

<b>SAFETY GUIDELINES FOR IRON &amp; STEEL SECTOR</b>		
MINISTRY OF STEEL, GOVT. OF INDIA	<b>Rolling Mills (Semi-Automatic)</b>	Doc. No: SG / 36
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## 1. OBJECTIVE:

Rolling and Re-Rolling is the process of plastically deforming the metal by passing it between a set of rolls revolving in opposite direction. It is carried out on crude or scavenged steel/Scrap products for shaping into semi-finished or finished forms in a Re-Rolling Mill or a partially automated or a Manual Rolling Mill. Rolling is the most widely used metal forming process. It is employed to convert metal ingots to products like blooms, billets, sheets, plates, strips etc. The main objective of rolling is to decrease the thickness of the metal and give it a desired profile. Rolled products are used for different engineering, constructional & fabrication purposes.

As steel is not ductile at room temperature, heavier reductions require it to be heated to temperatures of 1500-1200 °C to make it ductile by converting its crystal structure from BCC to FCC. In re-rolling mills, this operation is called reheating process and is carried out in reheating furnaces. Hot rolling operation is always preceded by reheating operation.

This entire process of Rolling is associated with various safety hazards like hit / entanglement with moving stock, burns, slip & fall, exposure to dust, noise, heat & gas etc. Most hazards in rolling process arise from coming in contact with moving hot material, falling etc. Second threat is from emissions of reheating furnaces which contain toxic gases such as carbon monoxide, Sulphur dioxide, NOx etc. Also leakage of fuel gas like producer gas, Piped Natural Gas (PNG), Coal Bed Methane (CBM) etc is a constant threat.

## 2. SCOPE:

This safety Guidelines is applicable to Reheating Furnaces & Rolling and Re-rolling mill (semi-automatic) of a Mini Steel Plant.

## 3. PROCESS BRIEF :

The Rolling and re-rolling mill has following main sections:

### I. Raw material Section:

In this section, the raw materials like ingots/billets 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.

## II. Reheating Furnace:

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

- a) **Fuel Handling Section:** The fuel handling section may include coal pre-crushers, coal pulveriser, conveyor belt, gas train, gas pipes, Pressure Relief Valve etc. The main function of this section is to prepare fuel for proper/efficient combustion in reheating furnaces.
- b) **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.
- c) **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 stock material for further hot rolling operation. The reheating operation includes Charging, Pushing, heating and discharging/conveying to rolling mill.
- d) **Conveyor table:** To carry the heated discharged material to rolling mill for rolling operation.

## III. 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:-**

- i. Drive mechanisms
- ii. Roughing stands
- iii. Intermediate stands
- iv. Finishing mill
- v. Cooling bed
- vi. Shearing section/finishing yard
- vii. Dispatch yard
- viii. Oil Cellars

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

Sl. No.	Area	Major equipments
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1.	Raw material section	Conveyors, grinders, hoist/overhead crane etc.
2.	Reheating furnace section	Coal Crushers/Pulveriser (hammer/ Jaw crusher), Pusher, gas pipe line, flue channel, burners, pressure regulators etc.
3.	Rolling Mill Section	Roller Table , power transmission mechanism including oil cellars , belts, flywheel, motors etc.

#### 4.0 PROCESS HAZARD ANALYSIS & NECESSARY RISK CONTROL MEASURES:

Sl. no .	Area / Section	Hazards	Risk Control Measures
<b>A) Raw material section</b>			
1.		Injury in grinding operation	<ul style="list-style-type: none"> <li>❖ Wear goggles for all grinding machine operations.</li> <li>❖ Operate grinding wheels at recommended speed with recommended depth of cut.</li> <li>❖ Use proper wheel guards on all grinding machines.</li> <li>❖ Use PPEs.</li> <li>❖ Develop and Follow SOPs</li> </ul> <p><i>(Refer SG-10 : Safety Guidelines for Hydraulic System )</i></p>
2.		Hazards due to conveyors	<ul style="list-style-type: none"> <li>❖ Avoid sitting, standing, or walking on conveyors</li> <li>❖ All conveyor to be provided with proper guards.</li> <li>❖ Never perform maintenance while a conveyor is in operation.</li> <li>❖ Ensure correct operation of conveyor controls.</li> <li>❖ Avoid loose clothing, long hair, jewellery and other loose items near conveyor</li> <li>❖ Emergency "shut-off" devices to be provided</li> <li>❖ Follow lock-out/tag-out procedures</li> </ul>

