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Generator Responses during the 2020 Mumbai Blackout

Santosh V. Singh[1], Gopal Gajjar[1], P. V. Navalkar[1], A. M. Kulkarni[1], and G. T. Jawale[2]

[1]Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai, India

[2]Tata Power Company Limited, Mumbai, India

(GitHub)

The Mumbai Blackout of 12th October 2020

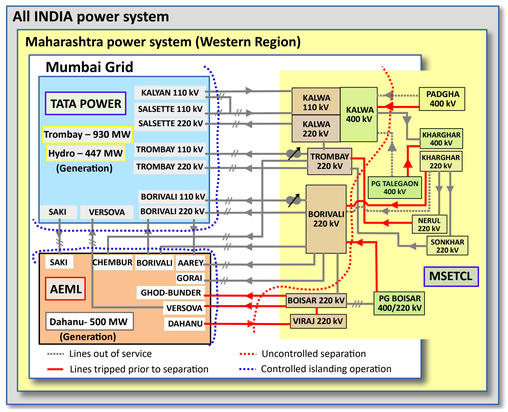

Fig. 1: Network in and around the **Mumbai region**. The **cut-set** of the designed **controlled islanding scheme**, and **uncontrolled separation** during the disturbance of **12th October 2020** is also shown.

AEML: Adani Electricity Mumbai Ltd., MSETCL: Maharashtra State Electricity Transmission Company.

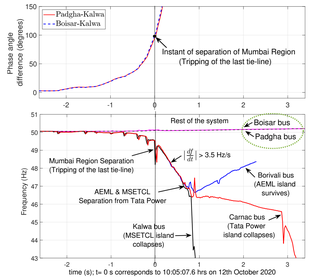

Fig. 2: Angular difference and frequency transients during the disturbance.

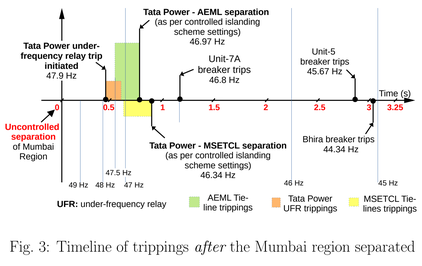

Fig. 3: Timeline of trippings *after* the Mumbai region separated from the rest of the system. Frequency is computed from instantaneous waveforms of DRs.

Measurement Pre-processing

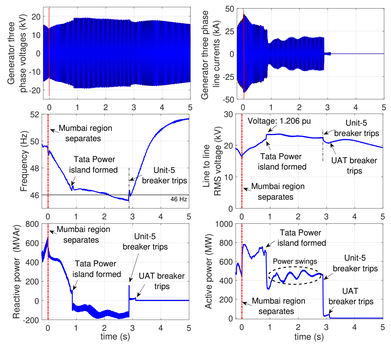

Fig. 4: Trombay Unit 5 **derived quantities** from the three-phase instantaneous voltages and currents.

- Measurements from several **DRs, PMUs** at 8 locations, and the pre-fault information from **SCADA**.
- Derived quantities from instantaneous voltage and currents.
- Time-aligning the data.

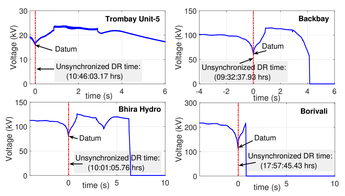

Fig. 5: Datum identification in various DRs.

Behavior of Trombay Unit 7A and 7B Generators

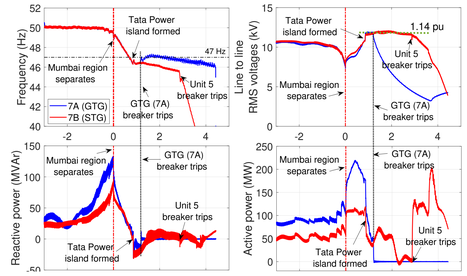

Fig. 6: Unit-7 generator responses.

