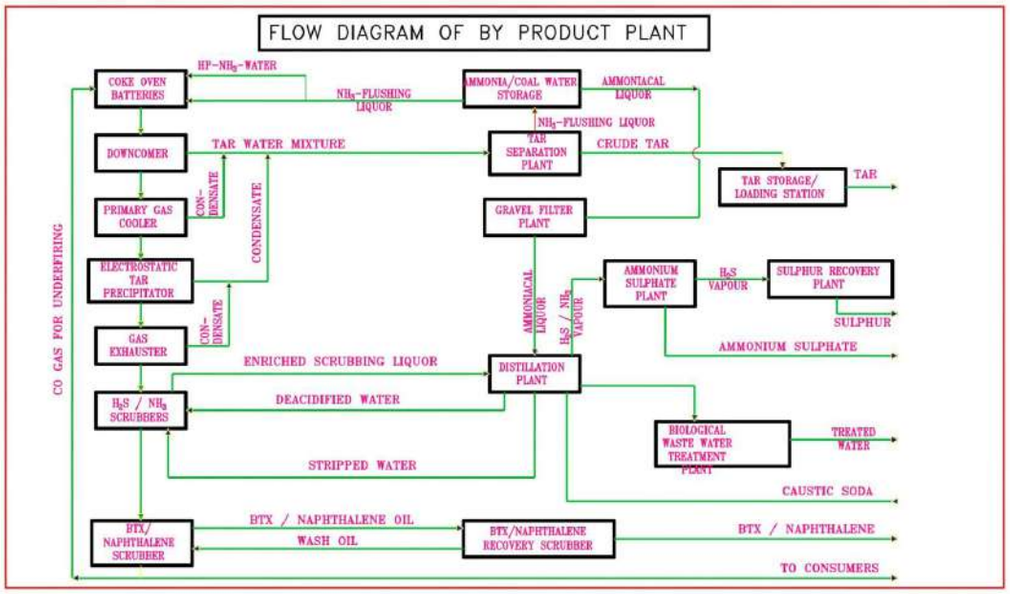
3.2. COAL CHEMICALS / BY-PRODUCT PLANT

The coke oven gas coming out from batteries contains valuable chemicals like tar, ammonia and benzol. These chemicals are recovered and gas is cleaned in the by-product plant which is subsequently used as fuel gas in the process.

This plant comprises of the following sections:

- Gas Recovery and Condensation Section
- Ammonium Sulphate Plant
- Benzol Recovery section & Benzol Distillation Plant
- Tar Distillation Plant

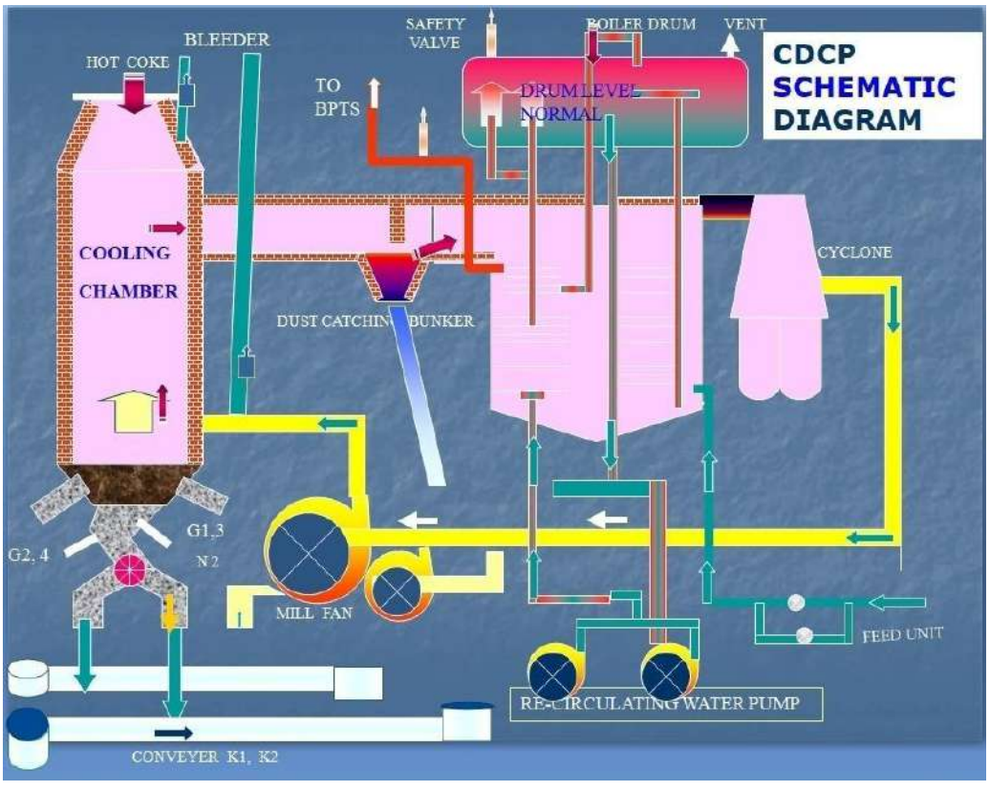
The above process is narrated below schematically in a simplified way



3.3. COKE DRY COOLING PLANT

Hot coke produced in Coke Oven Battery is fed in the cooling chamber of CDCP at the top. In the CDCP, hot coke from Coke Oven at a temperature of around 1050 0C is cooled down to cold coke of temperature less than 200 0C. The heat extracted from hot coke is utilized in Waste Heat Boilers to generate High Pressure Steam for power generation.

Refer below a typical schematic diagram of a Coke Dry Cooling Plant:



Some of critical equipments/ facilities in Coke Ovens, Coke Dry Cooling Plant (CDCP), and Coke Sorting Plant & By product Department are as follows**:**

Sl. No.	Area	Major equipments
1	Coke Ovens (Recovery &Non Recovery)	· Coal blending Silos/bunker, · Crushers (hammer/ roll crusher), · Auto-Proportioning Device (APD), screens, · Ovens machines like charging cars, pusher car, coke guide car, quenching cars. · DFDS (Dry Fog Dust Suppression), · Dust Extraction System, · Quenching Pump, Coke Screens, · Hot flue gas ducts, regulation dampers. · Ovens isolation Valves, Goose neck, raw gas off take system.

Sl. No.	Area	Major equipments
2	Coke Dry Cooling Plant (CDCP)	· Coke Bucket Lifter, · Waste heat boiler, High pressure drum · Mill fan & Aux mill fan · Coke Bucket Car & Electric Loco, · Waste Heat Boiler, · High Pressure Drum, · Feed Water Pump, Re-circulating Pump, · Charging Device, Discharging Device, ID Fan, Bag Filter, · Coke Conveyor, Ventilation fan · Dust settling station, Steam Ejector, · High Pressure / Low Pressure Steam Piping & Valves, HP/LP Dosing System, · Pressure Reducing & De-superheating System, etc. · Dust Pneumatic Transport System(DPT)
3	Coal Chemicals(for recovery type Battery)	· Tar decanters, · Primary coolers, Exhausters, Electrostatic Tar precipitators, · Ammonia saturators, · Final Gas coolers, · Benzol scrubbers, associated process & storage tanks, piping& pumps etc. · Sulphur recovery plant & Sulphur solidification plant · BOD (Biological Oxygen Demand) Plant

4.0 PROCESS BASED SAFETY HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.1	**COKE OVEN (Recovery/Non-Recovery Type)**		
4.1.1	Coal Handling Plant (Coal Tower & conveyor belts)	Caught in-between the head/tail pulley/take-up pulley and belt resulting into fatality, deep cut, impact injury, blunt injury	· Avoid loose clothing. · Avoid cleaning of spilled material in running condition. · Avoid working near running belt. · Proper housekeeping regularly. · Follow Permit to work system. · Hooters/siren to be sounded for at least 30 seconds before starting the conveyor · Safety guards to be provided and inspected at regular intervals. · Pull cord system to be provided · Illumination level to be checked regularly. · Area barricading if material is removed from height. · Crossing the conveyor only through the designated place. · Use scotch block (skid) below wagon wheel, while coupling/decoupling of wagons. (*Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance) & SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG-05: Safety Guideline for illumination at work place)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Rotating machineries	· Coupling guards must be in place. · Avoid loose clothing (Refer *SG-09: Safety Guideline in Equipment & machine Guarding*)
		Moving Conveyor / shuttle conveyor which may lead to entanglement hazards	· Shutdown/permit must be ensured to work with electrical isolation. · No work should be done on conveyor in running condition. · Always operate Local emergency switch for approaching conveyor. · Availability of Pull chord. · Siren system prior to restarting conveyor. · Loose cloths prohibited. · Area barricading if material is removed from height. · Head/Drive end and tail end guard. · Crossing the conveyor only through the designated place. · Conveyor guard throughout length of conveyor including return side. · Sufficient illumination to be provided / maintained. · Spillage, if any, to be cleaned regularly to avoid slippages. · Auto hooter blowing whenever shuttle shifting command is given. (*Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance) & SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG-05: Safety Guideline for illumination at work place)*
		Engulfment/ Entrapment	· Ensure Shutdown and cleanliness of feeding belts / chutes before any job in chutes. · Maintain safe distance during poking of coal below silo / chute.
		Concussion / Bruise during gate valve operation.	· Inspection and cleaning of gate valve. · Ensuring sufficient length, freeness of valve lever. · Ensuring proper condition of platform, railing.
		Hit Injury from flying particles from Hammer Mill.	· Timely Maintenance. · Hammer mill Vibration monitoring.
		Gallery collapse	· Liquidating any pipeline leakages at/near galleries. · Timely inspection, cleaning and repair of galleries. · NDT of concrete / metallic columns. · Restriction of sheds / shelter below galleries.
		Slip, Trip & Fall	· Chute opening shall be covered with grills.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Fire hazard due to self-ignition of coal and due to rubbing of conveyors/ Idlers etc.	· Maintain housekeeping · Avoid overloading. · Zero speed switches to be ensured. · Maintain the health of rollers/ idlers & couplings to prevent friction sparking. · Ensure Fire Detection Alarm (FDA) &MVWS based fire fighting system working. · Beltway switches to be maintained. · Checklist based execution and startup after Hot job in Conveyors. *(Refer SG-16: Safety guideline for Fire Safety)*
4.1.2	Partial Briquetting	Burn Injury due to steam and tar.	Regular inspection/maintenance Any technical measure to prevent steam/ tar leakage
		Moving conveyors	(*Refer SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts*)
4.1.3	Coke Oven Batteries	Slip & fall of persons in coal cake during stamping hammers operation	· For maintenance, proper shutdown Protocol to be followed. · Adherence to SOP for operation & maintenance jobs
		Oven operation : Drop in suction due to ID fan trip or sudden closure of Chimney damper valve(For proper combustion and to avoid any explosion of gas)	· Open the chimney damper in case of ID fan failure · Normalize the chimney damper / restart ID fan · Open the primary air openings of individual ovens pressurized · Vent out the flue gases wherever possible
		Flue duct operation & maintenance: Possibility of burn injuries due to hot spots, duct failure, duct repair	· Regular duct shell temperature measurement and record, identify hot spots · Persons to wear Heat resistant full coats while working near hot spots & duct repair
		Wrong Pushing due to mismatch of machine positioning which may lead to coke spillage	· Machine interlock to be provided & maintained. · Ensuring good and fail-safe communication. · Anti-Collision system to be provided. · Manual inspection by supervisor and high alertness of operators to be ensured when pushing is done manually during repair of interlock system.
		Coke falling on person from an open door. Falling of objects from height.	· Nobody should pass in front of open door. · All door man should wear FR jackets. · Manual frame cleaning to be done by standing in a side and not directly in front. · Charging level to be maintained and leveling shall be done. · Avoid simultaneous jobs at different height and at same place. · Prohibit standing at / below service platform during brick dismantling.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Person hit by moving machines and equipment.	· Auto announcement during any coke oven machine operation, and machine movement. · Before starting a standing car long hooter should be given and operator to check for any person doing any job. · Permit to work prior to undertaking any maintenance job. · Climbing prohibited on running machine. · Danger lights to be provided near power trolley lines / catenary.
		Hazard related to Gas of off take system. (Fire during closing of leveling door, Burn by flame coming out from oven, flue during movement on oven top ,Hot water falling during closing of AP lid, Flame coming out during Goose neck and AP cleaning ,Flame coming out due to liquor, exhauster or power failure.)	· Ensure exact oven is opened through oven positioning system. Confirm from oven top man about opening of HPALA valve. · Stay away from flue cap and charging holes. · Proper sealing of charging lids after charging should be done using refractory material. · Proper pressure to be maintained for GCM. · Ensure Auto opening of bleeder valve. · While moving on oven top, must wear cotton hand gloves and never touch metallic parts present in this area. · Safety signage to be provided about use of required PPEs at oven top. · Unauthorized entry to be prevented if possible by access control. · Emergency evacuation in case of uncontrolled gas emission. · Camera to be provided
		High Temperature of empty ovens during first coal charging/commissioning which may lead to process abnormality	· Temperature of empty ovens to be around 1050°C to avoid catching of fire of the coke oven gas vent through AP once coal is charged. · Once the ovens are charged and connected to Exhauster, oven temperatures can be increased.
		Running repair of ovens (Goose Neck and Isolation valve changing which may lead to gas leakage	· Detail job safety protocol is to be prepared to undertake the job. · Emergency action plan and rescue controls to be identified.
		Gas Leakage and backfire in cellar and gas pipelines	· Online CO monitors with alarm system to be installed for detecting gas leakage if any. In addition to this Portable CO monitors to be made available at site to detect gas leakage. · Person should not move without detector inside cellar. · Check that all COG DP plugs are in position before opening CO gas cocks.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			· Close BF gas cock by observing the indication mark. · Use gas monitor to check concentration of CO. · Don't be empty stomach. · Ensure smooth operation of CO /BF gas butterfly valve. · Ensure positive pressure (>50mmwc) always in gas pipe line. · Ensure no Low Draught conditions take place. Manual stopper to be provided so that draught damper never be closed completely · Interlock to be provided to bring reversing winch machine in pause in case of very low pressure to prevent air infiltration inside the pipe line to protect explosion. · Maintain low draught / high regenerator pressure alarm and reversal cut off system to ensure battery heating system does not pressurize and lead to harmful gas leakage. · Fire Extinguisher and water line to be provided. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
		Pre heater cleaning in CO line which may lead to toxic exposure / explosion	· Proper and strong scaffolding with proper clamping and railing to be made. · Use full body harness when working at height. · Proper closing of valves to be done. · Ensure that proper size plates are used for blanking. · All bolts to be tightened properly after blanking. · Proper ventilation to be maintained in and around area where job is going on. · No cutting/ welding job is allowed. · No spark to be allowed in the area. · Explosion test to be done before starting of job. *(Refer SG-02: Safety Guideline for Working at Height, SG-21: Safety Guideline for Handling Fuel Gas)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Gas cutting operation : Fire/ Explosion resulting into burn injury	· Prior inspection of gas cutting set by site supervisor. · Cylinder to be supported properly & shifted using properly trolley and kept with individually chained. · Gas regulators to be provided on gas cylinders · No gas cylinder to be allowed inside the confined space. · Use of flash back arrestor to be necessary in all cutting set. · Pilot Lighter to be used for gas cutting set. · Only skilled workers to be deployed on the job. *(Ref. SG-01: Safety Guideline on storage, handling & use of gas cylinders, SG-07 : Safety Guideline for Gas cutting & Gas Welding)*
		Maintenance of gas pipeline header.: Slip & fall from header maintenance platform resulting into fracture of bones, deep cut & blunt injury	· Isolation to be done for section under maintenance. · Only skilled workers to be engaged. · Maintenance platform to be fixed every time before the job if permanent is not there. · Life line for fixing safety harness belt to be ensured. · Safe maintenance procedure for maintenance/repair of gas header to be developed and implemented. *(Ref. SG-21: Safety Guideline for Handling Fuel Gas, SG-02 : Safety Guideline for Working at Height, SG-18: Personal Protective Equipment (PPE) Management)*
		Replacement of oven door: Door may fall during operation resulting in fracture & burn injury	· Sling rope to be fixed with door lifter so that in case the hydraulic fails, the door will not fall. · SMP to be developed and implemented. · Pin to be welded with bracket. · Bracket bolt tightening to be done as per the schedule. · Only skilled workers to be engaged. · Preventive maintenance schedule to be followed as per check list.
		Operation of Pusher car machine/SCP/Coke guide car: Person may get trapped between rail track and machine resulting to crush injury or fatality	· Hooter is to be blown while machine is in operation. · Access control in the vicinity of machine movement · Proximity based movement tripping of machines

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Operation of quenching car: Contact with hot coke and hot water during shifting through car may result to burn injury.	· Flap gate to be provided to prevent coke spillage from the tray. · Hooter to be provided and sounded while car is in operation. · Multilayered positioning system and Stoppers for prevention of over travel of loco near quenching station.
		Working near DSL: Contact with Live DSL resulting into electric shock	· Danger signs & warning lights to be provided at suitable locations. · Fencing to be provided along the DSL · Shutdown procedure is to be strictly followed. *(ReferSG-14: Safety Guideline for work on Electric Overhead Travelling (EOT) Crane)*
		Repair / maintenance of hydraulic system : Contact with hydraulic oil under pressure resulting into amputation of limbs or fatality	· Residual pressure to be released by relief valves. · Permit to work system to be followed. · Only skilled persons to be engaged for the job. · Safe operating procedure on operation/ maintenance of hydraulic system to be developed and implemented. *(Refer SG-10: Safety Guideline for Hydraulic System)*
	.	Heating process of bridge pipe & oven door: Exposure to high temperature, smoke resulting into severe burn injury. Exposure to CO gas resulting in unconsciousness& blood poisoning.	· CO detector to be used in regular way. · Vent Pipe to be provided for exhaust the burnt gas. · Inspection of burner to be done before starting heating chamber to ensure safety. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
		Wheel bogie replacement of Quenching Car : May result in cut injury, bone fracture, fall of material, failure of hydraulic jack	· Only certified & tested chain block, slings to be used for handling load. · LT wheel to be locked mechanically. · Power to be kept off from electric panel. · Certified & tested hydraulic jack to be used
		Replacement of Quenching tray : Fall of quenching tray / any loose material resulting into injury & serious accident	· Usage of certified sling. · Welding of hook to be done by skilled welder & before lifting the tray, load testing done by lifting to a small height. · Before lifting of tray, loose material to be removed to avoid falling of any object.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Sole Repairing of Oven : Burn Injury, Material fall from height	· Covered Cage is to be made to protect from fall of hot bricks. · Inspection of Heat resistant and protection shield to be done before starting the job. · Face shield safety helmet, heat resistant gloves, shoes & jacket to be provided to protect the workers
4.2	**COKE DRY COOLING PLANT (CDCP)**		
4.2.1	CDCP & associated facilities	Explosive mixture on circulating gas route	· Working of interlocks and automation shall be ensured. · Percentage of oxygen content should not exceed 1 %. · Percentage of hydrogen content should not exceed 4 %. · Percentage of Carbon mono oxide should not exceed 8%. · Availability of Nitrogen shall be ensured. · Proper functioning of nitrogen valves shall be ensured. · Proper functioning of gas bleeder valve after mill fan shall be ensured. · Proper functioning of pre-chamber bleeder valve shall be ensured. · Explosion flaps located in the circulating gas path shall be in proper cleaned condition and should be inspected time to time. · Proper functioning of air breather valve at pre-chamber shall be ensured. · Proper functioning of gas analyzer shall be ensured. *(Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance) & SG-16: Safety Guideline for Fire Safety)*
		Person hit by arms & hooks of Crane at Coke bucket repair garage.	· Siren gong bell and auto announcement during movement of Crane. · Before starting of Crane long hooter should be given and operator to check for any person doing any job. *(Refer SG-13: Safety guideline for Material handling (manual and mechanized) & storage)*
		Moving Conveyor after discharging device which may lead to entanglement	· Shutdown/ permit to work with electrical isolation. · No work should be done on conveyor in running condition. · Always operate Local emergency switch for approaching conveyor. · Availability & working of Pull chord. · Siren system prior to restarting conveyor. · Loose cloths prohibited.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			· Area barricading if material is removed from height. · Head end and tail end guard. · Crossing the conveyor only through the designated place. *(Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance), SG-13: Safety guideline for Material handling (manual and mechanized) & storage & SG-19: Safety guideline on Operation and Maintenance of Conveyor Belts)*
		Burn & Injury due to High/ Medium/ Low Pressure steam	· Regular inspection of steam pipeline. · IBR authorized / certified personnel should only be allowed for operation and maintenance of Boiler. · The periodic inspection of Boiler inspector for certification & validity of license shall be ensured. · Calibration of visible inspection gauge on regular basis. · Proper inspection, testing and functioning of safety valves of Boiler drum & SH Steam pipeline. · Operator/ technician should wear Safety jackets while working around steam pipeline. *(Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance), SG-05: Safety guideline for Illumination at workplace & SG-18:* Safety guideline for *Personal Protective Equipment (PPE) Management)*
		Hot coke falling on person from coke bucket while lifting/ moving of Coke Bucket Lifter. Free fall of hot coke bucket leading to injury.	· Visual inspection of coke bucket lifter rope on regular basis. Scheduled replacement of rope · Visual inspection of brake and brake shoes of coke bucket lifter on regular basis. · Nobody should pass in front/ below of Coke Bucket Lifter. · Proper gripping of hooks at both side arms of coke bucket shall be ensured while lifting hot coke bucket. · Interlock to stop lifting of the bucket in case the hook is engaged only one side. Also it is preferred to install load cells on lifters to give feedback of load being lifted as well as individual hook load to ascertain proper load transfer on the lifter hooks. · All watchman / field-man of lifter should wear FR jackets. · Siren gong bell during lifting / moving of Coke Bucket Lifter. · Working of interlocks and automation of coke bucket lifter shall be ensured.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			(Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance)
		Person hit by Coke Bucket Car & Electric Loco	· Siren gong bell during movement of Coke Bucket Car & Electric Loco. · Auto announcement during Coke Bucket Car & Electric Loco operation. · Before starting a standing Coke Bucket Car & Electric Loco long hooter should be given and operator to check for any person doing any job. · Permit to work prior to undertaking any maintenance job around Coke Car Track & Bus bar. · Climbing prohibited on running machine. *(Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance), & SG-25 Safety guideline for Loco Operation)*
		CO Gas accumulation in Conveyor Tunnel which may lead to toxic effects / poisoning	· Online CO monitors with alarm system to be installed for detecting CO gas accumulation. · Portable CO gas monitors to be made available at site to detect CO gas accumulation. · Ensure continuous running of ventilation fan on Conveyor Tunnel. · Person should not Move without detector inside Conveyor Tunnel. · Don't go for work with empty stomach. *(Refer SG-04; Safety Guideline for Permit to Work (Operation & Maintenance), & SG-16: Safety Guideline for Fire Safety)*
		Fire in Conveyor Tunnel	· Coke temperature detectors installed on discharging device will give feed back to control the discharging rate to avoid hot coke discharge on Coke conveyor beyond the permitted value. · Spot quenching system interlocking with fire detector or sensor to be provided to extinguish hot coke onto the moving conveyor. · Working of interlocks and automation of shall be ensured. · Provide automatic fire detection cum alarm system (by LHS cable) along with automatic MVWS system. · Fire Extinguisher to be provided. *(Refer SG-04; Safety Guideline for Permit to Work (Operation & Maintenance) & SG-16: Safety Guideline for Fire Safety)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Work in confined space / pits	· Permit to Work to be taken from owner department. · Safety training and do's/ don't instruction to workers. · Check concentration of oxygen, toxic, explosive gases, etc. prior to work. · Proper emergency rescue arrangements. *(Refer SG-03:Safety Guideline for Working in a Confined Space,SG-04: Safety Guideline for Permit to Work (Operation & Maintenance) & SG-05: Safety Guideline for Illumination at workplace)*
		Falling from height (Coke Bucket Lifter maintenance jobs, crane operation, etc.	· Safety training and do's/ don't instruction to workers. · Use of full body harness with lifeline. · Use of safety hooks & belt. · Adherence to Safe work procedure. *(Refer SG-02: Safety Guideline for Working at Height& SG-04: Safety Guideline for Permit to Work (Operation & Maintenance)*
		Fire	· Fire extinguisher & hydrant ring. · Prohibition on usage of mobile phones. · Working of interlocks and automation shall be ensured. · Periodical mock drills to be conducted *(Refer SG-16: Safety Guideline for Fire Safety)*
		Hand getting pressed during coupling/ decoupling of Coke Bucket Car & Electric Loco	· Use Scotch block below wheel of Coke Bucket Car and Electric Loco. · Long Lever/ Tool is to be used *(Refer SG-04: Safety Guideline for Permit to Work Operation &Maintenance)*
		Rotating machineries (ID Fan, Mill Fan, Pumps, Motors, etc.) which may lead to entanglement / entrapment	· Coupling guards to be in place. · Loose cloth to be prohibited. · Motor fan cover to be in place. *(Refer SG-09: Safety Guideline in Equipment & machine Guarding)*
4.2.2	Coke Sorting Plant / Coke handling Plant	Moving Conveyor	· Conveyor safety procedure to be followed. · Long height Toe guards for overhead conveyors to prevent the vertical fall of material from overhead conveyors onto roads underneath. (*Refer SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts*)
		Fire due to hot coke	· Spot quenching at wharf & provision of MVWS to avoid hot coke going on conveyor.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Caught in-between the head/ tail pulley/ take-up pulley and belt resulting into fatality, deep cut, impact injury, blunt injury	· Workers not to wear loose clothing while working. · Cleaning of spilled material not to be allowed in running condition of the belt. · No job to be allowed on a running belt. · Proper housekeeping to be done regularly to ensure obstruction free movement. · Permit to work system to be followed for any repair/ maintenance activity. · Hooters/siren to be sounded for at least one minute before starting the conveyor · Safety guards to be provided and inspected at regular intervals. · Pull cord system to be provided/ · Illumination level to be checked regularly. *(Refer SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts)*
		During maintenance, Slip & fall from Coke cutter receiving chute resulting into fracture of bones, deep cut & blunt injury.	· Only skilled manpower to be deployed for this job · Illumination level to be checked as to the schedule. · Shutdown to be taken with proper power ISOLATION before starting inspection. *(Ref. SG-05: Safety Guideline for Illumination at workplace , SG-18: Personal Protective Equipment (PPE) Management , SG-04 :Safety Guideline for Permit to Work(Operation & Maintenance)*
		Vibratory units like Vibro-feeders and vibro-screeners: Failure of Positive isolation procedure in parallel standby equipment	· Compliance to LOTOTO procedure · Green/Red lighting for parallel equipment setup for 'fit to work' confirmation
4.3	**COAL CHEMICAL / BY- PRODUCT PLANT**		
4.3.1	Gas Condensation section	Spillage of hot liquor from leakage of flanges / pump gland.	· Regular inspection to observe flange / gland leakage before change over and rectify the same with safety protocol.
		Burn due to leakage of steam line flange / hot condensate / touching hot steam line	(*Refer SG-18: Personal Protective Equipment (PPE) Management*)
		Exposure to COG from leaking lines/flanges/valve gland packing etc	· Regular inspection of COG lines to detect leakage if any. · Online CO monitors with alarm system to be installed & portable CO monitors to be used to detect Gas leakage. (*Refer SG-21: Safety Guideline for Handling Fuel Gas*)

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Explosion in COG line.	• Regular check of Oxygen % in COG and take appropriate action in case O_2>1.5%. (with the help of online analyzer) • Hot job is prohibited. (*Refer SG-21: Safety Guideline for Handling Fuel Gas*)
		Exposure to gas leakage from flanges opened during job execution	• Protocol Job • Use of gas masks • Thorough isolation of gas lines before opening flanges (*Refer SG-21: Safety Guideline for Handling Fuel Gas*)
		Fire Hazard due to spark generation while opening flanges	• Job protocol to be made. • Thorough isolation of gas lines before opening flanges. • Use grease smeared tools / non sparking tools. • Keep portable fire extinguisher ready on easy approach or call fire services for stand by duties if required. • Take shutdown of nearby equipments, power etc. to avoid chances of spark. • Proper scaffold / platform with 2 means of exits. (*Refer SG-21: Safety Guideline for Handling Fuel Gas*)
		Exposure of body parts to coal tar which may cause acid burns	• Safety training and do's / don't instruction to workers (*Refer SG-18: Personal Protective Equipment (PPE) Management*)
		Work in confined space / pits may lead hazards on account of oxygen deficiency / enrichment	• Permit to work to be taken from owner deptt. • Confined space work permit provided by competent person • Safety training and do's / don't instruction to workers • Check concentration of oxygen, toxic , explosive gases etc. prior & also intermittently as required • Proper emergency rescue arrangements • Check proper cross ventilation (*Refer SG-03 Safety Guideline for Working in a Confined Space*)
		Exposure to CO/ Mixed gas causing poisoning	• Use of gas mask if CO % is above 50ppm • Maintain water seal. (*Refer SG-21: Safety Guideline for Handling Fuel Gas*)
		Injury due to sudden rotation of machine	• Take shutdown of Motor in proper pro-forma. • Close suction & discharge valves to avoid back rotation. (*Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance*)

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Falling from height	· Use of full body harness with lifeline, Adherence to Safe work procedure (*Refer SG-02: Safety Guideline for Working at Height*)
4.3.2	Ammonium Sulphate Plant	Exposure to ammonium Sulphate powder which may lead to burns	· Regular housekeeping in the section. · Proper maintenance of equipments to prevent spillage · Ensure proper forced ventilation to prevent exposure to ammonium sulphate powder. (*Refer SG-18: Safety guideline Personal Protective Equipment (PPE) Management*)
		Exposure to sulphuric acid spray which may lead to acid burns	· Regular checking of pipe lines, repair as per requirement. · Maintain condition of pipe, flanges & flange guards, valve glands etc. · Keep distance while acid unloading is going on. · Addition of sulphuric acid in saturators to be done through PLC control system · Provision of Safety Shower and eye wash fountain near acid handling areas · Ensure proper housekeeping and cleaning of spillages
		Exposure to acidic liquor which may lead to acid burns	· Provision of Safety Shower and eye wash fountain near acid handling areas
4.3.3	Benzol Recovery section	Exposure to Benzol vapours which may lead to health problems	· Use gas chemical cartridge masks. · Online hydrocarbon monitors with alarm system to be installed. · Check/ use of continuity jumpers over pipeline flange. · Proper maintenance of pipelines, equipments, storage tanks etc. · Summer cooling of storage tanks with water spray to reduce vapour formation of benzol products. (*Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) Management*)
4.3.4	Benzol Rectification Plant	Exposure to BTX vapours which may lead to health problems	· Usage of mechanical seals in pumps. · Usage of gas/chemical cartridge masks. · Online hydrocarbon monitors with alarm system to be installed.
		Fire	· Fire extinguisher & hydrant ring. · Continuity jumpers over pipeline flanges to prevent static electricity buildup. · Foam fire suppression system for the storage tanks and high range fire fighting systems at storage areas. · Earth rite system for tankers while loading and unloading to prevent static electricity buildup.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			• Prohibition on usage of mobile phones. • Access control is to be ensured to avoid entry of unauthorized persons. • Online hydrocarbon monitors with alarm system to be installed. • Automatic level control systems for preventing overflows • Regular NDT test shall be carried asses the health of pipelines and equipment • Proper earthing of tanks and equipments • Electrical fittings and equipments should be explosion/flame proof. • (Refer SG-16: Safety Guideline for Fire Safety)
4.3.5	Tar Distillation Plant	Formation of Explosive mixture leading to explosion	• Explosive mixture is to be checked before starting of hot work. • Proper ventilation is to be ensured for dispersion of explosive mixture.
		Explosion/ Fire hazard	• Use of PTW before start of job for ensuring proper isolation. • Lines to be thoroughly flushed before start of job. • Fire extinguishers are kept near work place for use in case of minor fire. • Proper ventilation is to be ensured for dispersion of explosive mixture (*Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance*)
		Spraying/ Spillage of tar/ tar product which may lead to burn injury.	• Isolation of line & draining of line before starting job. • Regular cleaning of the area. • Provision of Safety Shower and eye wash fountain near acid handling areas • Flange guards are to be ensured in order to prevent spraying of acids in case of leakages (*Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) Management*)
		Exposure to cold wash oil which may lead to skin infections	• Use of apron with face shield
4.3.6	Sulphuric Acid Plant.	Exposure to acid from leaking flange, valve glands etc	• Regular checking of pipe lines, flanges and gland for possible leakages and attend leakages on priority. • Keep safe distance from acid lines while pump is in operation, • Flange guards are to be ensured in order to prevent spraying of acids in case of leakages

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Overflow of acid from tanker	· Keep a safe distance from acid wagon. · Any technical suggestion to prevent overflow · Spillage handling systems are to be maintained in healthy condition in order to prevent acid contaminating the environment. · Automatic level control systems for preventing overflows
		Exposure to acid from leaking / open flange, valve glands etc.	· Ensure proper isolation and shut down before hand over of line for maintenance; · Keep safe distance from open flanges. · Flange guards are to be ensured in order to prevent spraying of acids in case of leakages *(Refer SG-22: Safety Guideline for Energy isolation)*
		Exposure of molten sulphur to body part. Inhalation of sulphur dust, eyes exposed to sulphur dust	(*Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) Management*)
		Exposure of acid vapour due to leakage in acid vapour line.	· Regular NDT test shall be carried asses the health of pipelines and equipment. · Provision of Safety Shower and eye wash fountain near acid handling areas
4.3..7	Naphthalene scrubber	Fire in naphthalene vapour, Contaminate loss wash oil, CO gas exposure	· Ensure proper isolation and shut down before hand over of line for maintenance; · Use of PTW before start of job for ensuring proper isolation. · Lines to be thoroughly flushed before start of job. · Fire extinguishers are kept near work place for use in case of minor fire. · Ensure healthiness (scrubber Resistance) of scrubbers
4.3.8	Naphthalene distillation	Fire in Naphthalene vapor, Contaminate loss wash oil, Exposure to Naphthalene Vapour/Liquid	· Ensure proper isolation and shut down before hand over of line for maintenance; · Use of PTW before start of job for ensuring proper isolation. · Lines to be thoroughly flushed before start of job. · Fire extinguishers are kept near work place for use in case of minor fire. · Naphthalene storage area is protected with automatic smoke detection and water drenching system

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.3.9	Ammonia cracking & Elementary Sulphur Plant	Exposure to NH3/ H2S vapours	· Portable and fixed type H2S monitors to avoid the area in case of any leak. · Process safeguards to stop the generation of vapours from coal water in case of any leak. · Ensure proper shutdown inserting dummies & Use gas mask during arresting and carrying out repair job of the leaky vapour line. · Regular inspection of Vapour lines condition and attending leakages on priority.

Note:

- The operating procedure as given in the write-up may vary from shop to shop due to different equipment disposition and type. Signage's and emergency escape route shall be shown covering the entire shop.
- Provision &Operability of safety fences should be ensured covering the entire shop.
- 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.
- Housekeeping is to be given utmost priority by regular cleaning of oil/tar spillages in Coal Chemical plant areas and cleaning of dust/spillage coke/coal in battery and conveyors area.
- Regular checking and maintenance of all process safety interlocks like CO exhauster interlocks, Pushing/charging interlocks, CDCP interlocks, various alarms, level indicators, safety relief valves, control valves, gas monitors etc. are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.
- All applicable statutory requirements are to be followed as per respective state factory rules.

List of instruments/ equipment required for detection/management of the hazards

- Safety devices in conveyor system (PCS, BSS, ZSS , Interlocks, limit switches, etc.), Hooter before starting, guards over rotating components.
- NDT (Non Destructive Testing) of Structure.
- Fire Defection & Alarm system (FDA) with MVWSS (Medium velocity water spray system).
- Non- sparking tools while working on COG lines.
- Explosion/ flame proof fittings & electrical equipment for hazardous (flammable areas).
- Testing / detectors for toxicity, oxygen level, flammability /explosivity.
- Spot Quenching System over coke conveyors with fire detector or sensor.
- Automatic Level Control Systems for overflow of acid from tank.
- Automatic Rescue Device (ARD) for Lifter, Lift, etc.
- Oven Identification System.

PPE Matrix

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Suit-	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body Harness	Safety Belt	Breathing Apparatus	PVC Cover-alls
COAL OPRN	YES	YES	-	YES	YES	YES	YES	-	-	-	-	-
H&R	YES	YES	YES	YES	YES	-	YES	-	-	-	-	-
BATT OPRN	YES	YES	YES	YES	YES	-	YES	YES	-	-	-	-
CSP OPRN	YES	YES	-	YES	YES	YES	YES	-	-	-	-	-
CDCP OPRN	YES	YES	YES	YES	YES	YES	YES	-	-	-	-	-
CCD OPRN	YES	YES	-	YES	YES	YES	YES	YES	YES	YES	-	YES
CRG-REF	YES	YES	YES	YES	YES	-	YES	YES	YES	YES	-	-
CRG-MECH	YES	YES	YES	YES	YES	-	-	YES	YES	YES	-	-
M/M	YES	YES	-	YES	YES	-	YES	YES	YES	YES	-	-
E/M	YES	YES	-	YES	YES	YES	YES	YES	YES	YES	-	-

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like gas monitors etc.) may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviation:

Code	Description		Code	Description
COAL OPRN	Coal Operation		CCD OPRN	Coal Chemical Department Operation
H&R	Heating and Regulation		CRG-REF	Capital Repair Group – Refractory
BATT OPRN	Battery Operation		CRG- MECH	Capital Repair Group – Mechanical
CSP OPRN	Coke Sorting Plant Operation		M/M	Mechanical Maintenance
CDCP OPRN	Coke Dry Cooling Plant Operation		E/M	Electrical Maintenance

SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	ASSET MANAGEMENT	Doc. No: SG/29
		Rev no.: 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of having an asset management standard is to provide organizations with a systematic and standardized approach for managing their assets, including physical assets such as fixed assets. This standard approach will also help in avoiding incidents that can cause injury / property damage resulting from poor maintenance of assets.

2. SCOPE:

This guideline is applicable to all Steel Plants and addresses specially Fixed assets.

Fixed assets in a steel plant may include but not limited to followings:

- **Buildings and Structures**: The physical structures of the plant, including administrative offices, production facilities, warehouses, and storage buildings. The structural steel framework of the plant, including beams, columns, foundations and platforms etc.
- **Conveyor Systems**: Galleries, Equipment used for transporting raw materials, semi-finished products, and finished products.
- **Cranes and Hoists for material handling**: This includes equipment used for handling materials and transporting them within the plant.
- **Electrical and Control Systems:** Equipment used for controlling and automating the production process, such as electrical control panels, computers, and other electronic equipment etc.
- **Furnaces**: This includes furnaces of all kind including Blast furnaces, electric arc furnaces, induction furnaces, and other heating equipment used for melting and refining raw materials.
- **Land and Properties**: The land and properties owned by the steel plant, including the plant site, parking lots, and other land and properties used for operations.
- **Maintenance Equipment**: Equipment used for maintenance and repair of the plant and other equipment, such as cranes, hoists, and other lifting equipment, welding equipment, and hand tools.
- **Pipelines Lines& It's support Structure:** Various Gas lines (such as COG, BF, LD, Mixed Gas etc.) catering to main plant, Utility lines (O2, N2, Compressed Air) and Steam lines.
- **Pumps and Compressors**: This includes equipment used for handling liquids and gases, such as cooling water, process gases, and air compressors etc.
- **Rolling Mills**: This includes equipment used for shaping steel, including hot and cold rolling mills, and finishing lines etc.
- **Abandoned Structure:** This includes buildings, facilities, or equipment that are no longer in use and have been left in a non-operational state for an extended period without any plans for future use or repurposing. *(Ref: SG-12-Demolition of Building & Structures)*
- These are some of the common fixed assets found in a steel plant, and the specific assets may vary based on the size and type of steel plant, as well as its production processes.

3. PROCESS BRIEF

3.1 General Steps

The General steps for asset management in the steel industry are listed below: –

- **Asset identification**: Define the assets that need to be managed and identify their criticality to operations. This to be mapped in ERP system if available.
- **Asset classification**: Classify assets based on their importance, age, usage (Load Application, Cycles, Heat Exposure, Dust and fumes exposure etc.) accessibility, and condition to prioritize maintenance and replacement needs.

  Sample criteria are listed below for reference: –

  Class 'A' Assets- Highly Corrosive Environment. High load bearing members. Difficult to approach and maintain. Open to atmosphere. High dynamic loading at heat zone

  Class 'B' Assets – Moderate Corrosive Environment. Less dynamic loading. Covered structures

  Class 'C' Assets – Low Corrosive Environment. Fixed load. Less members. Covered Structures. Away from heat
- **Maintenance planning**: Develop and implement a maintenance plan that balances the need for efficiency, cost-effectiveness, and safety. This includes regular inspections, preventive maintenance, and condition-based maintenance. This also includes frequency of cleaning & painting.
- **Maintenance execution**: Execute the maintenance plan, log the abnormalities in system with proper severity and track the abnormality notifications for compliance to ensure assets are maintained according to the plan. Vulnerable or critical structures to be given priority.
- **Asset optimization**: Continuously review and optimize asset utilization, considering factors such as utilization rates, maintenance costs, and replacement schedules.
- **Performance monitoring**: Monitor the performance of assets using appropriate metrics and KPIs and use the results to identify areas for improvement.
- **Data management**: Implement a robust data management system to track asset information, including maintenance history, inspection results, and performance data. System based dashboard shall be developed to review critical structures notification and compliance.
- **Collaboration and communication**: Foster collaboration and communication among all stakeholders, including maintenance staff, operations personnel, and management, to ensure effective and efficient asset management.

This is a general guideline and may need to be adjusted based on the specific requirements of the organization.

3.2 Structural Integrity Checks

Some general guidelines for structural integrity checks in the steel industry include:

- **New Structures**: Structural integrity checks (Quality control checks) should be performed during construction and upon completion of a new structure to ensure it meets design specifications and is free from defects.

- **Regular Inspections**: Structures should be inspected regularly, typically every 1–2 years, based on the criticality to identify any potential issues, such as corrosion or stress-related damage (deformation, disconnections of members etc.,), that could affect their structural integrity. Defect category to be defined based on severity. Once identified, immediate repairs need to be done as per Defect Severity to Maintain and avoid further deterioration of the structure.