			<p>for maintenance</p> <ul style="list-style-type: none"> <li>❖ Only authorized/trained personnel to operate or maintain the conveyor.</li> </ul> <p>( Ref: SG- -----)</p>
3.		Hazards in Material handling & stacking area	<ul style="list-style-type: none"> <li>❖ Maintained floors in proper condition</li> <li>❖ Stacked the material properly without any billet ends protruding out</li> <li>❖ Clearly defined walkways, proper stacking of material.</li> <li>❖ Regular clearance of debris.</li> <li>❖ Develop and Follow SOP</li> </ul> <p>( Ref: SG-13 Safety Guideline for Material handling (manual and mechanized) &amp; storage)</p>
<b>B) Reheating Furnace</b>			
1)		Gas poisoning due to leakage of gas	<ul style="list-style-type: none"> <li>❖ 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.</li> <li>❖ Blanking of gas line to be done before Removal of valves or flanges.</li> <li>❖ Proper packing to be provided in fixing of valves or flanges.</li> <li>❖ Regular inspection of gas lines to detect leakage if any.</li> <li>❖ Use Portable "CO" monitors to detect gas leakage.</li> <li>❖ Ensure the closure of main valve to cut off supply</li> <li>❖ Check all the flange/ welded joints for gas leakage.</li> <li>❖ Purge the gas pipe line with nitrogen in small segments by opening the bleeder valve</li> <li>❖ Develop and Follow SOP</li> </ul> <p>(Ref: SG-21 Safety Guideline for Handling Fuel Gas)</p>

2)		Fire hazards	<ul style="list-style-type: none"> <li>❖ Give clearance for cutting/welding etc after ensuring that there is no leakage of gas</li> <li>❖ Keep the Portable fire extinguishers ready for any hazards</li> <li>❖ While lighting up or off of the furnace, laid down procedures are to be followed strictly.</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-16 : Safety Guidelines for Fire Safety )</i></p>
3)		Burn injury hazards, Exposed to hot flames and hot billets/ingots	<ul style="list-style-type: none"> <li>❖ Use personal protection equipments</li> <li>❖ Keep the first aid kit having burn injury medicine on standby</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Ref: SG-24 Safety Guideline for Transportation in steel industry)</i></p>
4)		Hazards associated with re-lining of furnace with refractory bricks	<ul style="list-style-type: none"> <li>❖ Work permit system to be followed.</li> <li>❖ Monitor the temperature of area before starting work</li> <li>❖ Hand held 24 V bulb to be used during repairs in furnace</li> <li>❖ Detail job safety protocol may be prepared to undertake the job, if job is irregular.</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-04 : Safety Guidelines for Permit to Work(Operation &amp; Maintenance)</i></p>
5)		Hazard due to mechanical & Electrical Maintenance	<ul style="list-style-type: none"> <li>❖ All electrical equipment/ machines to be earthed properly</li> <li>❖ Use electrical PPEs</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-04 : Safety Guidelines for Permit to Work(Operation &amp; Maintenance) )</i></p>