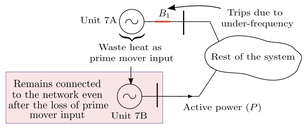

Fig. 7: Configuration of Unit 7A and 7B.

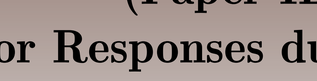

Fig. 8: Co-simulation of Trombay Unit 7B with the DR data.

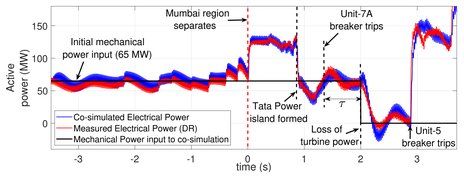

Fig. 9: Comparison of the co-simulated power response of Trombay Unit 7B with the observed power response

Behavior of Trombay Unit 5 Generator and its Auxilaries

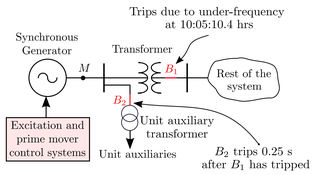

Fig. 10: Tripping sequence in Unit 5.

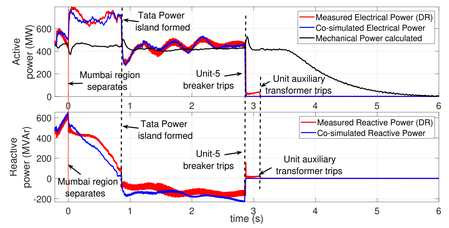

Fig. 11: Tripping sequence in Unit 5. Comparison of the co-simulated power response of Trombay Unit 5A with the observed power response.

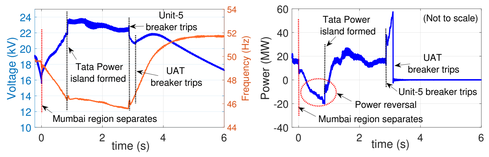

Fig. 12: Power flow reversal in a UAT of Unit 5 during the transient.

Induction Machine Parameters	
RMS Voltage	6.6 kV
Rated output power	3 MW
Rated frequency	50 Hz
Power factor at rated load	0.85
Efficiency at rated load	0.985
Slip at rated load	1.5%
Starting torque/Rated torque	1.5
Maximum torque/Rated torque	3
Starting current/Rated current	5

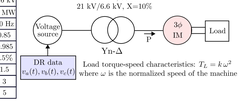

Fig. 13: Co-simulating an induction motor with the DR data.

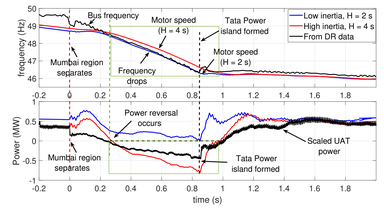

Fig. 14: Power reversal is seen for the large inertia motor when frequency dips.

Behavior of Bhira Hydro Generator

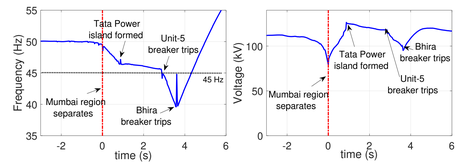

Fig. 15: Bhira hydro-unit response.

Conclusion

1. The post-mortem analysis brought out generator responses that are not generally seen during normal operating conditions.
2. **Co-simulation** approach proved useful in such analysis.
3. The paper presented and analyzed some interesting features in these responses and corroborated the analysis by simulating the generator models with the played-back DR data.
4. We expect that the analysis presented will be of **educational value for students and practicing engineers**.

Acknowledgement

The assistance of Kaustav Dey, post-doctoral fellow at University of Manitoba, in carrying out the co-simulation studies is gratefully acknowledged.

Reference

[1] P. Navalkar, A. M. Kulkarni, Santosh V. Singh, and S. A. Soman, "A proposal for a PMU based adaptive islanding scheme for Mumbai city," in 2022 22nd National Power Systems Conference (NPSC), IEEE, 2022.

GitHub: `https://github.com/svsingh68/PESGM_24_Poster_1104/tree/main`