


| INTER PLANT STANDARD – STEEL INDUSTRY  |   |  |
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| <br><b>IPSS</b> | <b>CODE OF PRACTICE FOR SAFE HANDLING<br/>OF LIQUID METAL</b> | <b>IPSS:1-11-009-15</b><br><i>(First Revision)</i> |
|  | Corresponding Indian Standard does not exist                  | Formerly<br>IPSS:1-11-009-03                       |

## 0. FOREWORD

- 0.1 This Inter Plant standard, prepared by the Standards Committee on Safety Appliances and Procedures IPSS 1:11, with the active participation of the representatives of all member steel plants and associated organizations in the field, was adopted in June 2003 and revised in February, 2015 in presence of experts from member organizations.
- 0.2 This standard has been prepared to introduce safe method of handling liquid metal in different areas of steel plants viz. Blast Furnaces, Steel Melting Shops, Foundries and Pig Casting Machines.

## 1. SCOPE

- 1.1 This Interplant standard covers the following aspects of liquid metal handling:

Ladle preparation  
 Inspection and maintenance of ladle cars  
 Pouring/Ladle filling  
 Transportation  
 Inspection and maintenance of hot metal tracks  
 Hot metal pouring  
 Dumping

## 2. PROCEDURE

### 2.1 Ladle/ Torpedo ladle Preparation

- i) Before the ladle is placed for pouring the metal, it shall be inspected for:
- whether the metal jams removed from lips/mouth etc
  - the lining of the mouth condition
  - the shell and lip condition
  - cleaning/changing the nozzle
  - cleaning/changing the slide gate plate/purging plug
  - Check the tare weight of torpedo, if more than normal tare weight de-slugging to be done at pit (de-slugging pit should be filled with dry sand/ dry granulated slag.

- Check shell condition, if shell temp > 300 deg C (mouth & charging pad) gunning with suitable refractory to be done
- ii) Place the cleaned and prepared ladle at heating stand for preheating/on transfer car.

## **2.2 Inspection & Maintenance of Ladle Cars / Torpedo ladle**

- i) a) Inspect the ladle car for the condition of:
  - their chassis
  - their suspension springs
  - bearing covers and alignment
  - coupling and coupling handle
  - any metal jam etc spilled on the car
  - cable and cable reeling drum (if provided)
- b) Inspection of Torpedo ladle

Cover the mouth of torpedo before starting the inspection. Inspect for the condition of:

  - their chassis and staircase
  - their suspension spring
  - bearing covers and alignment
  - DP and UT test of axle
  - any metal jam/debris on the torpedo platform
  - Drive system and limit switches.
- ii) Place the inspected and cleaned car near the heating stand. If the inspection/ maintenance time is more than 16 hrs then place the torpedo under heating station to heat up to 900 deg C.
- iii) Place the preheated ladle / prepared ladle on the car centering it properly following the signals.
- iv) Check the clearance of chassis of ladle car with the wheels after placing the ladle.
- v) Damaged chassis / suspension spring etc to be rectified.
- vi) All the metal transfer cars shall be fitted with warning bells which shall ring during movement.

## **2.3 (a) Pouring / Torpedo Ladle Filling – General Practices**

- i) Place the ladle car below the spout exactly aligned below the chute.

- ii) Put a skid below wheels.
- iii) Remove loco to a safe distance (6 mtrs).
- iv) Hot metal/Teeming ladles to be placed on the stand.
- v) Before pouring is started, it shall be ensured that:
  - No. of persons present shall be minimum (as per the recommended crew size).
  - They all shall use PPEs like face shield, flame retardant suit, anklets, goggle, and hand gloves, in addition to helmet and safety shoes.
- vi) Newly lined torpedo after proper heating to be filled 50% for the first time.
- vii) After taking out the metal it should be kept under cover for soaking.