  Sample table on Inspection frequencies is attached below for reference: –

SN	Tech. structures	Frequency of Inspection
1	Building Structures	1 year
2	Civil Structures	2 years
3	Gas Lines	6 months

- **Note**:-The frequency may be revisited with respect to current health of the structure and defect patterns observed in the history. However, daily inspections (look through) shall be done by area owners and any discrepancy found shall be intimated to structure inspection authority for further investigation
- **High-Risk Structures**: Structures that are subjected to heavy loads or severe environmental conditions, such as those located in areas prone to earthquakes or severe weather, High Cyclic Load, like Screen House may require more frequent inspections to ensure their structural integrity is maintained. Organizations shall develop the risk matrix and can conduct inspections accordingly.
- **Modifications**: Structural integrity checks should also be performed after any modifications or upgrades are made to a structure to ensure they do not negatively impact its structural integrity as well as to ensure it in compliance with design and technical standards.
- These are general guidelines, and the specific frequency of structural integrity checks will depend on the unique characteristics of each structure and the recommendations of the structural engineers and safety experts involved. It is important to perform these monitoring and control checks regularly to ensure the safety and stability of the structure and to identify and address any issues before they become more serious**.**

3.3 Legal Requirements

The Factories Act of 1948 primarily focuses on regulating the working conditions in factories to ensure the health, safety, and welfare of workers. It does not contain specific provisions or references to asset management. However Rule- 5 (Certificate of stability) of Model Factories Rules, 1987 (framed under sections 6 & 112 of Factories Act'1948) require that 'No manufacturing process shall be carried on in any building of a factory constructed, reconstructed or extended, or in any building which has been taken into use as a factory or part of a factory until a certificate of stability in respect of that building has been sent by the occupier or manager of the factory to the Chief Inspector, and accepted by him. The Certificate of Stability shall be signed by a competent person.'

3.4 International Standards & Requirements

ISO 55001 is an international standard that provides a framework for the management of physical assets, including fixed assets. The standard outlines requirements for the development, implementation, and improvement of an asset management system. The key requirements of ISO 55001 are as follows:

- **Context of the organization**: Establish the external and internal context in which the asset management system operates, including legal and regulatory requirements, stakeholder needs and expectations, and organizational objectives.
- **Leadership and commitment**: Ensure that top management demonstrates leadership and commitment to the development, implementation, and improvement of the asset management system.
- **Planning**: Develop a comprehensive asset management plan that defines the strategies, processes, and procedures required to manage assets effectively and efficiently.
- **Support**: Ensure that the necessary resources, including personnel, finance, and technology, are made available to support the asset management system.
- **Operation**: Establish and maintain effective processes for the acquisition, utilization, maintenance, and disposal of assets, including risk management and decision-making processes.
- **Performance evaluation**: Continuously monitor and evaluate the performance of the asset management system to identify opportunities for improvement.
- **Improvement**: Continuously improve the asset management system by using relevant performance data and the results of internal and external audits to identify areas for improvement.

In order to be compliant with ISO 55001, an organization must demonstrate that it has implemented a comprehensive asset management system that meets the requirements of the standard. The standard provides a systematic approach to managing assets, which can help organizations to achieve their strategic objectives, reduce costs, and improve the reliability and safety of their assets.

3.5 Benefits

The benefits of having an asset management standard include:

- **Enhanced safety**: By implementing a systematic approach to managing risks associated with assets, organizations can improve safety, reduce accidents, and protect their personnel and the environment.
- **Improved efficiency**: A well-structured asset management system can help organizations to optimize the use of their assets, reducing costs and increasing efficiency.
- **Better decision making**: By having accurate information about their assets and the costs associated with managing them, organizations can make better-informed decisions about their asset portfolio.
- **Increased reliability**: By implementing a comprehensive asset management system, organizations can improve the reliability of their assets, reducing the likelihood of equipment failure and downtime.
- **Compliance**: By following a recognized standard, organizations can demonstrate their commitment to effective and efficient asset management, and comply with relevant regulations and laws.
- **Improved stakeholder satisfaction**: By managing assets effectively and efficiently, organizations can meet the needs and expectations of stakeholders, including customers, regulators, and investors.

3.6 Safety Performance Indicators

The following Indicators shall be monitored by the management, shall be discussed, and

acted upon during the internal meetings.

i. Availability & Implementation of Asset Management plan

ii. % of Assets covered under the plan

iii. % Compliance of the Inspection plan

iv. Repair Compliance of the abnormalities

References

- Factories Act'1948 – Chapter IV – Safety
- ISO 55001
- JSW Steel – Asset management Standards
- Tata Steel – Asset management standards

Sample Checklist

Sample Asset Management Checklist								
Sr. No.	**Plant**	**Name of the Equipment**	**Location**	**SAP ID Number**	**Classification Critical (Y/N)**	**Inspection Frequency (As per checklist)**	**Status**	**Remarks**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

GENERAL STRUCTURAL INSPECTION CHECK LIST

SL No	STRUCTURAL MEMBER	CHECK POINTS	DESIRED PARAMETER	CONDITION OK/NOT OK	REMARKS
1	COLUMN / TRESTLE /JUNCTION HOUSE /OTS& PLATFORM	RCC FOUNDATION / CONCRETE ENCASING WITH SLOPING TOP IF ANY	FREE FROM ANY CRACK		
2		FOUNDATION BOLTS & NUTS	PROPERLY TIGHTNED & FREE FROM CRACK & RUST		
3		BASE PLAE / PACKING PLATE , RIBS & STIFFNERS	FREE FROM ANY CRACK & RUST , PACKING PLATES SHOULD BE GROUTED		
4		CORROSION OBSERVED IN MEMBERS	SHOULD NOT BE PERFORATED / LAMINATED / SEVERILY CORRODED		
5		VIBRATION OBSERVED IN STRUCTURE	NO SIGNIFICANT VIBRATION		
6		ANY DEFORMATION/BEND / KINK OBSERVED WITH LOCATION	FREE FROM ANY DEFORMATION		
7		COLUMN SPLCE PLATE & INTERMIDIATE STIFFNERS	FREE FROM WELDING CRACK/IN ADEQUATE WELDING/ RUST ALL CONNECTION BOLTS TO BE TIGHTNED		
8		FLOOR BEAMS/TIE BEAMS & ITS CONNECTIONS	FREE FROM BEND,CRACK & RUST , SHOULD BE PROPERLY TIGHTNED & PAINTED		
9		CROSS BRACINGS , GUSSET PLATE & CONNECTION	FREE FROM BEND,CRACK & RUST , SHOULD BE PROPERLY TIGHTNED & PAINTED		
10		PLATFORM HANDRAIL / FLOOR CHEQURED PLATE / TOE GUARD	FREE FROM BEND,CRACK & RUST , SHOULD BE PROPERLY TIGHTNED & PAINTED		
11	STAIRCASE	GRATING) CONNECTION WITH ANGLE SUUPORT TO INCLIND & HORIZONTAL	SHOULD BE PROPERLY WELDED / TIGHTNED & FREE FROM RUST		
12		HANDRAIL & TOE GUARD ON FOOTING & POST	SHOULD BE FREE FROM RUST,DISCONNECTION/TOE GUARD IS REQUIRED ON BOTH SIDES OF FOOTING & ALL THREE SIDES OF POST		
13		CONNECTION OF STAIR CASE WITH MAIN SUPPORT COLUMN	SHOULD BE FREE FROM RUST / CRACK / CORROSION		
14	MONO RAIL	BUCKLING /SAGGING / CRACK OF WEB & FLANGE OF MONORAIL	FREE FROM CRACK / DEFORMATION / CORROSION		
15		INTERMEDIATE STIFFNERS CONDITION	FREE FROM CRACK / DEFORMATION		
16		MONORAIL CONNECTION WITH SUPPORT STRUCTURE	SHOULD BE PROPERLY TIGHTENED / PACKING PLATES IF ANY SHOULD BE WELDED		
17	CONVEYOR GALLERY	CONDITION OF POST	FREE FROM CRACK / DEFORMATION / CORROSION		
18		CONDITION OF STRINGER	FREE FROM CRACK / DEFORMATION / CORROSION		
19		CONDITION OF HEAD END STR	FREE FROM CRACK / DEFORMATION / CORROSION		
20		CONDITION OF TAIL END STR	FREE FROM CRACK / DEFORMATION / CORROSION		
21		CONDITION OF CT WT STR	FREE FROM CRACK / DEFORMATION / CORROSION		
22		CONDITION OF DECK PLATE	FREE FROM CORROSION		
23		CONDITION OF GALLERY PORTAL	FREE FROM CRACK / DEFORMATION / CORROSION		
24		CONDITION OF ROOF/SIDE STRUCTURE	FREE FROM CRACK / DEFORMATION / CORROSION		
25		MATERIAL SPILLAGE	FREE FROM SPILLAGE		
26		DUST ACCUMILATION ON CONVEYOR GALLERY STR	FREE FROM DUST		
27		UNDER DECK STR	FREE FROM CRACK / DEFORMATION / CORROSION		
28	GENERAL OBSERVATION	PAINTING CONDITION	PROPERLY PAINTED		
29		SAP ID MARKED	SAP ID MARKED ON STRUCTURE		
30		DUST ACCUMILATION ON STRUCTURE	FREE FROM DUST		

Note:	Alarm Conditions:
	Thickness reduction: >20 to >40 %
	Verticality : >20 mm (Max)
	Sagging: >10 mm (Max)
	Vibration : >5 mm/sec

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	BLAST FURNACE	Doc. No: SG / 30
		Rev no.: 00 Effective Date: – 12.06.2024

1. OBJECTIVE::

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identification of hazards associated with Blast Furnace process and implementation of risk control measures.

2. SCOPE:

This guideline is applicable to Blast Furnace Department of an Integrated Steel Plant. The scope of this document covers Raw materials storage & charging system, Furnace section and Auxiliary section including Gas cleaning Plant, Slag Granulation Plant (SGP) / Slag Dumping Yard up-to the dispatch of hot metal in open/ torpedo ladles to SMS/ PCM.

3. PROCESS:

BF is a counter current heat and mass exchanger, in which solid raw materials are charged from the top of the furnace and hot blast, is sent through the bottom via tuyeres. The heat is transferred from the gas to the burden and oxygen from the burden to the gas. Gas ascends up the furnace while burden and coke descend down through the furnace. The counter current nature of the reactions makes the overall process an extremely efficient one in reducing atmosphere.

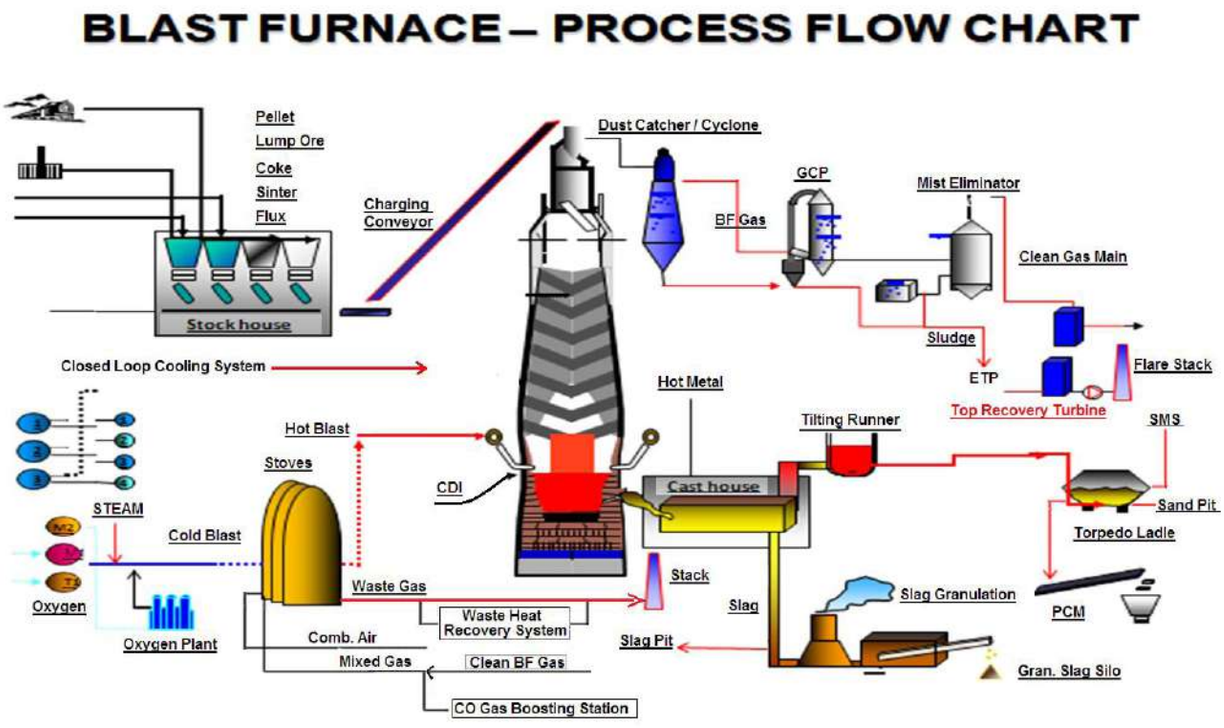
In the blast furnace process iron ore and sinter are transformed to hot metal with the help of reducing agents (coke and coal), and slag is formed from the gangue of the ore burden and the ash of coke and coal. Hot metal and liquid slag do not mix and remain separate from each other with the slag floating on top of the denser iron. The iron can then be separated from the slag in the cast house. The other product from the Blast Furnace is dust laden blast furnace gas, which is further cleaned in the gas cleaning plant and is used as a fuel all over the plant.

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 slag granulation plant in which slag is granulated attached with Cast House 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:

1.1. Furnace Proper:

Blast furnace is basically a counter current apparatus, composed of two truncated cones placed base to base.

The entire furnace is lined with suitable refractory and in addition to refractory lining, there are water coolers, designed to enhance the life of the furnaces. In a blast furnace, fuel, Iron ore, sinter and flux (limestone) are continuously supplied through the top of the furnace, either through 'double bell system' or 'bell less system'. In the hearth (bottom of the furnace),there is a tap hole of suitable dimension and length, for the purpose of tapping the hot metal.

Liquid iron collected in the hearth is taken out by opening the tap hole and filled in metal ladles. Slag that comes along with the metal is skimmed off with the help of skimmer plate towards slag runner and collected in slag ladles or to slag granulation plant of cast house (CHSGP).

1.2. Cast House:

The cast house is the most labor intensive area in the entire blast furnace operation. The function of cast house is to tap the liquid metal and slag via the tap hole from hearth on scheduled time and separate the metal and slag by skimmer block with siphon hole in trough which is made up of refractory mass (Castable) and direct metal to metal ladles and slag to the slag ladles or CHSGP.

1.3. Stoves and Hot Blast Supply System:

The function of Hot Blast stove is to preheat the air before admission into the furnace through tuyere. Air is preheated to temperatures between 1000 and 1200 °C in the hot blast stoves.

Stoves are also provided with Waste Heat Recovery System and Coke Oven gas enrichment facilities, if Coke Oven gas is available.

1.4. Raw Material storage / Stock House and Raw Material charging system:

High lines and Stock House Bins:

The main responsibility of high lines section is to receive the raw materials required for the production of hot metal from various sources, storing and transporting them to the top of the furnace in time, for the smooth running of the furnace.

1.5. Stock house:

The stock house consists of bunkers to store raw materials and the BF charge materials are screened and weighed. The BF size material is fed to a weighing hopper through discharge conveyor/ feeder. The weighing hopper discharges the material into the skip/ conveyor. There are conveyors to remove the return fines from the system.

1.6. Hoist house(BF Having Skip Charging Facility):

For taking charged materials to the furnace top, two-way skip hoist with two skips are provided or supplied by conveyor belt. The raw materials are proportionately weighed and conveyed to the top of the blast furnace via skip car or conveyors and are charged in the blast furnace. Belt conveyor system is provided for charging raw materials to the top of the furnace.

1.7. Gas Cleaning Plant (GCP):

The blast furnace gas generated in BF contains lot of dust in it and it is cleaned in dust catcher, venturi washer and scrubber and finally in electro static precipitator. The cleaned BF gas is sent to the gas network and is used as a fuel all over the plant.

Flow of BF gas to GCP is through Uptake, Down Comer, Dust Catcher, Venturi Washer, Scrubber, Electrostatic Precipitator, Cleaned BF Gas & Gas Main.

1.8. Slag Granulation Plant (SGP) / Slag Dumping Yard:

In this design the liquid slag from cast house runner is led to the granulating unit located very near to the cast house. Water jets are provided at the granulation unit to granulate and cool the liquid slag.

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

1.9. 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. Here, the hot metal ladles are tilted and hot metal poured into mould attached to belts and then water cooled. After cooling, the pigs (casted hot metal) are separated from the moulds.

1.10. Granshot:

The Granshot process converts excess liquid metal into granules by immediate solidification in water. The ready–to–use bulk material, is produced directly from liquid metal, producing little to no fume emissions or dust. In integrated steelmaking, the Granshot process is used to handle excess iron. The final granulated product is ideal for use in metals processing raw material handling systems.

1.11. Pulverized coal Injection/any other type of injections:

Non-coking coal is injected through tuyere using nitrogen as carrier. This reduces the coke rate and thus saves the valuable coking coal, which is also not abundantly available in India.

1.12. Cold Pig Yard:

Cold pigs from PCM come here. These are stacked according to their quality, and loaded in box wagons.

1.13. Clay Mass Shop:

Here, refractory mass required for blast furnace department is made and stored e.g. mud gun clay, tap hole frame mass and runner mass etc.

In many Blast Furnaces clay used is being supplied by external vendors expertise in Tap hole clay & BF refractory.

1.14. Slag Dump Yard:

The slag ladles from BF is sent to the dump post for emptying the ladles.

1.15. Sand Pit :

During commissioning or revival 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.

1.16. Slag Dry Pit:

In case of maintenance of slag granulation system, slag during tapping is diverted to slag dry pit for natural air cooling. When the pit is filled, the dried up slag due to natural air cooling is subjected to water cooling. The cooled slag is then removed from the pit and the pit is made ready for subsequent use.

1.17. Area Repair Shop:

Both Mechanical and Electrical Section have their repair shop where necessary supporting repair works are done. This is also called Fabrication yard in many places.

1.18. Torpedo Ladle Repair Shop:

Torpedo Ladle repair shops provided for relining, repairing and cleaning of the torpedo ladles.

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

SN.	Area	Major Equipment / facilities
1.	Blast Furnace & auxiliary sections	· Blast Furnace proper with top charging system including Bell Less Top · Stoves · Conveyor/skip charging system · Transfer Car · Vibro-feeders, Vibrating screens, Fines handling system, · De-dusting Units · Dust Catcher/Cyclone · Coal Dust Injection / Coal Tar Injection units · Drill machine, mud gun, jack dam drill machine, pusher cars · Ladle/ Torpedo · Top Recovery Turbine · Gas Cleaning Plant · Tilting/ Rocking Runner · Pig Casting Machine · Pump house and Cooling Towers · ETP · Filter press, Thickeners / Sludge pond, Flare Stack · CO gas boosting station · Dry Slag pit, Sand Pit · Ladle Repair Shop · Soft Water Plant, Softeners · Pressure Reducing and Measuring System (PRMS)

4. PROCESS BASED HAZARD & NECESSARY RISK CONTROL MEASURES:

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
	Furnace Proper	Gas leakage	· Ensure Proper Sealing of valves through routine maintenance and check sheet based Inspection · Injecting grouting materials through nozzles fixed on furnace shell · Ensuring cut off valve to remain in open condition · Regular de-dusting of cooling hoses so as to avoid puncture of cooling hoses and failure of coolers through which gases can leak · Installation of Online 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 need to go, minimum two people should go with "CO" monitors with proper safety precautions under intimation to control room. *(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)*

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
		Shell crack/ Corroded structure	· Dye penetration test and NDT of welded plates · Replacement of older shell before aging · Control of furnace shell temperature through control in thermal regime · Pressure testing of furnace after capital repair.
		Fine Dust deposition	· Installation of APCE,ESP/bag filter based cast house de-fuming system& regular cleaning · Use of runner covers to extract maximum dust fines to ESP, APCE Silo
		Sound from Leakages etc.	· Plug the leakage points and use Ear Plugs
		Slip, Trip and fall hazards. Material falling from height.	· Ensure proper barricading · Ensure step width and height as per standards · Ensure clean, dry and plain surface · Ensure proper housekeeping. · Secure materials or objects at height. (*Refer: SG-18: Safety Guideline for Personal Protective Equipment (PPEs) management).*
		Fire and explosion	· Ensure absence of inflammable material near fire source · Ensure control of uptake temperature · Ensuring availability of fire fighting equipment. · Human Exposure during manhole opening at the time of gas burning to be minimized using chain block and long iron rod from a safe distance (wherever auto igniter is not available). · Practicing controlled water spraying for burden cooling and meticulous checking of hydrogen content in the gas for avoiding explosion during shutdown. *(Refer SG-16: Safety Guideline for Fire Safety)*
		Working at height	· Work permit system to be followed for Non-routine jobs *(Ref: SG-04: Safety Guideline for Permit to Work (Operation & Maintenance))*
		Working inside Bins and hoppers of top charging area	· Work permit system to be followed with proper isolation of area as per Confined space standards (Ref: SG-03: Working in a confined space)
4.2	**Cast House**	Hot metal/slag over flow from runner	· Ensure optimum tap hole length to control flow of metal and slag · Ensure clean & scaffold free runners · Ensure proper dam height of metal and slag runners · Minimize lancing activity for opening the tap hole · Maintaining Runner depth · Provision of water spraying system

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
		Hot metal splinter during casting	· Ensure recommended clay quality · Ensure no water ingress inside the furnace · Ensure no water-metal contact in runners during tapping · Timely closing of Tap holes after blow. · Ensure use of shin guard while lancing to avoid burn injury by metal spatter. · 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. *(Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) management).*
		High radiant heat, molten metal, dross or slag, fumes, dust.	· Provision of covers on hot metal and slag runners. · Provision of heat shield in cast house control pulpit/pulpits. · Dust and fume collectors ESP /Bag filter system should be in working condition. *(Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) management)*
		Wet sand in runner	· Use of dry sand only. · In the rainy session ensure its dryness before using.
		Water ingress in runner	· Stopping the source of water leakage · Ensure drying of runners
		Gas leakage from surrounding area	· Identify the source of leak · Use of burners at hearth bottom to ensure burning of leaking gas if any · Stoppage of furnace if required · Provision of Online Gas monitor & Portable "CO" (carbon Monoxide) monitors. · Emergency Plan & mock drill. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
		Fire in Elect panel/cable nearby	· Ensure temperature control in panel rooms · Ensure proper ventilation in panel rooms · Ensure absence of inflammable materials inside the panel rooms · Ensure healthiness of Fire Detection and Alarm (FDA) System. · Ensure availability of portable fire extinguishers. *(Refer SG-16: Safety Guideline for Fire Safety)*

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
		Movement of Cranes and Mobile equipment	· Keep away from moving Cranes. · Effective audible and visual communication devices should be installed on a crane or hoist. · Established and effective signaling between operator and work supervisor to be followed. · Locking of crane hook as per SOP. · Tested slings with suitable capacity to be used. · Regular inspection of crane hook & ropes. *(Refer SG-14: Safety Guideline for work on Electric Overhead Travelling (EOT) Crane)*
		Failure/ Melting of tuyeres	· Monitoring of cooling system at tuyere platform. · Monitoring of delivery pumps installed in pump house. · Ensure diesel pumps/ DG set in working condition to take care of power outages. · Changing of life over tuyeres during shutdown.
4.3	**Hot Metal / Slag Handling including Ladle preparation & Ladle repair**	Accumulation of water near rail track / Ladles	· Regular inspection of tracks, Ladles to ensure no traces of water/moisture. · Ensure permanent drainage system to take care of sudden water ingress · Ensure elevation of track with respect to ground level · Ensure Storm drains to be clean and free from muck. *(Refer SG-23:Safety Guideline for Safe handling of Liquid Metal)*
		Wrong placement of ladles	· Proper Coordination between BF &Hot Metal Logistic (HML) Department · Ensure placement of ladles as per check list of fit and unfit ladles available at weighbridge · For placement of ladles during tapping, follow the call sign of cast house operators · Ensure placement of ladles prior to tapping after proper communication between furnace shift I/c and Weighbridge I/c
		Over flow of metal/slag	· Clear visibility to be maintained at filling station. · Ensure proper functioning of primary and emergency mechanism of tilting runner operation. · Detachment of loco during ladle filling. · Ensure proper functioning of Auto-couplers. · Inspection to ensure proper filling of ladles. · Provision of level sensors.
		High radiant heat, fumes, hot metal splashes	· Ensure runners are covered · Ensure availability of Firefighting and fire prevention system at site. *(Refer SG-18:Safety Guideline for Personal Protective Equipment (PPE) management)*

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
4.4	**Stoves**	Gas leakage	· Ensure the healthiness of 'ISO GAS" logic. · Leakages from valves and flanges to be eliminated immediately after isolation of the system by means of changing flange packing or the valve with a new one. · Provision of Online Gas monitor & Portable "CO" monitors to detect gas leakage. · Prohibition of people working on stove platform area when stove status is changed from isolation mode to heating mode. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
		Working at height	· Work permit system to be followed for Non-routine jobs. (*Ref: SG-04: Safety Guideline for Permit to Work (Operation & Maintenance))*
		Working inside stoves	· Work permit system to be followed with proper isolation of area as per Confined space standards *(Ref: SG-03: Working in a confined space)*
		Sound from Leakages etc.	· Arrest the leakage points.
		Hot spot development	· Regular inspection of shell temperature and provision of water spray cooling.
		Fire & Explosion	· Ensure no ingress of water inside the stove. · Ensure no ingress of hot air in gas circuit.
4.5	**High lines /Stock House**	Spillage accumulation	· Ensure working of Belt-sway Switch (BSS) and Pull Cord Switch (PCS) · Ensure feed control of raw material through feeders by optimum gate opening to avoid overloading · Ensure working of Chute Block Switch(CBS) · Regular cleaning to be ensured (*Ref: SG-19: Safety Guideline On Operation and Maintenance of conveyor belts)*
		Structure Stability	*(Refer SG-29: Asset management)*
		Cleaning running conveyors may lead to entanglement	(Refer SG-19: Safety Guideline On Operation and Maintenance of conveyor belts).
		Fall into raw material Bins	· Railings are to be provided around the bins wherever possible. · Iron Grill covers over bins to prevent fall.

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
		Working inside Bins	· Work permit system to be followed with proper isolation of area as per Confined space standards (Ref: SG-03: Working in a confined space)
		Materials falling, Releases of dust	· Open-mesh walkways to prevent objects from falling through and causing injury to people below. · Ensure working of dust and fume collectors ESP /Bag filter system.
4.6	**Gas Cleaning Plant (GCP)**	Gas leakage	· Identify the source and immediately stop the furnace if required for rectification.* · Periodically NDT of raw gas pipe and scrubber inlet pipe. · Periodically NDT of axial cyclone shell. · Ensure required water level of AGE- scrubber · Ensure proper working of furnace bleeders in auto mode(Electrical and Mechanical) · Provision of Online Gas monitor and maintain its regular calibration & mandatory use of Portable "CO" (Carbon Monoxide) monitors to detect gas leakage. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
		Hot flue dust dumping	· Dust catcher level measurement should be in working condition. · Operation of dust valve should be done remotely. · Valve operation failure with end limit switch indication should be available in the control room.
		Water seal breakage due to pressure fluctuation and damaged water seal	· Ensure working of furnace bleeders in AUTO mode(Electrical and Mechanical) · Regular inspection to be done & Process parameters to be monitored continuously to avoid any deviations. · Water seal breaking signal monitoring at centralized location. · Online CO detection near water seal to monitor leakages. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
4.7	**Slag Granulation Plant (SGP)**	Spillage accumulation	· Ensure working of Belt-sway Switch (BSS) and Pull Cord Switch (PCS). · Ensure feed control of raw material through feeders by optimum gate opening to avoid overloading. · Ensure working of Chute Block Switch (CBS). · Regular cleaning of settling tanks of cooling towers. · Regular inspection and cleaning of conveyor galleries.

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
		Water accumulation in slag pit	· Water draining system to be maintained. · Regular inspection to be done.
		Conveyor belt hazards	*Refer SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts*
		Presence of hot metal in slag	· Ensure proper dam height of metal and slag runners · Proper segregation of hot metal & slag at cast house in main iron trough to be maintained.
		Working inside Granulation tanks and Bins	· Work permit system to be followed with proper isolation of area as per Confined space standards *(Ref: SG-03: Working in a confined space)*
		Overflow of Hot water from drains	· Regular cleaning of Drains.
4.8	**Pig Casting Machine (PCM)/ Gran Shot**	Overflow of hot metal from runner & machine	· Ensure pouring of hot metal through by controlling the tilting mechanism
		Handling hot liquid, dust, heat.	· Ensure effectiveness audio-visual communication devices. · Hand railing near PCM pouring end.
		Spillage of hot pigs	· Ensure working of CAPSTAN for proper placement of NPC wagon. · Ensure stand by loco in case of CAPSTAN failure.
4.9	**Pulverised Coal Injection (PCI)**	Fire & explosion	· Ensure cleanliness of shop floor · No coal dust accumulation to be allowed in any platforms · Ensure the healthiness of the most critical equipment i.e. CO & O2 analyser · CDI system works on the principle of negative suction in ducts. Ensure sealing of ducts so that there is no ingress of atmospheric air
		Inhalable agents (gases, vapours, dusts and fumes); gases containing concentrations of carbon monoxide, moving machinery, conveyors	· Work-related training programmes to cover all workers including contractors. · CO gas (Carbon Monoxide) detector, training 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. *(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.)*

S. No.	Area/ Section / Equipment	Hazards	Risk Control Measures
4.10	**Sand Pit**	Person falling into hot metal pit	· Provision of suitable hand rails all around the pit. · Unauthorized entry in the area should be prohibited.
		Explosion Flying splinters	· Ensuring drying of pit after preparation before pouring of hot metal. · Siren alert for pouring of Hot metal to alert people. · Ensure no one should be in line of fire (safe distance). · Barricading the road.
4.11	**CO gas boosting Station**	Exposure to gas leakage	· Ensure healthiness of carbon seals of the pumps · Provision of online gas monitor and portable gas monitors to detect gas leakage. · Provision of proper ventilation. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
4.12	**Repair work in Gas lines, GCP, TRT & Flare Stack**	Explosion	· Preparation of proper 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.
4.13	**Slag Dry Pit**	Explosion/ Blasting	· Ensure dryness of sag dry pit before the slag dry pit is put in use. · Ensure sufficient air cooling of slag tapped in dry pit so as to form a skin layer before water cooling.
		Spillage of liquid slag	· Ensure proper dam height at bottom edge of slag dry pit so hat liquid slag does not break the dam and spill out
4.14	**Gran Shot**	Explosion due to overfilling of Tundish in case water is present.	· Availability of Load cell at Tundish followed by operator action to stop pouring from Torpedo. · Availability of Emergency launder which will divert metal to emergency pit in case if tundish gets overfilled.

Note:

- The operating procedure as given in the write-up may vary from shop to shop due to different equipment disposition and type. Safety hazards and its precautions under each head may be separately identified.
- Other existing standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be shown covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- 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.

- All applicable statutory requirements are to be followed as per respective state factory rules.
- Housekeeping of all working areas should be maintained.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection/management of the hazards.

- Portable & fixed CO monitors
- Dye penetration & NDT of structures, gas lines, shell, etc.
- Pressure testing of furnace after capital repair, other vessels as per Factory rules
- Defuming / ESP/ Bag filter system
- Safety devices in conveyor system (PCS, BSS, ZSS ,Interlocks etc.), Hooter before starting, guards over rotating components
- Smoke & Fire detection/alarm system in all Electrical installation facilities.
- Crane- limit switches, emergency brakes, hook latches, hooters, Safe Load indicator, corner switches, annual load test etc.
- ELCB/ RCCB in welding machines.
- CCTV Surveillance
- Testing of Earth pit (Annual)
- Fire Hydrant system
- LOTOTO system

PPE Matrix

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body Harness	Shin Guard	Breathing Apparatus
FURN.	YES	YES	YES	YES	YES	YES	YES	YES	YES	-	-
CH	YES	YES	YES	YES	YES	YES	YES	YES	-	YES	-
HMSH	YES	YES	-	YES	-	-	-	-	-	-	-
STV	YES	YES	-	YES	-	YES	-	-	YES	-	-
HL/SH	YES	YES	-	YES	YES	YES	YES	-	YES	-	-
GCP	YES	YES	-	YES	YES	-	YES	-	YES	-	YES
SGP	YES	YES	YES	YES	YES	-	-	-	YES	-	-
SDP	YES	YES	YES	YES	YES	-	-	-	-	-	-
PCM/GS	YES	YES	YES	YES	YES	-	-	-	-	-	-
PCI	YES	YES	YES	YES	YES	YES	YES	-	-	-	-
SP	YES	YES	-	YES	-	-	-	-	-	-	-
COGB	YES	YES	-	YES	-	-	YES	-	-	-	-
RW/GL	YES	YES	-	YES	-	-	-	-	-	-	-

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like gas monitors, aluminized suits etc.) may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviation:

FURN.	Furnace Proper	**SDP**	Slag Dry Pit
CH	Cast House	**PCM**	Pig Casting Machine
HMSH	Hot Metal and Slag Handling	**PCI**	Pulverized Coal Injection
STV	Stoves	**SP**	Sand Pit
HL/SH	High Line and Stock House	**COGB**	Coke Oven Gas Booster
GCP	Gas Cleaning Plant	**RW/GL**	Repair work in Gas lines, GCP, TRT & Flare Stack
SGP	Slag Granulation Plant	**GS**	Gran Shot

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	SINTER PLANT	Doc. No: **SG/31**
		Rev no.: **00** Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identification of hazards associated with Sinter making process and implementation of risk control measures.

2. SCOPE:

This guideline applies to the Sinter manufacturing process plant as well as the Sinter Plant Department of an Integrated Steel Plant, considering the process from Proportionating Bins to Sinter Coolers to Screen Building to Sinter Storage Bins. In some plants, the base mix preparation at the Raw Material Handling Plant is also part of the Sintering Plant.

3. PROCESS BRIEF:

Sintering is an agglomeration process of fine mineral particles into a porous mass by incipient fusion caused by heat produced by combustion within the mass itself. Iron ore fines, coke breeze, limestone, and dolomite along with recycled metallurgical wastes are converted into agglomerated mass at the Sinter Plant, which forms 70–80% of the iron-bearing charge in the Blast Furnace.

The sintering process is developed mainly to utilize under size of lump ore called iron ore fines; which otherwise, could not be charged directly in the Blast Furnace. During the Sintering process, Iron ore fines, otherwise waste material, are compacted together and made into lumps.

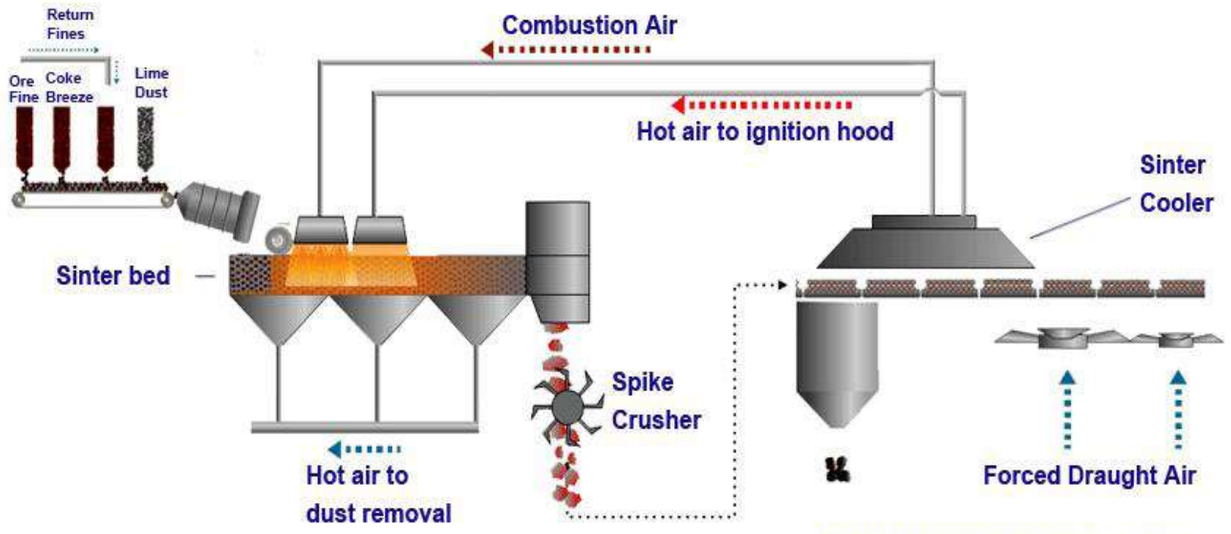
As per the given burden, raw materials are collected on a common conveyor from the respective bunkers through weigh feeders and then mixed homogeneously in mixing drums (primary & secondary mixing drums) or High intensive mixer & granulator by adding required water (7 to 8 %) and then feed on sinter machine. Generally, raw mix bed height is 550 mm but for large-size sinter machines, the total bed height on the sinter strand shall be 700 mm including a hearth layer of 40–50 mm (approx.) and is adjusted based on the quality of the raw material. The bed in running (motion) condition is taken to the ignition front. The raw mix undergoes through the ignition furnace and there is a negative suction from the bottom. The coke at the top of the blend is ignited by gas burners that can be fueled by coke oven gas, Blast Furnace gas, or natural gas. As the sinter bed moves, hot products of combustion are sucked through the bed and transfer its heat to the next layer of the bed keeping it ready for the combustion. The generated flue gases are let out from the chimney through ESP, The temperatures in the bed maybe 1000 – 1250 °C.

After completion of the sintering process, the sinter cake is crushed and screened after discharge from the machine. After cooling in the sinter cooler, the sinter will be fed to the belt conveyor for further transportation to the sinter screening unit either through the sinter crushing unit or directly to the screen. Sinter with size (<150 – 200 mm) is fed to the sinter cooler from the sinter strand. Sinter having size <5 mm goes to proportioning section as

process return. An emergency water spray system is provided at the conveyor below the sinter cooler for emergency cooling. In the sinter screening unit, the sinter is screened to different required size fractions. Sinter of size <5mm will be recycled in the sintering process and Sinter of size >5mm goes to BF.

This entire process of sinter making is associated with various safety hazards like hit/entanglement with mobile equipment, burns, fire, slip & fall, exposure to dust, smoke, noise, heat & gas etc.

SINTER MAKING PROCESS



Source: Adapted from nettecnologies.co.in

Some of the critical Equipment/ facilities in the Sinter Plant are asunder:

SN.	Major Equipment
1.	· Conveyors · Hammer Crushers · Four Roll Coke Crushers · Rod Mills · Charging bins for Iron Ore Fines/ Coke Breeze/ Lime Dust/ Return Fines · Mixing Drums · Sinter Machine · Sinter Breaker/ crusher · Screens (Hot & Cold) · ESPs (Electrostatic Precipitator) · Exhausters · Storage Bunkers · High intensive mixer & granulator/ noduliser · Weigh feeders, air blasters · Cranes, hoists · Bag filters, drum roll feeder · Crash deck, grizzly bars · Cooling air fans, combustion & hot air fans, and pneumatic conveying system · Lift, Electrical Control Room, Pump House, Hydraulic system etc.

4. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

SN.	Equipment / Area/ Section/ Activity	Hazards	Risk Control Measures
4.1	Conveyors	· Engulfment / entanglement with Rotating parts of the conveyor system, like conveyor belts, head pulley, Fire, tail pulley, snub pulley, coupling guards, counterweight, etc.	· Guarding all rotating parts of the conveyor system. · Pull chords in conveyors. · Emergency switch. · Auto hooter blowing whenever conveyor starting command is given. · Fire-fighting equipment (water, chemical powders). · Shutdown/permit (PTW) must be ensured to work with any energy isolation. · The chute opening shall be covered with grills. *(Refer: SG-09: Safety Guideline for Equipment and Machine Guarding, SG-04: Safety Guideline for Permit to Work (Operation &Maintenance), SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG-05: Safety Guideline for illumination at work place)*
4.2	Charging Bins/ Hoppers	· Health hazards due to fine dust generation. · Electrical Drives. · Noise. · Confined space hazard. · Fall from height.	· Effective functioning of Dust Extraction (DE) System. · Guarding all rotating parts of the conveyor system. · Pull chords in conveyors. · Emergency switch. · Display of Noise level at the site. · Adherence to electrical safety precautions. · Protective cover/ grill at storage bin top. · Dislocation stopper at bin top. · Entry monitoring for confined space, rescue plan, atmosphere oxygen measurement, 24V Hand lamp, rope ladder as per the need. · Full body harness with an anchoring arrangement. · Shutdown/permit (PTW) must be ensured to work with any energy isolation. *(Refer SG-18: Safety Guideline for Personal Protective Equipment (PPE) Management, SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG-15: Safety Guideline for Electrical Safety, SG-03: Safety Guideline for Working in confined space, SG-02 Safety Guidelines for Work at Height.)*
4.3	Mixing Drums	· Rotating Machineries which may lead to entanglement/entrapment hazard	· Guarding all rotating parts. · Door interlocking with the proxy sensor. When the door opens mixer will trip & Mixer Drum to be locked after the position.

