High Frequency Modulation in France and in TRIMET Saint-Jean de Maurienne for F and G Lines

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Abstract

The unplanned shutdown of several nuclear reactors in France at the beginning of the winter 2016 - 2017 led to the possibility of electricity supply disruption in the country. The TRIMET Saint-Jean-de-Maurienne smelter located in the French Alps is one of the main electricity users in France and has implemented high frequency modulation on its potlines to stabilize the frequency of the electricity grid. This article explains the need for such a service in the winter 2016 - 2017 and describes the technical challenges faced by the plant in designing, installing and validating the power modulation equipment. It also describes the effect of high frequency amperage variations on the pot control system and the mechanisms leading to extra anode effects.

Keywords: High frequency grid electricity modulation, Saint-Jean-de-Maurienne smelter, power modulation equipment, high frequency amperage variations, pot control system.

1. Description and Examples of the High Frequency Modulation in France

As many electricity grids in Europe, the French one had to face a new challenge with the growing importance of renewable energy such as Solar and Wind.

Electricity cannot be stored cheaply onlarge scale so at any moment, electricity demand and supply must be equal. If there is too much electricity through the grid, equipment could fail,if there is too little, there is a risk of a black out.

The system frequency is a measure of the balance between energy generated and consumed, as it is linked with the rotation speed of the synchronized electricity generators (Figure 1). It is a constantly shifting number that must be managed and controlled all the time.

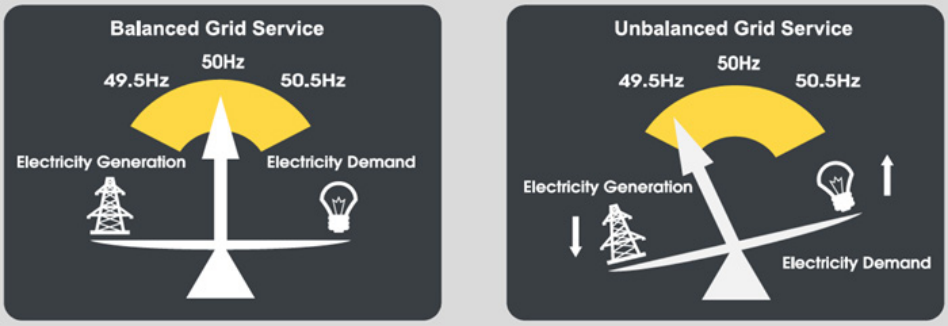

Figure 1. Principle of grid frequency modulation [1].

The control of the grid is “simply” to maintain the balance, in other words, the frequency at 50 Hz. Since 2014, RTE (Réseau de transport d’électricité - Electricity Distribution Network) has developed

with several companies known as “Pool” some new contracts to help maintaining the grid. This contract can be classified in 3 groups depending on the speed of their activation (Figure 2):

- Primary Reserve (PR): Stop the drift of the frequency, activated in less than 30s,
- Secondary Reserve (SR): Restore the frequency, activated in less than 15 min,
- Tertiary Reserve (TR): Manually activated by RTE to help the restoration of the frequency or Reserve replacement.