**2.3 (b) Pouring/Torpedo Ladle filling – specific practices at Blast Furnace**

- 1) Ladles shall be placed on both the lines on both sides of the rocking runner. Track line of torpedo must be marked for proper placement below (marking will be at position of last wheel of torpedo car)
  - Track line should be dry and filled with sand.
- 2) Rocking runner shall be checked before pouring. Check proper placement of torpedo by taking metal for few second and changing to other side. If proper placement is not there replacement to be done.
- 3) After opening the tap hole, pouring shall be done in one ladle leaving 250 mm from the top empty to avoid spillage during transportation. After filling upto 90% of the torpedo tilt the runner to other side.
- 4) As soon as one ladle is full (250 mm empty from top) rocking runner shall be turned to fill ladle on other side.
- 5) Next ladle shall be brought in position on the other side using the pusher car. Before removing the filled torpedo tilting runner drive must be under control stop.
  - Remove filled torpedo and place empty torpedo as soon as possible and check proper communication between cast house and traffic crew.

- 6) As soon as tapping is completed, ladles with hot liquid metal shall be removed by locos.
- 7) Hot metal ladles / Torpedo then shall be sent to Steel Melting Shop, pooling pit Foundry or Pig Casting Machines, as per requirement.

#### **2.4 Transportation**

- 1) The ladle cars and the ladle shall be inspected again for spillage after pouring.
- 2) Before withdrawal, track position, metal jamming etc shall be checked.
- 3) Ladle shall be removed only after clearance from the furnace Incharge.
- 4) If any ladle / Torpedo is overfilled, it shall be transported with utmost care at a very slow speed of less than 5 kmph and take it to pooling pit and dump about 10-15 ton of metal & then send it to steel melting shop.
- 5) Loco Shunting Staff shall come down at every rail-road crossing and caution people before allowing the train to pass. Park the torpedo before fouling mark to avoid side collision.
- 6) Loco shall move at slow speed and shall not apply sudden brakes to prevent spillage and splashing of hot metal.
- 7) Ladle shall not be transported in tilted condition.
- 8) It shall be ensured that persons are removed from the vicinity of the track during movement.

#### **2.5 Inspection and Maintenance of Hot Metal Tracks**

- 1) Hot metal transport tracks shall be regularly inspected for any undulations and prompt action to remove undulations shall be ensured.
- 2) Track alignment shall be checked periodically and any sinking shall be immediately attended to.
- 3) Tracks shall be inspected regularly for any scraps and other materials.
- 4) De-weeding shall be done to ensure the safety of the persons moving along with rolling stock.

- 5) All the dry weeds along the track shall be removed to avoid fire due to metal splashing during transportation of hot metal.
- 6) Accumulation of water on the tracks or near the tracks shall not be allowed.

## **2.6 Liquid Metal Pouring**

Hot metal from Blast Furnaces tapped and transported as described in earlier clauses is poured at following different locations:

### **2.6.1 Ladle to Mixer**

- a) Ladles are brought to the line below Mixers and loco removed.
- b) The Crane Operator lowers and engages the hooks in ladle.
- c) The Crane Operator lifts the ladles full of hot metal continuously giving siren/alarm so that people working in the area move away.
- d) He brings it near the mixer platform where the crust is broken using lancing or punching as per requirement.
- e) Ladle is then taken to the top of the Mixer.
- f) Lid of the pouring hatch of Mixer is opened.
- g) Metal from the ladle is poured very slowly and continuously into the Mixer carefully avoiding jerks and sharp movement so that there is no spillage of hot metal.
- h) Ladle is fully drained off as per signals of the Mixer Operator.
- i) Avoid falling out of any crust pieces (during pouring) as they may fall outside. This is watched by the Mixer Operator who stops the pouring whenever the crust is about to fall.
- j) Straighten and lower the ladle.
- k) Place empty ladle back on the ladle car.
- l) Repeat the process with other ladle.

### **2.6.2 Mixer to HM ladle/Mixer Ladle**

- a) Ladle shall be inspected for the condition of refractory lining.

- b) All the ladles shall be placed below the spout of the Mixer one by one.
- c) Ladle shall be aligned/ placed below the spout perfectly by the Loco Operator following signals of the pourer.
- d) Mixer shall be tilted by the Pulpit Operator and metal poured into the ladle as per requirement.
- e) After completion of pouring, the ladles shall be drawn and brought to the twin hearth furnaces/converters.

