**ACTIVITY: REFRACTORY JOBS FURANCE AREA**

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* Objective : - Refractory jobs in furnace area
* Scope : - Blast furnace accessories
* Ref. : - Launder Drawing, Grouting Pump Manual, Grouting material safety data sheet, Cooler plate drawing, grouting

Nozzle drawing

* Responsibility : - Refractory engineer, Cast House In-Charge & Mason

**PPE to be used** : Helmet, safety shoes, hand gloves, nose mask, goggles, full

Body safety harness, CO monitor. torch.

* Activity No 1 : Mortar/Carbon paste injection in the furnace
* Activity No 2 : Mortar/ Carbon Injection machine shifting
* Activity no 3 : Grouting nozzle fitting on Furnace Shell
* Activity No 4 : Runner (Drainable) repair and refractory job
* Activity No 5 : Ladle repair near Bag House
* Activity No 6 : Non-drainable Launder minor repair
* Activity No 7 : Non-drainable Launder major repair

**Aspect- Impact**

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| --- | --- |
| Scrap generation | Resource depletion |
| Spillage of carbon mass, resin | Land contamination |
| Fire of resin | Air pollution, resource depletion |
| Oil leakage | Land contamination |
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Hazards identified:

Mechanical Hazard

1. Fall of object.
2. Fall/Trapping of person in rotating parts
3. Impact of material, machinery, crane hook, etc.
4. Entanglement.
5. Getting trapped between rotating equipment.
6. Fall of grout material in eyes / body due to Hose puncture / gasket failure.
7. Falling inside the BF runner
8. Fall of person from height.
9. Fall of pump, tank, cylinder, bricks
10. Trapping of body parts in moving cylinder during mortar injection
11. Hit by coke/material thrown out from peephole due to explosion/furnace slipping.
12. Burning of any inflammable material due to contact of hot coke thrown out from peephole during explosion/furnace slipping.
13. Topple of mixer machine
14. Topple of excavator machine
15. Hit by castable bags while feeding to mixer machine
16. bursting of tyre by sharp metal piece/metal jam in crane bay
17. Hit by runner forma while mixing
18. Slipping of legs in between forma
19. Hit by excavator arm
20. Hit by vibrator needle

Physical hazard:

1. Dust inhalation.
2. Gas exposure
3. Burn injury from main runner, launders
4. Burn injury due to hot metal spillage.
5. Burn injury while working in front of Y spout
6. Burn injury from hot blow pipe.
7. Splashing of hot carbon paste, resin, in eyes/ body due to opening of valve during removing of hose/ nipple.
8. Fire.
9. Slippage of hose from air pressure clamps
10. Noise of compressor, drill machine
11. Darkness.
12. Congestion.
13. Suffocation
14. Burn injury due to hot gas/air coming out from blow pipe peephole during explosion/ furnace slipping.
15. Burn injury due to Hot metal and slag
16. Burn injury due to grouting material splashing out from nozzle

Electrical Hazard

1. Electric shock from welding machine.
2. Electric shock from grouting machine.
3. Electric shock from punctured cable

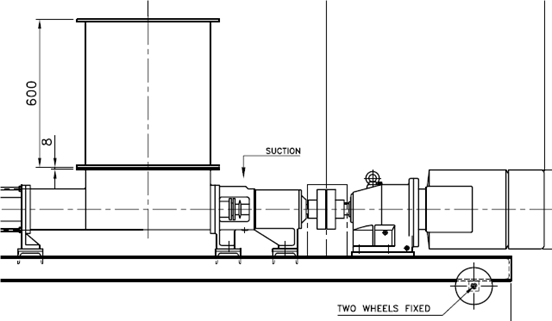
**Behavioral Hazard:**

1. Workmen under influence of alcohol
2. Violation of procedure
3. Not wearing PPE’s
4. Not concentrating while operating machine