SN.	Equipment / Area/ Section/ Activity	Hazards	Risk Control Measures
		· Burden Spillage, which may cause unsafe conditions/ working areas · Noise · Slip, trip and fall due to hydraulic oil leakage · Work inside a confined space	· Scraper adjustment, belt sway switch. Gratings may be considered around the source of spillage. · Electro-mechanical interlocks may be considered. · Entry monitoring inside a confined space, rescue plan, atmosphere oxygen measurement, 24V hand lamp. · A system of periodic inspection of hydraulic systems is to be developed. *(Refer SG-09: Safety Guideline for Equipment and Machine Guarding, SG-03: Safety Guideline for Working in confined space) SG-10 Safety Guidelines for Hydraulic System Safety)*
4.4	Sinter Machine & ignition furnace	· Moving Sinter Bed may lead to entanglement. · CO Gas Leakages. · Rotating Machinery. · Handling Hot Burden. · Spill over of hot burden. · Hot burden splinter during sintering. · Fire in Electrical panel/cable nearby. · Electrical Drives. · Hot Flue Dust. · Contact with a hot surface. · Fine Dust deposition. · Structural Corrosion. · Heat &Burn. · Pallet changing, the entanglement of fingers, hit or fall of heavy machine parts while handling by crane. · Chances of entanglement while putting slings on the pallet.	· Barricading/railings along the sinter machine. · Emergency push button along the Sinter Machine. · Online gas detector on both sides of ignition furnace, portable gas detector. · Checking of feedback of CO monitor reading to control room. · Guarding of all rotating parts. · Use of Fire-retardant jacket in hot zones. · Smoke detectors in electrical rooms. · Periodical inspection to be developed by user. · Display of Hot Area at site. · Adherence to electrical safety precautions. · Care must be taken to lift the pallets carefully with the use of hand gloves. · Ensure dedusting suction from the sinter machine discharge hood to avoid localized heat. · Application of heat insulation at required places. · A preventive Maintenance schedule shall be in place and strictly followed. · Ensure authorized persons are present during the ignition of the furnace. · Auto hooter blowing whenever starting the furnace. · Provision of eyewash point. · Availability of self-contained breathing apparatus. *(Refer SG-11: Safety Guideline for Barricading, SG-16: Safety Guideline for Fire Safety, SG-15: Safety Guideline for Electrical Safety, SG-21: Safety Guideline for Handling Fuel Gas).*

SN.	Equipment / Area/ Section/ Activity	Hazards	Risk Control Measures
4.5	Blanking and De-blanking of Ignition Furnace	· Fire and Explosion Hazards. · Toxic Gas Exposure.	· The protocol shall be followed for blanking and de-blanking involving the Energy Management and Safety experts. · Use of non-sparking tools while working on gas lines. · Shutdown procedures for gas lines shall be ensured, and regular monitoring of gas lines. *[Ref: SG-21: Safety Guideline for Handling Fuel Gas, Refer SG-04: Safety Guideline for Permit to Work (Operation & Maintenance)]*
4.6	Furnace Light Up & Operation	· Gas leakages. · Fire & Explosion hazards. · Heat & burn.	· Online gas detectors & portable gas detectors. · Periodical inspection of Seal pots. · Always purge the gas lines, preferably with nitrogen. · There shall not be any naked power cabling near gas lines. · Ensure only authorized persons are present during the ignition of the furnace. · Protocol shall be followed for furnace light up. · A display board with emergency contact numbers shall be kept at the site.
4.7	Gas main duct, inspection, and cleaning during maintenance	· Confined space hazards. · Trip & fall hazards.	· Atmospheric oxygen level measurement. · Entry monitoring inside the confined space & rescue plan. · Provision of proper illumination & usage of 24 V hand lamp. · Full body harness with an anchoring arrangement. · Trained & skilled persons shall be allowed to perform the job. · Rescue arrangement shall be made while cleaning the duct in shutdown. *(Refer: SG-03 Safety Guidelines for Working in Confined Space)*
4.8	Sinter Breaker/ Crusher	· Handling Hot Sinter. · Electrical Drives. · Fine Hot Dust. · Noise. · Fire due to hot material discharge.	· Fire retardant jacket hand gloves, eye goggles in hot zones. · Adherence to electrical safety precautions. · Permit to Work, LOTO. · Provision of water tap along with hose pipe. *(Refer SG-09: Safety Guideline for Equipment and Machine Guarding, SG-15: Safety Guideline for Electrical Safety)*
4.9	Screen (Hot & Cold)	· Handling Hot Sinter. · Hot Dust. · Noise. · Fall from height.	· Guarding all rotating parts. · Access Control. · DE System. · Display of Noise level at the site.

SN.	Equipment / Area/ Section/ Activity	Hazards	Risk Control Measures
		· Work inside a confined space.	· Fire retardant jacket/fire suit, in hot zone. · Full body harness with an anchoring arrangement. · Entry monitoring inside confined space, rescue plan, atmosphere oxygen measurement, · 24V hand lamp. *(Refer: SG-09: Safety Guideline for Equipment and Machine Guarding) SG-02 Safety Guidelines for Working at Height, & SG-03 Safety Guidelines for Working in Confined Space.)*
4.10	Sinter cooler	· Rotating/ moving equipment. · Partial handling of hot sinter. · Dust. · Noise. · Occasional red hot sinter discharge from the cooler. · Work at height. · Work inside a confined space.	· DE system. · Guarding of rotating parts and railing along circular bed both inside and outside site. · Emergency switches near drives. · Display of noise level. · Ensure water spray on belt conveyor (below cooler) based on sinter discharge temperature. · Full body harness with anchoring arrangement. · Entry monitoring, rescue plan, atmosphere oxygen measurement,24V Hand lamp. · Ensure emergency stop is in healthy condition. · Use of eye goggles. · Provision of proper lighting/ illumination. *(Refer SG-09: Safety Guideline for equipment and machine guarding, SG-11: Safety Guideline for barricading, SG-15: Safety Guideline for electrical safety, SG-16: Safety Guideline for fire safety)*
4.11	ESP	· Hot Flue Gas. · Fine Hot Dust. · Electrical Transformers. · High Electrical Voltages. · Work at height. · Work inside a confined space.	· Access control. · Use of dust mask. · Application of heat insulation at required places. · Proper earthing system. · Full body harness with an anchoring arrangement. · Entry monitoring, rescue plan, atmosphere oxygen measurement, 24V Hand lamp. · Shutdown procedure and Energy isolation procedure. *(Refer: SG-15: Safety Guideline for Electrical Safety, SG-03: Safety Guideline for Working in confined space, SG-04 : Permit to Work (Operation and Maintenance), SG- 22: Energy Isolation)*

SN.	Equipment / Area/ Section/ Activity	Hazards	Risk Control Measures
4.12	Exhauster/ Waste gas fan	· Rotating Machinery · Electrical Drives · Noise · Working at height · Work inside a confined space · Oil tank, surrounding Oil and water spillages · High vibrations	· Guarding all rotating parts. · Access control. · Adherence to electrical safety precautions. · Use of Ear Plug. · Display of Noise level at the site. · Full body harness with an anchoring arrangement. · Entry monitoring in confined space, rescue plan, atmosphere oxygen measurement, 24V hand lamp. · Oil tank room heat exhausters, in case of closed rooms need ventilation. · Vibration monitoring. *(Refer: SG-09: Safety Guideline for Equipment and Machine Guarding, SG-15: Safety Guideline for Electrical safety)*
4.13	Raw Material receiving bins top trolley, Trolley over Surge bin, Trolley over Sinter Storage bin top	· Moving Shuttle, which may cause hit injury. · Confined Space related hazards. · Conveyor-related hazards.	· Auto hooter blowing whenever shuttle shifting command is given. · Guards / Barricading. · Adequate size gratings on top of hopper openings. · End stoppers and limit switches for shuttle conveyor. *(Refer: SG-11: Safety Guideline for Barricading, SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG -03: Safety Guidelines for Confined Space entry)*
4.14	Lime conveying or lime dosing system	· High-Pressure Lime dust. · Tanker movement. · Fine dust deposition.	· Separate glass cabin for tanker staff. · Access control. · Dedusting system. · Provision of eye wash point.
4.15	Secondary material feeding & Housekeeping	· Heavy vehicle movements like pay loader, dumper, and poclain may cause hit injury · Diesel storage which may cause Fire · Dust	· Reverse horn. · Ventilated storage as per norms. · Traffic Safety Measures. (*Refer SG-24: Transportation in Steel Industry)*
4.16	Base mix yard equipment (stackers, reclaimers, conveyors)	· Over travel of luffing, LT and CT. · Dust.	· End limit switches for travel movement restriction. · Provision of the emergency stop button. · Pull chords. · Clean approaching road. · Proper earthing. *(Refer: SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts)*

Note:

- The operating procedure as given in the write-up may vary from shop to shop due to different equipment dispositions and types. Safety precautions under each head may be separately identified.
- Other/respective standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be shown covering the entire shop.
- The above safety guidelines have been prepared to keep in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes/equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- Housekeeping of all working areas should be maintained.
- All maintenance activities should be followed as per the standard Preventive Maintenance plan.
- All applicable statutory requirements are to be followed as per respective state factory rules.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments / equipment required for detection / management of the hazards.

- Safety Device in conveyor system (PCS, BSS, ZSS, interlocks, etc.),Hooter before starting, guards over rotating components.
- Crane Limit Switches, Emergency brakes, hooks latches, hooter, annual load test etc.
- Door interlocking with proxy sensor in mixing drums
- Auto hooter blowing whenever starting the furnace
- ELCB / RCCB & VRD in welding machine.
- Fixed and portable CO (Carbon Monoxide) gas detectors at strategic locations to detect gas leakages
- Inergen System to Control Fire in Control room, PLC room, Server room.
- Fire Detection & Alarm System in various area of the Sinter Plant.
- Electrical safety systems including proper grounding, insulation, and protection of electrical equipment and transformers.
- Ventilation systems to control dust, fumes and maintain air quality in working areas.
- Safety valves and rupture discs on pressure vessels and equipment.
- Anti collision system in Cranes over Sinter machine.
- Weighing system working under capacity without any bypass.
- Public Address system for announcement.
- Sensors and interlocks to monitor and control process parameters like Temperature, Pressure, Level & Flow etc. within safe limits

PPE Matrix

PPE / AREA	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body Harness	Arc Flash Suit
SINTER PLANT AREA	YES	YES	-	-	-	YES	YES	-	-	-
SINTER MACHINE	YES	YES	YES	YES	YES		YES	-	-	-
SINTER MIXERS	YES	YES	YES	YES		YES	-	-	-	-
RAW MATERIAL STORAGE BINS	YES	YES	YES	YES	YES	-	YES	-	-	-
BELT CONVEYORS	YES	YES	-	YES	YES	YES	YES	-	-	-
IGNITION HOOD	YES	YES	YES	YES	YES	YES	YES	-	-	-
SINTER COOLER	YES	YES	-	YES	-	YES	YES	YES	YES	-
ESP	YES	YES	YES	YES	YES	-	YES	YES	YES	-
DUST COLLECTOR	YES	YES	YES	YES	YES	-	YES	YES	YES	-
FANS	YES	YES	-	YES	YES	-	YES	YES	YES	-
PUMP HOUSE	YES	YES	-	YES	YES	YES	YES	-	-	-
ECR ROOM	YES	YES	YES	-	YES	YES	-	-	-	YES
CABLE GALLERY	YES	YES	-	YES	YES	-	-	-	-	-

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like gas monitors etc.) may vary based on the specific Sinter Plant's hazards, safety procedures and policies etc., Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviations:

SOP	Standard Operating Procedure	**PPE**	Personal Protective Equipment
SMP	Standard Maintenance Procedure	**CO**	Carbon Monoxide
BF	Blast Furnace	**LT**	Long Travel Motion
PTW	Permit to work	**CT**	Cross Travel Motion
DE	Dust extraction	**ESP**	Electrostatic Precipitator
LOTO	Lock -out , Tag –out		

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	DIRECT REDUCTION PLANT (COAL BASED)	Doc. No: SG/32
		Rev no. : 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent workplace injuries & incidents including damage to plant and machinery through identification of hazards associated with Coal based Direct Reduction Process Plant and implementation of risk control measures.

2. SCOPE:

This guideline of safety is applicable to all coal based Direct Reduction Plants. The scope of this covers Raw material handling system, kiln charging & cooler area up-to DRI storage.

3. PROCESS BRIEF

Direct Reduced Iron and its Production Processes

Direct reduced iron (DRI) is the product which is produced by the direct reduction of iron ore or other iron bearing materials in the solid state by using non-coking coal or natural gas. Processes which produce DRI by reduction of iron ore below the melting point of the iron are normally known as the direct reduction (DR) processes. The reducing agents are carbon monoxide (CO) and hydrogen (H2), coming from reformed natural gas, syngas or coal. Iron ore is used mostly in pellet and/or lumpy form. Oxygen (O2) is removed from the iron ore by chemical reactions based on H2 and CO for the production of highly metalized DRI.

In the direct reduction process, the solid metallic iron (Fe) is obtained directly from solid iron ore without subjecting the ore or the metal to fusion. Direct reduction can be defined as reduction in the solid state at O2 potentials which allow reduction of iron oxides, but not of other oxides (MnO, and SiO2 etc.), to the corresponding elements. Since reduction is in the solid state, there is very little chance of these elements dissolving (at low thermodynamic activity) in the reduced iron, so the oxides which are more stable than iron remain essentially unreduced.

DRI has a porous structure. This is because DRI is produced by removing O2 from iron ore. It is also known as sponge iron since its structure is just like sponge with a network of connecting pores. These pores results in a large internal surface area which is around 10,000 times greater than the internal surface area of solid iron.

Iron content in the DRI is in two forms. One is in metallic form which is known as metallic iron, Fe (M), and the second form of iron which is present in residual iron oxides, Fe (O). The total iron, Fe (T), in DRI is the sum of these two iron components. Metallic iron is the aggregate quantity of iron, either free or combined with carbon (as cementite) present in DRI. Metallization of DRI is a measure of the conversion of iron oxides into metallic iron (either free or in combination with carbon as cementite) by removal of O2 due to the action of the reductant used. Degree of metallization of DRI is the extent of conversion of iron oxide into metallic iron during reduction. It is defined in percentage of the mass of metallic iron divided by the mass of total iron.

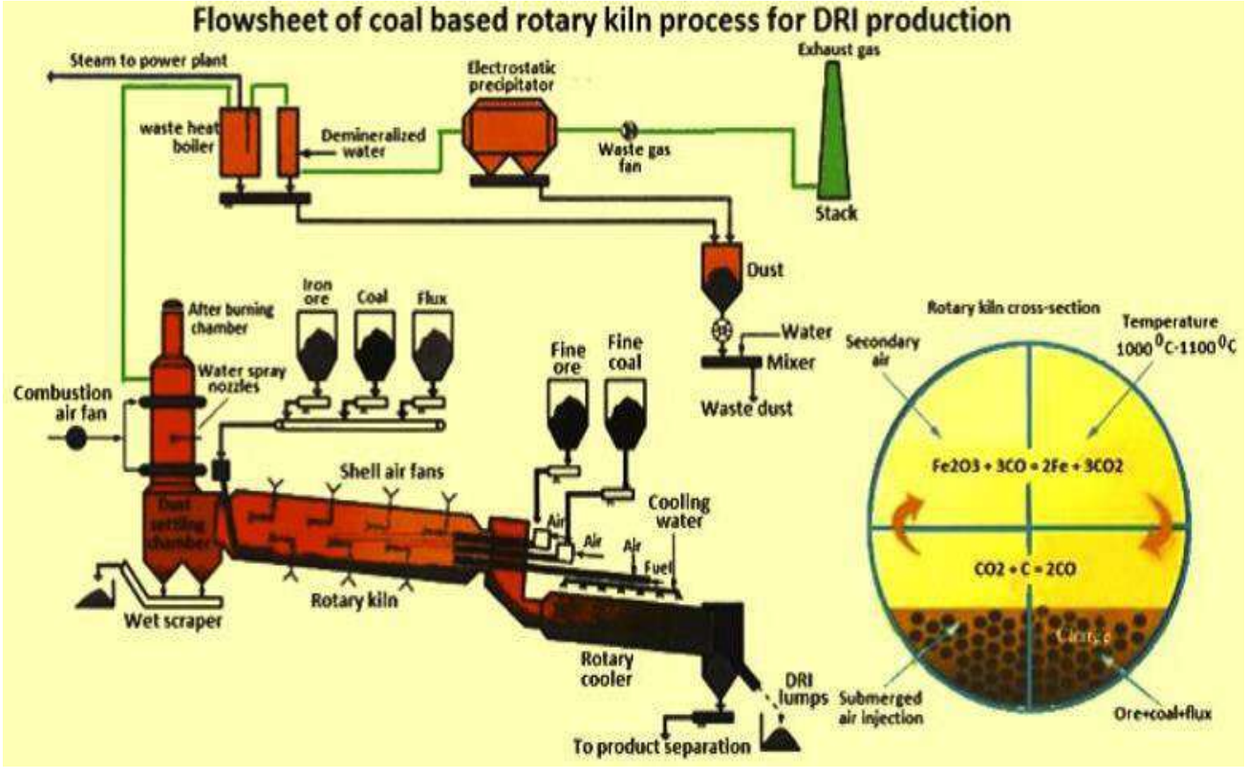
Coal Based Process:

In a coal based process, the reactor for the reduction reaction is a rotary kiln which is slightly inclined to the horizontal position. The process of direct reduction is carried out with the operating temperatures maintained in a range from 1,000 deg C to 1,100 deg C. In the rotary kiln, both coal and the iron ore feed material is charged from the same end of the kiln.

During the movement of feed material forward the oxidation reaction of carbon in coal and reduction reaction of CO gas is carefully balanced. A temperature profile ranging from 800 deg C to 1050 deg C is maintained along the length of the kiln at different zones and as the material flows down due to gravity the ore is reduced. The basic reduction reactions in the process are (i) C + O2 = CO2, (ii) CO2 + C = 2CO, (iii) 3Fe2O3 + CO = 2Fe3O4 + CO2, (iv) Fe3O4 + CO = 3FeO + CO2, and (v) FeO + CO = Fe + CO2.

The product of the kiln (DRI and char mix) is then cooled in a rotary cooler with external water cooling system to a temperature of 100 deg C to 200 deg C. The product after it is discharged from the kiln is screened and magnetically separated. DRI being magnetic gets attracted and gets separated from non- magnetic char. The separated DRI is screened into two size fractions of +3 mm and -3 mm. -3 mm fractions is sometimes briquetted by using hydrated lime and molasses as binders.

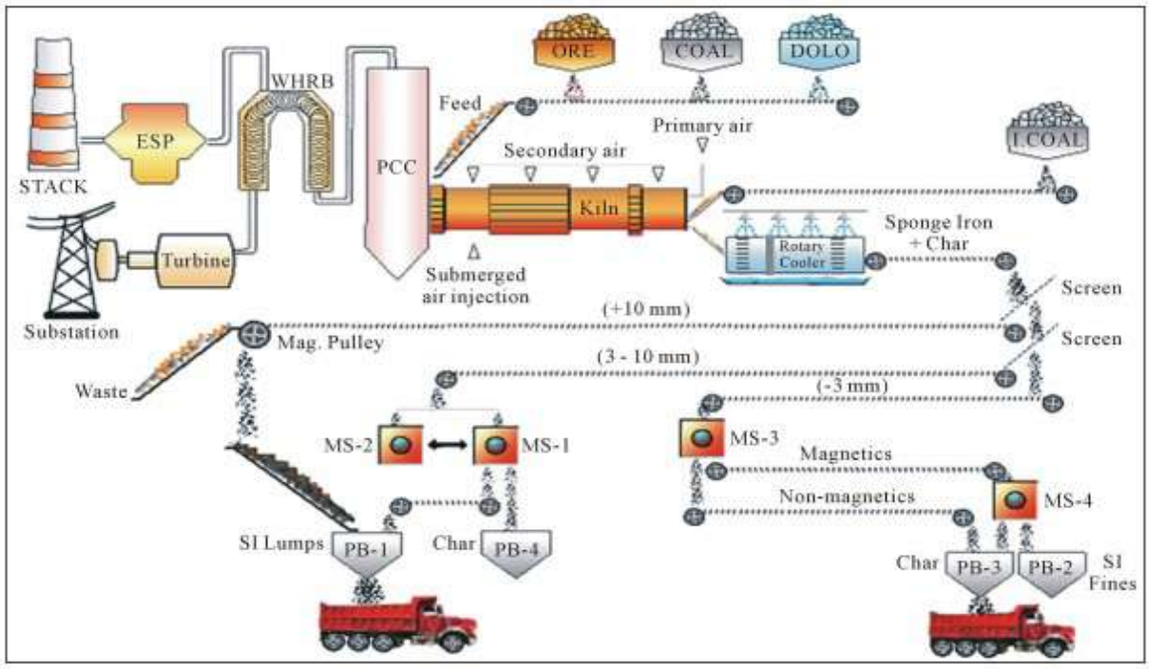
Flowsheet of coal based rotary kiln process for DRI production:



MAJOR AND CRITICAL EQUIPMENT FOR MANUFACTURING OF SPONGE IRON IN THE DIRECT REDUCTION PLANT

Sl. No.	Area	Major equipment's
1.	Raw material Handling	• RMHS- Belt Conveyers • Crusher • Screen • Stacker Reclaimer • Heavy truck/Hyva
2.	Kiln charging	• Weigh feeder • Conveyor belt • Storage Bin • Screen • Vibrating feeder
3.	Kiln & Cooler Area	• Support Roller / Tyre • Thruster • Girth gear and pinion • Electrical motor and Gear box • Magnetic separator • ABC • Dust settling chamber • WHRB • ESP • ID fan • De-dusting system

Process Flow Diagram of Sponge Iron Plant/ Direct Reduction Iron Plant is given below:



4.0 PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES

SN.	Equipment	Hazards	Risk Control Measures
4.1	Belt Conveyors	· Rotating parts of conveyor system, like head pulley, tail pulley, snub pulley, coupling guards etc. · Moving conveyor belt	· Guarding of all rotating parts i.e. tail drum, head drum, underneath of the idler and entire conveyor including take-up pulley and snap pulley of the conveyor system shall be ensured. · Pull chord, emergency switches, zero speed switches (ZSS) and interlocking system in conveyor to be provided to ensure the personal safety as well as the equipment safety. · Positive isolation (LOTOTO – Lock out- Tag out- Try out), permit to work system and Job Safety Analysis (JSA) wherever required to be ensured during working the conveyor. · All conveyor gallery walkways shall be provided with standard guard rail and toe boards for safe access and aggress also in connecting staircases. *(Refer: SG-09: Safety Guideline for Equipment and Machine Guarding, SG-19: Safety guideline on Operation and Maintenance of Conveyor Belts)*
4.2	Silos / Charging Bins / Hoppers	· Fine Dust deposition · Electrical Drives · Noise · Work in confined spaces · Falling of material · Falling out from working platform · Exposure to dust · Use of hand held work equipment during cleaning	· Mechanized dust cleaning system (Industrial vacuum cleaning system) should be provided. · Radar based level indicator in Silo should be installed to easy measurement of bin level to avoid the silo/ hopper collapse due to over load also load cell provided for weight measurement. · Hazardous Gas i.e. toxic – Carbon monoxide, Oxygen level and flammable/ Explosive limit (LEL) detection before and during working inside. Blower should be used for artificial air supply to maintain the oxygen level end evacuate the other harmful gases. · Peripheral area of Silo opening to Guarded and display of warning signage. · Positive isolation (LOTOTO) must be done for working. · Dust Extraction (DE) System shall be installed to extract the fugitive dust from system. · Ensure the guarding of all rotating parts of the conveyor system. · Ensure the health condition of the Pull chord in conveyors. · Ensure Emergency switches availability and its healthy conditions. *(Refer: SG-18: Safety guideline for Personal Protective Equipment (PPE) management, SG-19: Safety guideline on Operation and Maintenance of Conveyor Belts, SG-15: Safety Guideline for Electrical safety, SG-03: Safety guideline for working in confined space)*

SN.	Equipment	Hazards	Risk Control Measures
4.3	Kiln & Cooler	· Rotating Machineries · Burden Spillage · Noise · Falling of materials · Falling out from platform (Air tube replacement) · Fire hazard · Hotspot	· Ensure the guarding of all rotating parts with interlocks. · Skirting guard arrangement in Feed belt. · Regular Inspection of all safety devices for checking of its healthiness. · Monitoring Shell temperatures to prevent the inner side detoriation due to excess heat. · Kiln sealing system & pressure monitoring shall must be checked and ensure its healthiness. · Regular inspection & repair of cracks and Corrosion. *(Refer SG-03: Safety guideline for working in confined space, SG-09: Safety Guideline for Equipment and Machine Guarding, SG-18: Safety guideline for Personal Protective Equipment (PPE) management)*
4.4	Magnetic Separators / Vibrating Screen	· Rotating Machineries · Burdon Spillage · Noise · Falling of materials · Fall out	· Guarding of all rotating parts. · Monitoring of over feeding of material through the level indicator. · Inspection & maintenance of Chute to prevent the spillage and leakage. · Cooling the spillage material by water. Indirect water cooling system. · Mechanized cleaning system in place of manual cleaning by human. · Guarding of magnetic separator & vibrating screen to be ensure to prevent the people working that area. · Proper housekeeping to be ensured. *(Refer SG-03: Safety guideline for working in confined space, SG-09: Safety Guideline for Equipment and Machine Guarding, SG-18: Safety guideline for Personal Protective Equipment (PPE) management)*
4.5	ESP	· Hot Flue Gas · Fine Hot Dust · Electrical Transformer · High Electrical Voltages	· Access control system shall be installed at hazardous areas. · Energy Isolation i.e. electrical and mechanical shall be ensured before starting the work. · Application of heat insulation at required places like hot pipe line and surfaces. · CO monitoring shall be done through online or manually by portable CO detector at CO gas prone area. · Dust auto cleaning system should be installed and monitored. · Temperature monitoring of flue gas (>160 Deg. C) to be done on regular interval. *(Refer SG-03: Safety Guideline for working in confined space; SG-15: Safety Guideline for Electrical safety; SG-18: Safety Guidelines for Personal Protective Equipment (PPE) Management; SG-22: Safety guidelines for Energy isolation)*

SN.	Equipment	Hazards	Risk Control Measures
4.6	Dust Settling Chamber	· Hot burden Spillage · Fire · Explosion · Hot dust(burn)	· Sealing of dust settling chamber to prevent the fugitive dust emission. · Use of auto sprinklers & water jet for cooling and dust evacuation. · HMI Based temperature monitoring system. · Regular maintenance of wet scrapper for evacuates the wet dust from dust settling chamber. · Regular removal of dust from wet scrapping area. · Inspection of hot spot and crack and repair on regular basis. · Barricading of wet scraper area to prevent unauthorized entry. · Area monitoring with use of CCTV. · Audio visual alarm system with flasher light for warning. · Water level maintain in Wet scrapper. · Fan Interlock. · Inert gas blanketing (in dry dust system). *(Refer SG-03: Safety Guideline for working in confined space; SG-18: Safety guideline for Personal Protective Equipment (PPE) management)*
4.7	After Burning Chamber	· Gas leakage · Fire · Explosion	· Sealing of dust settling chamber to prevent the fugitive dust emission. · Use of auto sprinklers & water jet for cooling and dust evacuation. · HMI Based temperature monitoring system. · Inspection of hot spot & crack and repair. · Interlocking of fans with CO monitoring device to check % CO in off-gas. · Barricading of wet scraper area. · Area monitoring with use of CCTV · Audio visual alarm system with flasher light. · Water level maintain in Wet scrapper. *(Refer SG-03: Safety Guideline for working in confined space; SG-09: Safety Guideline for Equipment and Machine Guarding; SG-18: Safety guideline for Personal Protective Equipment (PPE) management)*
4.8	DRI Storage	· Fire Hazards	· Sponge iron should be loaded dry and it should be below a temperature of 65°C. The bin temperature should be monitored regularly (at least once every day). · Water ingress to the bin should be avoided. *(Refer SG-16 Safety Guidelines for fire safety)*

SN.	Equipment	Hazards	Risk Control Measures
4.9	ID Fan with motor	· Rotating parts · Electric Shock	· Guarding the rotating parts. · Permit to work before S/D maintenance. · Interlock health condition should be checked in regular interval. · Use of ear plug in high noise area. · Double earthling system to be provided for electrical equipment. *(Refer: SG-09: Safety Guideline for Equipment and Machine guarding, SG-15 Safety Guidelines for electrical safety)*
4.10	Electrical Panels	· Electric Shock	· Energy isolation shall be taken as per "Work Permit" condition. · Display of "Men at Work" at HT switching on panel. · Only authorized electrician/ engineer shall be issue the electrical permit and isolate electrical panel. *(Refer SG-15: Safety guidelines for Electrical Safety)*
4.11	Transformer Room	· Electric Shock · Oil leakage · Fire	· Energy isolation as per Work Permit. · High velocity spray system/ Automatic Nitrogen gas flooding system as per requirement. · Fire extinguisher at site and fire protection system in place. *(Refer SG-15: Safety guidelines for Electrical Safety; SG-16: Safety guidelines for Fire Safety)*
4.12	Capital Repair	· Electric shock · Fall out · Slips	· Preparation of proper protocol. · Taking shut down and complete purging of the system before work. · Cordoning of repair area and prohibition of any unauthorized entry. · Adequate precautions during storage & handling of material, gas cylinder, electrical equipment, work at height, etc. · Proper Illumination to be ensured. · Adequate fire prevention and mitigation system to be placed. *(Refer SG-01: Safety Guideline on storage, handling & use of gas cylinders; SG-02: Safety Guideline for Working at Height; SG-03: Safety Guideline for Working in a Confined Space; SG-04: Safety Guideline for Permit to Work (Operation & Maintenance); SG-05: Safety Guideline for Illumination at workplace; SG-07: Safety Guideline for Gas cutting & Gas Welding; SG-10: Safety Guideline for Hydraulic System; SG-11: Safety Guideline for Barricading; 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-18: Personal Protective Equipment (PPE) Management).*

SN.	Equipment	Hazards	Risk Control Measures
4.13	Transfer chute operation.	· Hot flames · Exposure to dust · Falling out from working platform	· Open stack cap, keep kiln in negative pressure. · Kiln should be stand still. · Feeding & Injection system should be stopped. · Maintain distance and stay away from line of fire. · Provide safe platform & fall protection systems. · Ensure proper illumination.

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signages and emergency escape route shall be shown covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- Regular checking and maintenance of all process safety interlocks are to be ensured
- Housekeeping of all working areas should be maintained.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection/management of the hazards

- Safety devices in conveyor system (PCS, ZSS, Interlocks etc.), Hooter before starting, guards over rotating components.
- Smoke & Fire detection/alarm system in all Electrical installation facilities.
- Fire sealing, Fire Barrier, & fire protection compound layer over cables in Cable cellar
- Portable & Online CO monitors.
- Level & weight monitoring in silos/ charging bins.
- Dust extraction system.
- Crane- limit switches, emergency brakes, hook latches, hooters , Safe Load indicator. Annual load test etc.
- ELCB/ RCCB in welding machines.
- CCTV Surveillance
- LOTOTO system
- Flasher light provision in high risk areas.
- Hot spot monitoring (Thermography)
- Testing of Earth pit (Annual)
- Fire Hydrant system

PPE Matrix

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Breathing Apparatus
Belt Conveyor	Yes	Yes	-	Yes	Yes	-	Yes	-	-
Silos /Charging Bins / Hoppers	Yes	Yes	-	Yes	Yes	-	Yes	-	-
Kiln & Cooler	Yes	Yes	Yes	Yes	Yes	-	-	-	-
Magnetic Separators / Vibrating Screen	Yes	Yes	-	Yes	Yes	Yes	Yes	-	-
ESP	Yes	Yes	-	Yes	Yes	-	Yes	-	Yes
Dust Settling Chamber	Yes	Yes	Yes	Yes	Yes	-	Yes	-	-
After Burning Chamber	Yes	Yes	Yes	Yes	Yes	-	Yes	-	-
DRI Storage area	Yes	Yes	-	Yes	Yes	-	Yes	-	-
Panel room & Transformer area	Yes	Yes	-	Yes	Yes	-	-	Yes	-
Transfer chute operation	Yes	Yes	Yes	Yes	Yes	-	-	Yes	-

Note

This PPE matrix is for reference only, and the specific PPE requirement may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviation:

DRI	Direct Reduced Iron	**PPE**	Personnel protective Equipment
RMHS	Raw material handling system	**HMI**	Human Machine Interface
ESP	Electrostatic Precipitator	**SOP**	Standard Operating Procedure
ABC	After burning chamber	**SMP**	Standard Maintenance Procedure
DSC	Dust settling chamber	**WHRB**	Waste heat recovery boiler

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	DIRECT REDUCTION PLANT (GAS BASED)	Doc. No: SG/33
		Rev no.: 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identification of hazards associated with Gas based Direct Reduction Process Plants and implementation of risk control measures.

2. SCOPE:

This guideline of safety is applicable to all Gas based Direct Reduction Plants. The scope of this document starts from preparation of iron ore as input material for feeding to the furnace charge hopper to the furnace discharge section.

3. PROCESS BRIEF:

Gas-based direct reduction is a process used to produce sponge iron from oxides using natural gas or coke oven gas. The process involves two main steps: Reduction of iron oxide in the first step and cooling of sponge iron in the second step.

Here are the steps involved in the gas-based direct reduction process:

3.1. Raw Material Handling:

- Iron Ore: The primary raw material is iron ore, typically in the form of pellets or lumps.

3.2. Iron Ore Reduction:

- The iron ore is fed into a furnace bed.
- Reducing Gas: Gas is used as the reducing agent. It contains hydrogen (H2) and carbon monoxide (CO), which are essential for the reduction of iron ore.
- The reduction reaction is carried out at 800–830 °C, with the help of reducing gas.
- In the presence of the reducing gas, a chemical reaction occurs where oxygen is removed from the iron ore, leaving behind DRI (Direct Reduced Iron).

3.3. Cooling of DRI:

- The hot DRI is rapidly cooled to prevent further reactions.
- Cooling can be achieved through cooling gases which contain natural gas.

3.4. Product Handling and Storage:

- The produced DRI is handled and stored in silos or bins before further processing or transportation.

3.5. Off-Gas Treatment:

- The off-gas generated during the reduction process contains CO2 and moisture.
- Two third part of the top gas is used as the process gas for further reforming reaction with natural gas in reformer catalyst tubes at 1050–1100°C and one third of the top gas is used as fuel for heat generation in reformer box.

3.6. Energy Recovery:

- Heat recovery systems capture and reuse waste heat generated during the DRI production process.
- This recovered heat can be used to preheat incoming air or gas, improving energy efficiency.

Gas-based direct reduction is a widely used process in the steel industry, as it offers several advantages over the traditional blast furnace process, such as lower capital and operating costs, and reduced environmental impact.

4. MAJOR AND CRITICAL EQUIPMENT FOR MANUFACTURING OF SPONGE IRON IN THE GAS BASED DIRECT REDUCTION PLANT:

1.1. **Raw Materials Handling System** (RMHS- Flexowall conveyor and furnace discharge conveyor, Belt Conveyers, Crusher, Vibrating Screen etc. & Silos/Sheds/Storage Yards for Raw Materials storage purposes, Heavy earth moving equipment)

1.2. **Furnace** – Furnace Charge hopper, Burden feeders shaft, Feed legs, Hydraulic pumps, Top gas scrubber, cooling gas scrubber, cooling gas after cooler, cooling gas Christmas tree, Burden Feeder machinery cooling water tank.

1.3. **Reformer-** Catalyst tubes**,** Reformer Box, Reform gas cooler and seal gas cooler, Main air blower, Auxiliary air blower

1.4. **Heat Recovery system-** Preheating tubes, Ejectors stack fan, Dilution air blower

1.5. **Process gas compressor**- Process gas compressor and dampeners & cooling gas scrubbers

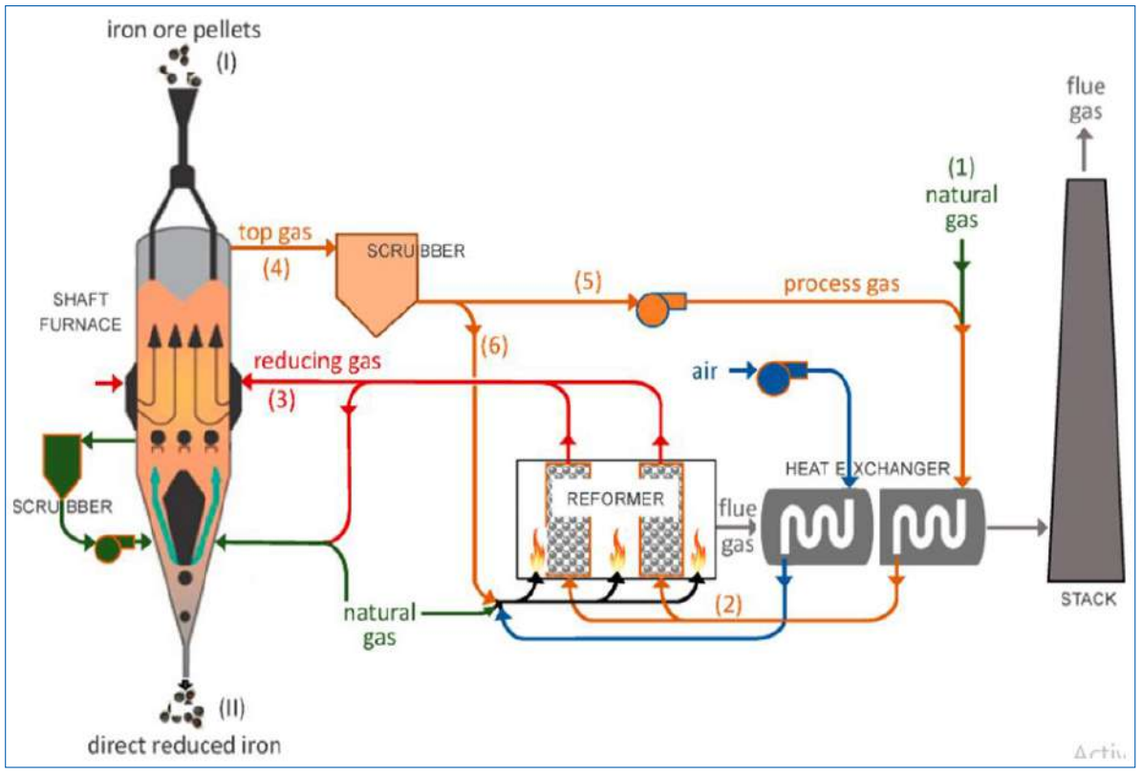
1.6. **CO_2 Removal System (if available)**

1.7. **Cooling gas compressor- Compressor and dampeners**

1.8. **Seal gas compressor-Compressor and dampeners**

1.9. **Discharging Equipment** – Conveyors, bins, Briquetting machine, discharge feeder.

Process Flow Diagram of Gas based Direct Reduction Iron Plant:



5. PROCESS BASED HAZARD ANALYSIS &NECESSARY RISK CONTROL MEASURES:

Sl..No.	Area/ Section / Equipment	Hazards	Risks Control Measures
5.1	Raw Material Handling	· Fire Hazard · Nip point Hazard · Belt sway · Dragging running by belt · Dust ingress in eyes	· Guarding of all rotating parts of conveyor system. · Pull chord in conveyors. · Emergency switch. · Sound annunciation system during startup of conveyors · Dust collection system/dust suppression system · Fire detection and suppressions systems (Linear Heat detection cables and Fire Hydrant points) · Belt sway detectors to avoid sway beyond allowable limits · Shutdown procedure *(Refer SG-16:SafetyGuideline for Fire Safety, SG-09:Safety Guideline in Equipment & machine Guarding, SG-13: Safety Guideline for Material handling (manual and mechanized) & storage,SG-19: Safety Guidelines on Operation and Maintenance of Conveyor Belts, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance))*

Sl..No.	Area/ Section / Equipment	Hazards	Risks Control Measures
5.2	Charge Hopper	· CO leakage · Falling of Pellets · Shell crack & · Corroded structure. · Oxygen deficiency · Fire due to leakage of combustible gases · Dust ingress in eyes · Failure of Top Seal of SIP Furnace	· Installation of fixed CO gas monitor& use of Portable monitors to detect gas leakage while working near the hopper · Prohibition of unauthorized people going the kiln as there are chances of gas leakage. If at all, one needs to go, he should be accompanied a safety man with adequate safety measures must be taken. · Regular inspection & repair as per requirement. · Installation of combustible gas detector *(ReferSG-18: Safety Guidelines for Personal Protective Equipment (PPE) management, SG-16:Safety Guidelines for Fire Safety, SG-09 Safety Guideline in Equipment & machine Guarding)*
5.3	Reduction Furnace	· Heat · Radiation · Confined space entry · Gas leakage · Shell crack & Corroded structure · Slip, trip & fall hazard · Material fall from height. · Fire & Explosion · Dust explosion · Dust ingress. · Hot water leakage · CO Poisoning	· Display of noise level. · Installation of on-line Gas monitor at strategic locations & use of Portable "CO" monitors to detect gas leakage. · Regular inspection of shell temperature to observe any Hot spot development and provision of water spray cooling. · Restricted access to higher platforms. · Regular inspection & repair of cracks and corrosion. · Preparation of layout showing hazardous area classification. · Prevent materials or objects falling. · Barricade Area/declare Prohibited area. · Cooling arrangement. · Fire hydrant points. · Adequate illumination · Thermography of hot area *(ReferSG-11: Safety Guideline for Barricading, SG-03: Safety Guideline for Working in a Confined Space, 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)*

Sl..No.	Area/ Section / Equipment	Hazards	Risks Control Measures
5.4	Process & cooling gas compressor and Scrubber.	· Gas Leakage · Confined space entry	· Provision of Online Gas monitor & Portable "CO" (Carbon Monoxide) monitors to detect gas leakage. · Pressure drop monitoring. · Purging the system with Nitrogen before starting maintenance job. *(ReferSG-11: Safety Guideline for Barricading, SG-03: Safety Guideline for Working in a Confined Space, SG-18: Safety Guidelines for Personal Protective Equipment (PPE) management, SG-16: Safety Guidelines for Fire Safety, SG-21: Safety Guidelines for Handling Fuel Gas)*
5.5	Reformer & Heat Recovery System	· Heat · Radiation · Confined space entry · Gas leakage · Shell crack & Corroded structure · Fire & Explosion · CO Poisoning	· Installation of on-line Gas monitor at strategic locations & use of Portable "CO" monitors to detect gas leakage. · Regular inspection of shell temperature to observe any Hot spot development and provision of water spray cooling. · Regular inspection & repair of cracks and corrosion. · Preparation of layout showing hazardous area classification. · Barricade Area/declare Prohibited area. · Fire hydrant points. · Thermography of hot area *(ReferSG-11: Safety Guideline for Barricading, SG-03: Safety Guideline for Working in a Confined Space, 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)*
5.6	Seal gas compressor	· Fire & Explosion · CO Poisoning	· Installation of on-line Gas monitor at strategic locations & use of Portable "CO" monitors to detect gas leakage.
5.7	Cold DRI handing & storage system	· Spillage of DRI · Exposure to high temperature · Hot fines generation at transfer and falling point.	· Preparation of proper protocol. · Water sprinkler system. · Complete purging of system before operation. · Level alarm at bins. · Guarding of nip points. · Cooling of spillage material by water.

