

## Pot Bypass Arrangement – Lifeline of Potlines

**Bibhudatta Mohanty<sup>1</sup>, Anant Vikram Singh<sup>2</sup>, Raghunath Patnaik<sup>3</sup> and Ashok Shankar N S<sup>4</sup>**

1. Head Maintenance-Potlines, Vedanta Limited, Smelter-1, Jharsuguda, India
2. Pot Relining & Startup -Potlines, Vedanta Limited, Smelter-1, Jharsuguda, India
3. Mechanical Engineer-Potlines, Vedanta Limited, Smelter-1, Jharsuguda, India
4. E & I Engineer-Potlines, Vedanta Limited, Smelter-1, Jharsuguda, India

Corresponding author: bibhudatta.mohanty@vedanta.co.in

### Abstract

Uninterrupted operation of potlines is a major challenge in aluminium business and this determines the sustainable operation of smelter. The interruption in potline operation shall be due to lack of raw materials, disturbance in DC power supply, potline open circuit, major fire, etc. Many factors evident for operational interruption are external drivers, however open circuit is only due to pot instability of various reasons. Such instability may result in shut down of entire smelter with huge loss of capital and business. The objective of this paper is to demonstrate the various ways of operating potline during any open circuit and to avoid interruption in operation. This concept was developed by considering various categories of open circuit incidents and related control measures were designed for the same. The cases considered are: short circuit bus bar damage of non-corner pot (Type-1), short circuit bus bar partially damaged in pot (Type-2), short circuit bus bar completely damaged in corner pot (Type-3) and several potshells got damaged due to major fire or structural failure (Type-4). To handle all such contingencies, different sets of tools were designed, developed and simulated for performance study. Contingency tool for Type-1, Type-2 and Type-3 were designed, tested and demonstrated in the potline; the result shows restoration of potline operation within 30 minutes for each riser. Type-4 design is in modelling stage and it has been designed in flexible model so as to bypass 'n' number of pots depending on severity of the incident.

**Keywords:** Interruption in pot operation, open potline circuit, pot fire, contingency tool.

### 1. Overview of Project

Vedanta Jharsuguda has six potlines of GAMI 320 kA pots, installed in two Plants: Plant 1 has two potlines of 304 pots each, Plant 2 has 4 potlines of which three lines are operating now & one line is under commissioning. The pot has five anode risers and uses pot bypass shunts at the base of each riser to shut down a pot for relining. The uninterrupted operation plays a vital role in defining the reliability and sustenance of potline and so the business deliverables. This paper highlights the pot bypass arrangements which shall act as the lifeline of potlines.

### 2. Introduction

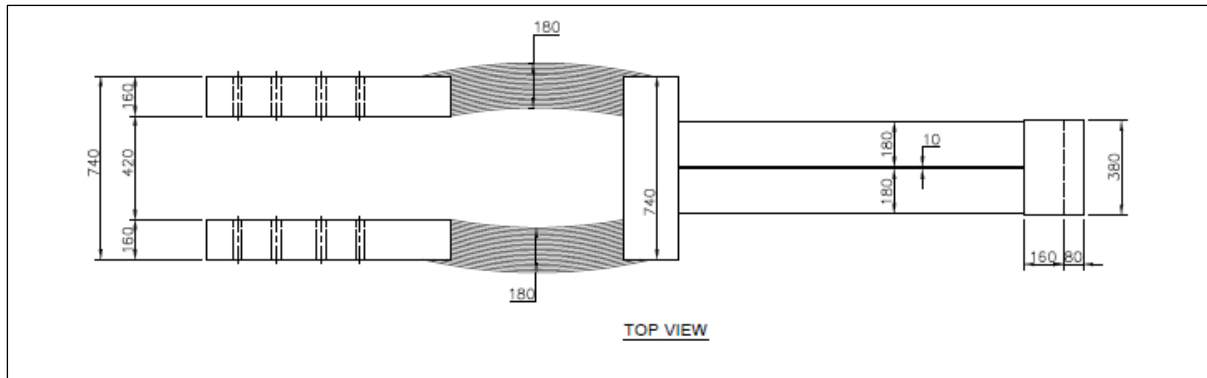
In potline operation, the major causes for potline interruption are:

- a. Shortage in raw materials,
- b. Interruption of DC power supply,
- c. Interruption in compressed air supply,
- d. Natural disaster,
- e. Major fire in potline,
- f. Open circuit.

