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## REVIVAL OF CHILLED FURNACE


- 1.0 PURPOSE:** To normalise furnace operation from abnormalities
- 2.0 SCOPE:** to produce desired grade production, maximising furnace productivity.
- 3.0 PERFORMANCE INDICATORS:**

Sr. No.	Measure	Unit	Frequency	Acceptance Criteria	Responsibility
<b>Quality</b>					
1	Hot blast temperature	Deg C	Continuous	1000	Control room engineer
2	Hot blast Pressure	KG/CM2	Continuous	1.4	Control room engineer
3	Top Gas Pressure	KG/CM2	Continuous	0.37	Control room engineer
4	Blast volume	NM3/HR	Continuous	31,000	Control room engineer
<b>Safety</b>					
	Top Gas Pressure	KG/C M2	Continuous	0.42	Control room engineer

## 4.0 PROCEDURE:

When the tap hole is opened but no metal or slag can be tapped from the furnace for more than two hours and after determining all the furnace parameters, the furnace can be declared as chilled & the following procedure comes in force.

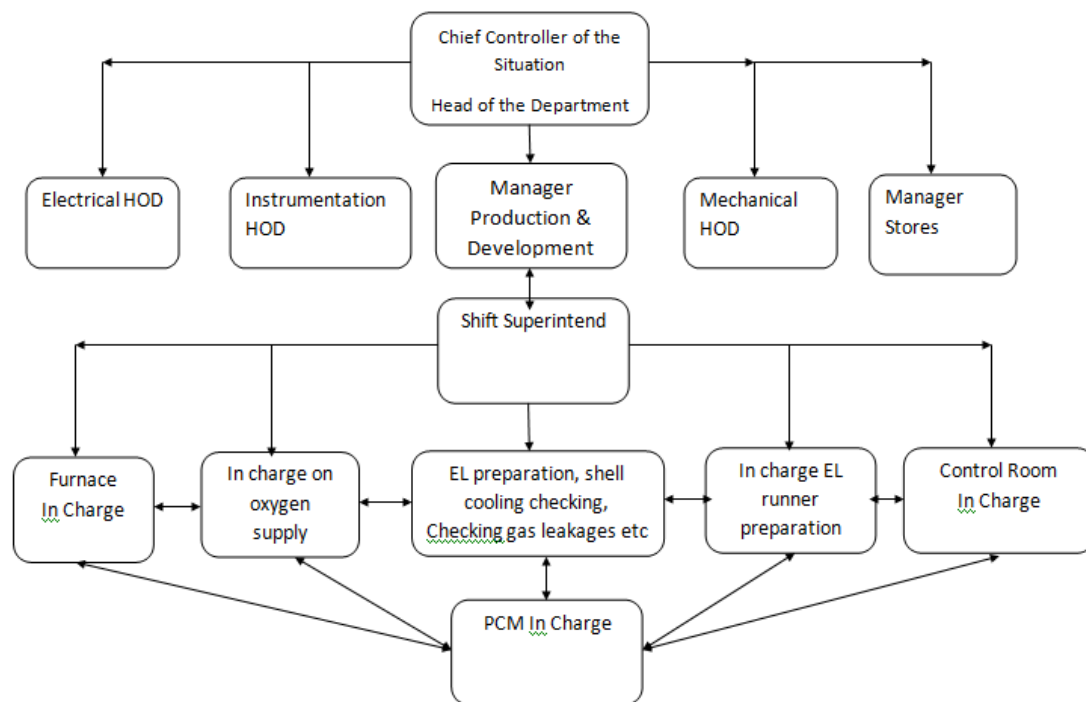
**Declare an emergency and sound a red alert.** Put all the emergency stations on alert. Intimate and alert the safety department and all service departments (instrumentation, mechanical, electrical). Check the physical stock of oxygen cylinders and lancing pipes. Ensure that the stock of oxygen cylinders is 300 Nos and that of lancing pipes is 10000mtrs. Also 1200 meters of ½ inch GI at any given time, till the furnace is revived. Procure on emergency basis, if there is a shortfall. Ensure that all the communication systems are working, effective and in a healthy condition, so that all communication within and outside is prompt and effective.

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All the emergency systems of the plant are expected to be healthy and operative in any emergency. All the systems should be checked promptly, for ensuring the same.


All service depts., including stores and purchase, have to be regular in touch with HOD (Prod) for better coordination and monitoring.