#### **2.6.3 Torpedo ladle to metal transfer car—**

- a) Place the torpedo at the desired pit at steel melting shop following light signal
- b) Plug the torpedo drive connection for pouring hot metal transfer car.
- c) After complete evacuation of hot metal plug out the drive connection.
- d) Ensure that the torpedo should be not be in tilted condition
- e) Remove the torpedo from SMS and send for filling or maintenance.

#### **2.6.4 Ladle to Furnace (Twin Hearth)**

- a) The furnace bottom is inspected when repair is done.
- b) Sil is prepared with dry raw dolomite.
- c) Scraps, lime etc. should be free from moisture are charged.
- d) As soon as the furnace is ready to receive metal, doors are lowered and closed.
- e) Spout (prepared and inspected) are lifted and fixed into the door with the help of hot metal crane.
- f) Hot Metal Crane then lifts ladle and pours into the spout as per the signals of the furnace Chargeman / Melter.

- g) Place back empty ladle on the car.
- h) Repeats this process with other ladles till the furnace has received the required quantity of metal.

#### **2.6.5 Hot Metal/Mixer Ladle to Converter**

- a) Ladle, after filling the required quantity of hot metal, is brought to converter platform on the self propelled ladle car/HMTC.
- b) It is lifted with the help of hot metal/charging crane.
- c) Converter vessel after emptying and slag coating is charged with heavy and light scrap.
- d) It is tilted again to receive metal and lifted ladle is correctly positioned.
- e) Ladle is then tilted gradually and metal is poured slowly into the converter taking care that no splashing takes place.
- f) Ladle is then straightened, taken back and placed on the ladle car.
- g) Converter vessel is brought to upright position to start the process.

#### **2.6.6 Converter to Steel Ladle**

- a) Inspected and preheated ladle is placed on transfer car and placed below the converter for tapping.
- b) After the blow is over, first slag is tapped in the slag ladle. Ensure that slag ladle should be dry.
- c) Ladle car is then moved back to bring ladle below the spout of the converter vessel, after removing the slag ladle.
- d) Vessel is tilted to other side and liquid steel is slowly tapped into the ladle till the slag appears.
- e) The metal car is then brought to slag and ladle preparation bay.
- f) Slag laddle is then taken out with the help of crane and the car with metal ladle goes to Argon Rinsing Station.

#### **2.6.7 Movement of Steel Ladle to Continuous Casting Machine through Secondary Refining Units**

- a) After Secondary Refining, the ladle is moved forward on car towards the caster side/lifting pit of CCS.
- b) EOT crane is brought above it from side movement.
- c) The hook is lowered and ladle is engaged as per the signals of the Chargeman/Operator. Ensure that area must be free from moisture.
- d) Ladle is then lifted slowly and very carefully to CCS pouring platform (on turret arm – in charging side).
- e) It is then placed on the other side by lifting the arm and rotating the turret for pouring and casting.
- f) After pouring and casting, turret arm is lifted and rotated to charging side for removal of empty ladle by crane. After that it is returned to pit side of SMS/Ladle Preparation Bay (after dumping) by Ladle Transfer Car.

#### **2.6.8 Twin Hearth Furnace to Steel Ladle**

- a) Proper preheating and inspection of ladles shall be done before tapping.
- b) Ladle shall be inspected for shell condition and skull free condition of refractory lining.
- c) Rigidity of slide gate mechanism shall be ensured.
- d) Ladle shall be placed at tapping stand.
- e) Place graphite powder at bottom of ladle exactly over the nozzle.
- f) Add dried out coke at bottom of ladle before tapping.
- g) Oxyppm of the heat shall be optimum.
- h) Add required quantity of Ferro Alloys during tapping with help of crane.
- i) Aluminium bars can be added manually.
- j) Continue tapping till molten steel gets exhausted at furnace.
- k) In case of high oxyppm, the flow of reactive slag into ladle is to be avoided by using suitable means.



- l) After filling up, ladle shall be covered with heat shield cover.
- m) Ladle shall be lifted by traverse hanger hook with the help of crane.