Work No 1: Mortar/Carbon Paste injection in the shutdown furnace

* 1. Wear goggles and full sleeve gloves while handling grouting material.
  2. Connect the delivery hoses to the outlet of the pump and ensure proper tightness of fittings.
  3. Give electrical connection to the machine and check the direction of the motor’s rotation. The motor’s rotation should be clockwise when watching from motor end.
  4. Carbon injection should do by Screw pump. Mortar injection should do by hydraulic pump.
  5. Pour the mortar \ carbon into the inlet tank of the machine and take trials of the pump till mortar\ carbon discharges through the hoses.
  6. Check the condition of fixed screen (50mm opening) inside inlet tank and ensure it is in good condition. Put the removable screen in clean condition before pouring. The purpose of fixed screen is to prevent anyone putting their hand in screw conveyor.
  7. Conduct trials and keep the machine ready. Obtain the work permit from the production department.
  8. Remove the caps of the tamping nozzles of the respective area or of the cooling plates, using proper spanners. Ensure that goggles are worn, before opening the tamping nozzles.
  9. Open the caps of the nozzles adjacent to the pumping area, to ensure proper venting. Clean the internal portion of nozzle for proper injection of new mortar/Carbon Paste.
  10. Connect the proper nipple with nozzle.
  11. Wear safety belt while working at heights.
  12. Connect the hose pipes of machine to the nipple and open the valve. Material injection will be started only after the hose is securely fitted.
  13. Recommended ratio of mortar and water is 60:40 for mortar injection. Stir the carbon paste before pouring it in the tank.
  14. Only authorized persons/ company’s masons should operate the pump and monitor the pumping process. Screw pumps should not run-in dry condition. Operator should monitor the material level in the tank.
  15. Inject 50 kg material at a particular point at a time and repeat the injection with a gap of one hour in the same point.
  16. Check adjacent open nozzles, tap hole area for any signs of material flow through them
  17. Ensure nobody is working at peephole opening during and after half an hour of completion of grouting.
  18. Ensure all asbestos blankets in front of peephole are covering peep hole opening.
  19. In case, explosion/furnace slip occurred inside furnace, stop injection immediately.
  20. Don’t inject grouting material in a running furnace.
  21. The maximum operating pressure for mortar\carbon injection is 25 kg/cm2.
  22. Close the valve after injection. Release the pressure inside pipe by opening the release valve.
  23. Opening of release valve and SRV should be downward. Empty bucket should be put there to collect discharge material.
  24. Disconnect the hose pipes from the nipple and fix the nipple to the next point. Follow the above points and repeat the same procedure
  25. The same procedure should be followed for the remaining points on the furnace and cooling plates.
  26. After mortar\carbon injection job is completed, add water in the inlet tank and flush all the hoses and the pump till clean water is discharged.
  27. To check the water level inside tank, the removable screen can be taken out.
  28. Clean the fixed screen by water spray.
  29. Clean the removable screen by water spray or take it outside if required.
  30. Disconnect the electric supply of the machine
  31. Remove all the hoses and shift the machine in the proper place.
  32. Shift all the mortar bags / material containers from the cast house to the specified place and clean the spilled mortar/carbon paste from the cast house floor.
  33. Ensure that proper housekeeping is maintained, and all the equipment is cleaned.

In case of repairing of fixed screen and cleaning of screw conveyor area, machine should be under shutdown and should not be connected to electrical supply. Take out the tank’s upper part from the flange by removing the nut-bolts. Position of fixed screen and removable screen is shown below:



**C/L of Screw conveyor**

**Position of Removable screen**

**Position of fixed screen**

**Work No 2**: **Injection Pump shifting**

1. Disconnect the electric cable of the injection machine.
2. Electric cable to be properly wound to the machine and tie the same to the machine.
3. Remove all the hoses connecting to power pack/ injection pump.
4. Ensure that all the loose parts like power pack with trolley; electric starter etc is secured properly.
5. Injection pump and power pack to be shifted manually to the desired location. Refer material handling **VL/IMS/PID1/MECH/WI/12** & SP44
6. Mobile cranes to be used for the shifting of machine and power pack from cast house to required location and vice versa. Refer **VL/IMS/PID1/MECH/WI/12**
7. Cover the machine properly when not in service.

Work No 3: Grouting nozzle fitting on Furnace Shell

1. This activity shall be carried out only when furnace is under shut down.
2. Take work permit from Cast House engineer.
3. Nozzle fitting area to be check physically for access of hoses and fitting work. Shell cooling water has to stop for particular area where nozzle will be fitted.
4. Keep safe distance from blow pipe. Don’t stand in front of peephole opening.
5. During gas cutting of shell tuyere and tuyere cooler hoses should be kept at safe distance to avoid burning.
6. Cutting hole diameter on furnace shell will be as per inner diameter of nozzle. Cutting will be continues till inside refractory are visible.
7. Nozzle shall be fitted on furnace shell covering the hole at the centre, with an inclination to keep valve end at down to avoid water intruding inside furnace.
8. During welding, nozzle valve should be kept open to vent out the fumes.
9. After completion of welding valve shall be closed.
10. Refer procedure SP44 for gas cutting & welding

In Case of Shell Puncture:

1. This activity shall be carried out only when furnace is under shut down.
2. Inform Furnace In-Charge, Mech In-Charge about the activity.
3. Clean the punctured hole from slag/metal/refractory/coke around 100 mm inside furnace shell in depth.
4. Cut the hole diameter to 45 mm.
5. Put perforated type grouting nozzle as shown below inside the hole. Perforated part (around 60mm) should be inside furnace shell. Reference drawing No: 2025-02089B.
6. Weld the nozzle (at least two run) with furnace shell as shown in the drawing from outside, there should not be any gap in the welding for gas passing. While welding, the valve should be opened to vent out the fumes.
7. After completion of welding close the valve.



