

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: --

1. OBJECTIVE:

The main function of IF Steel Making is to convert Solid Metallics like Steel Scrap, Sponge Iron, etc. into Liquid Steel by Induction heating. This gets further processed into Billets, Blooms and Ingots, and by various solidifying processes like Ingot casting or Continuous casting. (Refer Steel Melt shop, SMS Guidelines for secondary metallurgical processes and subsequent casting of liquid steel)

Entire process of IF steel making, is associated with various safety hazards. Most safety hazards in IF arise from the high temperature of liquid steel. These hazards are enumerated in this guideline.

2. SCOPE:

This safety guideline is applicable to all Electric Induction Furnace (IF) of standalone units or a Mini Steel Plant having induction furnaces.

3. PROCESS BRIEF :

- I. Process of IF Steel Making area includes the following areas
 - a) **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.
 - b) **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 and flux is charged into the Furnace either manually or from the Scrap/DRI 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.
 - c) **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.

- d) **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.
- e) **Material feeding System:** Depending upon the size of operation, the material is fed into the furnace manually or through EOT Cranes having magnets.
- f) **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.
- g) **Fume Extraction System:** A movable elbow collects the fumes from the top of the crucible and transfer 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.

II. The EIF comprises of the following major operations/critical equipments:-

Sl. No.	Operation	Equipments
1	Scrap processing	Shearing 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	

4.0 Process hazard analysis & necessary risk control measures:

Sl. No	Area/Section	Hazards	Risk Control Measures
A) ELECTRIC INDUCTION FURNACE			
1)	IF proper	Explosion hazard due to Water Leakage from coil, Water Cooled panel or power cables.	<ul style="list-style-type: none"> ❖ Stop operation. ❖ Stop tilting or stop any Furnace movement ❖ Identify the leakage point ❖ Develop and Follow SOP ❖ SG-23 Safety Guideline for Safe handling of Liquid Metal
		Metal splash or explosion due to water coming into contact with molten metal. (Water may be present in scrap material or from leaks in the furnace cooling systems)	<ul style="list-style-type: none"> ❖ Stop operation. ❖ Ensure use of PPEs ❖ Proper protection system like Ground Leak Detector (GLD) etc. in place ❖ Ensure No unauthorized person on furnace platform ❖ Ensure no wet scrap and leakage of water ❖ SG-23 Safety Guideline for Safe handling of Liquid Metal
		Metal splash or explosion due to improper scrap charging/wet scrap/chemicals in scrap	<ul style="list-style-type: none"> ❖ Stop operation ❖ Proper Segregation of scrap ❖ Inspection of scrap and approval process for worthiness ❖ Safe scrap charging through cranes/vibrators charging trolley ❖ Use of Hydraulic pusher for melting
			<i>(Refer SG-23 : Safety Guidelines for</i>

		<p>Injury from Material Handling like DRI, Pig Iron, Scrap shifting to furnace floor</p>	<p><i>Safe handling of Liquid Metal)</i></p> <ul style="list-style-type: none"> ❖ 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 <p><i>(Refer SG-14 : Safety Guidelines for work on Electric Overhead Travelling (EOT) Crane)</i></p>
		<p>Explosion due to high temperature/thinning of refractory with improper Melting system protection</p> <p>Additionally-Bridging in IF : Leading to superheating of furnace bottom and erosion of ramming mass and rupture of cooling water tubes and subsequent explosion.</p>	<ul style="list-style-type: none"> ❖ Water Temperature & flow sensors ❖ Ground leak detector ❖ Circuit breakers and tripping mechanism ❖ Frequency monitoring ❖ Lining conditions of crucibles & ladle etc.

			<ul style="list-style-type: none"> ❖ Develop and follow SOP ❖ <i>(Refer SG-23 : Safety Guidelines for Safe handling of Liquid Metal)</i>
2)	IF turnaroun d activity	Burn Injury due to splashing slag	<ul style="list-style-type: none"> ❖ Proper PPE and visor. ❖ Covering of all exposed area with cloth <p><i>(Refer SG-18 Personal Protective Equipment (PPE) Management)</i></p>
		Injury from Pressurized Vessels	<ul style="list-style-type: none"> ❖ 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 testing of PV Thickness and hydraulic testing every four years by competent person as per the factory act. <p><i>(Refer SG-01:Safety Guidelines on storage, handling & use of gas cylinders)</i></p>
		Person hit by moving machines	<ul style="list-style-type: none"> ❖ Siren, gong bell during movement machines. ❖ Auto announcement during any operation. ❖ Permit to work prior to undertaking any maintenance job. <p><i>(Refer SG-09 : Safety Guidelines in Equipment & machine Guarding)</i></p>
3)	Electrical	Electrical failures and	<ul style="list-style-type: none"> ❖ Proper Earthing pits

	system	shock	<ul style="list-style-type: none">❖ Earthing of all electrical motors/gadgets❖ Work permit system❖ Transformer testing (dielectric strength and dehydration of Transformer oil)❖ Refer SG-15 Safety Guideline for Electrical safety
--	--------	-------	--