#### 2.6.9 Teeming Operation

- a) Position the ladle to the required teeming platform through crane.
- b) Fix HPP cylinder to ladle for opening slide gate.
- c) Ideally on opening the slide gate, nozzle filling compound should fall down.
- d) Place ladle nozzle at centre of mould for uniform flow.
- e) During teeming, add aluminium shots as deoxidiser.
- f) Close slide gate after the mould is full.
- g) Crane along with ladle shall be moved to subsequent moulds till the teeming is complete.

#### 2.6.10 Blast Furnace Ladle to Foundry Ladle

- a) BF ladle shall be lifted by crane by engaging traverse in BF ladle properly.
- b) BF ladle shall be slowly tilted to transfer the hot metal into foundry ladle.
- c) Foundry ladle filled with hot metal kept on Hot Metal Transfer Car shall be driven slowly towards pouring bay.
- d) Ladle shall be lifted slowly by crane by engaging traverse in foundry ladle properly.
- e) Centering the foundry ladle on the pouring basin of Ingot moulds/Bottom plates, ladle shall be opened.
- f) No rolling of crane on the tracks shall be permitted.
- g) After pouring and filling the Ingot moulds/Bottom plates, foundry ladle shall be tilted with the help of auxiliary hoist of crane and total residual slag/metal shall be dumped into slag pots slowly.
- h) Foundry ladle shall then be kept horizontally before the lancing stand for lancing the nozzle of the ladle properly.

**2.6.11 Ladle pouring at PCM**

- a) Ladles are brought to PCM line (track) at the approach of shunting winch.
- b) PCM operator positions the ladle with shunting winch to PCM runner.
- c) With the help of vertical winch hook, ladle is slowly and continuously lifted from the bottom.
- d) After ladle is poured and emptied fully, it will be positioned into chassis and then pushed out of machine through the shunting winch.

**2.7 Safety Precautions for handling liquid metal in Converter/Concast/Twin Hearth & Teeming**

- a) Before ladle is lifted by the hanger hook, the hook and the crane shall be checked for its rigidity by lifting loaded ladle to smaller height and hold momentarily and check the breaking effect of both downward and upward movement before it is further transported.
- b) Person working in pit side should not come beneath the raised load.
- c) Other activity viz. cleaning, lancing, relining and de-bricking shall be momentarily stopped during heat movement in their area.
- d) At pit side, persons shall maintain safe distance at the time of tapping and teeming operations.
- e) All workmen involved in teeming, shall wear all necessary protective appliances in proper manner viz. Safety helmet, safety shoes, smelters glasses, face shield, flame retardant suit, hand gloves, anklets etc.
- f) During movement of crane, sound alarm shall be used to caution persons working below.
- g) Ensure proper coordination between different agencies at pit side.

**2.8 Hot Metal Ladle cleaning and dumping at LRS**

- a) Ladles from SMS, PCM and Foundry shall be brought to LRS for cleaning and inspection.
- b) With the help of LRS crane, punching and hooking shall be done.

- c) All scraps and slag shall be dumped in the skull pot.
- d) Ladle structure and refractories shall be inspected.
- e) If repair is needed, it shall be repaired and ladles shall be sent to furnaces for placement and metal filling.

## **2.9 General Safety Points for all the jobs of handling of liquid metal**

- a) The crane shall be load tested and inspected periodically.
- b) Load test date and SWL bearing capacity board shall be displayed prominently over the crane.
- c) The ladle hook arm and wire rope shall be tested for rigidity.
- d) Crane shall be made free from loose materials and inflammable materials.
- e) Crane shall be provided with cut off limit switches for all movement and maintained in operable condition.
- f) Sufficient clearance is needed by the side of railway track. No obstruction over the tracks should be permitted.
- g) Structures shall be periodically inspected and tested.
- h) All lifting equipment, tools and tackles are to be checked periodically.
- i) At the time of handling and transferring liquid metal, person shall be well trained in signaling operation to guide Crane Operator as per IPSS:2-02-013-01 'Hand Signals for EOT Cranes'.
- j) Ladles, cranes and locos when handling liquid metal, shall be driven at safe speed.
- k) Ladle trunion diameter shall be periodically checked for timely replacement.