The frequency and potentially catastrophic consequences of power interruptions in world smelters are described in [1].

This paper explains all the innovated contingency measures for ensuring uninterrupted operation of potline during "*open circuit of pot*".





**Figure 2. Top view of Type-1 contingency tool.**

Type-1 contingency tools are preserved in desired location (Figure 3) and the live demonstration and implementation for testing purpose of this contingency tool (Figure 4) shows the restoration of potline shall be done in 30 minutes per riser. During the implementation phase, various parameters like shunt drop, riser temperature, riser drop and compensating bus bar drop values are recorded (Table 1).



**Figure 3. Preserved location of Type-1 contingency tool.**



**Figure 4. Implementation of Type-1 contingency tool.**

**Table 1. Parameter recording of Type-1 contingency tool.**

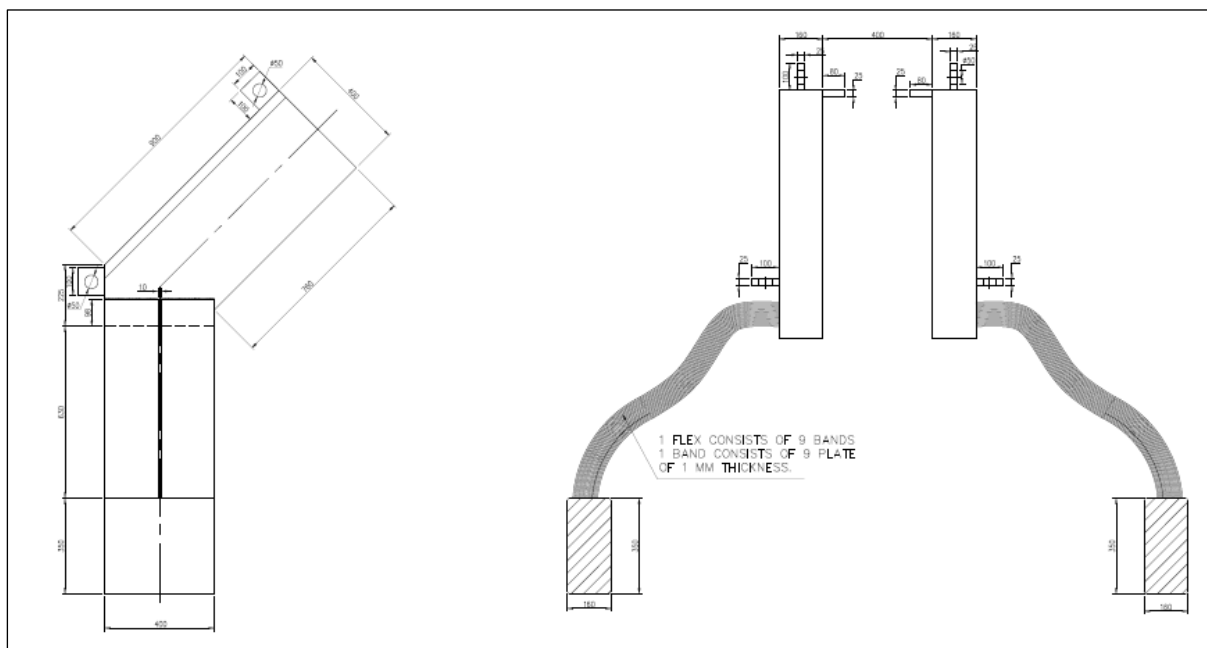
Anode riser	Shunt drop( mV)	Riser temperature (°C)	Riser voltage drop (mV)
R1	89/98	120/135	10/12
R2	120/189	154/147	9/12
R3	175/99	165/187	10/11
R4	85/68	174/162	10/10
R5	201/188	201/178	9/8
Compensating busbar voltage drop (mV)			
B1	4	B7	3
B2	3	B8	5
B3	4	B9	6
B4	5	B10	4
B5	5	B11	5
B6	4		

The two readings shown in shunt drop, riser temperature and riser voltage drop shows is for tap end and duct end of the pot. Compensating bus bar are the bus bar beneath the pot superstructure which will come in action for bypassing the current in a dead pot. It means compensating bus bar will be idle during pot running condition and it will be in action during dead pot condition. The voltage drop was taken at the various compensating bus bars from B1 to B11. All the readings taken during the contingency test shows to be nominal and within the allowed range.