The situation will be assessed, directed, reviewed, and controlled by a designated controller. The reporting hierarchy is as depicted below:



#### Identified hazards:

1. Contact with hot metal
2. Gas leakage
3. Fire & explosion
4. Contact with hot water
5. Contact with hot coke
6. Impact of hot coke

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7. Splashing of hot metal/slag during lancing
8. Hot met and slag splashing from blow pipes.
9. Backfire during lancing.
10. Non use of PPE.
11. Improper housekeeping.
12. Inadequate local lighting.

Injury due to fall and entanglement while running/hurry.


13. Burn injury due to coke from bleeder

**14. Significant Aspects:**


1. Fire & explosion
2. Gas leakage.
3. Leakage.

**Impact:**

1. Land contamination.
  2. Air pollution.
  3. Water contamination.
  4. Resource depletion.
  5. Work environment.
- 
1. Make all the people in the cast house aware of the emergency situation. Monitor the CO gas level in the cast house and gas cleaning system, on a continuous basis till normalisation.
  2. Keep the steam header charged with 5 kg steam pressure, all the time
  3. Take the shutdown of the furnace with utmost care and after evacuating all people from the cast house
  4. Check all the cooling members for leakage.
  5. Replace the punctured / burnt cooling members, if any.
  6. If any slag coating is observed, clean all the tuyeres by poking or lancing as required. Try to avoid lancing if the coating is not hard. Care should be taken while lancing with oxygen to avoid tuyere puncturing. Refer WI Tuyere lancing.
  7. **Do not keep the dust catcher bottom gate valve open during lancing of the tuyere. Ensure that the bleeders are open and steam is available between the bells and uptakes.**
  8. After clearing all the tuyeres , keep one tuyere on either side of the tap hole open, and plug the remaining six with plastic clay well rammed into the furnace by about 4 inches and full length of the tuyere.
  9. Remove the tuyeres and Lance the tuyeres on either side of the tap hole, to connect the tap hole, by keeping the bleeders open. Ensure that the dust catcher bottom valve is closed and steam is kept in between bells as well as uptakes.
  10. Charge extra coke as per issued guidelines.

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11. Start lancing through the tap hole also, to ensure the connection of tap hole with both tuyeres. Indication of tuyere/taphole connection is confirmed when flame from either Side of tuyere or taphole is visible during lancing.
12. If the tap hole connection to the tuyeres is established, Fix the two tuyere back and close the peephole flanges and blow in. Prepare the main runner and the emergency runner. Horizontal lancing of the top hole should to be done to ensure proper connectivity of tap hole with both tuyeres. Use pitch if required, for lancing. Observe the tap hole while lancing for yellow or greenish yellow coloured flame which is an indication of water ingress into the furnace.
13. Start blowing with wind volume 7000~8000 Nm<sup>3</sup>/hr that the furnace can accept. Maintain maximum blast temperature.
14. Continue lancing till some slag and metal comes from the tap hole.
15. Once the tap hole starts blowing, stop lancing the tap hole. Blow the tap hole till metal or slag is observed from the tap hole. If the main runner is getting jammed, close the tap hole with minimum clay. Clear the runner, prepare it and open the tap hole again, as fast as possible.
16. This process should continue till there is continuity in the flow of metal and slag from the tap hole. Observe the top gases continuously for CO and H<sub>2</sub>. H<sub>2</sub> will indicate the water ingress in to the furnace.
17. If H<sub>2</sub> levels are continuously going up, the source of water ingress is to be detected.
18. For water ingress, check the following .
  - a. Tuyere / tuyere cooler outlet water pressure and volume
  - b. Cooling plate outlet water temperature.
  - c. Check for cracks on the furnace shell.
  - d. Check the furnace top sprays for leakage.
  - e. Check the steam valves.
  - f. Check the hot blast valve's outlets.
19. Monitor tuyeres continuously for brightness, movement etc.
20. Monitor the charge movement. If the furnace hangs, give checks through snort as well as IVC.
21. Control the charging for better top gas temperature.
22. For controlling the top gas temperature use top sprays if necessary.
23. Prevent interruptions in the operation by preventing delay in the charging, breakdowns or any power failure.
24. While giving furnace check extreme care to be taken to avoid slag entry in to the blow pipe.
25. Send the slag metal samples, without any delay, to the laboratory.
26. Once the metal/slag flow from tap hole is continuous, carry on with the tapping till the cast blows. Check the metal temperature. If the metal temperature reaches more than 1350°, divert the metal into the ladle, which should contain some hot metal from the other furnace which will act as base metal and prevent ladle from bottom jamming.
27. If the metal temperature in the next few casts increases to 1450°C/or charged extra coke in the tuyeres has been established, stop the furnace and connect another two tuyeres adjacent to the open tuyeres, on either side of the tap hole.
28. Increase the wind volume to 15000 Nm<sup>3</sup>/hr. Connect the gas line.  
After the furnace accepts wind, movement is normalised, metal temperature is consistently above 1450 deg. C, metal and slag quality is good, only then two other tuyeres should be