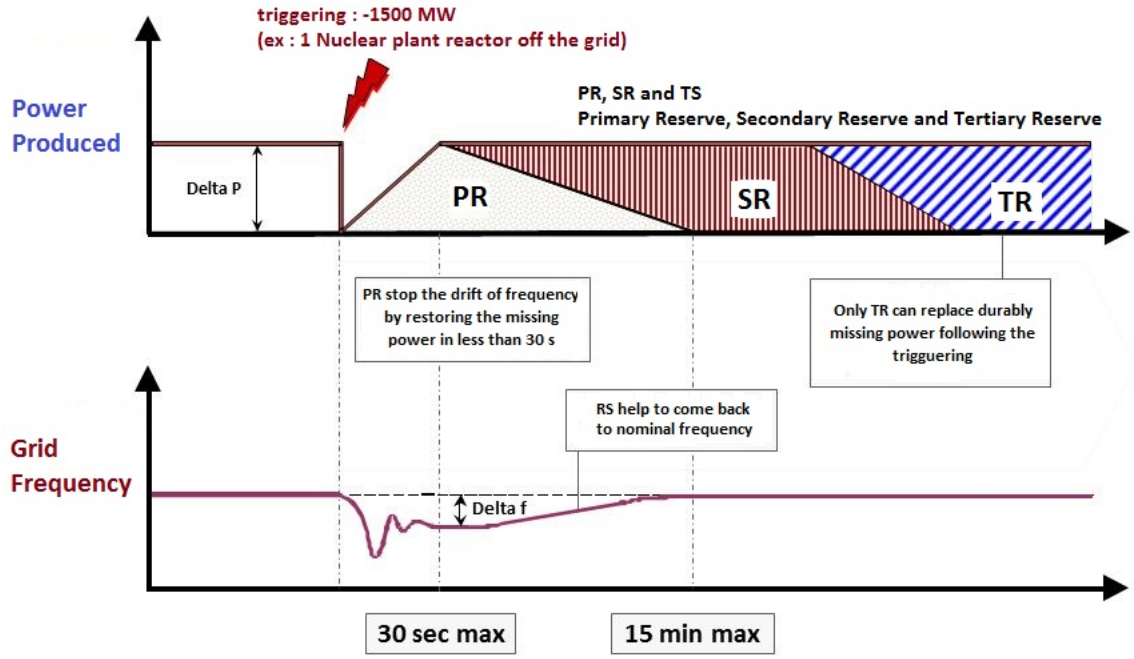

Figure 2. Frequency adjustment mechanism.

TRIMET France in its Saint-Jean de Maurienne plant has been doing Primary Reserve since September 2014 with 20 MW, which rose to 30 MW in mid-March 2015. Saint-Jean reacts in Primary Reserve with a coefficient K = 150 MW/Hz (K is the factor of primary setting) from 49.80 to 50.20 Hz with a “dead zone” of no response between 49.99 to 50.01 Hz.

To reduce the impact of power variation on the pots, we have shared power modulation between the 2 potlines: the F potline (AP18 at 200kA, 60 pots) and the G potline (AP30 at 340 kA, 120 pots).
Most of the time the power modulation stays within ± 5 MW: ±2 kA on F potline and ±4 kA of G potline. A lot of the frequency variation occurs also from 16:00 to 05:00 and at the top of the clock. During these peaks, power modulation can go over 20 MW and can generate some time process incident such as anode effects depending on the state of the pot.

variation during frequency modulation. This analysis proved that the anode effect increase shown in Figure 16 was not linked to the start of the frequency modulation in the potlines.

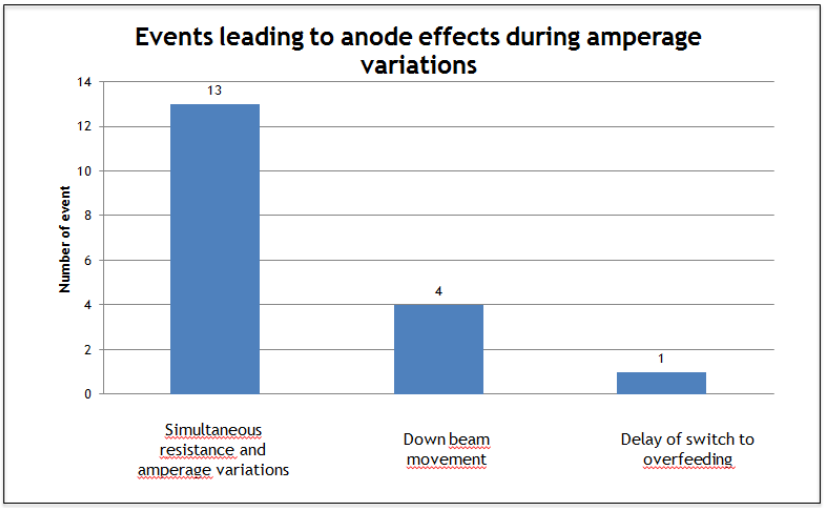

Figure 21. Events leading to anode effects during amperage variations linked to frequency modulation.

7. Conclusion

In response to new constraints on the electricity grid in France, the TRIMET smelter in Saint-Jean de Maurienne has managed to design, test and implement high frequency power modulation. This has helped in stabilizing the grid frequency during the cold spells of the winter 2016/2017 where the power production capacities were reduced by unplanned maintenance. The management of the amperage variations in both potlines has allowed stable operation and frequency modulation was shown to have limited impact in anode effect frequency.

8. References

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