**6. Contingency Tool - Type 2**

*This contingency tool of Type-2 (Figure 5) is designed for the condition when short circuit bus bar got partially damaged in a pot.*

Five of such sets are required in one pot, one per riser. Cross section of aluminium bus bar, design of flex, and all arrangements including the size of bolts and nuts are also specified and pre-defined. The flex used here consists of 9 bands and 1 band consists of 9 leaves of 1 mm thickness.



**Figure 5. Schematic drawing of Type-2 contingency tool.**

Type-2 contingency tools are preserved in desired location (Fig. 6) and the live demonstration & implementation for testing purpose of this contingency tool shows the restoration of potline shall be done in 25 minutes. During the implementation phase, various parameters like shunt drop, riser temperature, riser drop & compensating bus bar drop values are recorded (Tab. 2)



**Figure 6. Preservation of Type-2 contingency tool.**

**Table 1. Parameter recording of Type-2 contingency tool.**

Anode riser	Shunt drop( mV)	Riser temperature (°C)	Riser voltage drop (mV)
R1	13/18	131/141	11/11
R2	128/189	162/135	9/10
R3	77/68	121/172	10/11
R4	175/136	184/141	11/11
R5	187/212	185/191	12/11
Compensating busbar voltage drop (mV)			
B1	5	B7	4
B2	4	B8	5
B3	6	B9	6
B4	5	B10	3
B5	6	B11	4
B6	3		

The two readings shown in shunt drop, riser temperature and riser voltage drop shows is for tap end and duct end of the pot. Compensating bus bars are the bus bars beneath the pot superstructure which will come in action for bypassing the current in a dead pot. It means compensating bus bar will be idle during pot running condition and it will be in action during dead pot condition. The voltage drop was

taken at the various compensating bus bar from B1 to B11. All the readings taken during the contingency test show to be nominal and within allowed range.

### 7. Contingency Tool - Type 3

*This contingency tool of Type-3 (Figure 7) is designed for the condition when pot short circuit shunt got fully damaged in corner pot.*

This model has been designed (Figure 8) and preserved in desired location. This model has not yet been demonstrated in practice. But judging by the way Type-1 and Type-2 implementation succeeded, we are sure that Type-3 will also succeed.

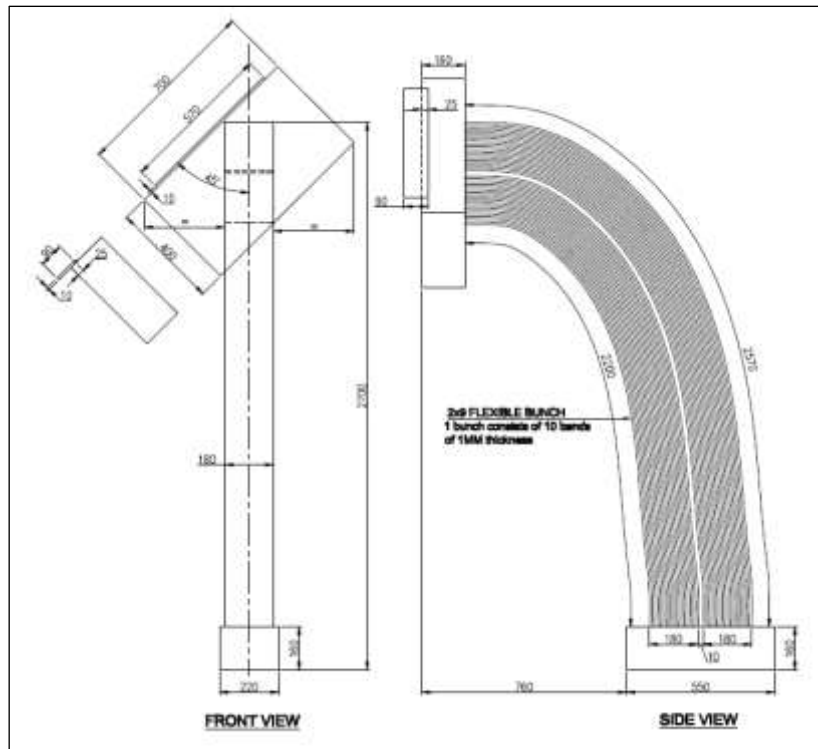


Figure 7. Schematic drawing of Type-3 contingency tool.

