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Mumbai Blackstart - Load restoration process

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Abstract -
Blackout is the most dreaded events in any power system. All LDCs & Utilities are combining their efforts to avoid the occurrence of blackout. In case of blackout occur effective measures & ancillary services are in place for restoring the system within minimum possible time. Mock black start drills and learning sessions on the subject familiarize the operators with the system recovery procedures, build their confidence to respond to contingencies and provide them an opportunity to address systemic deficiencies detected during the exercise. Tata power has carried out partial actual blackstart exercise with Tata hydro stations successfully in presence of RLDCs. These efforts ultimately reduce the time taken during actual system restoration and help in improving the coordination between various agencies. This paper describes the philosophy adapted during actual black start drills and Innovation practices adapted to reduce restoration time..

1. INTRODUCTION

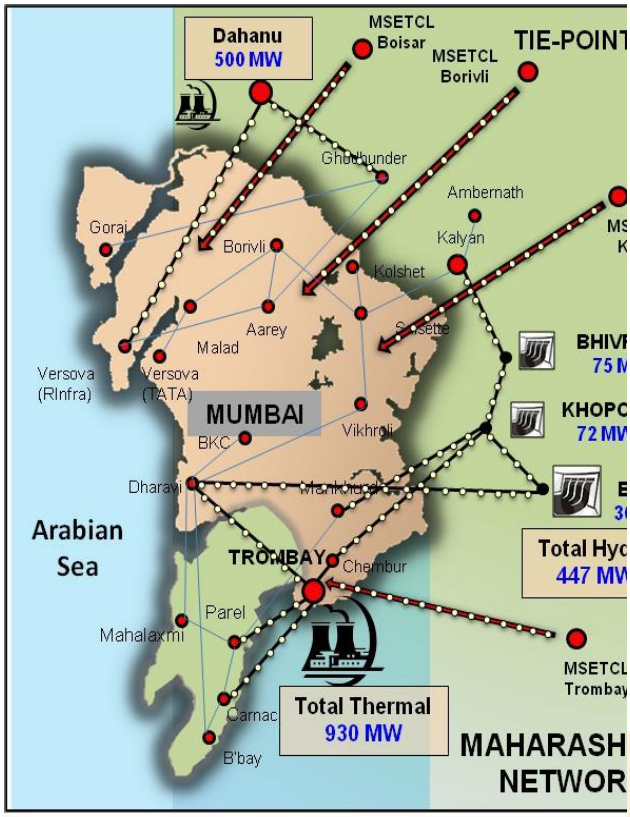
India's grid is connected as a wide area synchronous grid nominally running at 50 Hz. The first interconnection of regional grids was established in October 1991 when the North Eastern and Eastern grids were interconnected. The Western Grid was interconnected with the aforementioned grids in March 2003. The Northern grid was also interconnected in August 2006, forming a Central Grid synchronously connected operating at one frequency.[6] The sole remaining regional grid, the Southern Grid, was synchronously interconnected to the Central Grid on 31 December 2013 with the commissioning of the 765 kV Raichur-Solapur transmission line, thereby establishing the National Grid. Private & government power utilities are the part of this national grid. Even if the power system is more stable after national grid formation. RLDC has enforced some guidelines to maintain discipline and remedies for blackouts.

Mumbai, city, capital of Maharashtra state, southwestern India. It is the country's financial and commercial centre and its principal port on the Arabian Sea.

Tata Power always take pride in Keeping the city lighted up more than a decade. The in house Islanding facility which isolates Mumbai power system from rest of the grid in case of fault in outside grid has served the city in maintaining interrupted supply on 27 occasions.
It is always said that the candle is lighted only for candlelight dinners. The Islanding Scheme, commissioned way back in 1981 and achieved 100% success rate since 1997.

Islanding system works on the principle of having adequate embedded generation for serving equal load. The quantity of embedded generation has reduced by 500 MW with retirement of Oil fired Trombay 500 MW Unit-6 and hence if the islanding system fails then Tata Power is equipped with black start facility available at all three Hydro Stations.

Fig 1: Mumbai network connection with MSETCL



Above diagram shows the geographic location of Mumbai surrounded by Sea from three sides and It's connection with MSETCL system with interconnected tie lines.

Mumbai's embedded generation used keep Mumbai lighten up and secure from islanding/blackstart point of view.

2. THE OVERALL SYSTEM CONFIGURATION OF MUMBAI TRANSMISSION NETWORK

The Mumbai Power System consists of Tata power & Adani power transmission system, TPC-T handles @ 66% of Mumbai energy, which is further interconnected with Maharashtra State grid at three locations (Trombay, Kalwa Borivli, Boisar). The State grid is further interconnected with Gujarat and Madhya Pradesh State grids through 400 kV and 220 kV interstate tie lines.

The Tata Power Company forms an important component of the Maharashtra State grid. The present installed capacity of Tata is 1377 MW and Adani 500 MW in Mumbai. Tata power generating and receiving stations are strongly interconnected through 220 kV & 110 kV overhead and underground transmission lines and 33/22/6.6 KV distribution network.