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connected. Connecting the tuyere should be done carefully after due deliberation and assessment. After ensuring and confirming the quality of metal and slag, tuyere connection should be allowed.

29. Steam between bell and dustcatcher to be regulated depending upon CO level/top gas temperatures.
30. After connecting all the tuyeres, hot metal & slag quality is to be monitored for at least four casts and if found satisfactory, only then the red alert should be lifted.

## **Roles & Responsibilities:**

### **1. Head of the Department:**


- a. Declare Emergency.
- b. Declare 12 hours duty, if required, by dividing the three shifts into two shifts.
- c. Manager Production & Manager Hot metal to physically monitor the reviving procedures round the clock, between them.
- d. Declare the furnace chilled and activate the emergency services.
- e. Ensure availability of senior maintenance personnel at site, round the clock.
- f. Closely monitor the situation of the furnace.
- g. Ensure availability of all the required consumables.
- h. Ensure involvement of skilled people in critical activities.
- i. Ensure that all the safety procedures and practices are followed.
- j. Close monitoring and guidance of all activities.

### **2. Manager Production:**

- a. Ensure good coordination between various members of the task force.
- b. Ensure emergency preparedness in all areas.
- c. Ensure effective safety protocol is being maintained in all areas.
- d. Be in constant touch with all Production personnel, give timely and precise decisions, and monitor the overall operations.
- e. Keep the service departments abreast of all planned activities.
- f. Close monitoring of the thermal state of the furnace, during revival.
- g. Ensure sufficient stock of oxygen cylinders and other important consumables.
- h. Ensure involvement of skilled people in critical activities.

### **3. Shift Superintendent:**

- a. Should take the full control of the situation.
- b. Judge the furnace condition and the action needed in that situation.
- c. Giving the proper feed back to the Manager production.
- d. Guide the control room engineer and ensure delegation of responsibilities as per the Emergency task force plan.
- e. Arrange the man power as per requirement.
- f. Take decisions, in consultation with Manager (Prod) and AGM (Prod), depending on the thermal state of the furnace.

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- g. Supervise the cast house activities , like timely preparation of runner and casting, etc.
- h. Take the furnace shutdown and clear all the tuyeres, isolate the gas line, take two tuyeres in line, connect the tap hole, start the blowing with two tuyere opening and follow the above procedure.

#### **4. Furnace In Charge:**

- a. Continuous monitoring of tuyere movement as well as furnace condition.
- b. Religiously ensure that critical cast house equipment is safeguarded and looked after with dedication, in spite of difficult working conditions in such situations.
- c. Should ensure availability of all cast house stocks (consumables) especially oxygen cylinders, lancing pipes and poking rods.
- d. Arrange and control the manning and manpower.
- e. Supervising all the activities of oxygen bank, EL runner, control room, PCM in charge, water leakage, tuyere/cooler water outlet temperatures etc.
- f. Get the cast house ready as quickly as possible.
- g. He should take extra precautions for avoiding gas leakage and promptly arresting water ingress, if any
- h. Never allow jamming of main runner, during casting.
- i. Casting to be done under close control of SS and Manager (Prod).
- j. Check for greenish yellow gases while lancing the tap hole.
- k. He should plan the work in such a way that, if needed, the EL runner should be cleaned during casting.
- l. Lancing should be done horizontally till the furnace gets normal.
- m. Push minimum clay till the furnace is normalised (fill less clay in the barrel).
- n. Hard blowing of the cast will jam the cast house and cause additional problems. Mud gun and accessories could also get damaged. Hence hard blowing of cast should be avoided.
- o. If the slag is foamy and does not flow in the runner, lance it and facilitate it's flow in the EL.
- p. Extreme care should be taken to ensure that metal and slag do not come out of the runner into the cast house, as it could cause further severe safety and operational problems. If slag comes out of the main runner, stop it's flow by spraying it with water.
- q. Watch the tuyeres all the time for gauging the furnace condition. Slag entry, coating around the tuyeres, closing of the tuyeres etc. are to be immediately brought to the notice of the SS or Manager Production.
- r. Watch the tuyeres while force checking the furnace, for all above issues.
- s. Never allow anybody to take rest in gas prone areas.
- t. Check for gas leakage and ignite it.
- u. Ensure effective first aid apparatus in the control room.
- v. Ensure that all tuyeres are fully open. If coke pieces enter the tuyeres or the tuyere gets partially/fully choked by slag coating, it has to be cleared.