Sl..No.	Area/ Section / Equipment	Hazards	Risks Control Measures
			(Refer SG-03: Safety guideline for working in confined space, SG-18: Safety Guidelines for Personal Protective Equipment (PPE) management, SG-11: Safety Guideline for Barricading, SG-16: Safety Guideline for Fire Safety)
5.8	CO2 removal plant	· CO leakage · Noise · Exposure to chemicals	· Installation of fixed CO monitors & use of portable monitors to detect leak. · Purging of system before any maintenance job. · Water showers (for amine based plant). *(Refer SG-09: Safety guideline for equipment & machine guarding, SG-03: Safety Guideline for Working in a Confined Space, SG-18 for PPE management, SG-21 : Safety Guideline for Handling Fuel Gas)*
5.9	DE dusting system	· Noise · Dust · Slippery floor · Fall from height · Dust explosion	· Maintain platform. · Improve housekeeping. · Provide adequate illumination. *(Refer SG-02: Safety guideline for working at height, , SG-05 for Illumination at workplace, SG-18 for PPE management, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance))*
5.10	DRI Storage	· Fire hazard · Dust emission · Hot fines/Dust	· Sponge iron should be loaded dry and it should be below temperature of 60°C. · The bin temperature should be monitored regularly (at least once every day). · Water ingress to the bin to be avoided. · Facility for inert gas purging in case the bin temperature shows an increasing trend. · Flow measurement system for Nitrogen gas to storage system · Temperature monitoring system for storage bin and storage bin discharge conveyor *(Refer:-SG-16: Safety Guidelines for Fire Safety)*

Sl..No.	Area/ Section / Equipment	Hazards	Risks Control Measures
5.11	Hot DRI Transfer	· Inert gases · Toxic gases · Temperature · Dust inhalation · Oxygen deficiency · Hot fines spillage during valve operation	· Use of CO and O2 monitors during surge hopper empty condition · Ensuring proper ventilation to mitigate the risks associated with inert gases, toxic gases, and oxygen deficiency · Regularly inspecting and maintaining equipment to prevent leaks and spillages · Ensuring proper housekeeping to minimize dust accumulation · Establishing and following safe operating procedures for valve operation and other high-risk tasks · Conducting regular air quality monitoring to ensure a safe working environment · Providing emergency response training to workers to handle situations involving gas leaks, spillages, or fires *(Refer:-SG-16: Safety Guidelines for FireSafety,SG-03: Safety Guideline for Working in a Confined Space, SG-18 for PPE management, SG-21 : Safety Guideline for Handling Fuel Gas))*

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be shown covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- All applicable statutory requirements are to be followed as per respective state factory rules.
- Housekeeping of all working areas should be maintained.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection/management of the hazards.

- Fixed and portable CO (Carbon Monoxide) gas monitors at strategic locations to detect gas leakages

- Temperature monitoring systems for the reduction furnace shell to identify hot spots
- Pressure drop monitoring systems for process and cooling gas compressors and scrubbers
- Level alarms for cold DRI handling and storage bins
- Flow measurement systems for nitrogen gas in DRI storage systems
- Temperature monitoring systems for DRI storage bins and discharge conveyors
- Combustible gas detectors in areas prone to gas leakages and fire hazards
- Dust collection and suppression systems in raw material handling areas
- Fire detection and suppression systems, including linear heat detection cables and fire hydrant points
- Belt sway detectors on conveyors to prevent excessive sway and material spillage
- Emergency switches and pull cords on conveyor systems
- Oxygen level monitors in confined spaces and areas with potential oxygen deficiency
- Thermography equipment for monitoring hot areas and detecting potential fire hazards

PPE Matrix

PPE / AREA	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body Harness	Arc Flash Suit.
RAW MATERIAL HANDLING SYSTEM	YES	YES	YES	YES	YES	YES	YES	_	_	_
KILN CHARGING EQUIPMENT	YES	YES	YES	YES	YES	YES	YES	_	_	_
ROTARY KILN AND COOLER AREA	YES	YES	YES	YES	YES	YES	YES	_	_	_
PROCESS SAS SYSTEM	YES	YES	YES	YES	YES		YES	_	_	_
COOLER DISCHARGING EQUIPMENT	YES	YES	YES	YES	YES	YES	YES	_	_	_
PLANT DE DUSTING SYSTEM	YES	YES	YES	YES	YES	YES	YES	YES	_	_

Note:

This PPE matrix is for reference only, and the specific PPE requirement may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviation:

RMHS	Raw Material Handling System
PPE	Personal Protective Equipment
CO	Carbon Monoxide
DRI	Direct Reduced Iron
ESP	Electrostatic Precipitator
SOP	Standard Operating Procedure
SMP	Standard Maintenance Procedure

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	**STEEL MAKING-*Route* -ELECTRIC ARC FURNACE (EAF)**	Doc. No: SG/34
		Rev no. : 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identification of hazards associated with EAF route of steel making processand implementation of risk control measures.

2. SCOPE:

This Guideline of safety is applicable to Electric Arc Furnace whether an Integrated Steel Plant or a Mini Steel Plant.The scope of this document covers scrap yard, EAF unit, Pit side & auxiliary systems.

3. PROCESS BRIEF :

An electric arc furnace is a steel making plant that melts iron sources such as scrap, hot direct-reduced iron (DRI)/ HBI and hot metal using electric energy.

The EAF Steel Making area has following main sections:

1.1. EAF mains:

Various sub-sections of EAF and their functions are as follows:

1.1.1. Scrap Yard: To prepare scrap basket as per steel grade with different quantities of scrap, sponge iron, coke, lime and calcined dolomite.

1.1.2. EAF unit: This is the melting unit consisting of refractory lined lower shell, upper shell, graphite electrodes, water cooled panels (WCP) or refractory lined shell, water cooled roof, electrode mast, electrode holding arm and holder, secondary power cables, electrode regulation unit, tap hole or hot metal charging launder, slag door, EBT(Eccentric bottom tapping) hydraulic tilting mechanism, rocker platform. All Metallic charge and flux is charged into the Furnace from the Scrap basket lifted with an EOT crane. Power is put on through the Electrode and arcing takes place which starts melting the charge. The gangue in the charge combines with the lime and calcined dolomite to form the slag. The Metallic charge melts to form liquid steel. Oxygen is blown to reduce carbon and burn the Carbon Monoxide formed. This play with oxygen and carbon foams the slag and covers the arc. The slag coats the Copper and steel panel or refractory lined wall as the case may be, and protects it from the bare arc. As soon as the Liquid bath achieves a Temperature of near to 1620–1650°C it is tapped into Steel ladle for further processing.

1.1.3. Transformer and Static VAR Compensator (SVC): The main energy an EAF operates is electrical energy. Energy consumption varies from 300 – 600kWh/ Ton of liquid steel produced. So EAF's are rated by transformer capacity per ton of tapped steel. Low Power (LP), High Power (HP) and UHP (Ultra high Power) are in general ranges. Any EAF with a transformer of up to 0.5 MVA per ton is LP, between 0.5–0.8 MVA is HP and above 0.8 MVA per ton is UHP. So a 50 ton EAF with 50 MVA transformers is an UHP EAF. This transformer steps down voltage from 33kV or 11kV to 300–600V and a tap changer is available with the melter to change

voltage according to the melting profile and the Arc length. SVC (Static VAR Compensator) is a capacitor bank to take care of power factor, Harmonics and Flickers.

1.1.4. Gunning and fettling Machine: These machines are used for refractory repair of EAF in operation during the turnaround time.

1.1.5. Injection / Burner Systems: Coke/ Natural Gas/ Heavy Oil combined with Oxygen injection is a normal practice in an EAF. This has two functions. One to control oxygen and carbon in the bath and oxy-cut any large piece of scrap which may lead to an electrode breakage and the other one to maintain foamy slag to cover the arc for better absorption of the electrical energy. Further oxygen injection systems can also act as an effective post combustion device for enhancing energy recovery from CO (during hot metal de-carburisation in EAF).

1.1.6. Continuous Material feeding System: In a large steel making set up, fluxes i.e. calcined lime and dolomite are not added in the basket. They are fed in a continuous mode. This system also has cold DRI (Direct Reduced Iron or Sponge Iron) /cold HBI (Hot Briquetted Iron) feeding system. All these materials are kept in a bunker or hopper and are carried through a system of conveyors. At the exit of each bunker or hopper is a weigh feeder.

1.1.7. Hot DRI feeding system: Many energy efficient plants have different type of hot DRI feeding systems like gravity fed hot DRI containers, hot DRI sealed conveyors.

1.1.8. Lower Shell preparation area: Nowadays instead of stopping the EAF for lining the eroded refractory, the lower shell is changed after dismantling the upper shell. This helps is reducing the shutdown time for refractory repair and increase EAF productivity. A separate work area for masons and refractory workers are assigned in the EAF main crane approach.

1.1.9. Electrode Nippling area: Similar to point (3.1.7), addition of electrodes to the short electrodes column is no more done on the EAF top platform. A new electrode column is changed with the short electrode column. Here EAF workers under the Melter do electrode piece addition with the help of an EOT crane.

1.1.10. Fume Extraction System, Canopy and bag house: EAF roof has a side fourth hole meant exclusively to suck out fumes generated. A movable elbow and a combustion chamber and system of duct take the fumes away to a System of bag house. On the EAF bay shed over the cranes there is canopy which also picks up fugitive fumes and sends it to the bag house. It is also cooled. Ducts are all water cooled. This ensures EAF emission to limit PM10 and PM2.5 within the norms.

1.1.11. External Oxygen Lance (If not provided inside EAF) and manipulator: High pressure oxygen through steel pipes (consumable) are injected through joystick controlled manipulating device. The device helps to centre the pipes through the slag door and blow oxygen at high pressure. When oxygen blowing is complete the lances/pipes are taken out and parked away from the slag door.

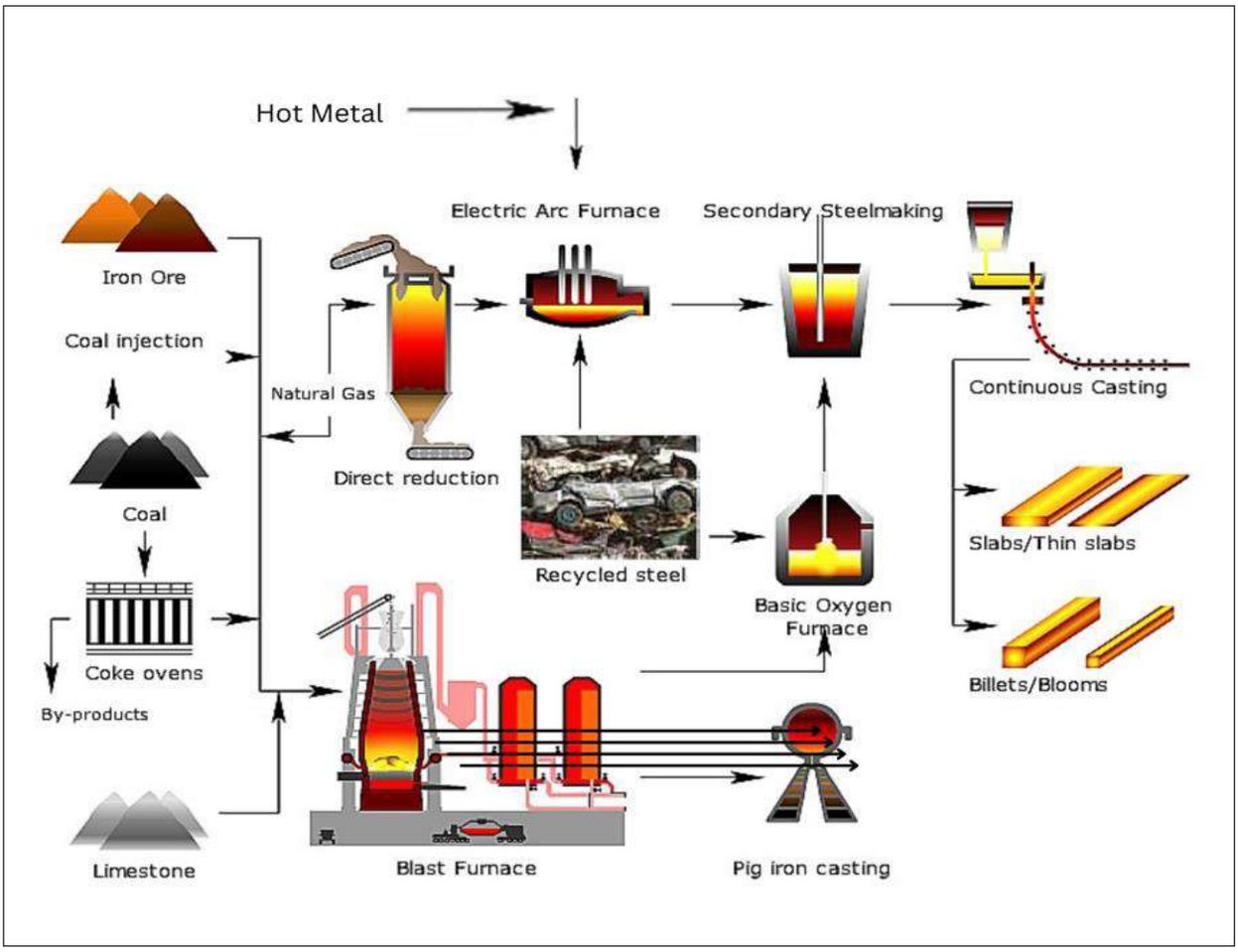
1.2. SECONDARY METALLURGY SECTION:

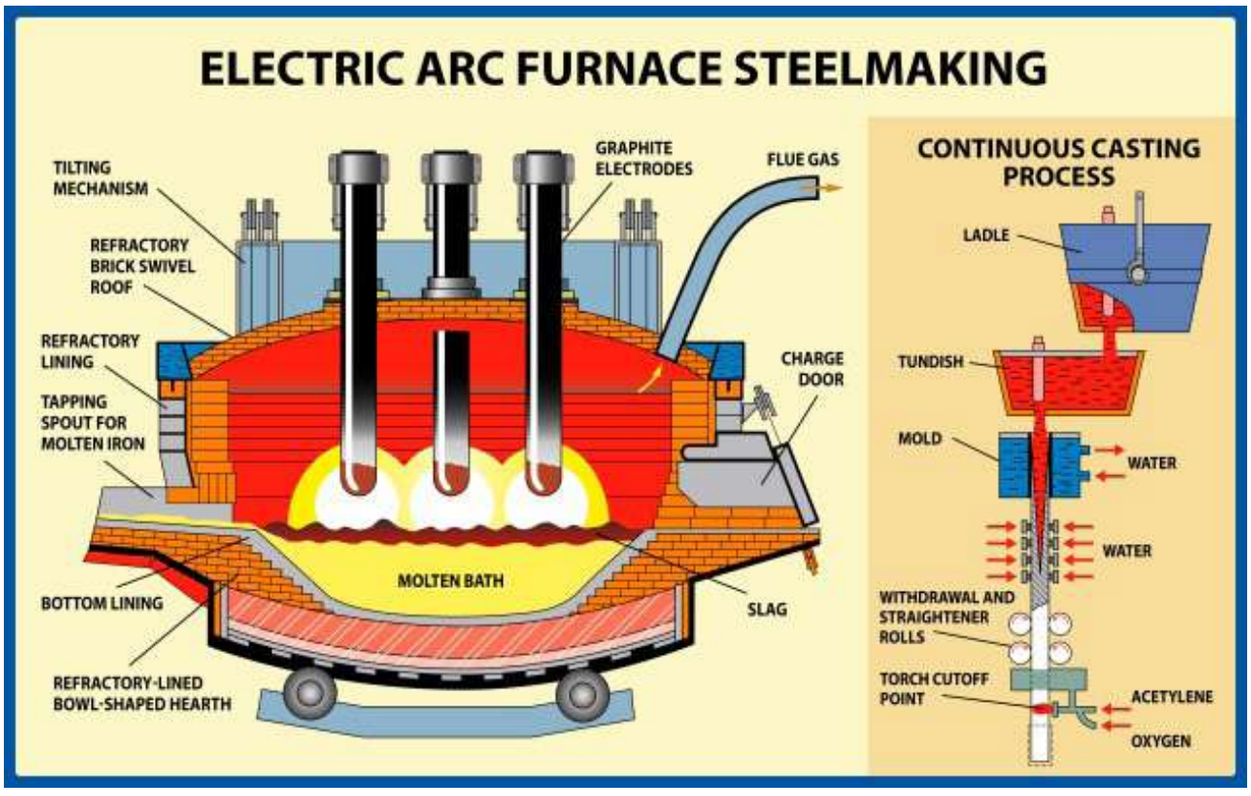
The tapped liquid steel is further processed in a Ladle Refining Furnace (LRF)/ Ladle Heating Furnace (LHF). In this section there may be a tank degasser or RH degasser.

This plant comprises of the following sections:-

- LRF with a hood, electrode mast, holder and arm and a transformer.
- Ferro Alloy feeding system,

- Cored wire injection system
- Carbon addition / dispensing system
- Electrode storage stands
- Ladle preparation, ladle drying and preheating area
- Ladle de-slagging and de-sculling area
- Ferro Alloy storage area
- Ferro-alloy and flux addition (FAFA) System
- Ladle purging System with inert gas mainly Argon or Nitrogen depending on the grade of steel (bottom purging system and top lance based purging system.
- Temperature and sampling system
- Fume Extraction System (FES)





Some of critical equipment/ facilities in EAF Steel Making Department are as follows:

Sl. No.	Area	Major Equipment's
1.	EAF	· Scrap transfer car, · Grab crane, magnet crane · Orange peel type (Clamshell bucket) · Charging basket, · EOT cranes, · Fork lift with boom for slag door cleaning, · Conveyors, bins/ silos, screens, weigh feeders, diverter gates, screw conveyors, charging chutes, · Hot Metal charging launders, · Furnace shell · Furnace roof with off-gas elbow duct, · Furnace rocking mechanism, electrode mast with rotating gantry turn table, secondary & primary de-dusting systems
2	LRF	· Electrode handling cranes, · Electrode mast with fixed gantry arm, · Electrode regulation system · Water cooled furnace roof with lifting & lowering system, · FAFA system, · FES system · EOT Crane, · Tank degasser and RH Degasser.

4. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

Sl. no.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.1	EAF process	Explosion and spillage of hot slag and metal due to Water Leakage from Water Cooled panel inside EAF	· Arcing to be stopped immediately. · Stop tilting activity and any other furnace movement. · Identify and close the incoming water valve safely. · Identify and rectify the source of leakage / puncture. (Note-Adopting advanced furnace cooling system with use of automised water spraying system or Air/Nitrogen cooling system in lieu of conventional water tube cooling system.) *(Refer SG-23 : Safety Guidelines for safe handling of liquid metal)*
		Carbon boil and violent throw of hot metal and slag through the slag door	· Arcing to be stopped immediately. · Stop oxygen blowing inside EAF in a controlled manner. · Inject Coke to control the reaction. · Stop tilting or stop any other Furnace movement · Use off-gas composition analysis to control the oxygen injection system so that the entrapped CO doesn't reach the explosive range 12.5 to 74.2 % (excess CO accumulation in furnace head area during de carburisation phase). *(Refer SG-23 : Safety Guidelines for safe handling of liquid metal)*
		Possibility of explosion due to Water leakage and entrapment of water at the verge of completion of heat from top panel	· Stop Arcing immediately. · Stop tilting or stop any other Furnace movement · Identify source of leakage. · Adopting advanced furnace cooling system with use of atomised water spraying system in lieu of conventional water tube cooling system · Reduce water flow by stopping few pumps. · Carry out Visual Inspection of furnace. *(Refer SG-23 : Safety Guidelines for safe handling of liquid metal)*
		Injury during Manual filling of tap hole by movement of furnace roof and/or tilting	· Ensure hooter to alert persons prior to start of tilting and locking of furnace. · Interlocking and positive Isolation for furnace movement to be ensured. · Joy stick to be kept locked.

Sl. no.	Area/Section/ Equipment	Hazards	Risk Control Measures
		Explosion and fire and spillage of slag and/or metal during Charging of wet scraps.	· Wet charging materials such as scrap (may have been kept in an uncovered scrap yard) is a serious hazard. Entrapped water to be examined. · Avoid charging of sealed containers & boxes and ensure proper monitoring of nature of furnace charge material / hazardous material/toxic/chemicals & liquids/radioactive material. · Hooter to alert persons prior to charging to be ensured. · Control Room shutter to be kept closed. · Slow and intermittent opening of the basket to be ensured. · AI based access control at shop floor during charging in EAF process.
		Injury from rotating / moving parts of conveyor	· Shutdown/permit to work with electrical isolation (LOTOTO) to be ensured. · Conveyor Interlocking to be ensured. · No work should be done on conveyor in running condition. · Always operate Local emergency switch for approaching conveyor. · Availability of Pull chord to be ensured. · Hooter to alert persons prior to restarting conveyor to be ensured. · Ensure crossing the conveyor only through the designated place. *(Refer SG-19 : Safety Guidelines on Operation and Maintenance of Conveyor Belts)*
		Injury from Rotating machineries (gunning machine, fettling machines, screw conveyors etc.)	· Coupling guards to be in place. Loose cloth to be prohibited at all such areas. *(Refer SG-09 Safety Guideline in Equipment & machine Guarding)*
		Injury from spillage of Hot DRI	· Mechanised charging of Hot DRI ensuring proper sealing with Nitrogen/process gas to be ensured. · Improper or inadequate sealing may lead to fire and explosion.
4.2	EAF turn-around activity	Burn Injury due to splashing slag	· Hooter to be ensured. · Ensure workmen must away from line of fire.
		Explosion due to water ingress into slag/metal while Gunning and fettling operation	· Start the gunning machine outside EAF only. · Start water ingress. · Check the quality of mix. *(Refer SG-23 : Safety Guidelines for safe handling of liquid metal)*

Sl. no.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.3	Electrode changing	Falling of hot electrode/ hot loose piece falling off.	· Hooter to alert persons on crane and EAF operator to coordinate shop floor movement. · No person to be below a red hot electrode
		Lifting plug giving way/ Crane hook getting disengaged and subsequent injury during Electrode Jointing at Nippling stand	· Electrode to be lifted under the guidance of the crane operator with a cushion of electrode packaging material · Nipple to be centred over short electrode column (Refer SG-04 : Safety Guidelines for Permit to Work(Operation & Maintenance))
		Person hit by moving machines	· Hooter to alert persons, gong bell during movement machines. · Auto announcement during any operation. · Before starting a standing car long hooter should be given and operator to check for any person doing any job. (Refer SG-04 : Safety Guidelines for Permit to Work(Operation & Maintenance))
4.4	EAF Tapping Pit	Metal Splashing/Metal falling into tapping pit over water and explosion	· No water logging in tapping pit which may result in explosion. · Tapping pit should be in clean condition and have enough capacity to hold metal in case of furnace puncture. *(Refer SG-23 : Safety Guidelines for Safe handling of Liquid Metal)*
4.5	EAF shop floor area and general process management	· Gunning machine malfunction, Slag door cleaning Forklift with boom malfunction, Fettling machine malfunction causing hazardous condition near the EAF control room and the EAF shop floor. · Slag pit equipment malfunction and slag accumulation below EAF floor causing extremely difficult hot condition while doing Gunning, fettling and slag door repair near EAF slag door.	· Organisation of all EAF shop floor activities in coordination · Slag handling in slag pit and water spraying · Slag pot carrier movement and pathway to be fixed. (Refer SG-04 : Safety Guidelines for Permit to Work(Operation & Maintenance))
4.6	Slag Dumping Pit	· Fire / Explosion due to presence of water in the slag dumping pit. · Fire in slag handling vehicles due to high slag temperature.	· After dumping the slag must be allowed to cool down in slag pit and then excavator can engage for digging. · Empty pot and full pot area shall be demarked and kept separately. · Proper illumination at work place should be ensured. · For slag Cooling water spray system to be installed · After cool down, the slag to be loaded by loader in the hyva for dumping / processing yard. · Authorized personal shall work in the slag yard.

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be displayed covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- Regular checking and maintenance of all process safety interlocks are to be ensured
- Housekeeping of all working areas should be maintained.
- Refer Process based safety guidelines for Steel Melting Shop(SG/39) for casting operation, Argon Oxygen De-carburiser (AOD) operation, ladle furnace operation, EOT crane operation, etc.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection/management of the hazards

- Safety devices in conveyor system (PCS, BSS, ZSS , Interlocks etc.), Hooter before starting, guards over rotating components
- Hot metal weighment on ladle trolley.
- Portable & fixed CO monitors
- Smoke & Fire detection/alarm system in all Electrical installation facilities.
- Crane- limit switches, emergency brakes, hook latches, hooters , Safe Load indicator, annual load test etc.
- ELCB/ RCCB in welding machines.
- CCTV Surveillance
- Testing of Earth pit (Annual)
- Fire Hydrant system
- LOTOTO system
- Terminator machine for refectory gunning
- Electrode regulation system

PPE matrix

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Clothing	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Aluminized Suit
EAF Process activity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EAF turnaround activity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Electrode changing activity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes
EAF Tapping Area	Yes	Yes	Yes	Yes	Yes	-	-	Yes	Yes
EAF Shop Floor	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like arc flash suits etc.) may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviations:

EAF	Electric Arc Furnace
DRI	direct-reduced iron
WCP	water cooled panels
EOT	Electric Overhead Travelling
SVC	Static VAR Compensator)
CO	Carbon monoxide
PM	Particulate Matter
LRF	Ladle Refining Furnace
LHF	Ladle Heating Furnace
FAFA	Ferro-alloy and flux addition
FES	Fume Extraction System
SOP	Standard Operating Procedure
SMP	Standard Maintenance Procedure
LOTOTO	Lock Out- Tag out- Try out

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	**STEEL MAKING-*Route*-INDUCTION FURNACE (IF)**	Doc. No: SG/35
		Rev no. : 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identification of hazards associated with Induction Furnace route of Steel making process and implementation of risk control measures

2. SCOPE:

This safety guideline is applicable to all Electric Induction Furnace (IF) of standalone units or a Mini Steel Plant having induction furnaces**.** This document covers IF proper, Ingot/Billet casting, stripping and auxiliary units.

3. PROCESS BRIEF :

1.1. **Process of IF Steel making area includes the following**:

3.1.1. Scrap Yard: The scrap is kept in the scrap yard generally under a shed. The scrap is prepared as per the requirements of steel grade with different quantities of scrap, sponge iron, other additives etc.

3.1.2. IF unit: This is the melting unit consisting of refractory lined crucible, water cooled panels (WCP),water cooled power cables, hydraulic tilting mechanism, Capacitor bank, etc. All Metallic charge is charged into the Furnace either manually or from the Scrap/ sponge iron lifted with an EOT crane. Power is put on through the power cables to induction coil which starts melting the charge. The Metallic charge melts to form liquid steel. As soon as the Liquid bath achieves a Temperature of around 1650°C,it is tapped into Steel ladle for further processing. Normally a spare crucible is kept for alternate use. The crucible is selected with the help of a changeover system.

3.1.3. Water cooling system: The induction furnace coil, panel and power cables are water cooled. An effective cooling water system is provided with suitable water pumps, cooling towers and heat exchanger having backup system for emergencies or break downs.

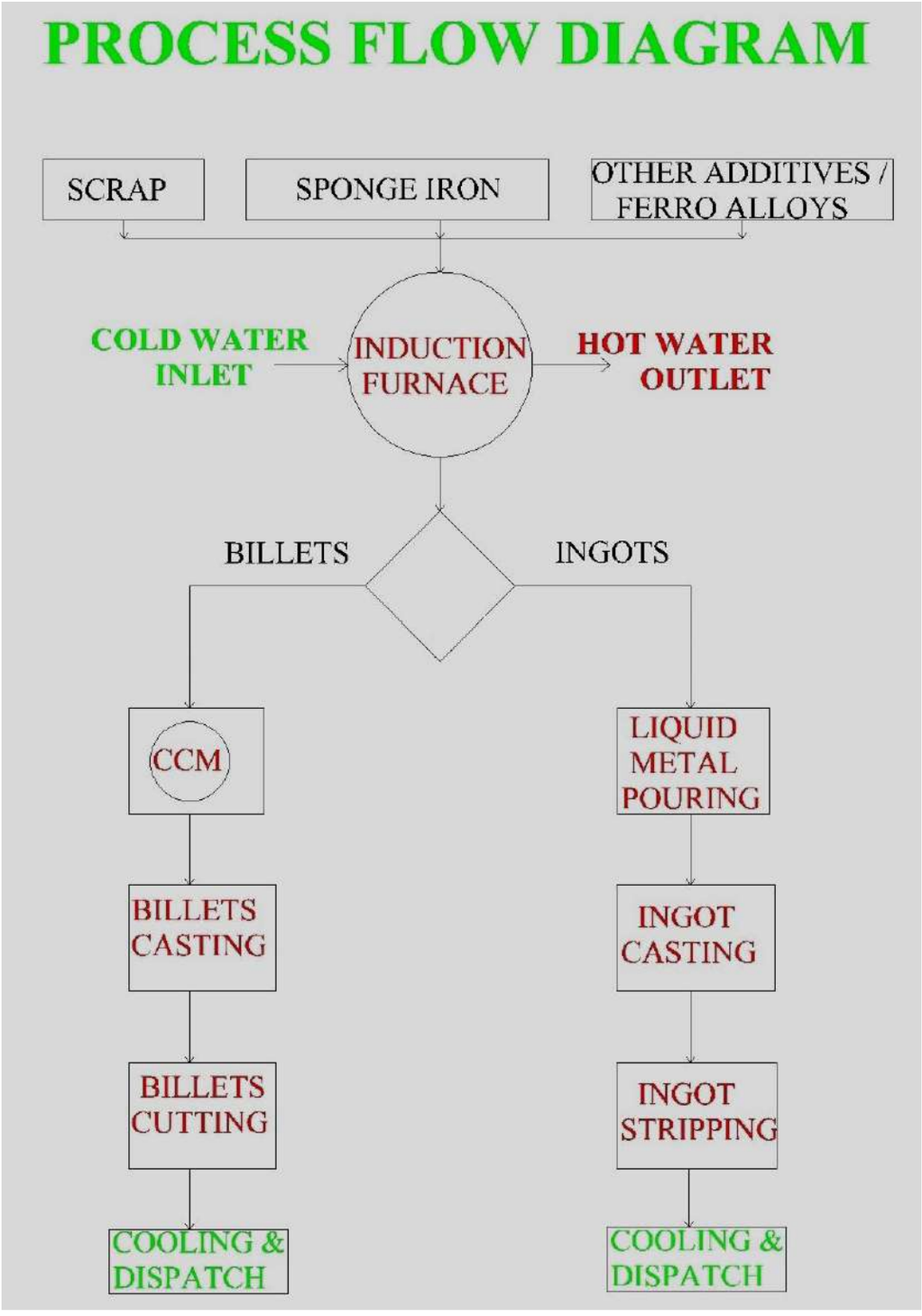
3.1.4. Transformer: The main energy on which an IF operates is an electrical energy. It is considered to be a very high energy intensive process. In these days, the induction furnaces are generally designed for running at medium frequency. The transformer is one of the major equipment which is selected based on the requirement of melt rate and rating of induction coil. This transformer steps down voltage from HV (e.g. 33kV) to LV (e.g. 850 V). Power is controlled through a variable power pot available on the furnace platform. A capacitor bank is also provided for compensation to take care of power factor.

3.1.5. Material feeding System: Depending upon the size of operation, the material is fed into the furnace manually or through EOT Cranes having magnets.

3.1.6. Pit side: The molten metal is poured in to the Bottom Pouring set through teeming ladle for casting in ingot moulds. The ingots are taken out manually from the moulds. In case of continuous casting the molten metal is transferred in a teeming ladle for carrying out

continuous casting after loading on the ladle turret/ladle stand/ladle transfer car as per the shop facility with the help of EOT Crane.

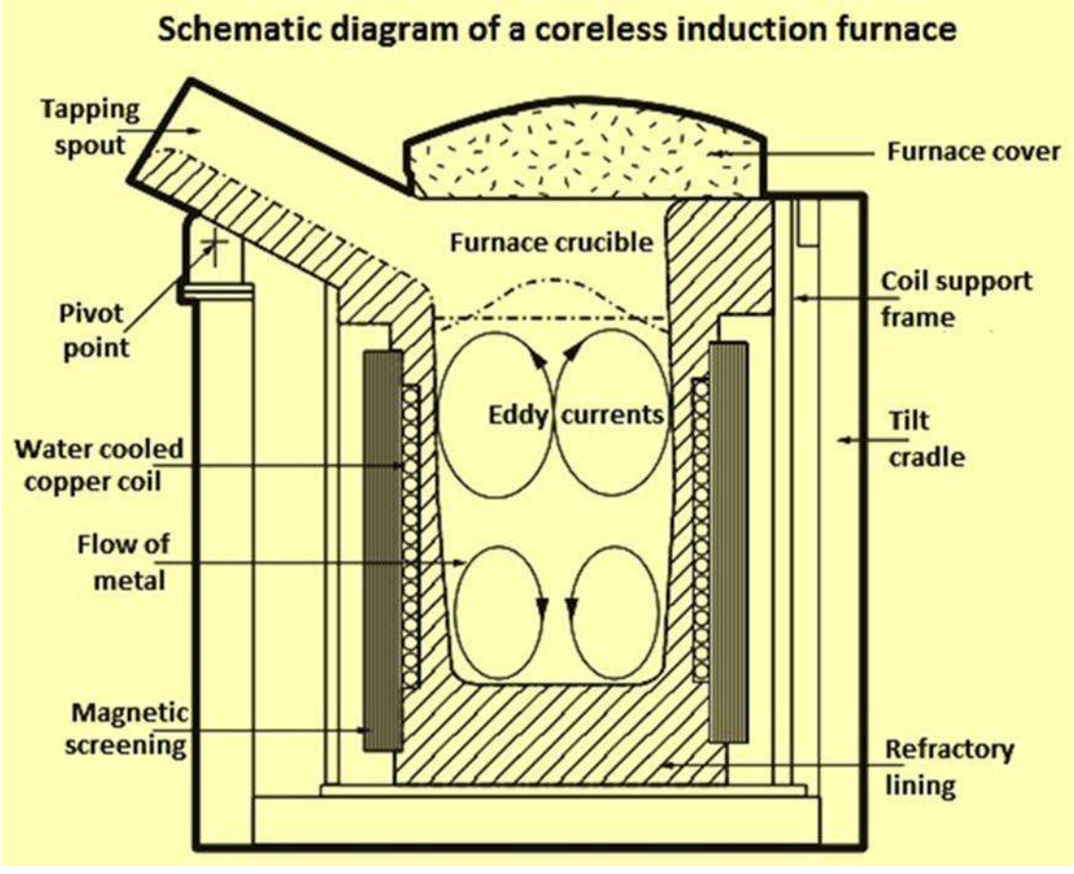
3.1.7. Fume Extraction System: A movable elbow collects the fumes from the top of the crucible and transfers it to the dust collector/bag house through ducts. The solid dust is collected in the hoppers and the fumes/air is released through chimney.



3.2. **The Induction Furnace comprises of the following major operations/critical equipments:-**

Sl. No.	Operation	Equipments
1	Scrap processing	Shearing machines, Bundling machines
2	Electrical distribution	Transformer, Cables, Capacitors, Motors,
3	Melting system	Panel, Changeover, choke, DM water plant, Hydraulic power pack
4	Crucibles and lining arrangements	Coil/Crucibles, Vibrators
5	Pump house	Water pumps, cooling tower, heat exchanger
6	Material Handling system	EOT Cranes, Transfer trolley
7	Fume extraction system	Hood, Ducts, ID Fan, Bag house
8	Dispatch yard	Steel teeming ladle transfer car

1.3. Schematic diagram of a coreless induction furnace



1.4. Few photographs of actual operation of induction furnace

4. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

Sl. No	Area/ Section	Hazards	Risk Control Measures
4.1 ELECTRIC INDUCTION FURNACE			
4.1.1	IF proper	Explosion hazard due to Water Leakage from coil, Water Cooled panel or power cables.	· Pressure testing is to be carried out as per the schedule or recommendations of manufacturer. · All the joints are to be checked and set right before start of each operation. · Stop operation and Stop tilting of Furnace in case of any leakage. · Identify the leakage point and rectify before operation *(Refer SG-23: Safety Guideline for Safe handling of Liquid Metal)*
		Metal splash or explosion due to charging of improper scrap/wet scrap/ chemicals in scrap	· Inspection of scrap and approval process for worthiness · Proper Segregation of scrap · Precautions to be carried out for preventing charging of wet charge materials & sealed scrap. · Safe scrap charging through cranes/vibrators charging trolley · Use of Hydraulic pusher for melting · Ensure Proper protection system like Ground Leak Detector (GLD) etc. in place · Ensure no unauthorized person on furnace platform · Stop operation in case of any splash. *(Refer SG-23 Safety Guideline for Safe handling of Liquid Metal)*
		Explosion due to high temperature / thinning of refractory with improper Melting system protection. Additionally, Bridging in IF may lead to superheating of furnace bottom and erosion of ramming mass and rupture of cooling water tubes and subsequent explosion.	· Lining conditions of crucibles & ladle etc is to be monitored regularly after each heat and maintained to prevent run through of metal/ slag. · Precautions to be taken not to superheat the molten steel during breakthrough of bridge. Power to be turned off and all personnel must be evacuated from the furnace vicinity area until bridging problems are resolved. Bridging can be minimized by using proper charge material and by making sure that the different sizes of charge materials are added correctly. · Proper control of water temperature & flow through sensors · Proper working of Ground leak detector to avoid explosion & furnace eruption during metal to coil penetration. · Frequency monitoring on regular intervals · Furnace spill pits must be dry as any water, oil /fluid entrapment might cause explosions & fire hazards *(Refer SG-23 : Safety Guidelines for Safe handling of Liquid Metal)*

Sl. No	Area/ Section	Hazards	Risk Control Measures
		Injury from Material Handling like DRI, Pig Iron, Scrap shifting to furnace floor	· Regular Maintenance of EOT cranes in respect of wire ropes, brakes, lifting hook, rails/ wheels, electrical system/motors etc. · Provision of proper limit switches · Emergency main switch of cranes to be provided near platform or at an easily accessible place. · Bell/Siren is to be provided in the cabin for crane operator · Annual inspection of Cranes/Lifting tackles/ Magnets by competent person every year as per factory act · Display of safe working load on each crane · Proper Guarding of all stairs and crane's CT Trolley *(Refer SG-14 : Safety Guidelines for work on Electric Overhead Travelling (EOT) Crane)*
4.2 AUXILIARIES AND GENERAL SAFETY			
4.2.1	IF turnaround activity	Burn Injury due to splashing slag	· Covering of all exposed area with protective clothing. *(Refer SG-18: Personal Protective Equipment (PPE) Management)*
		Injury from Pressurized Vessels	· Air compressors/pressure vessels should be checked regularly for proper working of Pressure switches, safety valves and Pressure gauges. · Auto drain valve is to be provided on each pressure vessel · Six monthly examinations of PV and hydraulic testing every four years by competent person as per the factory act. *(Refer SG-01: Safety Guidelines on storage, handling & use of gas cylinders)*
		Person hit by moving machines	· Siren / gong bell during movement of machines. · Auto announcement during any operation. · Permit to work prior to undertaking any maintenance job. *(Refer SG-09: Safety Guidelines in Equipment & machine Guarding)*
4.2.2	Electrical system	Electrical failures and shock	· Proper Earthing pits · Earthing of all electrical motors/gadgets · Proper working of Circuit breakers and tripping mechanism · Effective implementation of Work permit system · Transformer testing (dielectric strength and dehydration of Transformer oil) *(Refer SG-15: Safety Guideline for Electrical safety)*

Sl. No	Area/ Section	Hazards	Risk Control Measures
4.2.3	Ingot Casting	· Exposure to Heat · Metal Splashes during bottom pouring. · Burn injury due to lance backfire during Non-Free opening · Contact with hot Moulds	· Proper PPE is to be worn (Fire proof hand gloves) · Working platform to be adequate for proper reach of each fixtures attached to ladle bottom · Moulds should be placed with a movable/Stationary heat shield with proper insulation *(Ref SG-18: Personal Protective Equipment (PPE) Management)*
4.2.4	Stripping of Ingots	· Burn Injury due to Hot Metal surface	· Transfer cars to be used wherever possible to move moulds out of the ladle bay operated only from the pulpit with proper protection · Caution alarm to be placed to warn the movement of mould transfer cars · Movement of vehicles and workers to be restricted · Adequate time to be allowed with SOP for casting shrinkage

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be displayed covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- 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.
- All applicable statutory requirements are to be followed as per respective state factory rules.
- Housekeeping of all working areas should be maintained.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- Refer Process based safety guidelines for Steel Melting Shop (SG/39)for Casting operation, Argon Oxygen Decarburiser (AOD) operation, Ladle Furnace operation, EOT crane operation etc.

List of instruments/ equipment required for detection/management of the hazards.

- Pressure vessels to have pressure switch/ safety valves etc.
- Six monthly examinations of PV and hydraulic testing every four years by competent person
- Bell/Siren in the cabin for crane operator
- Limit switches, Corner switches, Annual inspection of Cranes/Lifting tackles/Magnets by competent person every year
- GLD (Ground leakage detector)
- Auto alarm in moving machines during operations/ movement

- Ultrasound thickness gauge with probes
- Transformer testing (dielectric strength and dehydration of Transformer oil)

PPE Matrix

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Breathing Apparatus
Scrap Yard	Yes	Yes	–	Yes	Yes	–	–	Yes	–
IF	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	–
Ingot Casting	Yes	Yes	Yes	Yes	Yes	–	–	Yes	–

Note

This PPE matrix is for reference only, and the specific PPE requirement (like arc flash suits) may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviations:

DRI	Direct Reduced Iron	**GLD**	Ground Leak Detector
WCP	Water Cooled Panels	**DM**	Demineralised
ID	Induced Draft	**SOP**	Standard Operating Procedure
EOT	Electric Overhead Travelling	**SMP**	Standard Maintenance Procedure
CT	Cross Travel	**PV**	Pressure Vessel
PPE	Personnel protective Equipment	**CCM**	Continuous casting machines

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	ROLLING & RE-ROLLING MILLS (SEMI-AUTOMATIC)	Doc. No: SG/36
		Rev no. : 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent workplace injuries & incidents including damage to plant and machinery through identification of hazards associated with Rolling & Re- rolling Mills (semi-automatic) and implementation of risk control measures.

2. SCOPE:

This safety Guidelines is applicable to Rolling and Re-rolling mill(semi-automatic) of a Mini Steel Plant**.** The scope of this document covers Raw material Section, Reheating Furnace & Rolling mill sections.

