

SAFETY GUIDELINES FOR IRON & STEEL SECTOR		
MINISTRY OF STEEL, GOVT. OF INDIA	Direct Reduction Plant (Gas Based)	Doc. No: SG/33
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1. OBJECTIVE:

The entire process of making Sponge Iron by coal based DRI process is associated with various Safety hazards like Fire, Explosion, Radiation, Burns hit / entanglement with mobile equipment, slip & fall, electrocution, exposure to dust, smoke, noise, heat & gas etc. This guideline has been prepared to introduce safe methods applicable to all equipment of gas based Direct Reduction Iron Plant for mitigation & prevention of accidents.

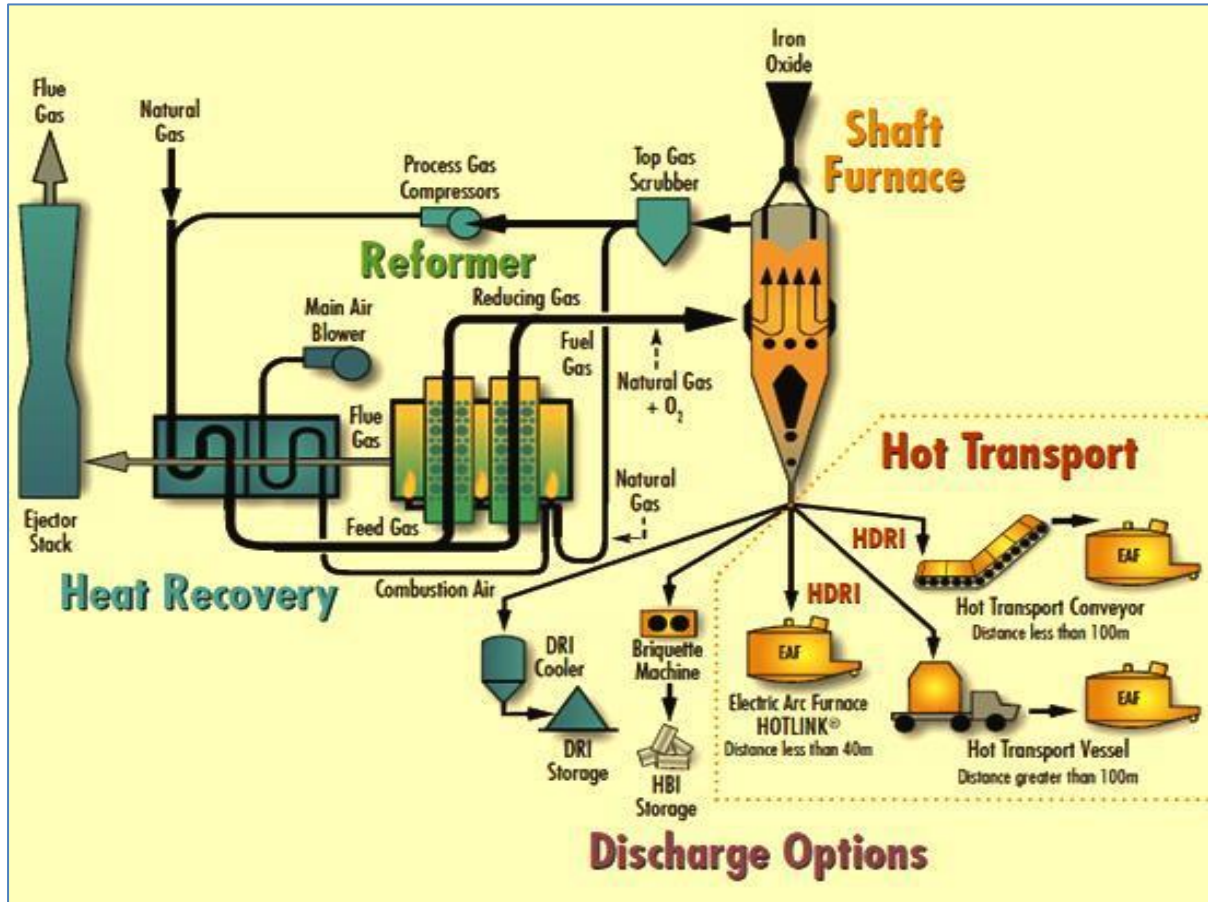
2. SCOPE:

This guideline of safety is applicable to all Gas based Direct Reduction Plants.