C)	Rolling Mill		
1)		Injury from Moving roller table	<ul style="list-style-type: none"> <li>❖ Shutdown/permit to work with electrical isolation.</li> <li>❖ No work to be done on conveyor in running condition.</li> <li>❖ Local emergency switch to be operated for approaching conveyor.</li> <li>❖ Availability of Pull chord.</li> <li>❖ Siren system prior to restarting conveyor.</li> <li>❖ Loose cloths prohibited.</li> <li>❖ Area barricading if material is removed from height.</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-09 : Safety Guidelines in Equipment &amp; machine Guarding)</i></p>
		Injury from Rotating machineries	<ul style="list-style-type: none"> <li>❖ Coupling guards to be in place.</li> <li>❖ Loose cloths to prohibited</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-11 : SG-11 Safety Guidelines for Barricading)</i></p>
2)		Injury during Working on mill stands	<ul style="list-style-type: none"> <li>❖ "Permit to work" practice to be followed strictly</li> <li>❖ Display of "Men at Work" board is to be done at Operator Control Panel</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-04 : Safety Guidelines for Permit to Work(Operation &amp; Maintenance) )</i></p>
3)		Injury during Roll Change	<ul style="list-style-type: none"> <li>❖ During Roll Change, Rolls to be cooled with water spray before work to avoid burn injury.</li> <li>❖ Ensure to take Power Shutdown for Roller Table and connected drive.</li> <li>❖ Ensure written Work Clearance to be given to concerned personnel for doing the work.</li> </ul>

			<ul style="list-style-type: none"> <li>❖ Cleanliness of area with respect to presence of oil, grease, jute and other inflammable materials before gas cutting/ welding job.</li> <li>❖ Availability of fire hydrant to be ensured if job involves gas cutting etc.</li> <li>❖ Display “Men at Work” board at Operator Control Panel.</li> <li>❖ Place a plate on rollers table for smooth entry of personnel.</li> <li>❖ Use required PPE when changing roll and after completion of jobs, ensure that men and materials are removed from site.</li> <li>❖ Ensure that “Job completion Report” is given in writing and then cancel “Power Shutdown,” remove “Caution Tags” and give clearance for operation.</li> <li>❖ Develop and Follow SOP (Refer SG-04 : Safety Guidelines for Permit to Work(Operation &amp; Maintenance) )</li> </ul>
4)		Electric shock	<ul style="list-style-type: none"> <li>❖ Ensures safety precautions like “Power Shutdown”, Work Clearance before stating the job</li> <li>❖ Displaying of "Men at Work" at HT switching on panel.</li> <li>❖ Proper earthing of brush holder arm etc.</li> <li>❖ 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 the supervision of the Manager of the plant, using established SOP's and written</li> </ul>

			<p>permissions.</p> <ul style="list-style-type: none"> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-15 : Safety Guidelines for Electrical safety )</i></p>
5)		Entanglement/ injury at Gear box/ coupling	<ul style="list-style-type: none"> <li>❖ For working in gear box/coupling, take power shut-down for connected drive.</li> <li>❖ Display “Men at Work tag”.</li> <li>❖ Develop and Follow SOP</li> </ul>
6)		Injury while Working on EOT Cranes	<ul style="list-style-type: none"> <li>❖ For safe working, ensure” power Shutdown,” Work Clearance Men at Work tag,</li> <li>❖ Watch by additional person to observe movement of nearby crane etc.</li> <li>❖ Stoppers are to be welded on both sides of crane on LT rails.</li> <li>❖ Submit job completion report after repair.</li> <li>❖ All the lifting tools and tackles to be checked every year as per statutory requirement.</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-14 : Safety Guidelines for work on Electric Overhead Travelling (EOT) Crane )</i></p>
7)		Injury in Motors with belt/chain drives	<ul style="list-style-type: none"> <li>❖ Provide guards on all the motors having belt/chain type transmission mechanism.</li> <li>❖ Develop and Follow SOP</li> </ul>
8)		Injury with Flywheel	<ul style="list-style-type: none"> <li>❖ Flywheel to run below safe speed limits.</li> <li>❖ Appropriate guard to be provided around flywheel.</li> </ul>