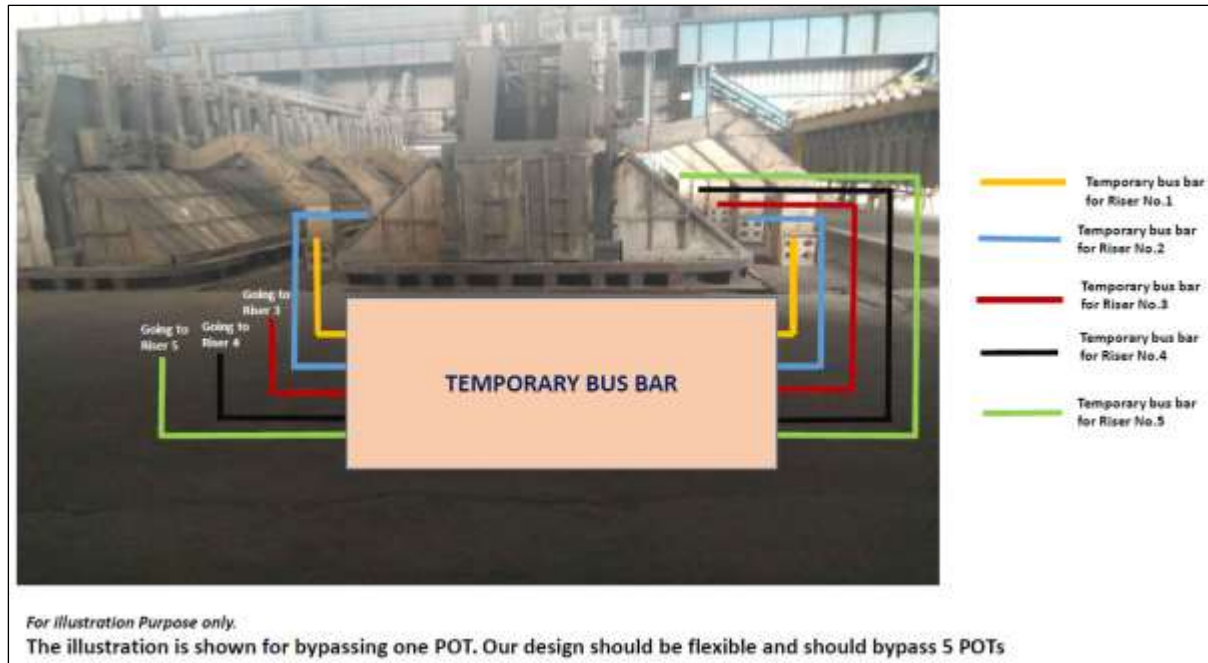


Figure 8. Schematic drawing of Type-3 contingency tool.

## 8. Contingency tool- Type 4

This proposed contingency tool of Type-4 (Figure 9) is suitable for the condition when several potshells got damaged due to major fire or structural failure.

The design and development phase have been initiated for this type of contingency tool but they have not been built yet.



**Figure 9. Proposed design of Type-4 contingency tool.**

### Proposed design as per sketch in Figure 9:

1. Riser-1 of one end will be connected to Riser-5 of another end
2. Riser-2 of one end will be connected to Riser-4 of another end
3. Riser-3 of one end will be connected to Riser-3 of another end
4. Riser-4 of one end will be connected to Riser-2 of another end
5. Riser-5 of one end will be connected to Riser-1 of another end

## 9. Conclusion

Stable and sustainable operation of the potlines is the key for aluminium business to grow and expand further. Any interruption in operation of a potline is a huge loss or setback for business. The mitigation plan for any interruption should be capable to retrieve the potline operation in minimal time. At Vedanta, the contingency tools are designed in such a way to manage and restore the potline operation to stable within 2 - 3 h maximum in any case of interruption. We designed four types of contingency tools, for different situations that could arise in a potline, of which two have been successfully tested in practice. As an aluminium leader, the thought process is to assure such potline operation to never have an instance to use these contingency tools in our operation. But we are readying for unpredictable.

## 10. References

1. Alton T. Tabereaux, The high risk of electrical power interruptions to the continuous production of aluminum smelters, *Light Metal Age*, October 2018, 24-30.
2. Dominique Duval et al., Potline open circuit protection, *Light Metals* 2012, 913-916.