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

- (i) Raw Materials Handling System (RMHS- Belt Conveyers, Crusher, Vibrating Screen etc & Silos/Sheds/Storage Yards for Raw Materials storage purposes)
- (ii) Kiln Charging Equipment - storage bins, Lime coating station, vibrating feeders, conveyors, shaft feed hopper
- (iii) Shaft furnace & cooler Area - Shaft furnace, cooler, Burden feeders, feed cone, hydraulic system, etc.
- (iv) Process gas system- Process gas reformer/heater, CO₂ removal system, process & cooling gas scrubbers, mist eliminators , process & cooling gas compressors etc.
- (v) Shaft furnace / Cooler Discharging Equipment - Conveyors, bins, Briquetting machine, vibrating feeder).
- (vi) Plant de-dusting system.
- (vii) Control Rooms, Electrical Panel Rooms and Transformers Rooms.
- (viii) Emergency DG Set

Process Flow Diagram of Gas based Direct Reduction Iron Plant:



4. PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

S.No.	Section	Hazards	Risks Control Measures
1.	Material Handling	<ul style="list-style-type: none"> • Fire Hazard • Nip point Hazard • Belt sway 	<ul style="list-style-type: none"> ❖ Guarding of all rotating parts of conveyor system. ❖ Pull chord in conveyors. ❖ Emergency switch. <p>(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-19: Safety Guidelines on Operation and Maintenance of Conveyor Belts, SG-04: Safety Guideline for Permit to Work (Operation & Maintenance))</p>

S.No.	Section	Hazards	Risks Control Measures
2.	Charge Hopper	<ul style="list-style-type: none"> • CO leakage • Falling of Pellets • Shell crack & Corroded structure 	<ul style="list-style-type: none"> ❖ Installation of online CO gas monitor & use of Portable monitors to detect gas leakage. ❖ 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 proper safety precautions under intimation to control room. ❖ Regular inspection & repair as per requirement. <p><i>(Refer SG-18: Safety Guidelines for Personal Protective Equipment (PPE) management, SG-16: Safety Guidelines for Fire Safety, SG-09 Safety Guideline in Equipment & machine Guarding)</i></p>
3.	Reduction shaft furnace and cooler for gas based DR plant	<ul style="list-style-type: none"> • Heat • Radiation • Confined space entry • Gas leakage • Shell crack & Corroded structure • Slip, trip & fall hazard • Material fall from height • Fire & Explosion 	<ul style="list-style-type: none"> ❖ 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. ❖ Uses of appropriate PPE, such as helmets, gloves, aprons and boots. ❖ Barricade Area/ declare Prohibited area. ❖ Cooling arrangement. <p><i>(Refer SG-11: Safety Guideline for Barricading, SG-03: Safety Guideline for Working in a Confined Space, SG-18: Safety Guideline for</i></p>

S.No.	Section	Hazards	Risks Control Measures
			<i>Personal Protective Equipment (PPE) management, SG-16: Safety Guideline for Fire Safety, SG-21: Safety Guideline for Handling Fuel Gas)</i>
4.	Process & cooling gas SG rubber / mist eliminators etc.	<ul style="list-style-type: none"> • Gas Leakage • Confined space entry • Shell crack / Corroded structure • Slip, Trip and fall hazards 	<ul style="list-style-type: none"> ❖ Provision of Online Gas monitor & Portable “CO” (Carbon Mono Oxide) monitors to detect gas leakage. ❖ Pressure drop monitoring. <p><i>(Refer SG-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)</i></p>
5.	Hot DRI Briquette Machine/Cold DRI	<ul style="list-style-type: none"> • Steam • Hot Water • Dust • Hot Product • Fumes • Hot fines • Fire Hazard 	<ul style="list-style-type: none"> ❖ Stack to be provided. ❖ Pond and Clarifier to be provided. ❖ De-dusting system to be provided. ❖ Process safety management. <p><i>(Refer SG-16: Safety Guideline for Fire Safety, SG-18: Safety Guidelines for Personal Protective Equipment (PPE) management)</i></p>
6.	Hot DRI handing & storage system	<ul style="list-style-type: none"> • Spillage of Hot DRI • Explosion • Exposure to high temperature • Oxygen deficient zone • Rotating parts (Rollers & chain guide) 	<ul style="list-style-type: none"> ❖ Preparation of proper protocol. ❖ Adherence to SOP. ❖ Water sprinkler system. ❖ Provision of safe contained breathing apparatus. ❖ Complete purging of system before operation. ❖ Level alarm at bins. ❖ Guarding of nip points. ❖ Cooling of spillage material by water. <p><i>(Refer SG-03: Safety guideline for working in confined space, SG-18:</i></p>