3. PROCESS BRIEF :

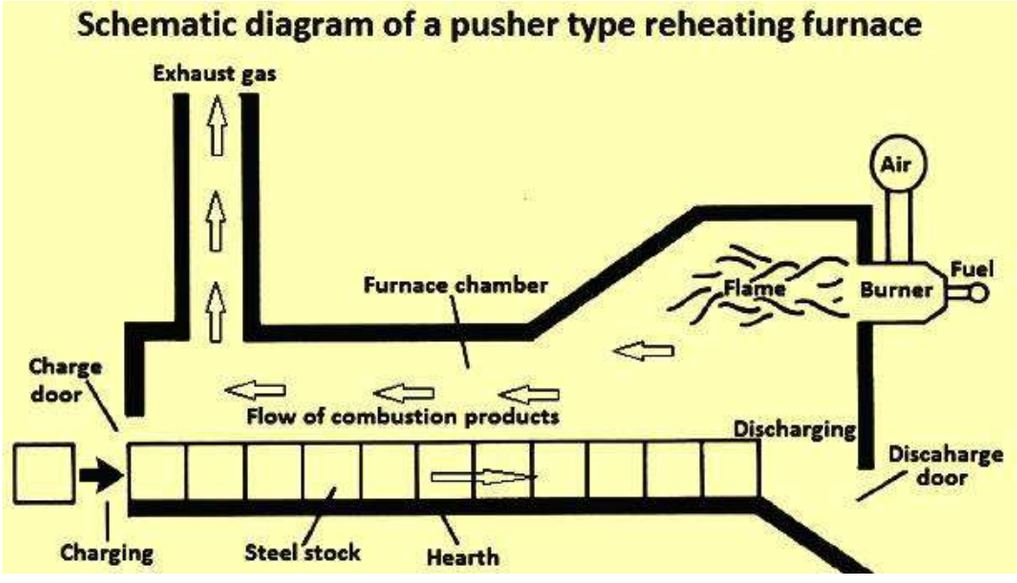
The Reheating Furnace and Re-rolling mill has following main sections:

3.1. Raw material Section:

In this section, the raw materials like ingots/billets /bloom etc are prepared for further rolling operation. Visual inspection is made to detect any defects like surface cracks, piping, bulge outs etc. Accordingly sorting, testing, cutting, grinding operations are performed in this section.

3.2. Reheating Furnace:

Various sub-sections of reheating furnace section and their functions are as follows:



3.1.1. **Fuel Handling Section**: The fuel handling section may include coal pre-crushers, coal pulveriser, conveyor belt, gas train, LDO, Furnace Oil, Producer gas etc., gas pipes, Pressure Relief Valve etc. The main function of this section is to prepare fuel for proper/efficient combustion in reheating furnaces.

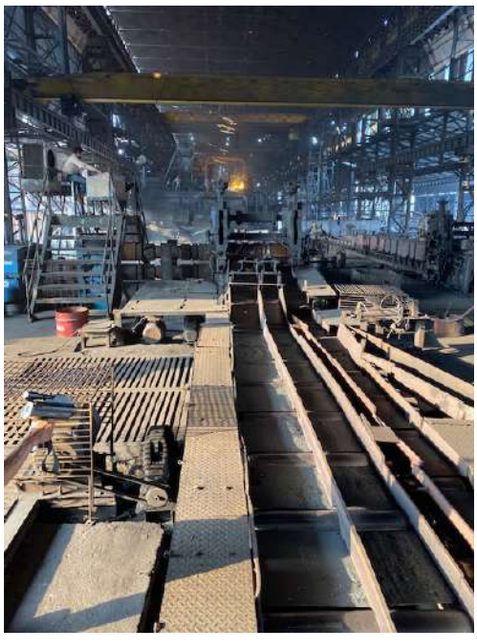
3.1.2. **Pusher Section:** The material to be heated is put on the pusher platform for charging into furnace. As per production/discharging rate, the material is pushed into furnace at regular intervals with the help of motorized/ hydraulic pusher.

3.1.3. **Reheating Furnace**: To convert chemical energy of fuels to heat energy and heat the material to required temperature efficiently and economically. Reheating furnace prepares the sock material for further hot rolling operation. The reheating operation includes Charging, Pushing, heating, air recuperating equipment/waste heat recovery and discharging/ conveying to rolling mill.

3.1.4. **Conveyor table**: To carry the heated discharged material to rolling mill for rolling operation.

3.3. Rolling Mill:

To roll the hot crude steel products into desired shape by passing and squeezing it between set of revolving rolls. The rolls may be plain or grooved rolls depending on product. Rolling operation may contain one or more roll stands depending on reductions required.



3.3.1. **The rolling mill comprises of the following sections:-**

- Drive mechanisms
- Roughing stands
- Intermediate stands
- Finishing mill
- Cooling bed
- Shearing section/finishing yard
- Dispatch yard
- Oil Cellars

3.3.2.Some of critical Equipments/ facilities in Re-rolling mills are as follows:

Sl. No.	Area	Major equipments
1.	Raw material section	Conveyors, grinders, hoist/overhead crane , gas cutting etc.
2.	Reheating furnace section	Coal Crushers/Pulveriser (hammer/ Jaw crusher), Pusher, gas pipe line, waste heat recovery, flue channel, burners, pressure regulators etc., Oil drums
3.	Rolling Mill Section	Working rolls, Pinch Roll, Shears, Roller Tables , power transmission mechanism including oil/Hydraulic cellars, belts, flywheel, motors etc.

4. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

Sl. No.	Area/Section / equipment	Hazards	Risk Control Measures
4.1 Raw material section			
4.1.1	Workshop	Injury in grinding operation	· Wear goggles for all grinding machine operations. · Operate grinding wheels at recommended speed with recommended depth of cut. · Use proper wheel guards on all grinding machines. *(Refer SG-09: Safety Guideline in Equipment & Machinery Guarding, SG-18: Personal Protective Equipment (PPE) Management)*
4.1.2	Material move-ment	Hazards due to conveyors	· Avoid sitting, standing, or walking on conveyors · All conveyors to be provided with proper guards. · Never perform maintenance while a conveyor is in operation. · Ensure correct operation of conveyor controls. · Avoid loose clothing while working near conveyor · Emergency "shut-off" devices to be provided · Follow lock-out/tag-out procedures for maintenance · Only authorized/trained personnel to operate or maintain the conveyor. (*Refer SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts*)
4.1.3	Material handling	Hazards in Ma-terial handling & stacking area	· Maintained floors in proper condition · Stacked the material properly without any billet ends protruding out · Clearly defined walkways, proper stacking of material. · Regular clearance of debris. *(Refer SG-13: Safety Guideline for Material handling (manual and mechanized) & storage)*

Sl. No.	Area/Section / equipment	Hazards	Risk Control Measures
4.2 Reheating Furnace			
4.2.1	Fuel (Pulverised coal/oil/producer Gas/NG/LDO/HFO) handling	Gas poisoning due to leakage of gas	· All the gas line to be insulated from circuit by "U" seal and also fill up water in water seal and ensure overflow of water to drain. · Water seal to be properly maintained in producer gas plant to avoid gas leakage. · Any type of fuel oil spillage/leakage to be immediately repaired. Also thermostats monitoring oil temperatures to regularly monitored for proper functioning. · In case of pulverised coal firing, preheated air temperature to be properly maintained to avoid back fires in pipe. Also, the silo meant for storage of powder coal may be kept 1/3rd empty in order to avoid fires due to spontaneous combustion. · Blanking of gas line to be done before Removal of valves or flanges. · Proper packing to be provided in fixing of valves or flanges. · Regular inspection of gas lines to detect leakage if any. · Use Portable "CO" monitors to detect gas leakage. · Ensure the closure of main valve to cut off supply · Check all the flange/ welded joints for gas leakage. · Purge the gas pipe line with nitrogen in small segments by opening the bleeder valve · In case of Natural gas firing(NG), ensure that a proper gas train is installed having all the components as per Norms. Always refer to the burner manufacturer instructions and safety precautions. Ensure that all the safety shutoff valves and pressure switches are working properly. Maintain the gas pressure as per burner manufacturer's recommendations. Filter or strainer to be properly maintained to protect downstream safety shutoff valves. *(Refer SG-21: Safety Guideline for Handling Fuel Gas)*
4.2.2	Cutting/Welding	Fire hazards	· Give clearance for cutting/welding etc after ensuring that there is no leakage of gas · Keep the Portable fire extinguishers ready for any hazards · While lighting up or off of the furnace, laid down procedures are to be followed strictly. *(Refer SG-16: Safety Guidelines for Fire Safety, SG-07: Gas cutting & welding)*

Sl. No.	Area/Section / equipment	Hazards	Risk Control Measures
4.2.3	Burn injury	Burn injury hazards, Exposed to hot flames and hot billets/ingots	· Keep the first aid kit having burn injury medicine on standby *(Refer SG-24: Safety Guideline for Transportation in steel industry)*
4.2.4	Re-lining of furnace	Hazards associated with re-lining of furnace with refractory bricks	· Work permit system to be followed. · Monitor the temperature of area before starting work · Hand held 24 V bulb to be used during repairs in furnace · Detail job safety protocol to be prepared to undertake the job · Confined space safety precautions to be ensured during furnace relining *(Refer SG-04 : Safety Guidelines for Permit to Work(Operation & Maintenance) , SG-03: Working in confined space)*
4.2.5	Maintenance	Hazard due to mechanical & Electrical Maintenance	· Shutdown/permit to work with electrical isolation · All electrical equipment/ machines to be earthed properly *(Refer SG-04: Safety Guidelines for Permit to Work (Operation & Maintenance))*
4.3 Rolling Mill			
4.3.1	Roller Table and Rotating machines	Injury from Moving roller table	· Shutdown/permit to work with electrical isolation. · No work to be done on conveyor in running condition. · Local emergency switch to be operated for approaching conveyor. · Siren system prior to restarting conveyor. · Loose clothes prohibited. · Area barricading if material is removed from height. · Standard maintenance schedule to be strictly followed for proper upkeep of rollers. · Anti sharp protrusions on rollers to be avoided. *(Refer SG-09: Safety Guidelines in Equipment & machinery Guarding)*
		Injury from Rotating machineries	· Prohibited Entry during operation – Area to be demarcated clearly · Coupling guards to be in place. · Loose clothes to prohibited *(Refer SG-09: Safety Guideline in Equipment & machinery Guarding,* *SG-11: Safety Guidelines for Barricading)*

Sl. No.	Area/Section / equipment	Hazards	Risk Control Measures
4.3.2	Mill Stands	Injury during Working on mill stands	· "Permit to work" practice to be followed strictly · Display of "Men at Work" board is to be done at Operator Control Panel *(Refer SG-04: Safety Guidelines for Permit to Work(Operation & Maintenance))*
4.3.3	Rolls change	Injury during Roll Change	· During Roll Change, Rolls to be cooled with water spray before work to avoid burn injury. · Ensure to take Power Shutdown for Roller Table and connected drive. · Ensure written Work Clearance to be given to concerned personnel for doing the work. · Cleanliness of area with respect to presence of oil, grease, jute and other inflammable materials before gas cutting/ welding job. · Availability of fire hydrant to be ensured if job involves gas cutting etc. · Display "Men at Work" board at Operator Control Panel. · Place a plate on rollers table for smooth entry of personnel. · Ensure that "Job completion Report" is given in writing and then cancel "Power Shutdown," remove "Caution Tags" and give clearance for operation. *(Refer SG-04: Safety Guidelines for Permit to Work(Operation & Maintenance))*
4.3.4	Electrical	Electric shock	· Ensures safety precautions like "Power Shutdown", Work Clearance before stating the job · Display Warning & Danger Boards at strategic locations · Use of rubber Mats &Gloves to avoid electric shocks. · Displaying of "Men at Work" at HT switching on panel. · Proper earthing of brush holder arm etc. · Checking protection and safety devices may expose the maintainer to risks in the event that the devices are not functional. For this reason, the machines must be isolated from their main power sources (electrical switchboards, main delivery valves, etc.) under proper supervision, using established procedures and written permissions. *(Refer SG-15 : Safety Guidelines for Electrical safety,* SG-18 Personal Protective Equipment (PPE) Management *)*

Sl. No.	Area/Section / equipment	Hazards	Risk Control Measures
4.3.5	Gear box/ coupling	Entanglement/ injury at Gear box/ coupling	· For working in gear box/coupling, take power shut-down for connected drive. · Display "Men at Work tag". *(Refer SG-09: Safety Guideline in Equipment & machinery Guarding)*
4.3.6	EOT Cranes	Injury while Working on EOT Cranes	· For safe working, ensure" power Shutdown," Work Clearance Men at Work tag, · Watch by additional person to observe movement of nearby crane etc. · Anti-Collision devices to be mounted on all Cranes · Stoppers are to be welded on both sides of crane on LT rails. · Submit job completion report after repair. · All the lifting tools and tackles to be checked every year as per statutory requirement. *(Refer SG-14: Safety Guidelines for work on Electric Overhead Travelling (EOT) Crane)*
4.3.7	Belt/chain drives	Injury in Motors with belt/chain drives	· Provide guards on all the motors having belt/ chain type transmission mechanism.
4.3.8	Flywheel	Injury with Flywheel	· Flywheel to run below safe speed limits. · Appropriate guard to be provided around flywheel. *(Refer SG-09 : Safety Guidelines in Equipment & machinery Guarding)*
4.3.9	Hot material handling in Repeater type and/or Direct Rolling of transfer of Hot Billets	Person hit by rolling hot material during looping and play and transfer of hot billet from caster to mill	· Auto Announcement during pusher/ejector/ roughing operation. · Proper guards to be provided to avoid material coming in the way of workmen. · Safety cages to be incorporated in areas of High Speed shears · Proper pathways to be provided for safe movement. · Proper leg/arms guards/safety goggles to be provided to tongs men · Permit to work prior to undertaking any maintenance job. *(Refer SG-11: Safety Guidelines for Barricading and SG-18: Personal Protective Equipment (PPE) Management)*
4.3.10	Cooling Fans	Injury from Cooling Fans	· Appropriate guards to be provided around fan blades. · Proper stand to be provided. · Earthing to be provided. *(Refer SG-15 : Safety Guidelines for Electrical safety)*

Sl. No.	Area/Section / equipment	Hazards	Risk Control Measures
4.3.11	Handling of Heavy loads	Injury from Manual Handling of Heavy loads	· Use appropriate lifting tackles like chain pulley block , hoist etc to lift heavy parts
4.3.12	Handling of stock at stands	Injury from Handling of stock at stands	· All hand tools to be well designed, frequently inspected and well maintained. · Rivets of tongs used at mills to be renewed frequently.
4.3.13	Major Repair	Injury during Capital Repair Job in Rolling Mill	· All the power shutdowns of the required system to be taken as per the dully filled work permit form and necessary clearance from concerned operation and electrical area. · Ensure that all lifting tools & tackles (winches, Hug-zugs, Chain Pulley Blocks etc.), mobile cranes are tested by a competent person and test certificates are submitted. · For working at height, a "Work at heights pass" to be obtained from safety department and use of appropriate safety belts. · All portable electrical equipment, welding machines to be earthed effectively (body earthing). · Before any heavy structural member is gas cut, it is to be supported by ropes, chains or any other means to prevent its dropping or swinging. · Suitable fire extinguisher in working condition must be kept close to all welding and gas cutting operations. · Rolling of gas cylinders to be avoided and transferred / shifted by proper trolleys. · Proper protection to be provided to conveyor and electrical cables to prevent fall of sparks from welding/ gas cutting. · Isolation of electrical power and written clearance to be obtained from electrical section before start of dismantling operation. · Area of work to be illuminated, before starting the job. · Movement of the employees to be restricted to working area only. · Mono rail hoist/EOT crane, to be operated with in safe working load (SWL) of the equipment. · All the openings created during dismantling to be immediately covered/ barricaded. · Compressed air vessels and pipelines to be depressurized before dismantling.

Sl. No.	Area/Section / equipment	Hazards	Risk Control Measures
			· Combustible/Inflammable materials such as coal powders, oil spillages etc. are to be removed from the place where gas cutting/ welding jobs are to be carried out. · A charged water hose pipe may be kept near the place of work. · People involved in hazardous area to be imparted first aid & fire fighting training. · Prior to actuation it must be ensured that no persons are in the active area of the dangerous energy (mechanical, electrical, hydraulic, pneumatic, etc.).
4.3.14	General safety norms for Hydraulic & Pneumatic Systems		· All pressure systems are dangerous if tampered with during their operation · It is therefore essential before carrying out any operation on the plant to make sure that the system has stopped and that there is no residual pressure in the pipes and, if replacements are necessary, loosen the connections lightly to discharge the residual fluid. · Any pressure accumulators in the system (tanks with nitrogen pockets, pressurized air or oil tanks, etc.) must be cut off from the rest of the system by means of the valves provided in the design. When carrying an accumulator with a full nitrogen pocket, the pocket should be completely emptied *(Refer SG-10: Safety Guidelines for Hydraulic System safety, SG-22: Energy isolation)*

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be displayed covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- Housekeeping of all working areas should be maintained
- Regular checking and maintenance of all process safety interlocks, emergency switches etc. are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection/management of the hazards.

- Safety devices in conveyor system (PCS, BSS, ZSS , Interlocks etc.), Hooter before starting
- Guards over rotating components
- Hooter before start of roller table
- Portable & fixed CO monitor
- U- seals for isolation
- Stopper, anti collision devices to prevent crane collision

PPE Matrix

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Breathing Apparatus
Raw Material Section	Yes	Yes	-	Yes	Yes	-	Yes	-	-
Reheating Furnace	Yes	Yes	-	Yes	Yes	-	Yes	-	-
Rolling Mill area	Yes	Yes	-	Yes	Yes	-	-	-	-
Hydraulic Area	Yes	Yes	-	Yes	-	-	-	-	-
Bundling area	Yes	Yes	-	Yes	Yes	-	-	-	-
Despatch area	Yes	Yes	-	Yes	-	-	-	-	-
Coal Pulveriser	Yes	Yes	-	Yes	Yes	-	Yes	-	-
Repeater Area/Direct rolling transfer path	Yes	Yes	Yes	Yes	Yes	-	Yes	-	-

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like gas monitor etc) may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviations:

SOP	Standard Operating Procedure	**CO**	Carbon Monoxide
SMP	Standard Maintenance Procedure	**SWL**	Safe Working Load
EOT	Electric Overhead Travelling	**PPE**	Personnel protective Equipment

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL,GOVT. OF INDIA	HOT ROLLING MILLS(AUTOMATIC)	Doc. No: SG/37
		Rev no. – 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent workplace injuries & incidents including damage to plant and machinery through identification of hazards associated with Hot Rolling Mills and implementation of risk control measures.

2. SCOPE:

This safety guideline is applicable to High-speed Automatic Hot Rolling Mills. The scope of this document starts from receipt of Input Slab/billet/ blooms from SMS-CCS up to finish coil dispatch yard.

3. PROCESS:

Rolling Mills consist of different type of Mills based on the desired products namely:

3.1. Long Product Mill

- Light and Medium Merchant Mill/ Bar Mill.
- Wire Rod Mill.
- Medium Merchant Structural Mill.

3.2. Flat Product Mill

- Plate Mill
- Hot Strip Mill

3.1. Long Product Mill

All Long Product Rolling Mills (Automatic) are having following main sections:

3.1.1. Charging grid:

In this section, the raw materials like Ingots/ blooms etc. are received from Steel melting shop. Visual inspection is made to detect any defects like surface cracks, piping, bulge outs, Heat no's etc. The defective Ingots/blooms etc. are identified and are ejected from charging roller tables. The material to be heated is put on the charging grid for charging into furnace. As per production/discharging rate, the material is charged / pushed into furnace at regular intervals with the help of motorized/ hydraulic pusher. Blooms/ billets etc. are charged into the reheating furnace.

3.1.2. Furnace & Roller table:

- Reheating Furnace/ Walking beam furnace/Tunnel furnace: Mixed/ Coke oven gas/ Corex gas is taken from the common gas network and is utilized for reheating the blooms/ billets/slabs up to a required rolling temperature. The reheating furnace is walking beam type and uses mixed gas for fuel and indirect water cooling system for cooling skids, charging rollers and doors. The walking furnace is equipped with air recuperators, for waste gas heat recovery from flue gas, which pre- heats the combustion air from combustion fans before combustion. Inside the furnace the blooms can be heated up to

the rolling temperature of around 1200°C. The heated blooms/ billets etc. are discharged from furnace through the side discharging door and are send to the roughing train of the mill for rolling process.

- Roller table: To discharge the hot blooms/billets/slabs to rolling mill for rolling operation.

1.1.3. Mill Section:

- To roll the hot blooms / billets / slabs etc. into desired shape by passing it between set of revolving rolls. The rolls may be plain or grooved rolls depending on product. Rolling operation may contain one or more roll stands depending on reductions required.

The Mill section comprises of the following sub sections:

- Rolls & Guides preparation area
- Roughing stands
- Intermediate stands
- Finishing Mill
- Cooling bed / Conveyors
- Shearing section /cold saw
- Oil cellars / Hydraulic room
- Shipping area
- Coil Box

Some of critical Equipment's/ facilities in Rolling mills (Automatic) are as follows:

Sl. No.	Area	Major Equipment's
1.	Charging grid	· Slab/Billet/Bloom Storage · EOT Crane · Yard Roller Table · Lever type Pushers · Elevators and Take over devices.
2.	Reheating Furnace Section	· Charging Roller Table, · Bloom Pusher, · Dilution Air Fans, · Combustion Air Fans, · Air Recuperators, · Burners, · Evaporative Cooling System, DMDA(De-mineralized and De-aerated) · Pumps, Gas and Air Control Valves, U-Seals etc
3.	Rolling Mill Section	· Delivery Roller Table, · Vertical & Horizontal Stands, · Pinch Roll, · Measuring Roll, · Flying Shear, · Run out Roller Table, · Approach group Roller Table, · Turnover Cooling Beds, Oil cellars, · Scale Flume Tunnels, EOT Cranes, Cable cellars etc.

1.2. Flat Product Mill

The Flat Product Hot Rolling Mill has following main sections:

1.2.1. Yard management Section:

In this section, the raw materials like Billets / Slabs etc. are prepared for further rolling operation. Ingots / Billets / Slabs charging in furnace scheduled through automated planning management system and unique identification number / code generated against the product to track the material till final dispatch. The raw materials like ingots/billets/slabs etc. transported to furnace for reheating through automated transfer trolley, roller tables and EOT /charging cranes.

1.2.2. Reheating Furnace:

Various sub-sections of reheating furnace section and their functions are as follows:

1.1.1.1. **Fuel management Section**: The fuel management section may include, Different gas lines like CO gas, Natural gas, Mixed gas, Nitrogen gas etc., different Gas pipes, various types of electro pneumatic valves, Pressure Relief Valve, injector blowers ,waste gas exhaust system, chimney etc. The main function of this section is to prepare fuel for proper/efficient combustion in reheating furnaces.

1.1.1.2. **Roller Conveyor/Roller table**: To transport and charge the material into the furnace as well as transfer discharge heated material to rolling mill for rolling operation.

1.1.1.3. **Reheating Furnace**: To convert chemical energy of fuels into heat energy and heat the material to required temperature efficiently and economically. Reheating furnace prepares the material for further hot rolling operation. The reheating operation includes Charging, Pushing, heating and discharging/conveying to rolling mill.

1.2.3. Rolling mill:

To roll the hot crude steel products into desired shape by passing and squeezing it between set of revolving rolls. The rolls may be plain or grooved rolls depending on product. Rolling operation may contain one or more roll stands depending on reductions required.

The Rolling Mill comprises of the following sections:

- Primary De-scaling
- Roughing stands/ Intermediate stands
- Roller tables
- Coil Box
- Finishing Mill
- Cooling bed/laminar area
- Down coiler
- Shearing section/finishing yard
- Dispatch yard
- Oil Cellars
- Flume tunnels
- Scale pit/settling tank
- Drive mechanisms

Some of critical Equipment/ facilities are as follows:

Sl. No.	Area	Major equipments
1.	Yard managementsection	Slab/Billet handling transfer trolley, Roller tables and EOT /chargingcranes etc.
2.	Reheating furnacesection	Gas pipe line, blowers, burners, pressure regulators, explosion flaps, extractor table etc.
3.	Rolling Mill Section	Roller Table, Mill Stand, Crop Shear, Coil Box, Down coiler / Recoiler, Power transmission mechanism including oil cellars, Conveyors, Motors etc.

Typical Layout of Flat Product Hot Rolling Mill

1. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
4.1.1	Charging Grid Section	Hit by Object	· Keep away from moving cranes. Effective audible and visual communication devices should beinstalled on a crane or hoist. · Unauthorized Entry to be restricted by interlocking system. · Crane operators are to be get alert when someone is moving in that area. · Use crane fingers while carrying Ingots/ blooms/billets/slabs etc. by using magnetic crane. · Battery backup for the magnetic cranes to be ensured. *(Refer SG-13: Safety Guideline for Material handling (Manual and Mechanized) & storage)*
		Fall of Material	· Stacking height should be specified. · Maintain floors in proper condition. · Stack the material properly without any bloom/billet ends protrudingout. · Clearly define walkways and properstacking of material. · Ensure regular clearance of debris.
		Slip, trip & fall	· Regular removal of over lengthbillet cutting pieces (Obstructions). · Maintain clean surroundings by following housekeeping plan. *(Refer SG-13: Safety Guideline for Material handling (Manual and mechanized) & storage)*
		Contact with hot billet	· Entry to be restricted. · Hard Barricades should be in place. · Cautions display.

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
4.2 REHEATING FURNACE			
4.2.1	Reheating Furnace	Gas poisoning due to leakage of gas	· Gas Line, Color coding of pipeline, cautions of gas hazards displays. · Fixed Gas monitors surrounding of the furnace · Only authorized movement · Always carry portable CO Gas monitor while moving in gas prone area · U-seals are in line always and should be maintained effectively. · During shutdown proper protocol to be maintained, blanking, purging, testing, etc. · Emergency preparedness plan should be in place. · (Ref: SG-21 : Safety Guideline for Handling Fuel Gas)
		Fire/ Explosion hazards	· Hot work permit system in place. · Explosive mixture should be zero before starting any hot job on gas pipeline. · Emergency preparedness plan should be in place. · Training to employees on Operation and maintenance safety of Mechanical equipments. · Fire fighting Engineering controls. · Administrative (procedural) controls. · HAZOP should be done for gas line system. *(Refer SG-16 : Safety Guideline for FireSafety, SG-21 : Safety Guideline for Handling Fuel Gas)*
		Burn injury hazards, exposed to lames and billets/ingots	· Ensure Furnace door in closed condition. · Entry restricted. · Use standard safety gadgets.
		Hazards associated with re-lining of Furnace with refractory bricks	· Work permit system to be followed. · Task based risk assessment to be done for all the activities involved during relining. · Monitor the temperature of area before starting work. · 24 V bulbs to be used during repairs in furnace. *(Refer SG-04 : Safety Guideline for Permit to Work(Operation & Maintenance),SG-03: Safety Guidelines for working in confined space, SG-18: Management of PPE, SG-13: Safety Guidelines for Material Handling, SG-01: Safety Guideline on storage, handling &use of gas cylinders, SG-15: Safety Guidelines for Electrical Safety)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
4.3 MILL SECTION			
4.3.1	Rolling	Caught in between machinery	· Coupling/Spindle guards to be inplace. · Loose clothes to be prohibited. · Emergency stop button shall be installed near to major drives/roller table group drive · Crossovers to be provided in the mill with wire mesh *(Refer SG-11: Safety Guidelines for Barricading)*
		Person hit by rolling hot material during cobble	· Auto Announcement during pusher/ejector/ roughing operation. · Proper guards to be provided to avoid material coming in the way of workmen. · Proper pathways to be provided for safe movement. · All required safety Interlocks of the Equipment & Process including auxiliary system for sequencing of operation. · Provision of Emergency stop of Mill during cobble. · Reviewing previous incident reports, Periodic Check / Maintenance including critical process safetyequipment. *(Refer SG-11 : Safety Guidelines for Barricading)*
		Burn injuries during removal of cobble by Gas cutting/ Lancing	· Usage of no touch tools. · For removing of cobbling material person should not move on apron stands. · Maintain clean surroundings with good housekeeping. *(Refer SG-07 : Safety Guideline for Gascutting & Gas Welding, SG-18 : Personal Protective Equipment (PPE) Management)*
4.3.2	Roll Change/ Pass Change	Fall of object	· Ensure proper condition and load carrying capacity of slings beforeuse. · Trained Riggers are deployed. · Material handling and safety practices training to be given. *(Refer SG-13 : Safety Guidelines for Material handling (manual and mechanized) & storage)*
		Caught inbetween objects	· Permit and LOTOTO procedure to be followed. · Person should not be in the line of fire. · Only trained/skilled team to be engaged.

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
		Burn injury	· During Roll Change, Roller's temperature shall be ensured before lifting through temp. gun.
		Slip & Fall from height	· Suitable platforms are to be provided near roller table for smooth entry of personnel. · There should be provision for anchorage (lifeline) of lanyards.
		Hit by flying object	· Never use a grinder without the grinding wheel guard which is provided for protection. · Check the grinding wheel for any kind of crack or damage before using the grinder. · Check the expiry of grinding wheel. · Check for RPM of Wheel and Machine
			· Check that the maximum operating speed, dimensions and other specifications of the grinding wheel are correct for the machine where itwill be used. · Use standard Tools during maintenance.
4.3.3	Mill maintenance	· Hazards duringWork-ing on EOT Cranes	· Bent-out, open-ended spanners notto be used. · Ensure use of correct sized tools. · For safe working, ensure "Power Shutdown,"(LOTOTO) procedure. · Stoppers are to be welded on both sides of crane on LT rails · All the lifting tools and tackles to bechecked every year as per statutory requirement. *(Refer SG-14 : Safety Guideline for work on Electric Overhead Travelling (EOT)Crane)*
4.4 SHIPPING AREA			
4.4.1	Material Dispatch	Interface be-tween Loco movement	· Automatic siren system is to be installed wherein the siren starts assoon as the wagon enters the shedin two places i.e. one at entry of shed and the other inside the shed to caution the movement of wagon. · Barricading is to be done on both sides of the track.(Access Control) · Attendant from traffic department is to be ensured along with moving wagons at the front carrying the signal lamp/flag alerting the personnel along the track way. · Blowing of horn by engine driver for alerting the personnel. · The maximum safe height of stacking is up-to 2 meters.

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
			· Track maintenance and leveling is to be done regularly by traffic maintenance group to prevent unexpected rolling-over of idle wagons. *(Refer SG-13: Safety Guideline for Material handling (manual and mechanized) & storage), SG-25 for 'Loco Operation')*
		Hit by Trailer	· Loading areas are to be earmarkedclearly. · Systematic distribution of trucks / trailers to various loading points to be ensured to prevent congestion. · In case of multi-layered loading of trailers, coils are to be additionally secured in place by proper lacing arrangement before leaving theshop floor. · Ensure that the vehicles movewithin the safe speed limits in the shop floor as per state specific guidelines. · Vehicles personnel are not allowed to crowd near the loading points. *(Refer SG-24: Safety Guideline forTransportation in steel industry)*
		Hit by Product/ material / object	· Keep away from moving cranes. · Effective audible and visual communication devices should be installed on a crane. · Battery backup for the magnetic cranes to be ensured. *(Refer SG-13 : Safety Guideline for Material handling (manual and mechanized) & storage)*
4.5 SHEAR AREA			
4.5.1	Shear Area	Cut piece fly-ingaway	· The shears shall have safety cage. · Maintenance of shear shall be done only after complete shutdown of the shear drive. In hydraulic operated shear, the line shall be de-pressurized completely. · Cautions shall be displayed near to the shear. · The mesh of safety cage shall be less than the minimum size rolled (rod/bar mill).
4.6 CELLAR AREA			
4.6.1	Oil Cellars	Fall from open-ing ,Suffoca-tion, Fire, Slip & fall, Electric Shock	· Proper Covering of all openings. · For covers removal, permit should be taken. · Proper Lighting in Cellars including Tunnels etc. · All required safety Interlocks of the Equipment & Process including auxiliary system for sequencing of operation.

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
			· Safety guard for rotating part in cellar like coupling Guard etc. · The Entry & Exit should be marked properly for easy escape incase of fire. · Proper Ventilation system as applicable. · Proper Fire fighting system to be provided for cellar to take care any fire accidents · Anti Skid tiles to be provided forflooring to avoid any slipping. · Sump pump should be installed in Cellar to avoid any flooding · Emergency lights should be in place. · Emergency plan in place and mock drill shall be conducted. · Oil Cellar to be checked everyday/week as per checklist forleakages · Access control deployment · Communication system in case of emergency · Regular housekeeping *(Refer SG-15: Safety Guideline for Electrical safety & SG-16 on 'Fire Safety')*
4.7 YARD MANAGEMENT SECTION			
4.7.1	Yard Management	Hazards due to material transfer trolley Hazards in Material handling & stacking area (Loading and unloading point hazards related)	· Avoid standing or moving near material handling transfer trolley. · Interlocks with sensors(auto Stop) · Audio visual hooter shall provide in trolley to generate alert during its auto movement. · Ensure correct operation sequence of transfer trolley movement. · Avoid loose clothing near moving equipment /transfer trolley /Roller tables. · Emergency "shut-off" devices to be provided. · Follow lock-out/tag-out procedures for maintenance, including all Energy source isolation – like fluid energy gas energy, power etc. · Unauthorized entry prohibited in billet / slab storage yards. · No human interface/ ground movement allowed in billet /slab yard during material handling with EOT/charging cranes. · Only authorized/trained personnel to operate or maintain the yard management section equipment. · Good flooring and adequate Illumination level to be maintained at material storage yards. *(Refer SG-13 : Safety Guideline for Material handling (manual and mechanized) & Storage)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
4.8 GENERAL AREAS			
4.8.1	Maintenance	Caught between	· Follow work permit and positive isolation procedure including all Energy source isolation (fluid energy, gas energy, electrical power etc.) · No work to be done on roller table/walking while conveyor in running condition. · Local emergency switch with key arrangements to be operated for approaching roller table /walking beam Conveyor. · Conveyor guards to be provided on moving conveyor area. · Siren system prior to restarting walking beam conveyor/Roller table. · Loose clothes prohibited. · Area barricading if material is removed from height. *(Refer SG-09 : Safety Guidelines inEquipment & machinery Guarding)*
		Rotating machineries	· Coupling guards to be in place. · Loose cloths to be prohibited. · Only Visual inspection from safe distance may allow in rotating machines. · Moving equipment potential hazards should display near moving equipment. *(Refer SG-11 : Safety Guidelines for Barricading and SG-09 : Safety Guidelines for Equipment & machinery Guarding)*
		Electric shock	· Follow work permit and positive isolation procedure including all Energy source isolation. · Displaying of "Men at Work" at HT switching on panel. · Use of Arc Flash suit of rated ATPV. · Use non-contact type testers to check the residual voltage after isolation of electrical power from main source. · Ensure Proper grounding of electrical power before executing job on electrical equipment. · Competent and trained person only allowed to perform job on electrical equipment. *(Refer SG-15 : Safety Guidelines forElectrical safety)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
4.8.2	Working on EOT Cranes	Fall from height and caught in between	· Follow work permit and positive isolation procedure including all Energy source isolation. · Scotch Block /Stoppers are to be welded on both sides of crane on LT rails to restrict the entry of running cranes in that area. · Crane under shutdown Red flag to be displayed to alert the other moving crane operators. · Indicative barricading (Red tape/Ribbon) to be provided on shop floor to restrict the pedestrian movement below the crane till the shutdown job completes. · Submit job completion report after repair. · All the lifting tools and tackles to be checked every year as per statutory requirement. *(Refer SG-14 : Safety Guidelines for work on Electric Overhead Travelling (EOT) Crane, SG-09 : Safety Guidelines for Equipment and Machinery guarding)*
4.8.3	Handling of Heavy loads (Mill gear box, Mill motors, Blowers,etc.)	Hit by vehicle, fall of material and object	· Use appropriate lifting tackles like chain pulley block, hoist etc. to lift heavy spares. · Use forklift, mobile cranes, trailers to transport the materials from one place to other place. · No job should perform under suspended load and maintain safe distance from mobile equipment. · Guy rope should be used to restrictthe swing of materials whilehandling with cranes. *(Refer SG-13 : Safety Guidelines for Material handling (Manual and mechanized) & storage)*
4.8.4	Scrap handlingin-cludes · Handling of scrap bin through EOT crane. · Handling of scrap coil /pup coil/ transfer bar. · Hoop iron/ trimmed scrap handling. · Chemical drum handling. · Sludge and muck handling	Hit by object, fall into opening, fall of object, splash-es of chemicals	· Warning bell and Auto Audio alarm while crane running. · Ensure no pedestrian movement below suspended load. · Access control deployment i n material handling area. · Trained driver and flagman deployment for mobile equipment. · Inspection of lifting tools and tackles mobile equipment by competent person. · Dyke wall provision at chemical drum storage area. · MSDS of chemical to be displayed & people to be trained. · Fire hydrant and fire extinguisher provision. · Safety shower provision near chemical drums storage area.

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
4.8.5	Major Repair Job in Rolling Mill (Automatic)	Fall of object, fall from height, hit by equipment's, electric shock, etc	· All the power shutdowns of the required system to be taken as per the dully filled work permit form and necessary clearance from concerned operation and electrical area. · Ensure that all lifting tools & tackles (winches, hydraulic jacks, Chain Pulley Blocks, slings etc.), Mobile cranes, Forklift are tested by a competent person and certified driver should only operate the mobile equipment. · For working at height, a "Work at heights pass" to be obtained from safety department and use of appropriate safety harness, scaffold to be ensured before executing the job at site. · All portable electrical equipment, welding machines to be earthed effectively (body earthing).RCCB/ELCB & VRD to be checked in all welding machine before the usage. · Heavy structural member should well be supported and guided by ropes, chains or any other means to prevent its falling or swinging during gas cut or removal from site. · Suitable fire extinguishers/ Fire tender/Fire hydrant lines should be provide at site before executing themaintenance jobs at site. · Rolling of gas cylinders to be avoided and transferred / shifted byproper trolleys. · Proper protection to be provided to conveyors and electrical cables to prevent fall of sparks from welding/gas cutting. · Isolation of electrical power and written clearance to be obtained from electrical section before start of dismantling operation. · Adequate illumination to be ensured before starting the job at site. · Unauthorized entry should be restricted at working site. · All the openings created during dismantling to be immediatelycovered/ barricaded. · Compressed air vessels and pipelines to be de-pressurized before dismantling. · Combustible/Inflammable materials should remove from the place where gas cutting/ welding jobs areto be carried out. · HOT work permit to beimplemented during gas cutting and welding in non-designated area.

Sl. No.	Area/Section/ Equipment	Hazards	Risk control measures
			· A charged water hose pipe may bekept near the place of work. · Emergency response training should be imparted to workingpersons. · Prior to actuation it must be ensured that no persons are in the active area of the dangerous energy (mechanical, electrical, hydraulic, pneumatic etc.). *(Refer SG-13: Safety Guideline for Material handling (Manual and mechanized) & Storage, SG-02: Safety* *Guideline for Working at Height, SG-15: for Electrical safety, SG-16: Safety Guideline for 'Fire Safety', SG-05: Safety Guideline for Illumination at work place, SG-04: Safety Guideline on Permit to Work)*

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be shown covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- All applicable statutory requirements are to be followed as per respective state factory rules.
- Housekeeping of all working areas should be maintained.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection/management of the hazards.

- Portable & fixed CO monitor, U-Seal etc.
- Safety cage in shear
- FDA system in oil cellar area with MVWSS
- Hooter before start of roller table
- Anti collision devices to prevent crane collision, audible alarm/ hooter, limit switches, emergency brakes, hook latches, Safe Load indicator , annual examination etc.
- ELCB/ RCCB & VRD in welding machines

PPE MATRIX

PPE / AREA	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body Harness	Arc Flash Suit.
Reheating F/c	YES	YES	YES	YES	YES	-	-	YES	-	-
Roughing Mill	YES	YES	-	YES	YES	YES	-	YES	-	-
Coil Box Area	YES	YES	-	YES	YES		-	YES	-	-
Finishing Mill	YES	YES	-	YES	YES	YES	-	YES	-	-
Coiler Area	YES	YES	-	YES	YES	YES	-	YES	-	-
Roll Shop	YES	YES	-	YES	YES	YES	-	YES	-	-
Finish Goods Bay	YES	YES	YES	YES	YES	YES	-	YES	-	-
Coil Yard	YES	YES	YES	YES	YES	YES	-	YES	-	-
Systems Area	YES	YES	-	YES	YES	-	-	YES	-	-
Power and Crane	YES	YES	-	YES	YES	-	-	YES	-	-
RHF and RMA	YES	YES	-	YES	YES	-	-	YES	-	-
Mill (Slab Charging & Coil Dispatch	YES	YES	YES	YES	YES	YES	-	YES	-	-

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like gas monitors etc.) may vary based on the specific hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviations:

SMS	Steel Melting Shop	SOPs	Standard Operating Procedures
CCS	Continuous Casting Shop	SMPs	Standard Maintenance Procedures
EOT	Electric Overhead travelling cranes	PPE	Personnel Protective Equipment
CO Gas	Carbon Monoxide gas	LT	Long Travel
RPM	Revolution Per Minute	HT Panel	High Tension/High Voltage Panel
LOTOTO	Lockout – Tagout- Tryout	RCCB	Residual Current Circuit Breaker
HAZOP	Hazard & Operability Studies	ELCB	Earth-leakage circuit breaker

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	COLD ROLLING MILLS- CRM (AUTOMATIC)	Doc. No: SG/38
		Rev No. : 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identification of the hazards associated with Cold Rolling Mills and implementation of risk control measures.

2. SCOPE:

This guideline is applicable to Cold rolling mill of an Integrated Steel Plant or standalone plant. The scope of this document starts from Coil receiving yard to packaging & discharge section.

3. PROCESS BRIEF:

A typical Cold Rolling mill has following main facilities:

3.1. Coil receiving yard: In this section, primary purpose of a coil receiving yard is to efficiently handle and store incoming coils, ensuring easy access and organized storage. The yard is equipped with specialized equipment and infrastructure to handle the weight and dimensions of the coils. This may include cranes, forklifts, coil cars, and storage racks or stands designed specifically for coils.

3.2. Coil tracking and transfer system :In this section, the raw materials like coils are prepared for further rolling operation. A coil feeding is scheduled through automated planning and yard management system and unique identification number/code generated against the product to track the material till final dispatch. The raw materials in the form of coils are transported to processing line through coil transfer car, trucks, forklifts, walking beam conveyors, ASRS (Automatic storage and retrieval system) and EOT cranes.