*Fig: Perforated Type Grouting Nozzle*

Work No 4 : Runner (Drainable) repair and refractory job

1. Take work permit from the cast house engineer.
2. Hot metal / debris /slag should be cleared and cooled before working in the runner.
3. Gumboots should not be used while working in the hot metal area.
4. Do not cross over the runner while walking from one side to the other side
5. The surface required to be repaired should be cleaned from all debris.
6. Remove the damaged bricks/castable of the runner and inspect the runner plate for damage. Carry out the plate repair work, if any. Refer SP44 for gas cutting & welding
7. Use safety belts while working near the spout. Place a steel stand below the spout for better access for working.
8. While working at the Y spout, ensure that the cast is closed properly. The hole of the skimmer plate of the main runner is to be blocked, and EL diversion to be kept ready in case of potential tap hole breakout. (Responsibility production)
9. Do not apply castable in the place of bricks in the main runner during the repair work, as the castable will not get cured properly.
10. Castable can be applied when there is sufficient time for curing and heating.
11. Runner mass can be used during repair work, where bricks cannot be used.
12. Clear the work permit and give clearance to the production dept.
13. Bricks consisting of 62 % alumina should be used for the runner application. (Available at ladle workshop).

Work No 5              :    Ladle repair near Bag House

1.      Take work permit for the ladle repair job, near the bag house area.

2.      Ensure that the ladles are cooled, prior to start of work

3.      Barricade the working area with work in progress tape.

4.      Take adequate precautions while working/moving near bag house for hazards like impact of crane, steam from granulation, burn injury while ladle dumping and movement of truck, backhoe, wheel loader, hydra etc.

Work No 6             :    Non-drainable launder minor repair

* 1. Tentative throughput of non-drainable launder till minor repair is around 20,000-25,000MT hot metal. However, launder need to be checked after complete draining for erosion profile, crack positions, other defects, metal penetration, dent holes, rat holes, surface & TCs temperature. Accordingly, decision to be taken for repairing. In case, refractory thickness and condition found okay, launder repairing can be postponed.
  2. Around 8-10MT of working layer castable and binder to be kept ready before going for repair. Pan mixer (500/1000 Kg Capacity), pneumatic breaker (2-3 nos) and vibrator (1 no) to be kept ready for repairing.
  3. Take work permit from Cast House In-Charge/ Shift Superintendent.
  4. Launder should be drained completely from molten metal before start of work.
  5. Launder to be cooled down to workable temperature by spraying water-air mix.
  6. Use heavy duty pneumatic breaker (2-3 no’s) for dismantling of metal/ slag jam/ oxidized materials.
  7. The areas where repairing to be done, need to clean from metal skull/ slag. In case of metal penetration, V groove cutting to be done. All the metal penetration to be removed completely. Oxidized materials to be removed completely.
  8. For crack more than 12 mm, or cracks with dent holes or with rat holes, V groove to be cut.
  9. Work out refractory to be removed in such a way that minimum 100 mm gap is maintained between the shuttering plate and residual lining for sidewall casting.
  10. For side wall- bottom corner repair, elephant foot to be made at bottom corner.
  11. After dismantling, trough to be clean from fine materials by compressed air. All unnecessary personnel should be evacuated and remaining workmen should wear adequate dust protection during cleaning.
  12. Pour the dry mix in mixer machine. Allow 1-2 mins dry mixing. Then binder to be added. For Sic-C based gel bonded castable (e.g. - ACCMON GB 16 SC C) silica gel with water to be added as binder. Silica gel and water mix in 1:1 ratio is preferable; however, the ratio may vary depending on workability. Gel % for any batch should be 6-6.3%.
  13. All materials and machineries to be shifted to cast house before repair.
  14. Mixing to be done for 3-4 min with binder. Check the workability of the mix by ‘ball in hand’ consistency method.
  15. Use 3-5mm MS plate with proper supporting arrangement for shuttering. Shuttering should be fixed (by welding) for build up at side wall as per actual condition and areas where V groove is made. If there is any erosion at skimmer block plate, shuttering plate can be fixed as well as per actual condition. Formwork also can be used for casting depending on actual site requirement.
  16. Discharge the mixed castable into a tray and then pour the same into the gap between residual lining and shuttering plate within the shortest time not exceeding 10 min.
  17. Thoroughly vibrate the mass using 40/60 mm needle vibrator. Vibrators/ pokers should be held vertically upright while vibrating the mix materials. The vibrator needle should be inserted such that the intermediate layers get vibrated into a single layer to avoid any laminations. Remove the vibrator slowly and vertically in running condition to avoid hile formation in the castable. Insert the needle at a distance of 400mm for 40mm needle / 600mm for 60mm needle.
  18. Maintain metal head and slag head distance as 100mm.
  19. Check and ensure proper setting of castable by thumb impression and by inserting welding rod. Setting of castable is indicated if no thumb impression is visible and if insertion of welding rod is difficult.
  20. Launder to be handover for heating after setting. Recommended heating schedule is given below. Before tapping, heat the trough up to 500-550 deg C. Gas burner may be used for heating. Avoid direct contact of flame with the castable.