#### **5. Control Room In Charge:**

- a. He is the direct link between the furnace and SS/Prod Manager. He should be very observant and should keep a close watch on the furnace behaviour. He should be in

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constant touch with the SS/Prod Manager, updating them of the behaviour of the furnace

- b. He should monitor the H<sub>2</sub> content frequently, if any abnormalities are observed need to inform SS, Furnace In charge, EL preparation In Charge.
- c. Furnace top gas temperature should be kept strictly under control.
- d. Batching delays and equipment breakdown will only compound the problem further, hence it should be avoided.
- e. He should ensure uninterrupted flow of wind in the furnace, and should take all steps needed in that direction.
- f. Continuous monitoring of the tuyere movement, stock rod movement etc to be done.
- g. Controlled charging of the furnace should be done. Dumping is to be done only when the top gas temperatures rise sufficiently.
- h. Furnace to be kept on off rod for at least 1 charge where we can observe stock rod movement.
- i. Keep a continuous flow of steam in between bells and up takes.

**6. In Charge EL runner preparation:**

- a. He should lead his workmen to achieve the desired results, in difficult circumstances. He should have a good command over his workmen and should communicate well.
- b. He should be working, in tandem, with the furnace in charge, all the time.
- c. He should plan the work in such a way, that if required, he should get his people to clean the EL runner during casting, efficiently and swiftly.
- d. He should follow all the safety norms as usual.


**7. In Charge oxygen supply:**

- a. He is responsible for ensuring uninterrupted oxygen supply to the cast house.
- b. Detecting and rectifying gas leakage in the cast house, on an ongoing basis.
- c. Ensure that the oxygen bank is full and healthy.
- d. He should communicate well and have good command over all his workmen.
- e. Ensuring all the safety procedures of the oxygen cylinder handling.
- f. Ensure the availability of a mech. fitter all the time, for cylinder changing.
- g. Should be in constant touch with Pig Shifting In charge, for availability of wheel loader.
- h. Should ensure the proper stock of the oxygen cylinders.

**8. EL preparation, shell cooling checking, checking gas leakages:**

- a. He is responsible for EL preparation.
- b. Ensuring the availability of Hitachi (back Hoe ).
- c. Ensuring the availability of sand for the cast house.
- d. Ensuring proper shell cooling.
- e. Checking for cooling member water outlet temperatures.
- f. Checking for gas leakage and burning the gas if any leakage found.
- g. Ensuring that no workmen who are taking rest in gas prone areas.

**9. PCM In Charge:**

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- a. He is responsible for the placement of ladles, cleaning of ladle placement area, cleaning of ladles, supplying of base metal from the hot furnace to the ladle of the cold furnace. He should be in constant contact with Furnace-in-charge/ SS/Prod. Manager.
- b. He should be having expertise on judging the situation of the furnace and its requirement.


## **Guidelines for the revival of chilled Blast Furnace:-**

Isolate the furnace only if we lose the taphole connection and the furnace is not showing any reviving tendency.