3.3. Pickling line: Pickling is a process used to remove the oxide scale that forms on the coil surface during hot rolling using hydrochloric acid. A typical pickling section consists of pickling bath, auxiliary tanks for circulating and storing the acid, rinse section, steam heat exchangers, acid fume exhaust system etc.

3.4. Cold Rolling Mill: Cold rolling is a process by which hot rolled coil/ strip is introduced between rollers and then squeezed or compressed to the desired thickness. Cold rolling is done to produce a product with good formability, superior surface finish, reasonable strength and close dimensional tolerance. Cold rolling mill comprises Roll Coolant System, Roll change car, Hydraulic & lubricating system, fume exhaust system etc. It comprises mill stand, roll coiling system

3.5. Skin Pass Mill:Skin passing involves a least amount of reduction. It is used to achieve the optimum mechanical properties to prevent occurrence of stretcher strains in annealed steel, to impart desired surface finish – "matte" on the strip surface and to improve strip shape. Skin pass mill comprises roll change car, different type of rolls, Hydraulic & lubricating system, electrostatic oiler etc.

3.6. Continuous Galvanizing/ Coating Line: Galvanizing is one of the most widely used methods for protecting metal from corrosion. It involves applying a thin coating of zinc to a thicker base metal, helping to shield it from the surrounding environment. Galvanizing line consists of a zinc bath, alkali section, zinc ingot charging mechanism, furnace, passivation and comet section etc.

3.7. RCL (Re coiling lines): For inspection of surface critical outer panel auto grade coils. Defect salvaging, parting, oiling and trimming.

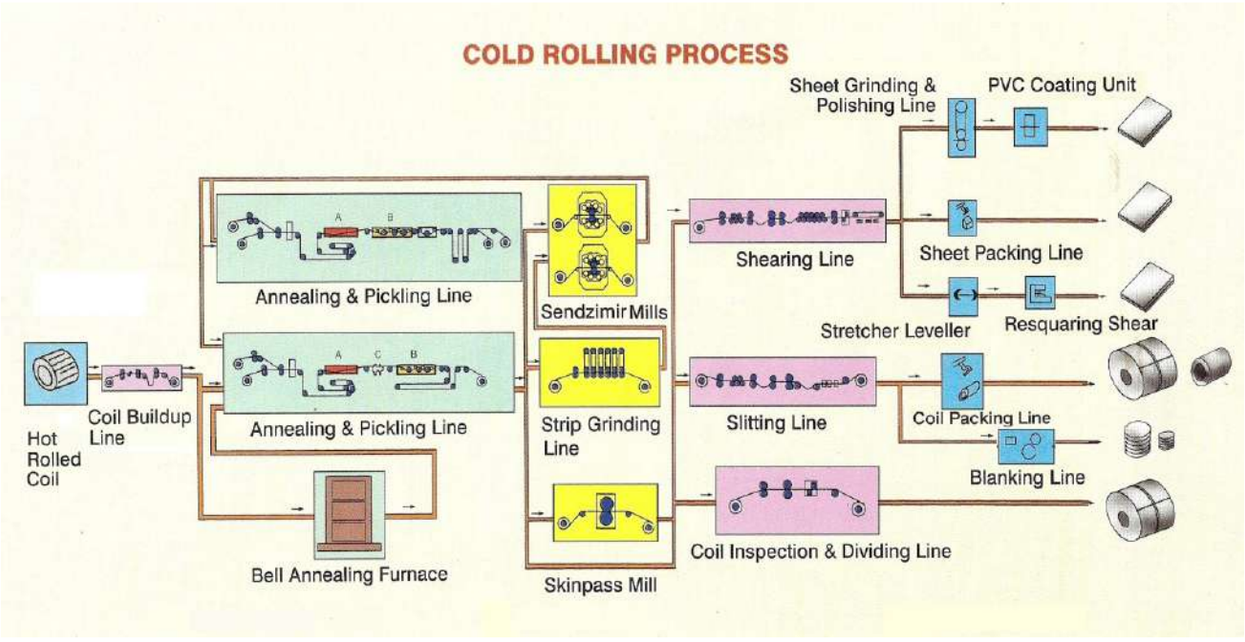
3.8. APL (Auto packaging lines) for finished coil packing to avoid handling and transporting damages. In addition, to avoid rust due to aging.

3.9. Slitting Lines: For slitting of Coils as per required width.

3.10. Packaging and Dispatch

Some of critical equipment/ facilities in Cold Rolling Mill are as follows:

Sl. No.	Area	Major equipment
1.	Coil tracking and transfer system	Coil handling transfer trolley, EOT cranes etc.
2.	Pickling line	Acid tanks and bath, Acid pipelines, Steam supply pipes, fume exhaust system, recoiler, uncoiler, crop shear, edge trimmer, Laser welder, Looper, Scale breaker, bridle rolls, dryer, scrap conveyors, Drive mechanism, Thickness gauge, ARP(Acid regeneration Plant) etc.
3.	Cold Rolling Mill	Mill stand, Crop shear,Coil looper, Uncoiler/Recoiler, power transmission mechanism including oil cellars, drives mechanism, HGC (Hydraulic gap control), Emulsion system, Thickness gauge, Belt wrapper etc.
4	Skin Pass Mill	Mill stand, Uncoiler/Recoiler, Hydraulic oil cellars, Belt wrapper, Drive mechanism, Oiler, HGC (Hydraulic gap control), Thickness gauge, etc.
5	Continuous Annealing Line	Pay off Reel, seam welder, Electrolytic cleaning line, annealing furnace, radiant tubes, loopers, skin pass mill, edge trimmer, oiler ,recoiler, exi walking beam, thickness and width gauge, electric power system and drive system, hydraulic system, gas handling system,
5	Continuous Galvanizing Line	Gas pipe line, blowers, burners, pressure regulators, explosion flaps, furnace, zinc bath, coil loopers etc.
6	RCL	Uncoiler, thickness gauge, Seam Welder, Bridle rolls, Tension Leveller, Trimmer, Inspection table, Stroboscopic light, Oiler, Recoiler, Strapping Machine, Coil cars, Entry & Exit Shear, etc.
7	APL	Inter connecting cars, Coil master, paper and metal body wrapping machines, eye and circumference strapping machines, weigher and auto label pasting robot etc.
8	Slitting Line	Uncoiler, slitting arbour, scrap baller, recoiler
9	Batch Annealing (100% Hydrogen)	Annealing Bases, Heating Hoods (Furnace), Cooling Hoods, Heat Exchanger, EOT Cranes, Coil transfer cars, Inner covers, Mechanical / Magnetic tong, Three arm gripper.



4.0 PROCESS BASED HAZARDS& NECESSARY RISK CONTROL MEASURES:

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.1 Yard Management system			
4.1.1		Hazards in coil handling · Heavy weight · Falling or shifting coils · Pinch points and crushing · Struck by objects · Sharp edges or protrusions · Heat Hazards · Rolling and Toppling	· Even surface and adequate Illumination level to be maintained at material storage yards. · Secure the coils safely on saddles to avoid the rolling of coils in the yard. · Clearly define and mark the walkways maintaining safe distance from material storage area. · Demarcation of walkways · Unauthorized entry to be prohibited in storage yards. · Audible alarms during crane movement, · Defined Crane movement flight way. · Anti-collision devices in cranes. · Crane and coil tracking – automated system. · Intrusion system for boarding / deboarding in cranes. · Coil stacking is typically recommended to be limited to a maximum of two coils high, taking into consideration the size and weight of the coils. However, it is crucial to ensure that the coils are adequately secured at all times during stacking.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.2 Pickling line			
4.2.1		Acid splash/ steam exposure/Burn Injury	· Emergency stop to switch off the pumps. · Follow Work permit. · Schedule maintenance and replacement of pipe joints (Expansion bellows). · Identification of adequate PPE's while working near the pickling line and implementation of the same to be done · Installation of Safety showers in close proximity of hazards. · Fire-fighting equipment (water, chemical powders) · Pickling tank's standard maintenance procedure · Auto fire suppression system, · Dyke in acid storage area · Approach to the tank to be secured · MSDS of acid /chemicals to be displayed & people to be trained.
4.2.2		Cut injury hazards from CR sheet and binding strap, Crush during roll cleaning	· Access control deployment to ensure stoppage of strip movement/ moving equipment while people movement. · Defined position for strap cutting & people at safe distance. · Use of shin guard to protect leg. · During roll cleaning, line should be stopped. · Use long handle cleaning tools. · Use Auto strapping / destrapping M/C · For roll cleaning – Auto Doctor's blade / Automatic Roll polisher may be used
4.2.3		Cut injury due to side edge trimming	· CCTV inside pulpit for monitoring the scrap spillage. · Inspection of track before scrap bucket operation. · Access control deployment.
4.2.4		Corrosion of technological structure	· Apply corrosion-resistant coatings to the structures. · Implement cathodic protection systems. · Conduct regular inspections for early detection of corrosion. · Ensure proper ventilation and control humidity. · Use corrosion inhibitors. · Implement effective drainage systems. · Provide employee education and training. · Address corrosion issues promptly.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.3 Cold rolling mill			
4.3.1		Fire hazard and cut injury during strip breakage recovery, due to presence of oil and use of gas cutting.	· Fume exhaust system should be in off condition. · Cleaning of oily surface before gas cutting. · Ceramic cloth placement over oily surface. · Water spray before gas cutting. · Removal of oil soaked cloth. · Inspection of strip puller before usage. · Lock pin in Carry over table. · Panel lock switch. · Fire extinguisher and fire hydrant availability at site.
4.3.2		Noise hazard during line running	· Regular noise level monitoring. · Noise damping system must be installed at feasible locations. · Visual Display of noise level.
4.3.3		Strip feeding threading related hazards · Entanglement · Strip movement · Man, machine Interface	· Access control deployment to ensure stoppage of strip movement/ moving equipment while people movement. · Proper communication with control pulpit.
4.3.4		Working on mill stands/ housing · Entanglement and crushing hazards from moving parts like rolls, drives, and couplings · Risk of unexpected start-up of machinery leading to injuries · Hazards from stored energy in hydraulic, pneumatic, or electrical systems during maintenance · Pinch points and shear hazards from moving components · Slips, trips, and falls while accessing mill stands or housing work · Electrical hazards during maintenance of mill stand or electrical components	· Adherence to Permit to Work system while working on moving machinery · Display of "Men at Work" board is to be done at Operator Control Panel. · Unauthorized entry should be restricted at mill stand area. · Hooter /Siren to be used before start or stop the mill. · Any Opening near the mill stands are to be guarded *(Refer SG-04 : Safety Guidelines for Permit to Work (Operation & Maintenance))*

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.3.5		Hazards during Roll Change · Crushing hazards from moving roll change cars or equipment · Struck-by hazards from suspended loads like rolls, chocks, or lifting equipment · Pinch points and shear hazards during roll positioning and installation · Stored energy hazards from hydraulic, pneumatic, or mechanical systems used for roll change · Slips, trips, and falls while accessing roll change areas or platforms	· Ensure safe distance of working personnel from suspended load /swing load. · Apply LOTO and ensure positive isolation. After Lock out and tag out ensure Try out to check for any stored energy. · When roll change command is given, mill should not be in ready to run condition. · Ensure Hooter/ warning signal to be used when roll change car movement takes place. *(Refer SG-04 : Safety Guidelines for Permit to Work(Operation & Maintenance))*
4.3.6		Hazards in Cellar · Slip, trip, and fall hazards due to wet, oily, or uneven surfaces · Electrical hazards from submerged or water-exposed electrical equipment and cables · Fire and explosion hazards from accumulation of oil mists or vapors in enclosed cellar spaces · Poor visibility and lighting conditions in the cellar affecting safe work	· Readiness of sump pump in cellar area. · Adequate illumination inside cellar area. · Access control deployment. · CCTV surveillance. · Active fire control system. · Regular housekeeping. · Hot job under strict supervision and hot work permit deployment. · Communication system in case of emergency. · Mock drill to check preparedness. · Fire / smoke detection system, · Automatic fire suppression system, *(Refer SG-16:Safety Guideline for Fire Safety)*
4.3.7		Handling of work roll, Intermediate rolls and Back up rolls · Crushing hazards from falling or inadvertently moving rolls during handling, loading, or unloading operations	· Audio visual hooter should be activated in roll change car. · Indicative barricading to be used to restrict the pedestrian movement during roll changing car movement. · Ensure safe distance of working personnel from suspended load / swing load while handling the rolls with EOT cranes. · Display "Men at Work" board at Operator Control Panel.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
		· Struck-by hazards from swinging or suspended rolls during lifting and transportation using cranes or other lifting devices · Pinch points and shear hazards during manual positioning, alignment, or adjustment of rolls in the mill stand or roll storage areas	*(Refer SG-16:Safety Guideline for Fire Safety, SG-09:Safety Guideline in Equipment & machine Guarding, SG-13: Safety Guideline for Material handling (manual and mechanized) & storage, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance))*
4.3.8		Mill maintenance · Hazardous energy sources (electrical, hydraulic, pneumatic, mechanical) · Pinch points, crush points, and shear hazards from moving parts · Improper use of tools and equipment leading to injuries	· Follow work permit and positive isolation procedure including all Energy source isolation. · Suitable Tools to avoid slippages (e.g: Ring spanners, box spanners etc.) and impact wrenches should be used for maintenance job in mill area. · Competent and trained persons should only perform job on mill equipment. · Tested and certified lifting tools, tackles, jacks to be used in mill area. *(Refer SG-04 Safety Guidelines for Permit to Work(Operation & Maintenance))*
4.3.9		Major Repair Job · Hazardous energy sources not properly isolated, locked out, and tagged out before repair work · Working at heights without proper safety measures and fall protection equipment · Improper handling and setup of heavy machinery, equipment, or structural components · Electrocution	· All the power shutdowns of the required system to be taken as per the dully filled work permit form and necessary clearance from concerned operation and electrical area. · Ensure that all lifting tools & tackles (winches, hydraulic jacks, Chain Pulley Blocks, slings etc.), Mobile cranes, Forklift should be tested by a competent person and certified driver should only operate the mobile equipment. · For working at height, a "Work at heights pass" to be obtained from safety department and use of appropriate safety harness, scaffold to be ensured before executing the job at site. · All portable electrical equipment, welding machines to be earthed effectively (body earthing).RCCB/ELCB to be checked in all welding machine before the usage. · Heavy structural member should well be supported and guided by ropes, chains or any other means to prevent its falling or swinging during gas cut or removal from site.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			· Rolling of gas cylinders to be avoided and transferred / shifted by proper trolleys. · Isolation of electrical power and written clearance to be obtained from electrical section before start of dismantling operation. · Adequate illumination to be ensured before starting the job at site. · Unauthorised entry should be restricted at working site. · All the openings created during dismantling to be immediately covered/ barricaded. · Compressed air vessels and pipelines to be de-pressurized before dismantling. · Combustible/Inflammable materials should be removed from the place where gas cutting/ welding jobs are to be carried out. · Hot work permit to be implemented during gas cutting and welding in non-designated area. · A charged water hose pipe may be kept near the place of work. · Emergency response training should be imparted to working persons. · Prior to actuation it must be ensured that no persons are in the active area of the dangerous energy (mechanical, electrical, hydraulic, pneumatic etc.). *(Refer SG-04: Safety Guidelines for Permit to Work(Operation & Maintenance) , SG-13 : Safety Guideline for Material handling (manual and mechanized) & storage), SG-16 : Fire Safety, SG-02: Working at Height,SG-05: Illumination at workplace, SG-15: Electrical safety, SG-22: Energy Isolation)*
4.4 Skin Pass Mill			
4.4.1		Coil preparation hazards · Improper handling and setup of heavy machinery, equipment, or structural	· Cleaning of oil during gas cutting. · Flash back arrester in gas cutter. · Awareness of workers on SOP. · Crane tong inspection & maintenance. · Fire / smoke detection system · Fire suppression system *(Refer SG-16 : Safety Guidelines for Fire Safety)*
4.4.2		Hazards during collection of scrap and sample	· Unauthorized entry should be restricted at scrap collection area.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.4.3		Hazards of Moving machineries at mill · Man Machine Interface · Electrical Hazard	· Fencing of all moving equipment i.e. rolls spindles, couplings etc. · Smart fencing to prevent man machine interface. · Loose cloths to be prohibited. · Visual inspection from safe distance. · Moving equipment potential hazards should be displayed near moving equipment. · Access control deployment. · Work permit and positive isolation procedure to be followed before performing any maintenance job. · Audible alarms during crane movement / walking beam conveyor movement *(Refer SG-11 : Safety Guidelines for Barricading, SG-04: Safety Guidelines for Permit to Work(Operation & Maintenance))*
4.5 Galvanizing			
4.5.1		Burn injury during zinc dross removal · High Temperature · Liquid metal	· Restriction of Zinc Ingot charging during drossing. · Access Control in Zinc Pot Area. · Use of Jig with Long handles to scoop out Dross. · Safety shower availability at close proximity. · First aid kit availability to be ensured. · Use AI robots for removing the dross if possible.
4.5.2		Burn injury hazards, Exposed to hot water, steam, and hot zinc · High Temperature · Liquid metal	· Use fire resistant personal protection equipment to protect from burn injury / heat exposure. · Keep the first aid kit at shop floor and ensure availability of burn injury medicines. · Maintain safety shower /Eye shower as per standard at shop floor area. · Follow work permit and positive isolation procedures including isolation of all Energy sources – like fluid energy, power energy etc. before executing any maintenance activity. · Competent and trained persons should only deploy to work on critical equipment. *(Refer SG-13 : Safety Guideline for Material handling (manual and mechanized) & storage)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.5.3		Gas exposure due to leakage of gas	· All the gas line to be isolated from main circuit by "U" seal and also filled up water in water seal and ensure continuous overflow of water to drain. · Blanking of gas line to be done before Removal of valves or flanges. · Goggle valves to be used for isolation of main gas lines. · Follow lock-out/tag-out procedures for maintenance,iIncluding all Energy source isolation – like fluid energy, power energy etc. · Proper packing to be provided in fixing of valves or flanges. · Regular inspection of gas lines to detect leakage if any. · Use Fixed and Portable "CO" detectors to detect gas leakage and system should generate auto alarm /hooter/ /siren in case of gas leakage. · Ensure the isolation of main inlet valve to cut off the gas supply. · Check all the flange/ welded joints for gas leakage. · Purge the gas pipelines with nitrogen in small segments by opening the bleeder valve. · Oxy pack should be readily available. · Mock drills should conduct in critical areas to evaluate the emergency preparedness. *(Ref : SG-21 : Safety Guideline for Handling Fuel Gas)*
4.5.4		Fire hazards · High temperatures · Combustible materials · Zinc dust and fumes: Zinc dust and fumes generated during the galvanizing process can create an explosive atmosphere if not adequately ventilated or controlled. Zinc dust can ignite and cause flash fires in the presence of an ignition source.	· Hot work permit clearance should be implemented before executing any maintenance activity like Gas cutting/ welding etc. to eliminate fire hazards in gas area. · Keep the Fire hydrant line /Portable fire extinguishers ready for mitigate the Fire hazards. · Ensure Area ventilation · Keep Emergency announcement / Siren / Hooter system ready. Majority of employees should be imparted Emergency response training and should participate in mock drills. *(Refer SG-16 : Safety Guidelines for Fire Safety, Refer SG-04 Safety Guidelines for Permit to Work(Operation & Maintenance))*

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.5.5		Hazards associated with re-lining of furnace with refractory bricks · Exposure to high temperatures and heat stress during furnace lining · Stored Energy · Confined Space Entry · Falling objects or collapse of unstable refractory structures during installation · Low illumination · Cuts, abrasions, and crushing injuries from handling heavy refractory bricks and materials	· Follow work permit and positive isolation procedures including isolation of all Energy sources – like fluid energy, power energy etc. · Monitor the temperature of area before starting work. Force drafting / Cool Air arrangement should be provided to maintain the normal temperature inside the furnace. · 24 Volt lighting arrangements to be used during repair job inside furnace. · Detail job safety protocol may be prepared to undertake the job if job is irregular. · Confined area permit to be taken from competent person. · Wes guard to be used in welding machines inside furnace/confined space. · Regular disposal of refractory bricks and housekeeping to be maintained in that area. · Temporary material handling conveyor may install to safely and easily transporting of material inside furnace. *(Refer SG-04 : Safety Guidelines for Permit to Work(Operation & Maintenance))*
4.5.6		Scrap handling hazards · Handling of scrap bin through EOT crane · Handling of scrap coil /pup coil/ transfer bar. · Hoop iron/ trimmed scrap handling. · Chemical drum handling. · Sludge and muck handling.	· Warning bell and Auto Audio alarm while crane running. · Ensure no pedestrian movement below suspended load. · Access control deployment in material handling area. · Trained driver and flagman deployment for mobile equipment. · Inspection of lifting tools and tackles and mobile equipment by competent person. · Dyke wall provision at chemical drum storage area. · Fire hydrant and fire extinguisher provision. · Safety shower provision near chemical drums storage area. *(Refer SG-13 : Safety Guideline for Material handling (manual and mechanized) & storage)*

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.5.7	CTL/Shearing line/ RCL/CR slitter.	Hazards in coil handling · Coil handling hazards (falling, rolling, or shifting coils) · Moving machinery hazards (entanglement, crushing, or drawing-in) · Cutting and shearing hazards from blades, knives, or slitters · Low Illuminations	· Good flooring and adequate Illumination level to be maintained at material storage yards. · Store the coils safely on saddles to avoid the rolling of coils in the yard. · Clearly define and mark the walkways maintaining safe distance from material storage area. · Walkways should be well barricaded. · Unauthorized entry prohibited in storage yards. · Audible alarms during crane movement · Defined Crane movement flight way · Anti-collision devices in cranes, · Crane and coil tracking – automated system · Intrusion system for boarding / deboarding in cranes.
		Hazards of Moving machineries · Man Machine Interface	· Fencing of all moving equipment i.e. rolls spindles, couplings etc. · Smart fencing to prevent man machine interface. · Loose clothes to be prohibited. · Visual inspection from safe distance. · Moving equipment potential hazards should display near moving equipment. · Access control deployment. · Work permit and positive isolation procedure to be followed before performing any maintenance job. *(Refer SG-11 : Safety Guidelines for Barricading) (Refer SG-04 Safety Guidelines for Permit to Work(Operation & Maintenance))*
4.6 Batch Annealing / Continuous Annealing			
4.6.1		Coil handling hazards · Struck by Heavy Coils · Collisions of coils · Unauthorized entry	· Clearly define and mark the walkways maintaining safe distance from coil handling area · Demarcation of walkways · Unauthorized entry prohibited in annealing area · Audible alarms during crane movement · Defined Crane movement flight way · Anti-collision devices in cranes · Crane and coil tracking – automated system · Intrusion system for boarding / deboarding in cranes.

Sl. No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.6.2		Fire / Explosion due to Hydrogen Gas / Fuel (Coke oven gas, LNG, Natural Gas, etc) used for heating	· Tightness test of equipment / valves must be carried out before start of annealing process · Tightness test of Furnace should be conducted before start of heating process · Online CO detectors · Online hydrogen detectors · Portable CO detector mandatory during working on shopfloor / cellar · Uninterrupted nitrogen supply should be available for emergency conditions · Emergency purging with Nitrogen – Interlocks should be incorporated in Annealing process in case of hydrogen leakage, or any type of pressure drop · Fire / smoke detection system · Automatic fire suppression system · CCTV surveillance system
4.7 Packaging and Dispatch			
		· Manual handling injuries from lifting heavy coils. · Falling objects causing injuries. · Struck-by and crushing hazards from shifting or falling coils. · Sharp edges and protrusions leading to lacerations. · Ensuring structural integrity of packaging and transport to prevent instability.	· Manual Handling Injuries: Use mechanical aids like cranes or forklifts for lifting and moving coils. Provide proper training on safe lifting techniques and encourage teamwork when handling heavy loads. · Falling Objects: Secure packaging materials tightly around the coils and inspect them for any signs of damage or weakness. Maintain a clear and organized work area to minimize the risk of objects falling. · Struck-By and Crushing Hazards: Ensure proper stacking and securing of coils during packaging and transport. Implement safety protocols, such as using appropriate restraints or braces, to prevent shifting or falling of coils. · Sharp Edges and Protrusions: Handle coils with care and use personal protective equipment, such as gloves and safety footwear, to minimize the risk of injuries from sharp edges. Regularly inspect coils for any sharp or protruding edges and address them promptly. · Structural Integrity: Regularly inspect packaging materials and transport vehicles for any signs of damage or wear. Ensure they are designed and maintained to withstand the weight and movement of the coils. Replace any compromised materials or equipment promptly. *(Refer SG-11 : Safety Guidelines for Barricading) (Refer SG-04 Safety Guidelines for Permit to Work(Operation & Maintenance))*

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signage and emergency escape route shall be shown covering the entire shop.
- Provision & operability of safety fences should be ensured covering the entire shop.
- The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- All applicable statutory requirements are to be followed as per respective state factory rules.
- Housekeeping of all working areas should be maintained.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard

List of instruments/ equipment required for detection/management of the hazards.

- CO detectors (fixed and portable) to detect gas leakage in galvanizing and annealing areas
- Hydrogen detectors in annealing areas to detect hydrogen leakage
- Fire and smoke detection systems in various areas of the CRM
- Automatic fire suppression systems in critical areas
- Emergency stop buttons to switch off pumps and equipment in case of emergencies
- Hooters, sirens, and audio-visual alarms for warnings during crane and equipment movement
- CCTV surveillance systems for monitoring critical areas and processes
- Anti-collision devices in cranes to prevent accidents
- Crane and coil tracking automated systems for material handling safety
- Interlocks in annealing process to initiate emergency nitrogen purging in case of hydrogen leakage or pressure drop
- Thickness and width gauges for process monitoring and control
- Fume exhaust systems in pickling and cold rolling areas
- Acid concentration and temperature monitoring instruments in pickling lines
- Level sensors and alarms in acid storage tanks and chemical drum storage areas
- Temperature monitoring systems in furnaces and annealing lines

PPE Matrix

PPE / AREA	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body harness	Arc Flash Suit.
COIL TRACKING AND TRANSFER SYSTEM	YES	YES	_	YES	YES	YES	YES	_	_	_
PICKLING LINE	YES	YES	YES	YES	YES		_	_	_	_
COLD ROLLING MILL	YES	YES	_	YES	YES	YES	_	_	_	_
SKIN PASS MILL	YES	YES	_	YES	YES		_	_	_	_
CONTINUOUS ANNEALING LINE	YES	YES	YES	YES	YES	YES	_	_	_	_
CONTINUOUS GALVANIZING LINE	YES	YES	YES	YES	YES	YES	YES	YES	_	_
RCL	YES	YES	_	YES	YES	YES	_	_	_	_
APL	YES	YES	_	YES	YES	_	_	_	_	_
SLITTING LINE	YES	YES	_	YES	YES	_	_	_	_	_
PACKAGING AND DISPATCH	YES	YES	_	YES	YES	_	_	_	_	_

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like gas monitors, arc flash suits etc.) may vary based on the specific hazards, safety procedures etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviations:

ASRS	Automatic storage and retrieval system	PPE	Personal Protective Equipment
RCBB	Residual Current Circuit Breaker	AI	Artificial Intelligence
RCL	Re coiling lines	DM	Daily Management
APL	Auto packaging lines	CO	Carbon Monoxide
HGC	Hydraulic gap control	ESP	Electrostatic Precipitator
EOT	Electric Overhead Travelling Crane	SOP	Standard Operating Procedure
CCTV	Closed-Circuit Television	SMP	Standard Maintenance Procedures
ELCB	Earth Leakage Circuit Breaker		

PROCESS BASED SAFETY GUIDELINES FOR IRON& STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	STEEL MELTING SHOP	Doc. No: SG/39
		Rev no. : Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identification of hazards associated with Steel Melting Shop (including Continuous Casting Shop) and implementation of risk control measures.

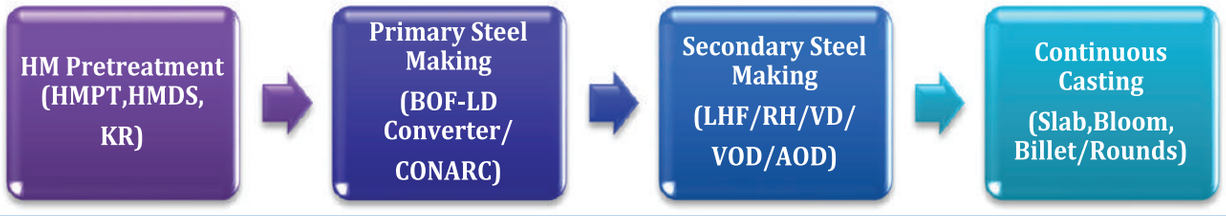
2. SCOPE:

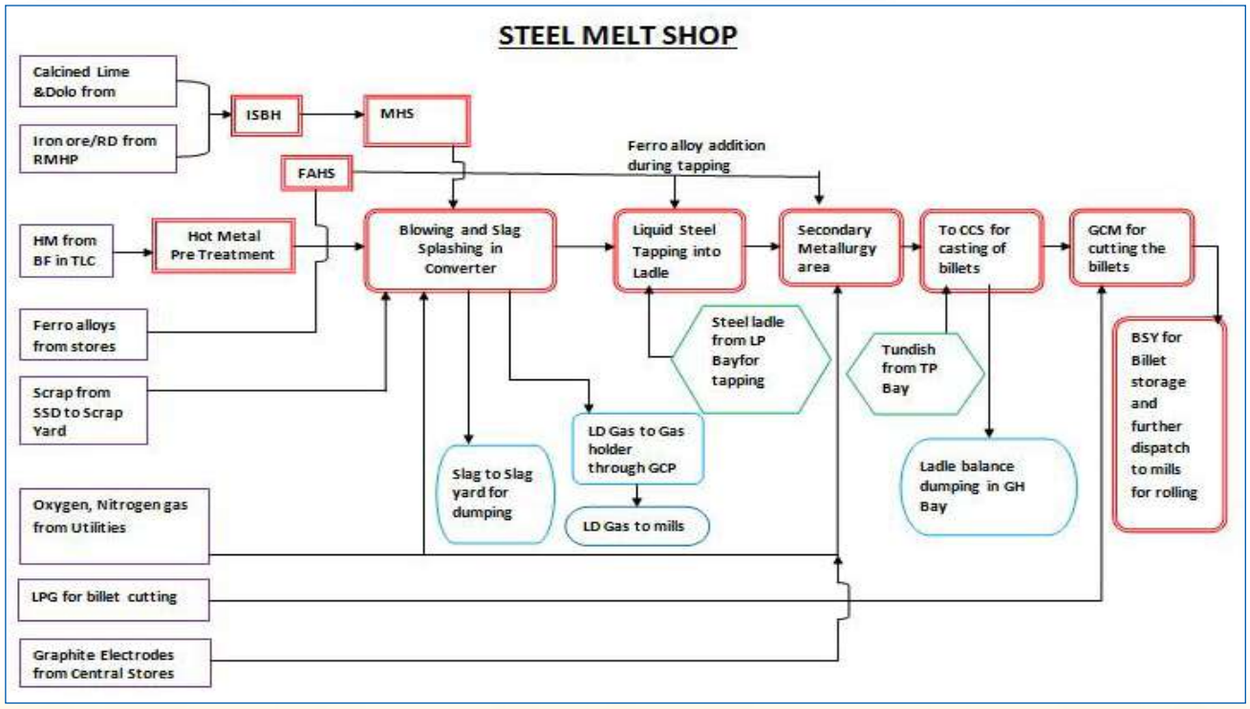
These guidelines are applicable to Steel Melt Shop department of an Integrated Steel Plant**.** The scope of this document starts from receipt of hot metal in open/ torpedo ladles from blast furnace, primary & secondary steel making, pit side & auxiliary units up to dispatch of Slab/Bloom/Billet from CCS (Continuous Casting Shop) storage yard.

3. PROCESS BRIEF:

3.1 Hot metal from Iron making is transported by Open ladles/Torpedoes, which are poured out into hot metal mixer / charging ladle into the furnaces. Conversion of iron into steel requires oxygen blowing or combination of oxygen / electric arcing to reduce carbon, silicon , manganese and phosphorous which are the main impurities.

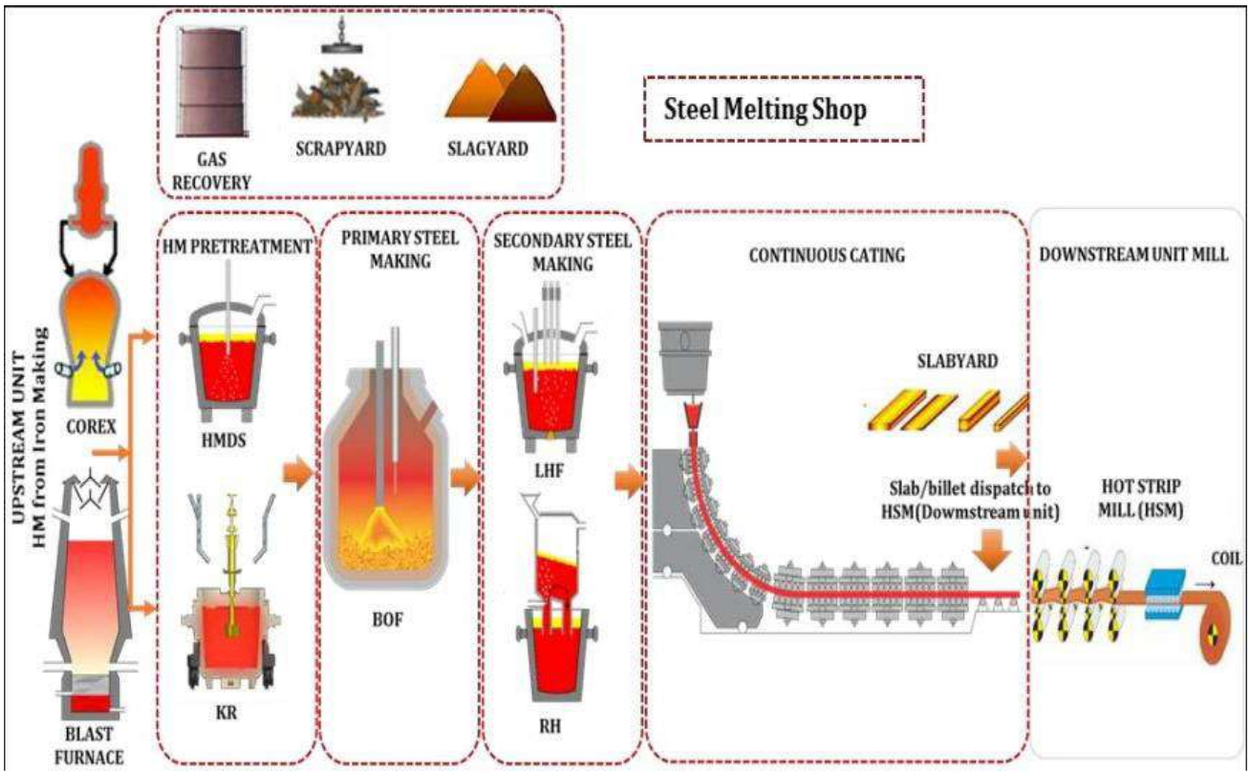
Typical flow chart is illustrated below:





NOTE:

TLC - Torpedo Ladle Car	**HM** - Hot Metal BF- Blast Furnace	**MHS** - Material Handling System	**FAHS** - Ferro Alloy Handling System	**ISBH** - Intermediate Stock Bin House
LD - Linz-Donawitz	**CCS** - Continuous Casting Section	**GCM** - Gas Cutting Machine	**TP** - Tundish Preparation	**SSD** - Scrap Salvage Department
BF - Blast Furnace	**RD** - Raw Dolomite			



NOTE:

HM – Hot Metal	**HMDS** - Hot metal De-Sulphurization
KR – Kanbara Reactor	**BOF** – Basic Oxygen Furnace
LHF – Ladle Heating Furnace	**RH** – RuhrstahlHeraeus

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

During Hot Metal refining, impurities like Silicon, Phosphorous & Sulphur are 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, post and pre treatment raking / slag skimming is done in Hot Metal ladles to ensure slag free metal for Primary steelmaking.

In some of the 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 & Basic Oxygen Furnace(BOF) units. However present day new steel melt shops mostly 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** : Hot Metal & Scrap are charged in to vessel after which Oxygen is blown to remove impurities in Hot Metal. Fluxes are added to get desired quality product output. Ferro alloys are added to steel ladle during tapping for obtaining required chemistry of steel.

3.3.2 **CONARC Process:** 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 oxygen blowing-led decarburization in one shell and electric melting in another vessel.

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

3.4.1 **LHF / LF:** Ladle Heating Furnace(LHF)/ Ladle furnace ensures reheating of Liquid Steel, coming from BOF. Ladle Furnace utilizes electric energy & graphite electrode to raise & maintain Temperature. Ferro alloys are added to adjust the chemistry of the Steel as per the requirement. Homogenization of liquid steel is achieved through inert gas stirring. Steel is refined & final composition is achieved. Alternately CAS-OB units are used considering sealed argon purging and aluminium based chemical heating.

3.4.2 **RH Degasser :**RH degasser is a secondary refining system that removes dissolved gases such as hydrogen, Nitrogen and Aargon. With Oxygen blowing arrangement at RH degasser, Low carbon / ultra low carbon high-grade steels can be produced .

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.

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 aluminum. Ox-

ygen 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 Induction Furnace (IF) / Electric Arc Furnace(EAF) based route for stainless steel making.In ultra-low carbon stainless steel making Vacuum Oxygen Decarburization (VOD) is used.

3.5 Caster:

3.5.1 **Continuous Casting Machine:** Casterconverts liquid steel into solid shapes either slabs, bloom, billets, rounds, beam blanks 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.In Thin Slab Casting route the cast thin slabs are routed through on-line tunnel furnaces and then in in-line Hot Rolling Mills for conversion to requisite Hot Rolled coils.

1.6 Auxiliary units:

1.6.1 Ladle preparation area : Where in relining, drying and pre heating of all steel & Hot Metal ladles are carried out. Slide gate and buttom purging mechanisms of steel ladles are prepared continuously in this area.

1.6.2 Slag yard: All BOF & Secondary steel slag is handled in this area. Solidified slag is dispatched for further processing.

1.6.3 Scrap yard: Receiving & Preparing of different types of scrap for feeding into BOF as coolent.

1.6.4 Slab/Bloom/Billet Yard: For Handling and transfer of Slab/Bloom/Billet to down stream units (Rolling Mills).

1.6.5 Fuel gases/Mixed gases are used as source for heating purposes within the plant for heating various refractory vessels.

1.6.6 Gas Recovery and Export system / Gas Holder: BOF process gas (LD Gas) is recovered during Oxygen 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.

3.6.7 **EOT Cranes** are used to handle hot metal / steel ladles / equipment handling/ maintenance for casters and slab / bloom / billet handling

3.6.8 **Water Treatment Plant :** BOF and Casting process consumes lot of water for cooling equipment / slabs where in primary cooling is in 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 meeting exigencies power failure/ Emergency situations.