Tata Transmission & Distribution network	
220 KV lines	**32**
110 KV lines	**51**
Transmission R/S No	**27**
Distribution Sub Station	**34**
Consumer Sub Station	**943**

The distribution node at PSCC is responsible for handling the TPC-D load of direct consumers at 33, 22 and 11 KV levels. Distribution node has total 6 zones:

1) North suburbs (North) 2) West (Central)
3) Metro (South-Central) 4) Urban(South)
5) East 6) City

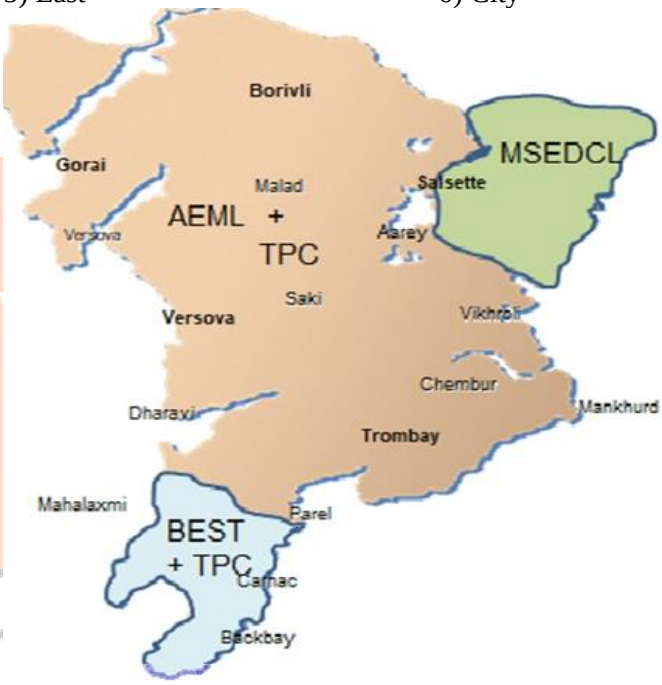
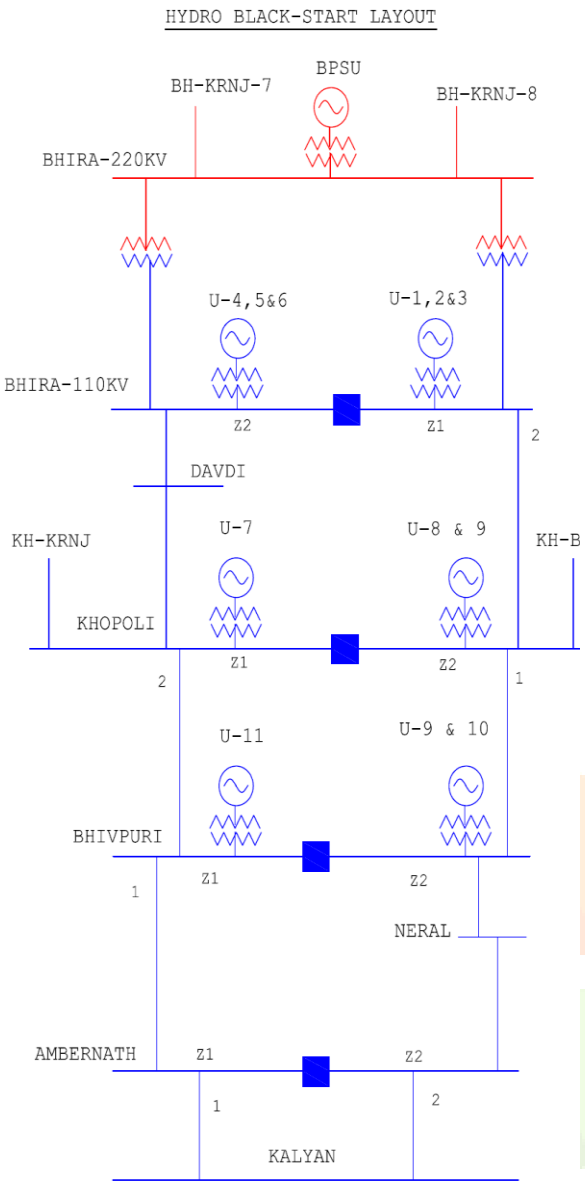


Fig 4: Mumbai Tata Power Distribution Layout

3. AS per Directive's from WRLDC & coordination with MSEDCL – Black Start Mockdrills carried out

- Bhira & Khopoli G/s: Black start mockdrill was carried out successfully between 1102 and 1259 hrs by forming Bhira and Khopoli Island on 27.12.2020

During the Black start trial at Bhira and Khopoli, Bhira and Khopoli stations are connected during black start and supply was extended to MSETCL Neral S/S through Bhivpuri 110 KV Bus-2 and radial load of MSECL Neral was restored. 22 KV Feeders were charged one by one and load of @ 15 MW restored from the island.