**The following safety precautions should be taken before taking the furnace off blast.**

1. Inform BM, all HOD's (to mobilize manpower), Company's resident doctor, dispensary and HR manager. Cordon off all entry points to the cast house, to restrict the unauthorised entry of people.
2. Keep only minimum people in the cast house and movement around the blowpipes should be restricted.
3. Inform GEPL about restricted availability of BFG. Shift the man cooler from the cast house and disconnect the supply.
4. Ensure all cables directly in front of the blowpipes are covered/protected by GI or Aluminium sheet.
5. Charge the steam header to 5 kg/cm<sup>2</sup>, Open steam in between bells, up takes, dust catcher and saturator and inform GEL not to reduce steam flow till further instructions.
6. Open one bleeder and start water sealing saturator, main gas line, all three stoves i.e. (isolation of gas line from the furnace. Follow laid down procedures.
7. Keep the bleeder valve handles in a safe place to avoid the damage due to metal or slag in cast house.
8. Sand bed/bund to be made below each blow pipe to prevent the slag falling in the furnace water trough.
9. Reduce the wind volume to the minimum by watching the tuyeres.
10. Open the peep hole flanges of all tuyeres. (bigger ones) to prevent the slag entry in bustle pipe during wind off. Care to be taken that the mech fitters are wearing safety coat, screen helmets and are made aware that slag may rush through the blowpipe while opening the flange.
11. Wind off the furnace very slowly and carefully.
12. Please note that there are chances of major slips, explosion etc during wind off time. Utmost care to be taken while conducting this operation, nobody should immediately rush and watch the tuyeres. If everything found normal, check the tuyeres and plug the same with clay.
13. In case any blowpipe/tuyere is found to be filled with slag, replace it.
14. Tuyeres to be cleaned manually or by oxygen lancing and plugged before giving clearance to mechanical. –Refer WI cast house 08 for lancing tuyeres.



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15. Ensure that while plugging the tuyeres, some amount of clay inside the furnace to avoid metal or slag jamming in tuyeres. It will facilitate the smooth opening of the tuyeres.
16. Inspect all cooling members for water leakages and replace the same if it is necessary.
17. Inspect the furnace shell (especially In front of taphole and bosh area) for any damage or crack.
18. Clear all blow pipes and hand over to Mechanical dept.for refixing.
19. Tuyeres and taphole connection to be made by lancing through the taphole and two taphole side tuyeres, after lowering the blowpipes.
20. Ensure the taphole connection by seeing the flames through tuyeres while lancing at the taphole.
21. Don't give clearance to service dept for furnace top maintenance.
22. Ensure 5 kg/cm<sup>2</sup> steam header, open and keep steam in uptakes, between bells, dust catcher, saturator till both bleeders are closed.
23. Start the furnace with two tuyeres (one each from either side of taphole). With wind volume 6500 NM<sup>3</sup>/ hr bleeders open and all water seals over flowing.
24. All other tuyeres and half blow pipes (minimum) to be plugged with plastic clay to avoid opening of plugged tuyeres. There were many incidents reported about similar cases and slag entered up to the bustle pipe from "plugged tuyeres".
25. Burden to be set at 3 % silicon with basicity 0.90
26. Immediately after wind on, ensure tuyere and taphole connectivity. If not lance continuously till achieve the same. Horizontal lancing of the taphole to be done.
27. Follow the charging sequence of fifteen extra cokes and ten normal charges till open all the tuyeres.
28. CO gas presence in cast house to be continuously monitored, lighted marshal torch to be moved around all tuyere/cooler, cooling plates seating, hearth for igniting gas leakage if any.
29. In case the metal temperature is continuously high >1380 deg cent for subsequent casts, take the furnace off blast and open two more tuyeres, one on either side of the already opened tuyeres.
30. Connect the gas line after opening 3<sup>rd</sup> and 4<sup>th</sup> tuyeres. Wind volume to be increased to 13000 NM<sup>3</sup>/Hr
31. Increase the tap hole angle gradually after attaining hot metal temperature of around 1400 degree C.
32. Casting schedule is to be done very quickly. Cast to be closed with minimum clay
33. Inspect the water outlet temperature of all cooling members frequently.
34. CO monitoring to be carried out regularly.

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## 5.0 RECORDS:

<b>Sr. No.</b>	<b>Record No.</b>	<b>Record Title</b>	<b>Maintained by</b>	<b>Soft/Hard form</b>	<b>Retention Time</b>
1.					
2.					
3.					
4.					
5.					
6.					

<b>Prepared By:</b> Head – Production PID I	<b>Reviewed &amp; Issued By:</b> Management Representative	<b>Approved By:</b> Head – Pig Iron Division
<b>Signature:</b>	<b>Signature:</b>	<b>Signature:</b>
<b>Date: 12.07.2021</b>	<b>Date: 12.07.2021</b>	<b>Date: 12.07.2021</b>