3.6.9 **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 Sub Entry Nozzle

(SEN) & Submerged Entry Shroud (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	· Hot metal Handling Facilities · BOF vessels, · Oxygen Lance systems · Refractory Ladles · Bulk material charging system (BMCS) & Bulk material handling system (BMHS) · Secondary emission control system (SECS) · Dog House · Ferro alloy Charging systems · Lance jam cutting stand and preparation area · Gas Collection, Cooling and cleaning Equipment, Induced Draught fans (ID fans) , Gas holder · Ladle Heating Furnace , Rinsing Stations · RH vessels · Transfer cars for handling of Hot metal, Steel, Slag and scrap · Mobile equipment like Fork lifts, Lining Wrecking machines, excavators , loaders etc., · EOT Cranes, Mobile Cranes, · Transformers , Automation and control systems
Continuous Casting / Caster	· Ladle Turret · EOT Cranes, Mobile cranes, Pay loaders · Mould , Tundish Car · Steam exhausters, Strand Guide Segments /roller blocks (for billet caster), Run out and Discharge roller table · Torch cutting machine, shear units, descalers (for thin slab casting), dummy bar disconnection system, dummy bar storage system, Deburring machine, slab weighing roller tables, Marking machine and product evacuation tables · Cooling beds · Cross transfer mechanism, pusher-piler units, cold and hot charging roller tables, scarfing units etc. · Auxiliary equipments are water pumps for cooling system, hydraulic systems, grease lubrication / atomized air-oil lubrication systems, pneumatic systems and scale flushing system · Mould , segment Repair facilities

4. PROCESS BASED SAFETY HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.1 Transferring HM from Torpedo to HM Ladles			
4.1.1	Movement of the Hot Metal ladle car and align the ladle properly underneath the Torpedo spout.	Fire & Explosion due to Hot Metal Spillage	· Bunds are made to avoid metal flowing to vast areas · All care to be taken to avoid even trace of water in pit where hot metal/ slag/ liquid steel is handled. In case of water ingress proper dewatering pumps to be available to drain water from pit · Regular Inspection of Condition of Transfer car and track · Proper torpedo and ladle lining maintenance with infrared thermography systems to check the thickness of the refractory lining · Trespassing to be avoided by proper barrication and caution lamps/hooter *(Refer SG-23: Safe handling of liquid metal)*
4.1.2	Pouring of Hot Metal from Torpedo ladles to hot metal Ladles	Metal spillage due to over flow	· Proper Positioning of the torpedo and controlled tilting to be ensured to prevent the spillage · Level sensors / load cells for free board measurement system to be in place (Laser/ Radar/Camera based) to avoid overfilling · An interlocking mechanism may be explored in the existing system to tilt torpedo only after correct placement of car. · Visibility to operator should be ensured by ensuring proper functioning of fume/ dust de-dusting system · Functioning of Tilt in / out of torpedo to be checked once before pouring hot metal into ladle. Functional Automation system to be ensured with proper control from control room / operator desk with alarm options and related safety interlocks *(Refer SG-23 for safe handling of liquid metal)*
		Falling out of any crust pieces (during pouring)	· Falling out of any skull pieces (during pouring) to be is watched by the TLC Operator &pouring to be stopped whenever the crust is about to fall.
		Fire/Explosion	· Ensure that pit is free of water. Proper functioning of dewatering pumps in inside the pit in auto mode to be ensured · Regular maintenance of TLC is to be ensured

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
		Trickling/ Puncture of Hot Metal ladle/ Torpedo ladle leading to metal spillage	· Visual inspection of ladle refractory, Life monitoring / Thermography of refractories to check the thickness · Hydraulic tanks if any on transfer car to be protected suitably with proper design and use fire resistant oil *(Refer SG-10: Safety Guidelines for Hydraulic safety)*
4.2 Transferring Hot Metal from Mixer to Hot Metal Ladles			
4.2.1	Pouring of hot metal from open top ladle to mixer	Burns due to Hot Metal Spillage/ Spark	· Metal from the ladle to be poured very slowly and continuously into the Mixer, carefully avoiding jerks and sharp movement so that there is no spillage of hot metal
		Falling out of any crust pieces (during pouring / mixer mouth cleaning)	· Falling out of any skull pieces (during pouring) is to be watched by the Mixer Operator & pouring to be stopped whenever the crust is about to fall. · Entry of person to be restricted during pouring operation.
		Malfunction of Crane	· During movement of crane, sound alarm shall be used to caution persons working below · Brake Test of Crane should be perfomed everyday before start of work and Maintenance of Crane as per the schedule · Limit switches of crane to be checked by operator at the time of takeover
		Improper engagement of crane hook	· Signal man should ensure proper engagement of crane hooks & maintain proper communication crane operator · Safety latch to be ensured for all the auxillary hoist crane hooks
		Improper housekeeping may lead to slip/ trip hazards	· Good Housekeeping is to be ensured
4.2.2	Movement of the Hot Metal ladle car and align the ladle properly underneath the Mixer spout.	Fire due to Hot Metal Spillage	· Level sensors / load cells for free board measurement system to be in place (Laser/Radar/ Camera based) to avoid overfilling · Bunds are made to avoid metal flowing to vast areas
		Jam Formation over Ladle	· Periodic Jam removal from ladle and maintain ladle in good condition
		Hitting of person by Hot Metal ladle car during crossing of Hot Metal ladle car track	· Trespassing to be avoided by providing brarrication & suitable caution boards / flasher lights/ alarms to alert people nearby *(Refer SG-23: Safe handling of liquid metal)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.2.3	Pouring of Hot Metal from Mixer to hot metal Ladles	Metal spillage due to over flow, Overturning of mixer & Mixer through	· Proper Positioning of the HM ladle and controlled mixer tilting to be ensured prevent the spillage / overturning of mixer · Visibility to operator should be ensured · Functioning of Tilt in / out of mixer to be checked once before pouring hot metal. Dynamic Brake / Emergency brake checking is to be done every day before start of work · Ensure functioning of the radar gauge level indicators *(Ref SG-23 for safe handling of liquid metal)*
		Trickling/ Puncture of ladle may lead to metal spillage	· Visual inspection of ladle refractory& Life monitoring / Thermography of refractories
4.3Unloading 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	· Cam-lock coupling to be provided in the hose to prevent unlocking of hoses during conveying pressure operation · Dry Sand in Buckets / Fire Extinguishers to be kept as standby *(Refer SG-16: Safety Guidelines for Fire Safety)*
		Water logging in the area may cause Fire catch/ Explosion	· Regular upkeep to be done &standby Fire Extinguishers to be made available · Any water/ moisture accumulation is to be strictly avoided *(Refer SG-16 Safety Guidelines for Fire Safety)*
		Moisture entrapment in the silo may cause Fire catch & Explosion	· Periodical Calibration of Acetylene analyser · Continuous monitoring of readings along with alarms *(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)	Fire hazard due to Splashing of Metal	· Ladle free board is to be maintained · Operators Cabin to be provided with proper protection to prevent splashes
		Fire hazard due to Trickling/ Puncture of Hot Metal Ladles	· Fire extinguishers and water spray systems to be available to extinguish any fire breakout · Remote operation in raking activity to be explored · Visual inspection of ladle refractory& Life monitoring / Thermography of refractories · Hydraulic tanks if any on transfer car to be protected suitably with proper design and use fire resistant oil *(Refer SG-10 for Hydraulic safety and SG-16 Safety Guidelines for Fire Safety)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
		Hitting of Loco to the transfer cars during operation	· Wheel stoppers to be provided for ladles cars, and camera displays at control rooms *(Refer SG-25 for Loco operation guidelines)*
		Wire rope failure of EOT crane may lead to Spillage of Hot Metal/Fire hazard	· Regular inspection of wire ropes & Maintenance of EOT crane to be ensured · Third party inspection of EOT crane to be ensured *(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)*
		Fall of Raking machine boom/ plate in to the ladle causing Spillage of Hot Metal/Fire hazard	· Routine inspection & Maintenance of raking machine to be done
4.4.2	Injection of Desulphurizing agent for Hot Metal Pre-treatment	Fall of Jam from dedusting hood	· Periodical Jam Clearing of dedusting hoods should be done
		Water Leakage from Splash Cover/Oxygen Lance may cause an Explosion	· Corrosion of pipes shall be monitored and Ladle should not be moved till water is completely drained out if it leaks · Ultrasonic thickness testing to be done to measure the thickness of critical pipelines *(Ref SG-20 Safety Guidelines for Oxygen & Nitrogen Gas line)*
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 may cause injury	· Ensure engagement of all the hooks to scrap box trunions · Periodic inspection& maintenance of crane to be done · Inspection of the healthiness of emergency brakes of crane during Periodic Maintenance · Ensure the healthiness of scrap buckets · Ensuring proper weighing of the loaded scrap box · Movement of people should be restricted under the crane caution/auto siren during movement to be incorporated *(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.5.1.2	Scrap falling out from scrap box	Fall of object/ loose scrap may cause injury	· Movement of people should be restricted under the EOT crane · Continuous alerts like hooter sound while movement of crane to be provided · Ensure working of Scrap car Load cell by Periodical Inspection *(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)*
4.5.1.3	Handling of Wet/ moist scrap	Explosion Hazard	· Converter should be empty/dried with lime · Rocking of convertor to be done after charging of scrap · There should not be any empty drums and inflammable material in the scrap box
4.5.2 HM Ladle Charging to Converter			
4.5.2.1	Hot Metal ladle is lifted by charging crane.	Free fall of Hot Metal/Steel ladle from EOT crane	· Auto / manual Emergency breaks shall be made available in cranes and operators to be trained · Hooter shall be provided to alert persons · Movement of people should be restricted under the crane and a safe distance to be maintained · Lifted weight tracking facility w.r.t. Crane capacity shall be provided to avoid overload lifting · Hazard Sign Board Display at critical areas to be made · Proper engagement of Both hooks of crane to the ladle trunnion to be ensured before lifting of ladle · Brake test of the crane is to be ensured before start of work *(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)*
4.5.2.2	Charging of hot metal into furnace	Slag in Converter may lead to explosion	· Highly oxidized slag (If any) inside converter, should be dumped out completely before charging of hot metal
		Flame shoot up	· Pouring should be started slowly. If any unusual flame is observed, stop pouring hot metal till the flame subsides · Nitrogen sealing shall be used continuously in dedusting system after adding lime & scrap rocking of converter to be done slowly before charging hot metal
		Explosion from Converter due to Moist Scrap	· Ensuring proper communication systems between furnace operator and crane operator for slow charging · Movement of people should be restricted during this process · Rocking of convertor to be done after charging of scrap

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
			· Emergency Preparedness shall be made available *(Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane, SG-23 for safe handling of liquid metal)*
		Mouth Jam in Convertor may cause spillage during hot metal charging	· Mouth Jam buildup in convertors is to be removed timely
4.5.3 Oxygen blowing in BOF			
4.5.3.1	Blowing of oxygen	Water leakage from lance tip may cause Blast inside vessel	· Lance Condition monitoring and testing of weld in Blow tip fixing and method to be standardized · Blow stop interlocking due to differential water flow in lance to be made mandatory and water diversion bypass line shall be available · Arrest the water leakage (if any), Ensure that water isn't entrapped in hot metal. Do not tilt furnace till water evaporation is ensured
		Skirt / lower / upper hood leakages may cause Blast inside vessel	· 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 · Ensure working of CO, Oxygen & Hydrogen analyzers
		Oxygen Lance free fall may cause explosion and blast inside vessel	· Digital encoder for lance movement measurements · Provision of Lance emergency Push button for pneumatic lifting of lance · Lance Drive mechanism healthiness to be checked periodically for condition of rope *(Ref SG-20 Safety Guidelines for Oxygen & Nitrogen Gas line)*
		Power failure of Lance Lift mechanism may lead to puncture of lance tip	· Lance positioning and facilitating converter tilt to be defined as standard procedures · Pneumatic test for lance lifting and any other emergency lifting mechanism for lance in case of power failure is to be checked before start of the shift every day

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.5.3.2	Slopping/Slag gush out of furnace/ Boiling	Slag and metal coming out from furnace mouth causing converter body jam and steel transfer car jam causing Fire / Explosion	· Lance height, O_2 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 · To control slopping ensure Silicon content in hot metal is in range of (0.5–0.9%) and recommended lime quantity to be added before blow *(Ref SG-23 for Safe handling of liquid metal)*
4.5.3.3	BOF / Furnace vessel	Converter shell puncture	· Deploy Scanning machine for refractory thickness measurement periodically (Portable or online scanning machine is recommended) · Ensure regular nitrogen based slag splashing in the converter vessel · Thermography measurement of shell can help to determine critical zones · Tilt the converter such that metal is positioned away from the puncture area · Standby HM/steel ladle to empty out the converter · Recommended lime Dolo to be added as per the Hot Metal Silicon content to ensure proper basicity of the slag
4.5.3.4	Sub lance measurement (if applicable)	Water leakage from lance may cause Blast in vessel	· Automatic Lance lift interlock with differential water flow / pressure to be provided
4.5.3.5	Blowing	CO leakage related hazards	· 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
		Slopping leading to STC/SPTC Jam	· Ensure that the Dog house doors of the convertor to be closed during blowing
		Incorrect analysis of Hot Metal may cause slopping	· Correct analysis of hot metal is to be provided · Silicon content in the hot metal is to be ensured as per the recommended value · Movement of people should be restricted during blowing period

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.5.4 De-slagging			
4.5.4.1	De-slagging	Slag overflow from pot causing car jam	· Salt/wood pieces to be used to suppress foaminess in slag & prevent overflow · Avoid wet jam falling inside pot during deslagging / avoid wet slag pot in usage. · Ensure healthiness of the slag pot transfer car and track
		Fire/ Blast in slag pot	· Ensure strictly slag pot is dry and free from moisture
4.5.4.2	Transfer of Liquid Slag from converter to slag pot on Slag Pot Transfer Car (SPTC)	Burn Injury due to Slag Spillage	· SPTC to be operated only from the pulpit with proper protection
		Tripping over while crossing SPTC cable	· Caution alarm to be placed to warn the movement of SPTC · Movement of vehicles and workers to be restricted on SPTC track
		Blast during cleaning of overflown slag on track	· Ensure slag is properly cooled before cleaning the over flown slag from the track
4.5.4.3	Taking temperature and sample after blowing	Burn Injury due to heat and metal splashes	· Sample to be taken from sampling car with protective shield. · Wet probes should not be used for taking sample
4.5.5 Bulk Material Charging System(BMCS) Bunkers			
4.5.5.1	Filling Lime and Calcined Dolomite into BMCS Bunkers From LCP	Failure of conveyors	· To avoid exposure to dust – Ensure working of De dusting system. · Camera monitoring · Ensuring Periodic maintenance practise of conveyors · Ensure proper functioning of CO gas detectors/ personal monitors with hooter and flashers to alert workers in galleries/ shop floor *(Ref.SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG-16 Safety Guidelines for Fire Safety)*
		Conveyor fire	· Conveyors are to be provided with proper protection to avoid water ingress and hydration of lime · Follow hot work permit system when carrying out Welding and gas cutting around conveyors and in chutes · Fire hydrant Systems for fire prevention · Nitrogen purging system in bunkers – To avoid gas ingress and fire.

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.5.6 BOF Converter Tapping			
4.5.6.1	Tapping	Fire/ Blast due to Spillage of slag/metal from the mouth	· De-slagging to be ensured before tapping so that slag do not fall · Ensure proper hot metal raking, minimum BF slag carryover and proper functioning of slag detection and arresting device (hydraulic actuated robust systems may be preferred in lieu of dart systems) · Tapping side doors are to be kept closed before tapping · Unauthorised Movement of people should be restricted · All care to be taken to avoid even trace of water where hot metal/slag / liquid steel is handled especially in transfer car track area · Ensure ladles are dry and free from moisture before tapping · Ensure placement of healthy ladles on Steel Transfer Car · Proper freeboard in ladle is to be ensured for safe handling · Effectiveness of slag arresting devices is to be ensured · Wet Ferro Alloys addition is to avoided during tapping · Follow recommended sequence of Coke, Ferro Alloy addition *(Refer SG-16: Safety Guidelines for Fire Safety)*
4.5.6.2	Manual addition of Ferro alloys	Ferro alloy chute jam causing exposure of persons to steel ladle	· Aluminium bar sizes are to be less than chute Diameter · Controlled additions to be done
		Slip and fall during manual addition	· If manual addition has to be done it should be under proper supervision and ensure that bags weight is as minimum as possible · Barrication to be done near the addition chutes · Follow recommended sequence of Ferro Alloy addition.
4.6 Secondary Steel making (LHF/RH/VD/VOD/AOD/VAD/CAS-OB)			
4.6.1 Ladle Preparation			
4.6.1.1	1. Lancing of Slide gate nozzle	Exposure to Heat due to metal Splashes	· Working platform to be designed for proper reach of each fixture attached to ladle bottom *(Refer SG-06: Safety Guideline for Lance Cutting)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
		Contact with hot ladle shell	· Purging plug lancing should be done through a movable heat shield with proper insulation placed opposite to the horizontal ladle · Design of working platform- Slide gate mechanism and porous plug shall be easily accesable · Maintennace platform shall be free from obstructions for escape during exigencies
		Burn injury due to lance backfire	· Flashback Arrestor in oxygen line is mandatory · While cleaning slide gate nozzle from backside , ensure positioning of movable shield in front of ladle
4.6.1.2	Cleaning of Purging Plug surface with Oxygen	Burn injury due to lance backfire	· Flashback Arrestor in oxygen line is mandatory · Ensure proper hose clamps for the lancing pipes *(Refer SG-06: Safety Guideline for Lance cutting)*
4.6.1.3	Slide Gate Plate / Nozzle Changing	Exposure to Heat due to metal Splashes	· Working platform to be designed for proper reach of each fixture attached to ladle bottom *(Ref SG-06: Safety Guideline for Lance Cutting)*
		Contact with hot ladle shell	· Purging plug lancing should be done through a movable heat shield with proper insulation placed opposite to the horizontal ladle · Design of working platform- Slide gate mechanism and porous plug shall be easily accesable · Maintennace platform shall be free from obstructions for escape during exigencies *(Refer SG-06: Safety Guideline for Lance cutting)*
4.6.1.4	Transfer of Liquid Steel in ladle on Steel Transfer Car (STC)	Burn Injury due to Metal Spillage	· STC to be operated only from the pulpit with proper protection · Caution alarm to be placed to warn the movement of STC · Movement of vehicles and workers to be restricted on STC track · If online purging is carried out during movement of steel transfer car, flow rate of argon/nitrogen is to be regulated to avoid metal spillage · Zone limit switches/ lights be provided for indicating change in zone when the STC is passing with the ladle
		Tripping over while crossing STC cable	· Movement of vehicles and workers to be restricted on STC track · Caution alarm to be placed to warn the STC movement

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.6.2 LHF (Ladle Heating Furnace)			
4.6.2.1	Positioning of Ladle in transfer car	Metal spillage due to improper positioning of ladle on transfer car	· Focus lights to be provided for proper visualization for crane operators · Crane cabin glasses to be maintained for better visibility · Proper Operators signalling / marking systems for ladle handling. · Ladle hook visualization camera with display at operator cabin may be placed to clearly view ladle hook engagement *(Refer SG-14: Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)*
		Equipment stalling	· Distance to be maintained by signal man while signalling to crane operator · Ensure ladle top, free of metal jam
4.6.2.2	Positioning of the ladle below the LHF hood	Blast due to Water leakage from hood puncture	· Jam free ladle top to be ensured. · Ensure that the pit is completely dry. Hood leakages,if any, should be rectified on priority · Process interlock for car movement/collision between roof / electrode
4.6.2.3	Heating by Electric Arc	Electrode breakage	· Roof balance to be ensured (automatic LVDT control system can be adopted) · Ceramic ring to be provided for non-contact of electrode and steel hood · Recommended steel temperature and slag free surface ensured for proper arcing · Ensure optimum fluidity of slag · Nipping of electrodes with torch wrench is mandatory as per vendor design · Telpher breaks check must be ensured before changing of electrodes
		Fire due to Metal Spillage	· Proper steel teeming ladle refractory lining condition to be monitored by ladle maintenance to prevent ladle throughs during treatment / prolonged arching in LHF · Water leakages from roof to be arrested *(Ref SG-16 Safety Guidelines -Fire Safety)*
		High Noise	· Display and monitoring of Noise level at shop floor
4.6.2.4	Trickling/Puncture of ladle on ladle transfer car	Fire/ Explosion hazard	· Visual inspection of ladle refractory & Life monitoring / Thermography of refractories · Ensure proper protection of electrical cables and hydraulics · Car to be pushed to crane handling area · Ensure that pit is dry and free from water *(Ref SG-16 Safety Guidelines for Fire Safety)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.6.2.5	Bottom Purging hose fixing	Splashes falling on workers	· Auto couplers to be used · Movable protection sheet to be provided for protection against splashes
4.6.3 RH De-gasser (Ruhrstahl Heraeus Process)			
4.6.3.1	RH process	Damage of Snorkel due to wrong placement of Steel ladle	· Proper monitoring of ladle during placement on Steel transfer car · Ensure ladle mouth jam cleaning at regular intervals
		Slag and metal over flowing out of the ladle fire	· Free board to be maintained and measured to ensure safe dipping · Depth of immersion to be measured · Establish Oxygen Blow chart as per process requirement.
		Fire hazard while Sucking of slag and metal during vacuum treatment	· Depth of immersion to be measured · Minimum 500 mm dipping of vessel inside the steel bath is essential. Measurement system to be incorporated · Ensure ladle mouth is free from mouth skulls · Periodical monitoring of LPG/oxygen valves and hoses to be done
4.6.3.2	Trickling/Puncture of ladle on transfer ladle car	Fire / Explosion hazard	· Visual inspection of ladle refractory & Life monitoring / Thermography of refractories *(Ref SG-16 Safety Guidelines for Fire Safety)*
4.6.3.3	Gunning of Snorkel	Burns due to Spraying particle splinter	· Area barrication during the process · Gunning suit with additional Head protection
		Eye Injury	· Eye wash / Safety Shower fountains to be placed at nearby locations *(Ref SG-18 Personal Protective Equipment (PPE) Management)*
4.6.3.4	Vacuum Ejector System with Boiler & Boiler House	Explosion/Fire due to Gas/ Steam leakage	· Periodical maintenance Vacuum ejector to be ensured · Adherence to electrical safety precautions *(Refer: SG-16 Safety Guidelines for fire safety)*
		Exposure to high temperature	· Ensure adequate ventilation and exhaust system in the high temperature and dusty area *(Refer: SG-16 Safety Guidelines for fire safety)*
		High Noise	· Display of Noise level at site and use of ear plugs to be ensured *(Refer: SG-18: Safety guidelines for Personal Protective Equipment (PPE) management)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
		Work in confined spaces	· Confined space working procedure is to be followed as per the Steel safety guidelines
		Rotating Machineries	· Guarding of all rotating parts of conveyor system · Pull chord in conveyors Emergency switch
4.6.4	**Vacuum Degasser (VD)**		
4.6.4.1	Metal treatment during degassing	Slag & metal overflowing from the treatment ladle may result in fire hazard and subsequent injury	· Adequate ladle freeboard to be ensured while tapping the heat. Ladle skull formation & mouth jams to be removed with better ladle management · Adequate refractory lining to be provided in the tank for ensuring non occurrence of fire hazards in case of metal overflow & metal boiling
		Water inside the tank/pit may result in explosion because of slag/ metal overflow	· All care to be taken to avoid even trace of water where hot metal/slag / liquid steel is handled
4.6.4.2	VD Vessel with Hood mounted on Trolley.	Toxic/Poisonous Gas leakage	· CO monitors with warning systems like alarm to be provided
		Exposure to high temperature/ fire/Dust exposure	· Ensure adequate ventilation and exhaust system in the high temperature and dusty area *(Refer: SG-16 Safety Guidelines for fire safety)*
		Working in confined space during relining and vessel repairs	· Confined space working procedure is to be followed as per the Steel safety guidelines *(Refer: SG-03: Safety Guidelines for working in confined space)*
4.6.4.3	Ladle and Ladle Preheater	High Noise	· Display of Noise level at site and use of ear plugs to be ensured *(Refer: SG-18: Safety guidelines for Personal Protective Equipment (PPE) management)*
		Exposure to High temperature	· Ensure adequate ventilation and exhaust system in the high temperature and dusty area
		CO leakage	· CO monitors with warning systems like alarm to be provided · Check the Gas leaks and arrest immediately

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.6.4.4	Vacuum Ejector System with Boiler & Boiler House	Explosion/ Fire Hazard	· Adherence to electrical safety precautions
		High Noise	· Display of Noise level at site to be done
		Exposure to high temperature	· Ensure adequate ventilation and exhaust system in the high temperature and dusty area
		Rotating Machineries	· Guarding of all rotating parts of conveyor system · Pull chord in conveyors · Emergency switch *(Refer: SG-09: Safety Guidelines for Equipment & Machine Guarding)*
		Work in confined spaces	· Confined space working procedure is to be followed as per the Steel safety guidelines *(Refer: SG-03: Safety Guidelines for working in confined space)*
		Falling out from working platform	· Adequate fall protection railing to be provided
4.6.5	**Vacuum Arc Degasser (VAD)**		
4.6.5.1	Metal treatment during degassing	Slag & metal overflowing from the treatment ladle may result in fire hazard and subsequent injury	· Adequate ladle freeboard to be ensured while tapping the heat. Ladle skull formation & mouth jams to be removed with better ladle management · Adequate refractory lining to be provided in the tank for ensuring non occurrence of fire hazards in case of metal overflow & metal boiling
4.6.5.2	Positioning of Ladle in transfer car	Metal spillage due to improper positioning	· Focus lights to be provided for proper Visualization
4.6.5.3	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

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.6.5.4	VAD Vessel with Hood mounted on Trolley.	Toxic/Poisonous Gas leakage	· CO monitors with warning systems like alarm to be provided · Check the Gas leaks and arrest immediately.
		Exposure to high temperature/ fire/Dust	· Ensure adequate ventilation and exhaust system in the high temperature and dusty area
		Working in confined space	· Confined space working procedure is to be followed as per the Steel safety guidelines *(Refer: SG-03: Safety Guidelines for working in confined space)*
4.6.5.5	Ladle and Ladle Preheater	Exposure to High temperature	· Ensure adequate ventilation and exhaust system in the high temperature and dusty area
		CO leakage	· CO monitors with warning systems like alarm to be provided · Check the Gas leaks and arrest immediately
		High Noise	· Monitoring of Noise level at site to be done
4.6.5.6	Vacuum Ejector System with Boiler & Boiler House	Explosion/ Fire due to Gas/ Steam leakage	· Guarding of all rotating parts of conveyor system · Pull chord in conveyors · Emergency switch · Monitoring of Noise level at site · Adherence to electrical safety precautions *(Refer: SG-18: Safety guidelines for Personal Protective Equipment (PPE) management)*
		High Noise	· Monitoring of Noise level at site to be done
		Exposure to high temperature	· Ensure adequate ventilation and exhaust system in the high temperature and dusty area *(Ref : SG-16 Safety Guidelines-fire safety)*
		Rotating Machineries	· Ensure adequate guarding for rotating Machines *(Refer: SG-09: Safety Guidelines for Equipment & Machine Guarding)*
		Work in confined spaces	· Confined space working procedure is to be followed as per the Steel safety guidelines *(Refer: SG-03: Safety Guidelines for working in confined space,)*
		Falling out from working platform	· Adequate fall protection railing to be provided

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.6.6	**Argon Oxygen Decarburiser (AOD)**		
4.6.6.1	Treatment in AOD vessel	Water leakage from lance tip may result in explosion	· Condition monitoring and testing of weld in blow tip fixing to be ensured. · Blow stop interlocking due to differential water flow in lance to be made and water diversion bypass line shall be available.
4.6.6.2	Blowing of oxygen	Explosion Hazard	· Lance positioning and facilitating converter tilt to be defined as standard procedures · Arrest the water leakage, Ensue that water isn't entrapped in hot metal · Periodical change of hoods based on heat load and frequencies
		Oxygen Lance free fall causing an explosion	· Digital encoder for lance movement measurements · 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

4.7 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.

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.7.1 Casting Operation			
4.7.1.1	Turret Operation	Metal spillage during ladle placement	· Trained operator for EOT crane with proper guidance system (laser / marker) should be installed for vertical placement of Ladle · Overfilled Ladle with liquid steel should not be placed on turret Ladle cover to be placed using the ladle cover manipulator (mounted on ladle turret) · Any ladle having red spot on shell should be not placed on turret · Interlocks to be in place for turret rotation while placement of ladles on loading arm · Slide gate attachment of hydraulic hose to be ensured *(Ref SG-10: Safety Guideline for Hydraulic System, Ref SG-14 Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)*
		Power failure	· Emergency Rotating system & Rotation of ladle turret from control pulpit is to be checked at regular intervals
		Breakout of Slide gate	· Immediate evacuation of ladle from Turret in case of ladle slide gate break out to a safer position by EOT Crane
4.7.1.2	Oxygen lancing while ladle not free open	Metal Spillage	· Controlling of metal stream to avoid spillage · Shrouding of ladle stream to be done immediately · Special High quality (chromite based) well sand usage for ensuring high ladle free open · Ladle centering over tundish is to be ensured *(Ref SG-18: Personal Protective Equipment (PPE) Management, SG-16 : Safety Guidelines for Fire Safety)*
		Backfire	· In-built Flash back arrester in lancing system *(Ref SG-06: Safety Guideline Lance cutting)*
4.7.1.3	Transfer of steel teeming ladle from secondary refining unit to Caster	Metal spillage	· Ladle is lifted slowly and very carefully to continuous casting machine (on ladle turret loading arm)with proper crane hook engagement hook to the ladle · Ladle hook visualization camera with display at operator cabin may be placed to clearly view ladle hook engagement · It is then positioned on the other side by lifting the arm and rotating the turret for pouring and casting. · Shop floor below the ladle movement and turret loading area shall be cleared of any personnel during operation

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
			· The pathway for overhead filled ladle movement shall not have any facilities involving manual engagement · Ensure fully killed steel (completely stable without any further internal reactions) before sending the steel ladle for casting
		Malfunction of Ladle Handling Crane	· Brake test of the ladle handling crane is to be done at regular intervals and Crane maintenance is to be done as per schedule
4.7.1.4	Casting operation related abnormalities & emergency situations	Fire/ Explosion due to Metal spillage	· During start of continuous casting operations, Ladle Turret emergency rotation must be checked to ensure proper rotation & safety measures during casting ladle throughs / slide gate failure led slag /metal splashing. Emergency ladle/ container 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 · Slag boxes should be made available for metal & slag spillage / tundish drain out during stopper running · Ladle and Tundish handling crane shall have inching speed for safe handling and cabin glass cleaning to be done regularly · Movement of filled tundish (after casting abort / break out) to be handled with crane over & along a free zone area · Refractory encasing and plate heat shield shall be provided for protection of all structures
		Radioactive hazard	· 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
		Tundish through	· Tundish shell condition to be monitored with infra red pyrometer for ensuring identification & elimination of hot spots for preventing tundish throughs & metal slag spillage during casting operation. Thermal mapping of tundish is to be done
		Mould Overflow	· Mould water flow interlocking system is to be provided with a warning and cutoff device for terminating casting to avoid mould explosion due to insufficient mould water flow

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
		Running stopper	· Closure of strand/ machine in case of uncontrollable running stopper/ tundish slide gate failure / through
		Mould Explosion	· Casting platform & shop floor below the filled tundish movement (after casting abort / casting close situations) shall be cleared of personnel for preventing hazards
		Shroud dislodge during casting	· Counter weight of shroud manipulator to be rightly adjusted and in case of pneumatic system air pressure to be maintained properly
4.7.1.5	Tundish	Free running of Steel from tundish	· Overflow bucket shall be in standby properly positioned below the tundish launder · Availability of swivelling launders in billet/ bloom – long product casting. · Condition monitoring of refractory during preheating · Tundish emergency bucket positioning at casting position is mandatory *(Ref SG-18 Personal Protective Equipment (PPE) Management)*
		Burn Injury	· Usage of heat resistant hand glove and protective clothing · Ensure availability of safety shower / eye wash
4.7.1.6	Temperature and Sample taking	Heat/Dust Hazard	· Good housekeeping in the work area is to be ensured *(Ref SG-18 Personal Protective Equipment (PPE) Management)*
		splashes	· Eye protection with goggle and face shield mandatory · Ensure availability of emergency eye wash
		Contact with hot materials	· Auto online temperature measurement is beneficial. · Manual sampling with all protective PPE's *(Ref SG-18: Personal Protective Equipment (PPE) Management)*
4.7.1.7	End of Casting	Heat	· Avoid spraying the water directly on the top of the liquid metal. Water to be sprayed on the mould wall outer faces
		Burn Injury due to explosion	· Face shield to be used by operator as additional safety · Movement of persons is to be restricted on the mould top area at the end of casting *(Ref SG-18 Personal Protective Equipment (PPE) Management)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.7.1.8	Slab cutting with torch cutting machine	Torch back fire, Equipment/ hoses damage due to back fire/ flash	· Cutting speed with respect to casting speed · Nozzle cleaning based on Pressure feedback · Edge feelers to start auto cutting. · Before casting ensure cleaning of Bunker/ Roller jams · During manual cutting avoid cutting blooms / billets from the top surface *(Ref SG-07 Safety Guideline for Gas cutting & Gas Welding)*
		Fire in LPG / Oxygen line	· Regular inspection of LPG/Oxygen lines for leakages is to be carried out and leaks are to be arrested
4.7.1.9	Run Out area Slab/Bloom/Billet evacuation	Exposure to radiation heat	· Trespassing / crossing in Run Out area should be banned. Cross over bridge should be installed
		Fire due to grease/hydraulic line leakage	· Oil leaks shall be arrested and over flown / leaked grease shall be cleaned at regular intervals · Fire hydrant support to be made near Run Out area *(Ref SG-16: Safety Guidelines for Fire Safety)*
		Burn Injury due to hot surface	· Leather hand gloves to be used *(Ref SG-18: Personal Protective Equipment (PPE) Management)*
4.7.1.10	Slag dumping after cast	Metal entry into pot / Red spot of slag pot	· 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
		Break out of slag pot and slag spillage	· Avoid pouring of steel into slag pot · Splashing shall be avoided by slow pouring
		Fire / Explosion Hazard	· Ensure moisture free slag pot and dumping containers *(Ref SG-16 Safety Guidelines for Fire Safety)*
4.7.2 Tundish Preparation			
4.7.2.1	Tundish Spraying with the spray gun	Spray mass dust falling in eyes	· Eye protection with goggle and face shield mandatory · Good housekeeping in the work area is to be ensured · Ensure availability of emergency eye wash *(Ref SG-18: Personal Protective Equipment (PPE) Management)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.7.2.2	Flame adjustment & Ignite the burner by visual inspection	Heat Hazard	· Auto pilot ignitor should be installed · In case of manual lighting of the burners , it is to ensured that gas valve is opened first for igniting the burner *(Ref SG-21: Safety Guideline for Handling Fuel Gas)*
		Exposure to hazardous gas like CO	· Ensure fixed CO monitor working on all preheaters
4.7.2.3	Deskulling of Tundish Skull on Tilter	Falling of debris dust in eyes	· Tilt the Tilter slowly to check if any liquid metal still exists · In case of liquid dropping tundish must not be deskulled · Healthiness of the tilters is to checked
		Exposure to heat/dust	· During tilting the skull barricading of area to be followed
4.7.3 Machine Preparation			
4.7.3.1	Machine checking	Heat/Dust/ Steam/ Humidity/ Asphyxiation/ Dehydration	· Ventilation by opening all doors of cooling chamber · Steam exhauster should be in operation · The working personnel should be cautious at the mould and chamber openings
		Hydraulic leakages	· Regular inspection is to be carriedout for identification and arresting of oil leaks from all casting equipments · While attending maintenance on hydraulic systems,Hydraulic pump is to be kept off and locked out (LOTO must be ensured) *(Ref SG-10: Safety Guideline for Hydraulic System)*
		Fall from Height	· Adequate fall protection to be provided
		Improper Illumination	· Illumination to be ensured before entering the cooling chamber *(Ref SG-05: Safety Guideline for Illumination at workplace)*
		Fall of dummy bar due to conveyor rope snap	· If dummy bars are handled by conveyor rope system, regular inspection/ maintenance of dummy bar handling mechanism (DBHM) and it's ropes are to be ensured
		Dummy bar slippage	· Low hydraulic pressure alarm system to be ensured in radial part gripping rolls to avoid slippage of dummy bar

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.7.3.2	Metallic jam cutting/slab/ Bloom/billet cutting inside cooling chamber	Burn injury due to contact of hot object or steam	· Illumination to be ensured before entering the cooling chamber · Ensure steam exhauster is in running condition while people are inside *(Ref SG-06: Safety Guideline for Lance cutting, SG-05: Safety Guideline for Illumination at workplace)*
		Back fire	· Ensure proper hose clamps for the lancing pipes · Wire breaded Hoses used for lance to be of rated pressure > 20 bar. · Lance with back flash arrestor to be used only *(Ref SG-06: Safety Guideline for Lance cutting)*
4.7.3.3	Lifting of cut slabs / Billets / Blooms	Contact with hot materials.	· Area to be barricaded to avoid tress passing. · Heat/ Fire retardant jacket and leather hand gloves are mandatory *(Ref SG-11: Safety Guideline – Barricading)*
		Fall from height Injury	· Usage of tested lifting tools and tackles of required capacity
4.8 Auxiliary Units			
4.8.1 Scap yard			
4.8.1.1	Unloading of scrap in pits	Dust	· Slag / muck /oil to be avoided while transporting scrap from inside or outside · Hot DRI should not be stored in pits · Dusk mask mandatory *(Ref SG-18: Personal Protective Equipment (PPE) Management)*
		High Noise	· Ear muffs are mandatory
		Fire Hazard	· No cutting / welding should be carried out in scrap yard · Good Illumination is to be ensured in the work area *(Ref SG-16: Safety Guidelines for Fire Safety)*
4.8.1.2	Handling of scrap with magnets	Fall of object	· Healthiness of the Crane magnet is to be checked every day · No trespassing of human manpower in loading area · Unloading trucks to be parked in designated place · Driver / helpers should use PPE & move out from the vehicle and wait outside the shop while unloading/loading is carried out. · Hooter must be installed in every material handling cranes *(Ref SG-18: Personal Protective Equipment (PPE) Management)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.8.2 Slag Yard – Slag Handling			
4.8.2.1	Dumping the slag pot into the slag pit	Explosion due to water accumulation in pits during slag cooling for digging	· Controlled Water Spray system and proper water drainage systems in the area · Slag shall be dumped in Dry areas · Movement of people should be restricted during slag dumping · Proper drainage system to be provided in slag yard pits to drain out the accumulated cooling water completely · It should be strictly ensured that there is no water stagnation in slag pits
4.8.2.2	Slag Cooling and evacuation	Fire catch of equipment	· Equipment healthiness checklist should be maintained for oil / diesel leak · Maintenance of Mobile equipment records should be maintained
		Explosion	· Ensure cooling of hot slag properly before digging with mobile equipment & Loading with pay loaders (excavators) to dumper · Controlled Water Spray system and proper water drainage systems in the area
4.8.2.3	Slag transportation to processing yard	Spillage on road can cause slip & fall for 2-wheelers	· Forming of cold slag bed in the vehicle before loading hot slag · Shifting dumpers should not be overloaded · Back side of dumpers/ trucks should have closing door
		Fire catch of tippers	· Slag shifting special dumpers should be used to avoid spillage during movement · Speed restriction to 16km/hr or as per rules
4.8.3 Slag processing & metal recovery plant			
4.8.3.1	Slag processing & metal recovery plant	Emission of Heat & dust fine particles	· Water sprinkling on slag heaps continuous basis · Fog Machine for dust suppression during dumping · Enclosed yard for fine dust slag (Pre-treatment / Secondary Steel making Slag · Slow dumping on slag piles *(Ref SG-16: Safety Guideline for Fire Safety, SG-18: Personal Protective Equipment (PPE) Management)*
		Struck in conveyor	· Metal Processing conveyor safety guidelines to be followed (*Ref SG-09: Safety Guideline in Equipment & machine Guarding*)
		Poor Illumination	· Adequate Illumination to be provided *(Ref SG-05: Safety Guideline for Illumination at workplace*)

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
		Fire of mobile equipment	· Healthiness of mobile equipment is to be ensured
		Skid and fall of people	· Good Housekeeping should be maintained
4.8.3.2	Drop balling of steel skull lancing	Scattering of metallic pieces	· Designated area with proper fencing to restrict movement of persons during drop balling activity
		Piercing of metal	· Oxygen storage facilities to be located at safe distance and fenced *(Ref SG-07: Safety Guideline for Gas cutting & Gas Welding, SG-06: Safety Guideline for Lance cutting)*
4.8.4 Slab/bloom/billet yard (Slab/bloom/billet Handling & Inspection)			
4.8.4.1	Moving of overhead crane along with slabs/blooms/ billets	Free falling of slab / Billet/ Bloom may cause Injury & equipment damage	· Preventive maintenance of EOT cranes and provision of emergency brakes · Inspection by a competent person as per statutory requirement · Inspection of Lifting Tong/Magnet to be done and documented · Battery backup may be ensured for Magnet crane · Installation of fingers in the crane for protecting against falling of bloom or billet from the crane in magnet using EOT cranes. *(Ref SG-14: Safety Guidelines for work on Electrical Overhead Travelling EOT Crane)*
		Collision of cranes	· Use of high temperature resistant magnets should be ensured. · LT & CT buffers healthiness to be ensured & Anti-collision devices may be used
4.8.4.2	Storage of Slabs/ blooms/billets and handling	Unsafe Stacking/ piling height may lead to Collapse	· Bend slab/Bloom/Billet should be separately stored · Uniform Ground Bed should be made · Stacking height to be 3–3.5m depending on Bay height · Uniform width should be stacked in each pile · Restricted entry signage boards should be displayed (Slab yard management system should be used for locating the slabs/billet/bloom pile) · Fenced for no tress passing zone *(Ref SG-13: Safety Guideline for Material handling (manual and mechanized) & storage)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.8.4.3	Slab/Bloom/Billet transportation	Run over if people movement	· Transfer movement area to be barricaded · Vehicle will be allowed to go only after ensuring that material is properly secured and tightened. Personnel will not be allowed/ stand on trailer during loading/ unloading of material · Hot Slab should be despatched on brick line car / trucks *(Ref SG-11: Safety Guideline for Barricading)*
4.8.4.4	Scarfing / Grinding	High Noise level	· Proper sound proof rooms to be made · Ear Muffs mandatory for entry *(Ref SG-18 : Personal Protective Equipment (PPE) Management)*
		Fire in gas line	· All Gas safety precaution and fail proof system for auto closing of valves to be installed in Gas Valve station *(Ref SG-16: Safety Guidelines for Fire Safety)*
		Flying Splinter	· Auto scarfing / Grinding machine are in enclosed chamber
		Burns/ Radiation Heat/ Dehydration due exposure to hot slab	· Heat protection platform to be provided where regular scraping/ grinding activity is carried out. *(Ref SG-06: Safety Guideline for Lance cutting)*
4.8.5 Gas Hazards			
4.8.5.1	ID fan/Change over valve	Exposure to CO gas	· Fixed CO monitors to be installed in ID fan area
		Injury due to exposure to rotating equipment	· Maintain safe distance from rotating machinery · Ensure adequate guarding for rotating Machines. *(Refer: SG-09: Safety Guidelines for Equipment & Machine Guarding)*
		Slip & fall due to slippery floor	· Good housekeeping to be maintained
4.8.5.2	Gas Line Leakages	Exposure to CO gas	· Pipes corrosion study, thickness measurement / U seals/Water seals,Checking of feedback of fixed CO monitors readings to control rooms
4.8.5.3	Gas Holder Leakage	Explosion due to Oxygen ingress	· Safety interlock for restricting Oxygen ingress in gas holder by Oxygen Analysers and quick shutoff valve · Gas holder to be Inspected & Certified by Boiler & Safety competent authority *(Ref SG-21: Safety Guideline for Handling Fuel Gas)*

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.8.5.4	Gas Holder Overfill	Explosion due to pressure build up	· Gas holder level to be maintained and working of volume relief valves to be ensured · Gas directing Dampers should be in healthy condition for flaring excessive gas · 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)*
4.8.6 Water Circulation Unit			
4.8.6.1	Plant pump room	Injury due to exposure to rotating equipment	· Adequate Illumination to be provided · Machine guarding is mandatory *(Ref SG-05: Safety Guideline for Illumination at workplace, SG-09: Safety Guideline in Equipment & machine Guarding)*
		Slip & fall due to slippery floor	· Pump leakages are to be eliminated · Water drainage system to be adequate to avoid accumulation on floor/platform
4.8.6.2	Compressor room	Noise Hazard	· Proper sound proof rooms to be made · Ear Muffs mandatory for entry *(Ref SG-18: Personal Protective Equipment (PPE) Management)*
4.8.7 EOT Cranes			
4.8.7.1	Free Fall of Ladle due to wire rope cut / rope drum failure / Brake failure	Equipment damage	· Frequency of wire rope changing based on cyclic load to be documented · Four rope system in all Hot Metal crane should be provided to main hoist and two rope system for auxiliary hoist for taking care of rope failures · Speed Encoder to be installed with interlock · PLC based cranes is safe for usage · Emergency brake system should be available in all EOT cranes · Strict Maintenance schedule/matrix to be adhered for all cranes · Statutory Inspection of all EOT, telfers, hoist mechanisms & lifting tools/ tackles to be done *(Ref SG-14 : Safety Guideline for work on Electric Overhead Travelling (EOT) Crane)*
		Fire & Explosion due to Hot Metal Spillage	· Entry of person to be restricted during crane movement
4.8.7.2	Collision of two cranes	Hot Metal Spillage	· Anti collision device is mandatory for all crane if two or more cranes operating in same bay

Sl. No.	Area/Section/ Equipment/ Activity	Hazards	Risk Control Measures
4.8.7.3	Crush of people between columns 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 side push button crane movement will not start *(Ref SG-14 : Safety Guideline for work on Electric Overhead Travelling (EOT) Crane)*

Note:

- · 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 further.
- All applicable statutory requirements are to be followed as per respective state factory rules.
- Other standard plant safety procedures shall be followed.
- Signages and emergency escape route shall be shown covering the entire steel melt shop.
- Provision &operatability of safety fences should be ensured covering the entire steel melt shop.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- All Techno Economic parameters related to processes in Steel Melting Shop are to be monitored as per standards/ performance guarantee.
- Housekeeping of all working areas should be maintained.
- 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.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection / management of the hazards:

S.No	NAME OF SYSTEM	INSTRUMENT	FUNCTION
1	Blowing oxygen Lance	Load Pin	To measure the load/weight of the blowing lances. Accumulation of Lance jam, lance imbalance, freefall is detected by the load pins.Acts as safety device monitoring healthiness of the blowing lances.
2	Cooling water circuit of Oxygen blowing lance	Magnetic Flowmeter	Monitors healthiness of the blowing lance, Detects any puncture of lance, which may cause blasts. Each Lance provided with 2 Nos of Magnetic flowmeters (inlet & outlet flow measurement).