			<ul style="list-style-type: none"> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-09 : Safety Guidelines in Equipment &amp; machine Guarding )</i></p>
9)		Person hit by rolling hot material during looping and play	<ul style="list-style-type: none"> <li>❖ Auto Announcement during pusher/ejector/ roughing operation.</li> <li>❖ Proper guards to be provided to avoid material coming in the way of workmen.</li> <li>❖ Proper pathways to be provided for safe movement.</li> <li>❖ Use of appropriate PPE hand gloves, gum boots, Face shield, dust mask, goggles by persons working on stands and handling hot materials.</li> <li>❖ Proper leg/arms guards/safety goggles to be provided to tongs men</li> <li>❖ Permit to work prior to undertaking any maintenance job.</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer : SG-11 : Safety Guidelines for Barricading and SG-18 : Personal Protective Equipment (PPE) Management)</i></p>
10)		Injury from Cooling Fans	<ul style="list-style-type: none"> <li>❖ Appropriate guards to be provided around fan blades.</li> <li>❖ Proper stand to be provided.</li> <li>❖ Earthing to be provided.</li> <li>❖ Develop and Follow SOP</li> </ul> <p><i>(Refer SG-15 : Safety Guidelines for Electrical safety)</i></p>
11)		Injury from Manual Handling of Heavy loads	<ul style="list-style-type: none"> <li>❖ Use appropriate lifting tackles like chain pulley block , hoist etc to lift heavy parts</li> <li>❖ Develop and Follow SOP</li> </ul>
12)		Injury from Handling of stock at stands	<ul style="list-style-type: none"> <li>❖ All hand tools to be well designed, frequently inspected and well maintained.</li> </ul>

			<ul style="list-style-type: none"> <li>❖ Rivets of tongs used at mills to be renewed frequently.</li> <li>❖ Develop and Follow SOP</li> </ul>
13)		Injury during Mill maintenance	<ul style="list-style-type: none"> <li>❖ Ring spanners and impact wrenches should be provided for roll changing crews;</li> <li>❖ Bent-out, open-ended spanners not be used.</li> <li>❖ Adequate training to be given to fitters in the use of all hand tools.</li> <li>❖ Develop and Follow SOP <i>(Refer SG-04 Safety Guidelines for Permit to Work(Operation &amp; Maintenance) )</i></li> </ul>
14)		Injury from Capital Repair Job in Rolling Mill (Semi Automatic)	<ul style="list-style-type: none"> <li>❖ 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.</li> <li>❖ Using required PPE as per requirement.</li> <li>❖ Ensure that all lifting tools &amp; tackles (winches, Hug-zugs, Chain Pulley Blocks etc.), mobile cranes are tested by a competent person and test certificates are submitted.</li> <li>❖ For working at height, a “Work at heights pass” to be obtained from safety department and use of appropriate safety belts.</li> <li>❖ All portable electrical equipment, welding machines to be earthed effectively (body earthing).</li> <li>❖ 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.</li> <li>❖ Suitable fire extinguisher in working condition must be kept close to all welding and gas cutting operations.</li> </ul>