* 1. For very small repair/ patch work, hand mixing can be done and same can be poured after holding small plate as shuttering. Heating by firing wood may be accepting for this type of repair.

Work No 7                :    Non-drainable launder Major repair

* 1. Tentative throughput of non-drainable launder till major repair is around 100000MT hot metal. However, launder need to be checked after complete draining for erosion profile, crack positions, other defects, metal penetration, dent holes, rat holes, surface & TCs temperature. Accordingly decision to be taken for repairing. In case, refractory thickness and condition found okay, launder repairing can be postponed.
  2. It is recommended to call representative of launder design & material supplier for supervising the activity.
  3. Around 30-35MT of working layer castable and binder & 2-4 MT back up layer castable to be kept ready before going for repair. Pan mixer (1000 Kg Capacity), pneumatic breaker (2-3 no’s) and vibrator (2 no) to be kept ready for repairing.
  4. Take work permit from Cast House In-Charge/ Shift Superintendent.
  5. Launder should be drained completely from molten metal before start of work.
  6. Launder should be drained completely from molten metal before start of work.
  7. Launder to be cooled down to workable temperature by spraying water-air mix.
  8. All Machineries to be shifted to cast house before repair.
  9. Working layer castable to be kept in crane bay area. Hydra/ Hot metal crane is required for shifting the materials from crane bay area to mixer machine in cast house.
  10. Dismantling to be carried out as explained in Work NO-6.
  11. All working layer castable to be dismantled and cleared.
  12. Back up layer to be inspected for damage. In case of damage in back up layer, repairing to be done by mixing back up layer castable (e.g. LC -50 Castable) with water 4-5%. Mixing to be done in pan mixer.
  13. After completion of back up layer inspection & repairing, working layer formwork to be placed. Working layer thickness to be checked for castable thickens as per requirement. Hydra & Cast house hoist to be used for placing the formwork.
  14. Formwork welding to be done with launder shell.
  15. Working layer castable mixing, pouring and vibration to be done as said in WORK NO 6.
  16. Setting to be checked as said in WORK NO 6.
  17. Heating to be carried out as said in WORK NO 6.

**Drawing for Refractory arrangement in BF1 Trough\_R1**



**Do:**

* During mortar injection operation, open the caps of the tamping nozzles and check for the presence of CO.
* While handling carbon paste, wear hand gloves and safety goggles.
* Check for the movement of vehicles, HITACHI backhoe and wheel loaders in the bag house area.

**DO NOT:**

* Hold/ touch the tool while operating the machine.
* Stand in front / below the nozzles where grouting is taking place.
* Hold/touch the blow pipes.
* Stand in front of peep hole of blow pipe.
* Work in the bag house area while ladle tilting job is in progress.
* Cross over runner

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| **Prepared By:**  Head – Production PID I | **Reviewed & Issued By:**  Management Representative | **Approved By:**  Head – Pig Iron Division |
| **Signature:** | **Signature:** | **Signature:** |
| **Date: 15.07.2022** | **Date: 15.07.2022** | **Date: 15.07.2022** |

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| **Amendment Record** | | | |
| **Revision date** | **Manual Section ref. and para** | **Brief details of revision** | **New Revision No.** |
| 15.07.2022 | Work instructions for refractory jobs furnace area | Drawing 001 Refractory arrangement in BF through R1 added | 11 |
| 15.07.2022 | Work instructions for refractory jobs furnace area | Change in format | 11 |