S.No	NAME OF SYSTEM	INSTRUMENT	FUNCTION
3	Charging Crane Weighing	Load Pin	Accurate weight of hot metal charged into Converter, ensures achieving required steel grade.
4	Area CO Monitors	CO Monitor	To detect the presence of CO gas in the working area & alert people by siren. Installed at 18, 25, 32M platforms, 42m Lance preparation platform, COV Lower seal & Upper seal areas & WGA room of each converter.
5	ID FAN	Vibration Sensor	Monitors vibration of ID fan, bearing and motor vibrations
6	WGA (Wet Gas Analyzer)	O2 Analyzer	Measure Oxygen % In LD Gas Recovered To GRP
7	Mixer hot metal Ladle level	Radar	Ensures safety during metal pouring, preventing overflows. Ensures required weight of hot metal to be given to Converters.
8	TLC Hot metal ladle level	Radar	Ensures safety during metal pouring, preventing overflows & accidents. Ensures required weight of hot metal to be given to Converters.
9	GRP-1 Gas holder level	Level Gauge	Ensures safety of gas holder which is the lifeline of plant gas network.
10	CCM L&T weighing	L&T weighing with load cell	Measure Weight Of Steel Ladle Casted In CCM.
11	Ladle bottom temperature	Radiation pyrometer	Monitoring of steel ladle

PPE Matrix

PPE / Area	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Breathing Apparatus
HMDP	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	-
CONV	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
LHF	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
CCM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
GCM	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	-
BSY/SSY	Yes	Yes	Yes	Yes	Yes	-	-	-	-
SLYD	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	-
SCRYD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
LP Area	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
TP Area	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	-
LD GH	Yes	Yes	Yes	Yes	Yes	-	-	-	Yes
GCP	Yes	Yes	Yes	Yes	Yes	-	Yes	-	Yes

Note:

This PPE matrix is for reference only, and the specific PPE requirement (like gas monitor, Aluminized suits, Arc flash suits etc.) may vary based on the specific hazards, safety procedures and policies etc., Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE.This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviation:

AOD	Argon Oxygen Decarburization	BF	Blast Furnace
BOF	Basic Oxygen Furnace	BMCS	Bulk material charging system
BMHS	Bulk material handling system	BSY	Bloom/ Billet Storage Yard
CAS-OB	Composition Adjustment by Sealed argon bubbling- Oxygen blowing	CCD	Continuous Casting Department
CCS	Continuous Casting Shop	CCM	Continuous Casting Machine
CO	Carbon Monoxide	CONV	Converter shop
CONARC	Combined	CT	Cross Travel
DBHM	Dummy Bar Handling Mechanism	DRI	Direct Reduced Iron
EAF	Electric Arc Furnace	EOT	Electrical Overhead Travelling
GCM	Gas Cutting Machine	GCP	Gas Cleaning Plant
HM	Hot Metal	HMDP	Hot metal Desulphurization Plant
ID	Induced Draft	IF	Induction Furnace
KR	Kanbara Reactor	LCP	Light Conveyor Platform
LD	Linz-Donawitz	LD GH	Linz-Donawitz Gas Holder
LF	Ladle Furnace	LHF	Ladle Heating Furnace
LOTO	Lock Out and Tag Out	LPG	Liquefied Petroleum gas
LP Area	Ladle Preparation Area	LT	Lateral/ Long travel
LVDT	Linear Variable Differential Transformer	PPE	Personal Protective Equipment
P.M	Preventive maintenance	RH	RuhrstahlHeraeus
ROT area	Run Out area	SECS	Secondary emission control system
SES	Submerged Entry Shroud	SEN	Sub Entry Nozzle
SG	Safety Guideline	SLYD	Slag Yard
SMP	Standard Maintenance Procedures	SOP	Standard Operating Procedures
SSY	Slab Storage Yard	SPTC	Slag Pot Transfer Car
STC	Steel Transfer Car	TLC	Torpedo ladle car
TP Area	Tundish Preparation Area	VAD	Vacuum Arc Degasser
VD	Vacuum de-gasser	VOD	Vacuum Oxygen Decarburization

PROCESS BASED SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	**PELLET PLANT**	Doc. No: SG/40
		Rev no.: 00 Effective Date: 12.06.2024

1. OBJECTIVE:

The objective of this guideline is to prevent injuries & incidents including damage to plant and machinery through identificationof the hazards associated with Pellet making process and implementation of risk control measures.

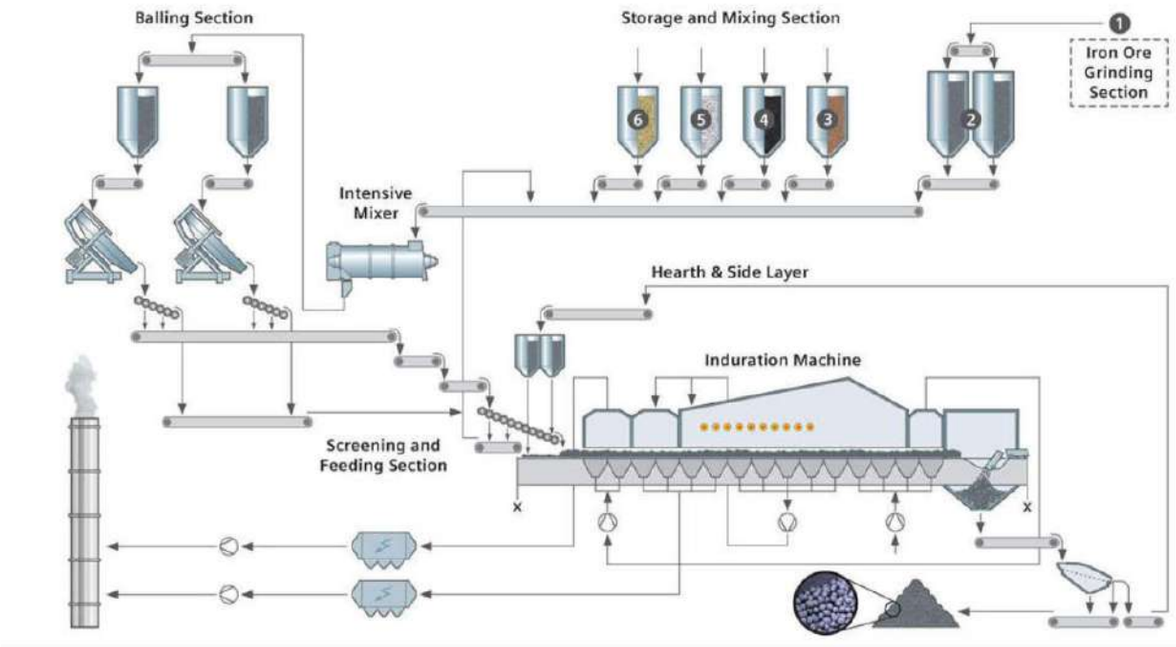
2. SCOPE:

This document covers the guidelines that apply to both standalone Pellet Plants and those integrated within steel plants. Its scope begins from the point of receiving raw materials to the process of pellet screening, storage and dispatch.

3. PROCESS:

Pellet Plant produces Pellets using Iron ore and additives such as limestone, bentonite, coke, anthracite coal, quartzite which are passed through balling disc/drum and the green pellets so formed are passed through a furnace either straight grate or rotary kiln to produce High Grade Pellet which are used in Steel making in Blast furnace or Direct reduction plants for steel making

PROCESS FLOW DIAGRAM - PELLET PLANT



1: Iron ore grinding & Filtration, 2. Iron ore concentrate/ Filter cake, 3. Dry dust from ESP / Bag filter,
4. Coke fines, 5. Bentonite fines, 6. Limestone fines

A pelletizing plant includes five processes:

- Raw material receiving,
- Pre-treatment
- Additive and Binder proportionating and Mixing
- Balling
- Indurating
- Pellet screening /HL Segregation

3.1 Process of receiving raw material

The location of a pelletizing plant affects the method of receiving raw materials such as iron ore, additives and binders.

3.2 Pre-treatment process of Iron Ore Fines

In the pre-treatment process, iron ore fines are ground into finer size, suitable for green ballformation. Dry or wet grinding process is adopted for grinding the iron ore fines.

3.3 Pre-treatment process of additives

Additives i.e. Lime stone, dolomite, coal/coke are required to be ground before mixing withiron ore fines. Un-like iron ore dry grinding process, Lime stone/dolomite and coke areground in ball mill/ roller mill together and bentonite is ground in a separate roller mill.

3.4 Proportionating & Mixing

Pre-wetting includes adding an adequate amount of water homogeneously into the dry ground material (including binders and additives) to prepare pre-wetted material suitablefor balling with optimum moisture.

3.5 Balling process

In this process, balling equipment produces green balls from the pre-wetted mixed material prepared in the previous process. The green balls are produced either by a balling drum, or by a balling disc. Both of the units utilize centrifugal force to form the fine materials into spheroids.

3.6 Indurating process

The firing of pellets establishes the binding of hematite particles at an elevated temperature ranging from 1,250 to 1,350°C in oxidizing condition. Slag with a low melting point may form in the pellets during this firing step, if the raw material contains fluxed gangue, or if limestone is added to it. In these cases, the product may have an intermediate structure with both metallic binding and slag binding. The firing process is characterized by process temperatures lower than those required by sintering which requires partial melting and sintering fine ore mixed with coke breeze, a fuel which generates combustion heat.

3.7 Storage and Dispatch

The storage and dispatch of pellets in a steel plant involves storing them in silos or storage yards, managing inventory through an inventory management system, handling and transporting them using specialized equipment, planning dispatch based on customer demands, loading them onto conveyors, trucks, railcars, or ships, conducting quality control checks, preparing documentation, and monitoring the dispatch process for efficient and timely delivery.

Major/Critical Equipment's of Pellet Plant

S.No.	Area / System	Different critical equipment
1.	Raw Material Handling System	Reclaimers, Conveyor System, Bunkers
2.	Wet Grinding System of Iron Ore	Storage Bins, Primary Screens, Ball Mills, Slurry Pumps, Hydro Cyclones, Sizing Screens, Thickener, Slurry Tanks, Filter press, Vacuum Pumps, Air Compressors
3.	Dry Grinding System of Iron Ore	Primary Screens, Fuel handling System, Hot gas generator, Dryer, Ball Mills, Cyclone Separators, Storage bin, Bucket elevator, Air separator, Dust collector, Re-circulation Fans
4.	Mixing Unit	Bins for Iron Ore concentrate/ Coke Breeze/ Lime stone/ Bentonite, Tramp MagnetConveyors, Mixers, Dosing Equipment, Belt Weighers
5.	Additive Grinding	Ball mill/ Roller mill, Hot gas generator (HAG), Cyclone / Bag Filter, Re-circulation fan
6.	Green Balling Circuit	Pelletizing Disc/Drum, Screens, Feeding Conveyors/ Roller Screens/ Feeders
7.	Induration & Process gas handling	Indurating machine, Process Fans, Induration hood & furnace, Grate machine/ rotary kiln/ cooler, ESPs, Process fans, Fines/ spillagehandling conveyor, Electro Static Precipitator(ESP)
8.	Product Handling	Conveyors, Hopper/Bin, Vibrating Screen, Gates

4. PROCESS RELATED HAZARDS & NECESSARY RISK CONTROL MEASURES:

S.No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.1	Conveyors, Screens	Rotating parts like head pulley, tail pulley, snub pulley, coupling guards etc.	· Regular Maintenance of all components of conveyor belts · Guarding of all rotating parts of conveyor system. · Pull chord in conveyors. · Emergency switch. (Refer SG-09: Safety Guidelines for Equipment and Machine Guarding, SG-19: Safety Guidelines on Operation and Maintenance of Conveyor Belts, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance))
		Spillage accumulation	· Conduct regular inspections to identify potential spillage sources. · Maintain equipment to prevent spillage, repairing or replacing damaged components. · Install conveyor skirting and sealing systems to contain material. · Use effective belt cleaning systems to remove material buildup. · Install spill containment systems beneath transfer points or common spill areas. · Store and handle materials properly to minimize spills. · Establish a regular cleaning schedule to remove accumulated spillage.

S.No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			· Train employees on spillage prevention and reporting. · Auxiliary chute may be developed to feed spilled material to main conveyor · Spillage cleaning not to be done on running conveyor, need to be executed by stopping the conveyor only · Engineering control to be applied to arrest spillage.
		Conveyor belt hazards /Cleaning running conveyors.	· LOTO procedures to be followed (Refer SG-19: Safety Guidelines on Operation and Maintenance of conveyor belts).
		Fall into raw material bins.	· Railings to be provided around the bins.
		Materials falling	· Open-mesh walkways to prevent objects from falling through and causing injury to people below.
		Releases of dust	· Respiratory protection dusk mask. · Dust and fume collectors ESP /Cyclone Separator
4.2	Tramp Magnet	Electrical & magnetic	Switch off power before any work. (Refer SG-15 : Safety Guidelines for Electrical safety)
4.3	Charging bins/ Hoppers	· Fine Dust deposition · Electrical Drives · Noise · Confined space	· Dust Extraction(DE) System · Guarding of all rotating parts of conveyor system · Pull chord in conveyors · Emergency switch · Display of Noise level at site · Adherence to electrical safety precautions. (Refer SG-18: Safety Guidelines for Personal Protective Equipment (PPE) management, SG-19: Safety Guidelines on Operation and Maintenance of Conveyor Belts, SG-15: Safety Guidelines for Electrical safety, SG-03: Safety guideline for working in Confined space and SG-04 : Safety Guideline for Permit to Work(Operation & Maintenance))
4.4	Ball mill	· RotatingMachineries · Confined space · Electrical hazard · Noise	Adherence to shutdown system/ PTW during maintenance (Refer SG-03: Safety Guidelines for working in confined space, SG-18: Management of PPE, SG-13: Safety Guidelines for Material Handling, SG-01: Safety Guideline on storage, handling &use of gas cylinders,SG-04: Safety Guidelines for work permit system, SG-15: Safety Guidelines for Electrical Safety)

S.No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.5	Filters-slurry tanks-Thickeners	· Noise · Dust · Rotating Machines · Slippery floor · Fall from height Hazard · Drowning hazard	· Provide guard to moving machinery. · Improve housekeeping. · Maintain Platforms. Provide adequate illumination. (Refer SG-18: Management of PPE, SG-19: Safety Guidelines for conveyors, SG-02: Safety Guidelines for working at height, SG-05: Safety Guidelines for Illumination and SG-04: for work permit system)
4.6	Tailing Pumps	Rotating Machineries	Proper shutdown during maintenance (Refer SG-04: for work permit system, SG-15: Safety Guidelines for Electrical Safety)
4.7	Hot air generators	Fire and explosion	· Training to employees on Operation and maintenance safety of Mechanical equipments · Fire fighting Engineering controls. · Administrative (procedural) controls. (Refer: SG-16: Safety Guidelines for Fire Safety)
4.8	Mixers	· Rotating Machineries · Material Spillage · Noise	· Guarding of all rotating parts. (Refer SG-09: Safety Guidelines for Equipment and Machine Guarding and SG-04 for work permit system).
4.9	Pelletising Disc	· Rotating Machinery · Noise	· Provide guarding (Refer SG-04: Safety Guidelines for Work permit system)
4.10	Process Fans	· Rotating Machineries · Confined space · Electrical hazard · Noise	· Proper shutdown during maintenance (Refer SG-03: Safety Guidelines for working in confined space, SG-18: PPE management, SG-01: Safety Guidelines for storage, handling and Use of LPG cylinders, SG-04: for work permit system, SG-15 Safety Guideline for Electrical safety)
4.11	Indurating Machine	· Hot pellet · Conveyors · Rotating pulleys · SOx/NOx Generation · Fall from height · Pellet car loading · Contact with hot surface · Spillage (pellets) · Gas leakage	· Training to employees on Operation and maintenance,safety of Mechanical equipment's. · Guarding of rotator parts · Display of Hot Area at site. · Adherence to electrical safety procedures · Proper care while loading of Pellet cars · On-line gas detector on both sides ofIndurating hood, portable gas detector · Ensure dedusting suction at Induratingmachine discharge hood to avoid localized heating. · Application of heat insulation at requiredplaces · House-keeping/cleaning of Indurating unitfloors

S.No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			(Refer SG-11: Safety guideline for barricading, SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts, SG-03: Safety Guidelines for working in confined space, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance), SG-23: Safety Guideline for Safe handling of Liquid Metal, SG-16: Safety Guidelines for Fire Safety, SG-15: Safety Guidelines for Electrical safety, SG-21: Safety Guidelines for Handling Fuel Gas) SG-18: Management of PPE)
4.12	Rotary Kiln	Gas leakage	· Installation of Online Gas monitor at strategic locations & use of Portable monitors to detect gas leakage. · Prohibition of unauthorised people going the kiln as there are chances of gas leakage. If at all, one needs to go, he should be accompanied with safety officer with proper safety precautions under intimation to control room. · Training to employees on Operation and maintenance safety of Mechanical equipment's. *(Refer SG-21: Safety Guidelines for Handling Fuel Gas)*
		Shell crack Corroded structure	· Regular inspection & repair as per requirement.
		Fine Dust deposition	· Installation of ESP & regular cleaning etc.
		Sound from Leakages	· Plug the leakage points
		Slip, Trip and fall hazards	· Ensure proper housekeeping.
		Spillage from Rotary Kiln	· Addressing the spillage points on regular points · Adequate guarding · Regular housekeeping
4.13	Annular coolers	· Rotating Machineries · Confined space · Electrical hazard · Noise	· Proper shutdown during maintenance · Guarding of rotatory parts · Permit to work for confined space jobs *(Refer SG-03: Safety Guidelines for working in confined space. SG-18: PPE management, SG-01 : Safety Guideline on storage, handling & use of gas cylinders, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance), SG-15: Safety Guideline for Electrical safety)*
4.14	Bucket elevators	· Spillage accumulation · Water accumulation · Conveyor belt	· Regular cleaning. · Water draining system to be maintained. · Regular inspection to be done. · Conveyor belt hazards *(Refer SG-19: Safety Guideline on Operation and Maintenance of Conveyor Belts)*

S.No.	Area/Section/ Equipment	Hazards	Risk Control Measures
4.15	Air Separators& Dust collectors	· Noise · Dust · Slippery floor · Fall from height Hazard	· Improve housekeeping, · Maintain work platforms. · Provide adequate illumination. · Monitoring working of dust disposal system-from hoppers below dust collectors & corrective measures. *(Refer SG-18: PPE Management, SG-02: Safety Guidelines for working at height, SG-05: Safety Guidelines for Illumination at workplace and SG-04: Safety Guideline for Permit to Work(Operation & Maintenance))*
4.16	Screen	Rotating machinery Caught between rollers	· Provide adequate guards *(Refer SG-09: Safety Guideline in Equipment & machine Guarding)*
4.17	Thickeners and Agitators	· Slippery floor · Fall from height Hazard · Water accumulation · Drowning Hazard	· Improve housekeeping, · Maintain work Platforms and hand railing and guarding. · Provide adequate illumination. · Water draining system to be maintained. Regular inspection to be done. *(Refer SG-18: PPE Management, SG-02: Safety Guidelines for working at height, SG-05: Safety Guidelines for Illumination at workplace and SG-04: Safety Guideline for Permit to Work(Operation & Maintenance))*
4.18	ESP	· Hot Flue Gas · Fine Hot Dust · Electrical Transformers · High Electrical Voltages	· Access control · Monitoring working of dust disposal system from hoppers below dust collectors & corrective measures *(Refer SG-18: Safety Guidelines for PPE management, SG-02: Safety Guidelines for working at height, SG-05: Safety Guidelines for Illumination at workplace, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance), SG-21: Safety Guidelines for Handling of Fuel Gas, SG-15: Safety guideline for electrical safety)*
4.19	Storage and Dispatch Section	· Dust inhalation · Fire and explosion · Structure Stability concern · Manual Handling Injuries · Transportation Hazards	· Dust inhalation: Ventilation, cleanliness, air quality monitoring. · Fire and explosion risks: Fire prevention protocols, detection systems, training, control of ignition sources, regular drills. · Structural stability concerns: Inspections, engineering standards, weight monitoring, maintenance programs. · Manual handling injuries: Training, mechanical aids, ergonomic practices, assessments. · Transportation hazards: Compliance with safety regulations, vehicle maintenance, load securing, driver training, communication protocols

S.No.	Area/Section/ Equipment	Hazards	Risk Control Measures
			(Refer SG-18: Safety Guidelines PPE management, SG-02: Safety Guidelines for working at height, SG-05: Safety Guidelines for Illumination at workplace, SG-04: Safety Guideline for Permit to Work(Operation & Maintenance), SG-21: Safety Guidelines for Handling of Fuel Gas, SG-15: Safety guideline for electrical safety)

Note:

- 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.
- Other standard plant safety procedures shall be followed.
- Signages and emergency escape route shall be shown covering the entire shop.
- Provision &operability of safety fences should be ensured covering the entire shop.
- The above safety guidelines have been prepared keeping in view standard points applicable to the area of work in the steel industry. SOPs & SMPs are to be developed and followed by users as per specific processes / equipment/ technologies deployed as well as prevailing site conditions, in respective plants.
- All applicable statutory requirements are to be followed as per respective state factory rules.
- Housekeeping of all working areas should be maintained.
- Regular checking and maintenance of all process safety interlocks are to be ensured.
- In addition to Risk control measures (prevention barriers) identified in the document, users shall define Mitigation barriers which will help in minimizing adverse consequences as a result of loss of control of hazard.

List of instruments/ equipment required for detection/management of the hazards.

- Gas detectors (online and portable) to monitor gas leakage, especially near the rotary kiln and other areas with potential for gas buildup.
- Dust extraction (DE) systems and dust collectors like ESPs to control fine dust emissions.
- Guarding and fencing around all rotating machinery, conveyor belts, and other moving parts to prevent entanglement hazards.
- Emergency stop switches and pull cords on conveyors and other equipment for quick shutdown.
- Fire detection and suppression systems, especially in areas with fire and explosion risks like storage and dispatch.
- Electrical safety systems including proper grounding, insulation, and protection of electrical equipment and transformers.
- Sensors and interlocks to monitor and control process parameters like temperature, pressure, flow etc. within safe limits.
- Ventilation systems to control dust, fumes and maintain air quality in working areas.
- Safety valves and rupture discs on pressure vessels and equipment.
- Machine guarding sensors to detect and prevent access to hazardous areas during operation.
- Sensors to detect belt sway, drift, speed and alignment issues on conveyors.

PPE Matrix

PPE AREA	Safety Helmet	Safety Shoe	Fire Retardant Suit	Hand Gloves	Goggle	Ear Plug	Dust Mask	Face Shield	Full Body Harness	Arc Flash Suit.
RAW MATERIAL HANDLING SYSTEM	YES	YES	-	YES	YES	YES	YES	-	-	-
CHARGING BIN HOPPERS	YES	YES	-	YES	YES	YES	YES	-	-	-
BALL MILL	YES	YES	-	YES	YES	YES	YES	-	-	-
FILTERS-SLURRY TANKS-THICKENERS	YES	YES	-	YES	YES		YES	-	-	-
HOT AIR GENERATORS	YES	YES	YES	YES	YES	YES	YES	-	-	-
PELLETISING DISC	YES	YES	YES	YES	YES	YES	YES	YES	-	-
INDURATING MACHINE	YES	YES	YES	YES	YES	YES	YES	YES	-	-
ROTARY KILN	YES	YES	YES	YES	YES	YES	YES	-	-	-
ANNULAR COOLERS	YES	YES	-	YES	YES	YES	YES	-	-	-
BUCKET ELEVATORS	YES	YES	-	YES	YES	YES	YES	-	-	-
AIR SEPARATORS & DUST COLLECTORS	YES	YES	-	YES	YES	YES	YES	-	-	-
THICKENERS AND AGITATORS	YES	YES	-	YES	YES	YES	YES	-	-	-
ESP	YES	YES	YES	YES	YES	YES	YES	-	-	-
STORAGE AND DISPATCH	YES	YES	-	YES	YES	YES	YES	-	-	-

Note:

This PPE matrix is for reference only, and the specific PPE requirement may vary based on the specific Pellet plant's hazards, safety procedures and policies etc. Employees should always follow their employer's safety guidelines and receive proper training on the use and maintenance of PPE. This PPE matrix shall be displayed at strategic locations in the shop floor.

Abbreviations:

HAG	Hot Gas Generator	**PTW**	Permit to Work
CO	Carbon Monoxide	**DE**	Dust Extraction
ESP	Electro Static Precipitator	**PPE**	Personal Protective Equipments
SOx	Sulfur Oxides	**SOP**	Standard Operating Procedure
NOx	Nitrogen Oxides	**SMP**	Standard Maintenance Procedures
LOTO	Lockout – Tagout		

SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	CONTRACTOR SAFETY MANAGEMENT (CSM)	Doc. No: SG/41
		Rev no.: 00 Effective Date: 12.06.2024

1. OBJECTIVE:

Contractors are an integral part of the steel industry, making up a significant proportion of the workforce. The number of hours worked by contractor's Vs. employees has been steadily increasing, with the total hours worked by contractors now equivalent to approximately twice those of direct employees. However, Contractors are more vulnerable and are having more fatalities than employees which calls for managing their safety aspects in a more structured manner.

The purpose of the CSM is to ensure that the work performed by contractors is carried out in a safe manner to protect all personnel, equipment and other assets of a Plant (where any contract is being executed) from any potential risk of injury, accident, production loss etc.

2. SCOPE:

This guideline is applicable to all Steel Plants. This Guideline shall apply to all contractor and subcontractor activities where an organization executed contract is in effect.

Organizations are expected to be aware that local regulations may impose mandatory requirements not reflected in this guideline. Additional information on regulations may be obtained from a number of sources, including statutory / regulatory documents. The most stringent mandatory requirement shall apply.

3. DEFINITIONS:

3.1 **Client**: A company that issues a contract to an independent entity to supply people, processes, equipment, or materials

3.2 **Contract**: A written agreement between Client and its contractor(s) or work order or License order or empanelment Order to supply manpower, services, and/or materials or to carry out the whole or part of any work required by Client.

3.3 **Contractor/Contractor Proprietor**: Any non-client entity or a person(s) who has contracted with client's to supply manpower, materials, services, or carry out whole or part of any work.

3.4 **Contract Employee(s):** Any person(s) employed by a contractor to carry out the contracted work, but not employed directly by the client's.

3.5 **Subcontractor**: An independent organization engaged, and/or used by a contractor to assist in the execution of the contractual work. The engagement and management of the subcontractors will be entirely under the control and management of the contractor engaging them.

4. TYPES OF CONTRACTOR WITH RESPECT TO THE TYPE OF WORKFORCE PROVISION:

4.1. Manpower supply only: Contractors who work under and are monitored by the client or the Prime Contractor. They are described as resident contractors and are usually engaged in Operation and Maintenance.

4.2. Supervised type: Contractors who conduct work pursuant to a contract with the client but manage and supervise their own employees and work activity. In this case, supervision is

provided by the contractor (e.g., Operation and Maintenance contractors including transporters) .

4.3. Set Apart type: This type of contract usually involves project work and/or assignment-based services. The contract is carried out within the site and the work is undertaken in an area 'set apart' and completely controlled by the contractor. The contractor, while working within the client's premises, is required to comply with all client's standards and procedures regarding safety. This type of contract also includes those organizations who provide their services at their premises to convert client's material for further processes and storage.

4.4. Transient type: Contractors who are engaged for short-term, one-time service support (e.g., out-bound transporters, material suppliers, etc.) .

4.5. Other Service providers: Contractors such as Consultants, Expert agencies, Auditors, trainers etc. who are not otherwise classified in any of the above categories.

5. CLASSIFICATION OF THE CONTRACTORS WITH RESPECT TO JOB CATEGORY:

SN	Description	Activities/Jobs but not limited to
1.	Contractors who are engaged to execute work involving **High Risk job**	· Working at height, roof sheet changing, painting etc.(above 2 mts.) · Hot work in fire prone / gas prone areas · Confined Space working · Electrical work · Lifting/ rigging/ hoisting activity: Heavy lifts · Operating heavy equipment (crane, loco, dumper, dozers, etc.) · Underground drain cleaning, Deep Excavation etc. (Less than 2 mts.) · Working in proximity to hazardous chemicals including gases · Demolition of buildings and structures · Working within or in proximity of High Hazard Operations · Transportation of goods & materials through heavy motor vehicles · Refractory relining jobs in kilns/ pre-heaters/ converters/ chimneys etc. · Releasing jam from hopper/ cyclones/ silos · Capital Repairs · Stock yards and transportation of material to customers · Hot metal handling/transportation · Underground and open cast mining etc.
2.	Contractors who are engaged to conduct work involving **Low Risk job.**	· All jobs/services, not otherwise classified or considered under High-Risk Job/services, such as; Cleaning services in non-hazardous areas /in office area/ Non-works Zone, Housekeeping in non-hazardous area/Non-work Zone, Engaged as experts, or consultants, Transportation by Light Motor Vehicles etc.

6. PROCESS BRIEF:

Contractor Safety Management (CSM) process is a comprehensive system for managing the health and safety of contractors who work at the plant facilities.

Indian Factories Act, 1948 sets out the obligations of employers to ensure the health and safety of workers in the workplace, and there are industry-specific guidelines and regulations related to contractor safety management.

The objective of this process is to ensure that contractors and workers are prepared and equipped to work safely at a plant facility, and to continuously monitor and improve contractor safety performance.

The generally adopted six-step process of Contractor Safety Management (CSM) process in line with global best practices is tabulated as follows:

Sl. No	Steps	Explanation	Key elements
1.	**Contractor Selection**	Pre-Qualification for Registration	· Identify contractors who comply with organization's Safety principles and standards; · Critically evaluate contractor's Safety performance before registration and Safety Competency Assessment for registered vendors
2.	**Contract Preparation**	Scope of Work, specific Safety clauses based on Safety Hazards Assessment and control measures	· Develop Contract orders using specific Safety clauses in the documents to clarify Health and Safety expectations; · Help understand how to deliver Contract Safety requirements
3.	**Contract Award**	Awarding the contract to qualified competent Vendors/contractors	Thorough & effective communication and review of Contract Safety specifications at bid, Pre-bid & pre-award meetings (as applicable);
4.	**Orientation and Training**	Contractor Safety training, generic & job specific, or Skill-based Safety training	Assure that contractor's workers embrace the company's 'health & safety culture' and follow the client's Safety standards and CSMS
5.	**Managing the Work**	Safety supervision ensuring implementation of Organization's Safety standards and SOP	· Hold Pre-work meetings and assessing field safety execution against contract requirements before contractors mobilize their resources; · Ensure that Safety Audits are directed at injury prevention; · Install a generic follow-up process that drives continuous improvement and avoids repetition of errors & violations
6.	**Periodic Evaluation**	Post-work Contractor Safety Performance Evaluation	· Establish the process and procedure for Safety Performance evaluation and feedback to Vendors (sample attached as **Annexure-1**) · Rewards and Consequence management to ensure that the contractor is either allowed to continue working for client, or is removed due to poor Safety performance

7. SAFETY PERFORMANCE INDICATORS:

The following Indicators shall be monitored by the management, shall be discussed and acted upon during the internal meetings:

- % of Contractors covered under PQA (Pre qualification assessment) – Target 100%
- % of Contractors assessed periodically
- Base line score for contractor Pre-Qualification
- % annual increase in Baseline score for contractor Pre-Qualification

8. References

- JSW Steel Group CSM Standard – GS 02
- Tata Steel CSMS
- Bokaro Steel Plant (SAIL), CSM Standard

Annexure-I:

Sample Format for Contractor Safety Performance Assessment (CSPA) "Star Rating System"

Form No.	Rev.	Effective Date

CSPA Process for New Contractors:

New Contractors are those registered high- risk work /service contractors who have been awarded the work order first time by ———— steel plant.

All new contractors will be subjected to safety performance assessment (Star-rating) by a CSPA team within six months (depending upon duration of the work) from the date of starting the work at site.

The validity of this assessment will be12 months. The CEA will be responsible to get the contractors audited. Assessment report is to be logged in 'IT' Base System by SED Safety Officer / Engineer.

All the high-risk work contractors shall be assessed for safety performance (Star rating) within 6 months after start of job.

CSPA Process for Existing Contractors (Running Contracts):

The existing high- risk work / service contractors who have not been undergone **safety competency assessment** process will be subjected to safety performance assessment with in a period of three months from the effective date of this standard.

The existing / working contractors who achieve 3-star rating will be subsequently assessed for safety performance (Star-rating) once in a year (within12months) and for 4-star and 5-star rated contractors to be reassessed once in two years from the previous assessment every time during duration of the contract.

The contractors achieving 4-star, or 5-star rating will be awarded a certificate of appreciation for safety excellence to recognize their efforts to maintain a safe work culture by the—— steel plant management.

The contractors who do not achieve 3-star rating will be given 3 more chances once in three months to improve their safety performance to achieve minimum 3-star rating. The contractors / vendors who are notable to achieve 3-star rating even after 3 more attempts shall be penalized suitably and they will not participate in new RFQ for one year, after which they will be re-examined for next upcoming work at———— steel plant.

NOTE:

Following are the guidelines for providing Star Rating based on marks:

5 Star: 851–1000 Marks

4 Star: 751–850 Marks

3 Star: 651–750 Marks

2 Star: 551–650 Marks,

1 Star: 451–550 Marks

No Star: Less than 451 Marks

All the requirements will be evaluated in a scale of 0 to 5 which will be weighted for Star rating score calculation.

CSMS Total Score		CSMS Star Rating	
Organization Name:		Assessment Team:	
Contractor Proprietor Name:		Team Leader:	
Organization registered address:		Team Member:	
—— Steel Plant representatives (CA, CEA, CSSA, DSO and SED safety professional)		Date of Assessment	
Vendor Code	Work Order No.1	Comments by Assessor:	
Active work order numbers with name of the department	Work Order No.2	Department:	CA Name:
	Work Order No.3	Department:	CA Name:
	Work Order No.4	Department:	CA Name:
		Department:	CA Name:
Audit Location:			

Type of Contract:		Risk Parameter:	
(Risk of the job where contractors to be engaged)			
Manpower Contract:	☐	1.HighRisk:	☐
Supervision Contract:	☐	2.LowRisk:	☐
Set apart Contract:	☐		
Transient Contract:	☐		
Other Services:	☐		

- Assessment frequency of safety performance Audit of 5 star rated contractors-Once in two years
- 3-star rated contractors-once in every year
- Less than3-star rated contractors-Once in three months

Tick (✓) the type of work the company is capable of undertaking.

Civil, Structural and Building Maintenance	☐	Lifting equipment Maintenance and Services	☐	Utility Services	☐
Cleaning Services	☐	Mechanical Maintenance and Services	☐	Electrical Maintenance &Services	☐
Instrumentation, Calibration and Testing	☐	Catering Services	☐	Transportation & Material Handling	☐
Reclaiming and disposal of waste materials/slag etc.	☐	Man power Supply	☐	Mining-related activity	☐
Lifting, Loading, Unloading, Feeding & Packaging	☐	Road Maintenance	☐	Rail Maintenance	☐
Any other (please specify)	☐				

1. What is total manpower of your organization working in at————Steel Plant and facilities?
   i. Number of supervisors and their qualifications(Attach list):
   ii. Number of Certified and skilled employees (Please attach list of names of employees with skill level):

iii. Number of unskilled employees:

iv. Number of CSS and their qualifications(Attach list):

2. Total Value of Contract in currency as applicable with —— Steel Plant: Example in Rupees: (less than 5Lakh /5 to 25lakh /25lakh to1crore,and above1crore. If more than 1 crore, mention exact value).

3. Name of the departments where you are currently engaged in—— steel plant:

4. Organizational Structure of your company (e.g. MD, GM, Managers etc.):

5. Evaluation criteria for safety performance and star rating evaluation

0= Process not yet started /No system.
1 = **Poor** - Weak safety management system and process, Leading Indicators have not been identified. Inadequate compliance, training of personnel, site inspection /monitoring. Lack of reporting and compliance monitoring ; little awareness; minimal or no ownership and commitment.
2 = **Reasonable** - Some system and process exist, inadequate identification of leading Indicators, reporting and compliance monitoring; awareness may be present, but implementation of this aspect is haphazard or not evident at all.
3 = **Good** - Safety Management system and process exist and documented, further scope for improvement of system of Lead Indicator identification, reporting and compliance monitoring; system i s implemented a t the minimum levels. Ownership and commitment visible to some extent.
4=**Very Good** -O H S Management System is addressed systematically, documented, and regularly updated, reaching the respective targets regularly; good system of Lead Indicator identification, reporting and compliance monitoring; integration with other activities is at high levels; felt and visible ownership and commitment.
5 =**Excellent** -Excellent OHS management system, be recognized as a leader in this aspect of the OHS Management; everyone is involved. A high level of participation ,integration, ownership, and commitment is demonstrated.; continuous improvement is evident.

6. **Questions for evaluation:**

S.N.	Criteria	Suggested Document to be verified	Evaluation (0 to 5)	Multiplying factor	Maximum Weighted Score	Actual score
1	Safety and Health Management System	EHS/Safety Policy, Safety Manuals, Safety Organization Structure, Risk Management HIRA/ JHA, Legal compliance Mgt. system, Emergency Planning system, Safety Dashboard,		10	50	
		Safety Audit & Review system				

S.N.	Criteria	Suggested Document to be verified	Evaluation (0 to 5)	Multiplying factor	Maximum Weighted Score	Actual score
2	Procedure for selection of personnel	Procedure for selection and deployment of qualified, skilled and certified employees, Managers, supervisors and CSS		10	50	
3	Planning for safe execution of jobs	Safety planning process for safe execution of jobs. (HIRA, JHA, Audit plan, Proper Tools & equipment, Job execution plan, HSE plan, Permits required, Method statement)		10	50	
4	System and processes for training	System and processes for training on Safety Standard, Behavioral Safety, Job-specific Skill development, Emergency Preparedness & Response for employees and supervisors.		10	50	
5	2-way communication between contractor leadership and their workforce	System for two-way communication (Top > Bottom> Top) between contractor leadership and their workforce (Proprietor engagement in Line Mgt. walk, Safety meeting etc.).		10	50	
6	Capability of Workforce	Verify Capability of Workforce, (Skilled, Certified Competent Supervisor, Site Safety Supervisors, and manpower etc.) through site visit and Interview.		10	50	
7	Toolbox, Pre-job briefing, General mass meeting and leadership engagement (Contractor Safety Walk)	Verify through Records, Interview & site visit		10	50	
8	Usage of Suitable Certified PPEs	Verify through site visit, Interview, and documentary evidence.		10	50	
9	Usage of standard, certified and right tools and tackles, equipment's and calibrated safety gadgets	Verify through Records, Site visit with random sampling/inspection of such equipment		10	50	

S.N.	Criteria	Suggested Document to be verified	Evaluation (0 to 5)	Multiplying factor	Maximum Weighted Score	Actual score
10	Standard of housekeeping	Verify through site visit ensuring a good housekeeping free from any slip / trip / fall hazards at working sites.		10	50	
11	Safety Initiative /Planning for Safety improvement	Self-Safety Initiative / Project safety planning by contractor Verification though various documentary evidence		6	30	
12	Contractor Safety Audit by CS & CSS	Verify records		10	50	
13	Ensuring the Corrective and preventive action	Verify records and site visit for taking Corrective and preventive action based on the risk potential severity.		6	30	
14	Compliance to generic and specific Safety clauses as per contract & Welfare amenities	Verify through site visit and Interview based on Work order Proper restroom available for workmen Adequate washroom facilities available. Adequate Drinking water facilities available Canteen / Eating area available for workmen		6	30	
15	Incident Reporting and investigation	Verify through documents for incident Reporting, investigation, analysis, and lesson- learnt of all incident / accident, occupational health issue.		8	40	
16	Near miss , Unsafe act / condition reporting	Verify through documents for Near-miss and Unsafe act/ condition reporting, investigation and corrective action.		10	50	
17	Policy or System on Skill- retention	Verify through document, records and Interview		8	40	
18	Safety Campaign e.g. (Safety Quiz, Safety Skit, FGD, Posters, participation in safety activities etc.) to develop Safety culture.	Verify through records and Interview		8	40	

S.N.	Criteria	Suggested Document to be verified	Evaluation (0 to 5)	Multiplying factor	Maximum Weighted Score	Actual score
19	Reward, Recognition and Consequence Management System of the Contractor	Verify through records		8	40	
20	Lost time /serious injury or permanent disability	Zero One or more such accidents	1 (-) 50 for each serious/ lost time incident	60	60	
21	First aid Case	Zero One or more first aid case	1 0	40	40	
22	Non-Injury Incidents (e.g., Property Damage/ production loss	Zero One or more such incidents	1 (-) 10	10	10	
23	Safety violation of fatality potential severity	Zero One or more safety violations of that nature	1 (-) 20	20	20	
24	Safety non-compliance/ cost recovery / penalty imposed / Job stopped	No case One or more such cases	1 (-) 20	20	20	
25	Fatal Accident:	Zero incident involving fatality For each incident involving fatality	0 score (-) 300			
Total Marks Obtained					**1000**	
Star Rating						

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