			<ul style="list-style-type: none"><li>❖ Rolling of gas cylinders to be avoided and transferred / shifted by proper trolleys.</li><li>❖ Proper protection to be provided to conveyor and electrical cables to prevent fall of sparks from welding/ gas cutting.</li><li>❖ Isolation of electrical power and written clearance to be obtained from electrical section before start of dismantling operation.</li><li>❖ Area of work to be illuminated, before starting the job.</li><li>❖ Movement of the employees to be restricted to working area only.</li><li>❖ Mono rail hoist/EOT crane, to be operated with in safe working load (SWL) of the equipment.</li><li>❖ All the openings created during dismantling to be immediately covered/ barricaded.</li><li>❖ Compressed air vessels and pipelines to be de-pressurized before dismantling.</li><li>❖ 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.</li><li>❖ A charged water hose pipe may be kept near the place of work.</li><li>❖ People involved in hazardous area to be imparted first aid &amp; fire fighting training.</li><li>❖ Prior to actuation it must be ensured that no persons are in the active area of the dangerous energy (mechanical, electrical, hydraulic, pneumatic, etc.).</li></ul> <p>Only the hydraulic/pneumatic</p>
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			<p>specialist is allowed to perform switching operations on hydraulic / pneumatic valves, provided the following conditions are fulfilled:</p> <ul style="list-style-type: none"> <li>✓ personnel involved in plant start-up and control must be warned of any operations that are to be carried out in the enclosed area before starting the machine</li> <li>✓ No persons must be present in the danger zone,</li> <li>✓ Voice contact must be established with a responsible person at the workplace in charge of monitoring the sequence of functions.</li> </ul> <p>❖ Develop and Follow SOP</p>
15)	<p>General safety norms for rolling mills (Semi Automatic)</p>		<ul style="list-style-type: none"> <li>❖ All required PPEs are to be used while working.</li> <li>❖ Use properly maintained tools &amp; tackles.</li> <li>❖ Hand tools to be checked in every six months.</li> <li>❖ All the lifting tools and tackles to be checked every year as per statutory requirement.</li> <li>❖ Permit-to-work to be filled up before taking any job.</li> <li>❖ Before starting any job compliance to be proper safety isolation procedure to be ensured by concerned agencies.</li> <li>❖ Compliance of special measures to be undertaken such as cooling of rolls in hot areas, use of supports, use of stoppers, closing of valves, housekeeping in the area, availability of fire hose/extinguishers.</li> <li>❖ Standard Operation Practices (SOPs) and Standard Maintenance Practices (SMPs) are to be followed strictly.</li> </ul>

			<ul style="list-style-type: none"> <li>❖ All the mechanical moving equipments are to be barricaded / guarded properly.</li> <li>❖ All electrical equipments to be earthed properly.</li> <li>❖ All high- pressure vessels are to be tested as per statutory requirements.</li> <li>❖ Oil Cellar to be checked every month for leakages.</li> <li>❖ Proper loading / unloading procedure for raw materials/finished products to be prepared and followed.</li> <li>❖ Ensure the availability of firefighting equipment.</li> <li>❖ Ensure proper illumination</li> <li>❖ Proper housekeeping to be done.</li> <li>❖ Before restoration of power of the equipment, it is to be ensured that men, materials including tools and tackles, supports, scaffolding etc. are removed.</li> <li>❖ Develop and Follow SOP</li> </ul>
			<ul style="list-style-type: none"> <li>❖ Safety signs are intended to ensure the safety of personnel at their workplace. Depending on the kind of hazard, the following signs must be placed: <ul style="list-style-type: none"> <li>✓ Prohibitive signs</li> <li>✓ Warning signs</li> <li>✓ Mandatory signs</li> <li>✓ Rescue signs</li> <li>✓ Informative signs</li> <li>✓ Signs identifying permanent danger areas</li> <li>✓ Signs for operating areas requiring individual safeguarding</li> </ul> </li> <li>❖ In operating and danger areas of the plant/machine, it is necessary to place the signs listed above before</li> </ul>

			<p>equipment is put into operation.</p> <ul style="list-style-type: none"> <li>❖ Before commencing their activities, all personnel must be instructed as to the significance of the safety signs, and renewed instruction must be given at appropriate intervals, but at least once per year.</li> </ul>
			<ul style="list-style-type: none"> <li>❖ In addition to the signs listed above, the user of the equipment shall clearly and distinctly indicate and place signs for the following: <ul style="list-style-type: none"> <li>✓ Escape routes/emergency exits</li> <li>✓ First-aid stations</li> <li>✓ Places where stretchers are available</li> <li>✓ Emergency showers/eye washing facilities</li> </ul> </li> </ul>
			<ul style="list-style-type: none"> <li>❖ The operational reliability and the safe use of the plant /machine are ensured (among other things) by electrical and mechanical interlock devices. These must be inspected at regular maintenance intervals.</li> <li>❖ Emergency push buttons / switches to be checked for their functioning at regular intervals.</li> <li>❖ All fixed guards, when removed for any work on the machine, must be correctly replaced and secured at the end of the work.</li> </ul>

**REFERENCES:**

1. Technical literature on Safety in Re-rolling mills by UNDP-GEF Project (Steel)
2. ILO Code of safety & health for Iron & Steel Industry