S.No.	Section	Hazards	Risks Control Measures
			<p><i>Safety Guidelines for Personal Protective Equipment (PPE) management, SG-11: Safety Guideline for Barricading, SG-16: Safety Guideline for Fire Safety)</i></p>
7.	Process gas compressors, cooling, cooling gas compressor, seal gas compressors etc.	<ul style="list-style-type: none"> • CO leakage • Work at height • Noise 	<ul style="list-style-type: none"> ❖ Guarding of all rotating parts. ❖ Access control. ❖ Adherence to electrical safety ❖ Precautions. ❖ Use of Ear Plug. ❖ Display of Noise level at site. ❖ Provision of Online Gas monitor & Portable “CO” monitors to detect gas leakage. <p><i>(Refer SG-09: Safety guideline for equipment & machine guarding, SG-15: Safety Guideline for Electrical safety)</i></p>
8.	Process gas system including Process gas heater/ reformer/ recuperator etc.	<ul style="list-style-type: none"> • Heat • Gas leakage • Fire hazard • Mechanical failure 	<ul style="list-style-type: none"> ❖ Maintenance of hot briquette cooling arrangement. ❖ Preparation of layout with Hazardous area classification. ❖ Provision of Fire & Gas detection system. ❖ Steam purging of the system before any repair, maintenance, etc. ❖ Fire proofing of cables. ❖ Safety showers in case of CO₂ removal plant. ❖ Regular Maintenance. <p><i>(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)</i></p>
9.	CO ₂ removal plant	<ul style="list-style-type: none"> • CO leakage • Noise • Exposure to chemicals 	<ul style="list-style-type: none"> ❖ Installation of fixed CO monitors & use of portable monitors to detect leak. ❖ Purging of system before any maintenance job. ❖ Use of PPEs. ❖ Water showers (for amine based plant). <p><i>(Refer SG-09: Safety guideline for equipment & machine guarding, SG-</i></p>

S.No.	Section	Hazards	Risks Control Measures
			03: Safety Guideline for Working in a Confined Space, SG-18 for PPE management, SG-21 : Safety Guideline for Handling Fuel Gas)
10.	Dedusting system	<ul style="list-style-type: none"> • Noise • Dust • Slippery floor • Fall from height 	<ul style="list-style-type: none"> ❖ Provide PPEs. ❖ Maintain platform. ❖ Improve housekeeping. ❖ Provide adequate illumination. <p>(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))</p>
11.	DRI Storage	Fire hazard	<ul style="list-style-type: none"> ❖ Sponge iron should be loaded dry and it should be below temperature of 65°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. <p>(Refer:-SG-16: Safety Guidelines for Fire Safety)</p>
12.	Electrical panels	Electric shock Flash over	<ul style="list-style-type: none"> ❖ Ensure permit to work / shutdown before start of job. ❖ Proper earthing. ❖ Display of “Men at work” at HT switchgear on panels. ❖ Develop & follow SMP. <p>(Refer SG-15: Safety Guidelines for Electrical Safety)</p>
13.	Transformer room	<ul style="list-style-type: none"> • Electric shock • Oil leakage 	<ul style="list-style-type: none"> ❖ Ensure permit to work / shutdown before start of job. ❖ Proper earthing. ❖ Display of “Men at work” at HT switchgear on panels. ❖ Develop & follow SMP. ❖ High velocity water spray system / Nitrogen injection system as per requirement. ❖ Fire extinguishers to be provided at site. <p>(Refer SG-15: Safety Guidelines for</p>

S.No.	Section	Hazards	Risks Control Measures
14.	Capital repair	<ul style="list-style-type: none"> • Slip & fall • Electrical shock 	<p><i>Electrical Safety)</i></p> <ul style="list-style-type: none"> ❖ Preparation of protocol. ❖ Adherence to SOP & SMP. ❖ Taking shutdown & complete purging of system. ❖ Blanking as per requirement. ❖ Barricading to prevent unauthorized entry. <p><i>(Refer SG-03: Safety guidelines for working in Confined space, SG-15 for Electrical Safety, SG-18 for PPE management)</i></p>

Note:

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