Similarly, At Bhivpuri G/s black start mockdrill was carried out successfully between 1125 and 1341 hrs by forming Bhivpuri + Neral Island on 20.12.2020

4. Blackstart procedure – Automation practices adapted

- Background -
Islanding system works on the principle of having adequate embedded generation for serving equal load. The quantity of embedded generation has reduced by 500 MW with retirement of Oil fired Trombay 500 MW Unit-6 and Mumbai demand has increased with the development. Hence, the chances of the islanding system failure has increased. Development of these blackstart procedure for faster restoration is needed considering Mumbai importance. Tata Power is equipped with black start facility available at all three Hydro Stations.

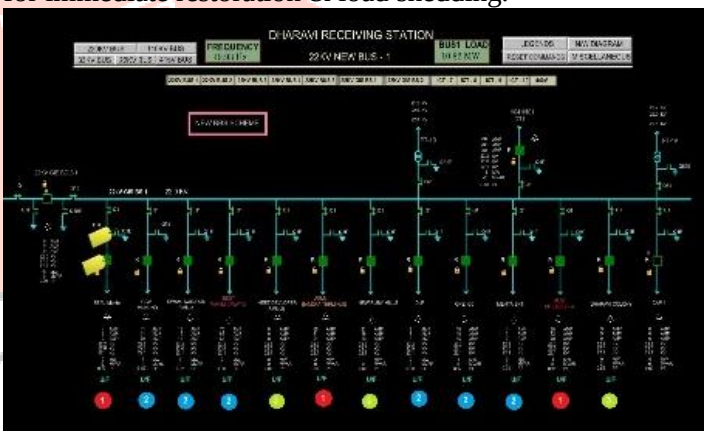
Normal Blackstart procedure takes more than 2 hours for restoration:

- Identification of Mumbai Blackout
- Available system checking and Network clearing
- Communication with Hydro / RS for startup
- Identifying & resolving restoration prob
- Islanding system – Maintaining Freq & Voltage
- Grid Synchronizing & normalization

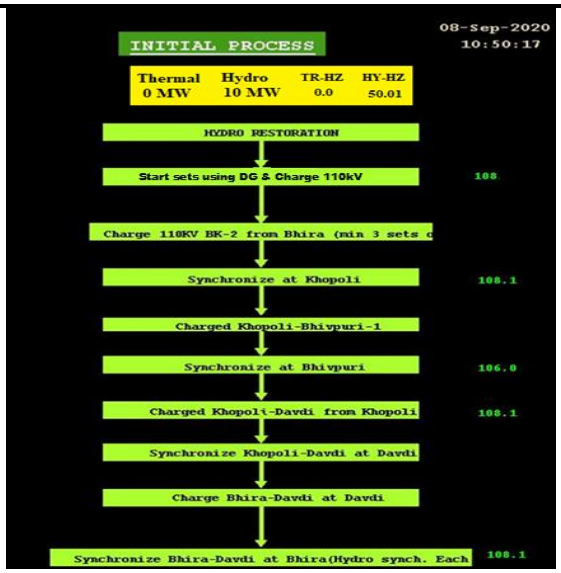
We need to carry out continue communication with SLDC / RLDC and Management for real time status and outside grid stability
For Utility-wise feeder restoration also need continue communication with TPCD, AEML & BEST feeders as per priority.
Tata power has standard hard copy blackstart procedure and expertise on electrical restoration. Hence, we worked on cycle time reduction and existing technologies to implement new ideas.

Ideas implemented -

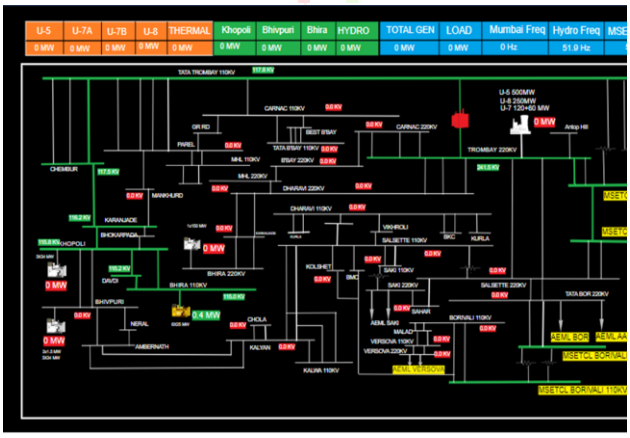
1. Implementations in SCADA – feeder Priority marking on operator SCADA window as per utility for immediate restoration & load shedding.



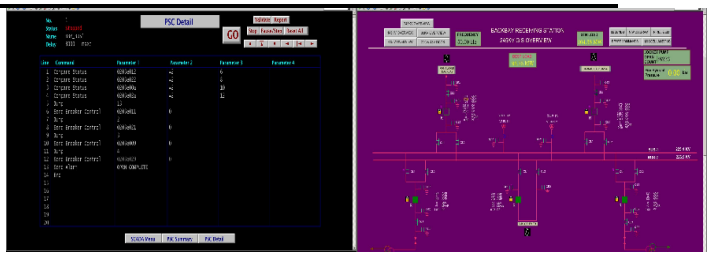
2. Implementations in SCADA – Online step by step procedure in flow chart format with live status indications of all buses for operator easiness.



3. WEB PI implementation – Mumbai Network (Hydro & MSETCL restoration) live network status availability on web for internal & external customer

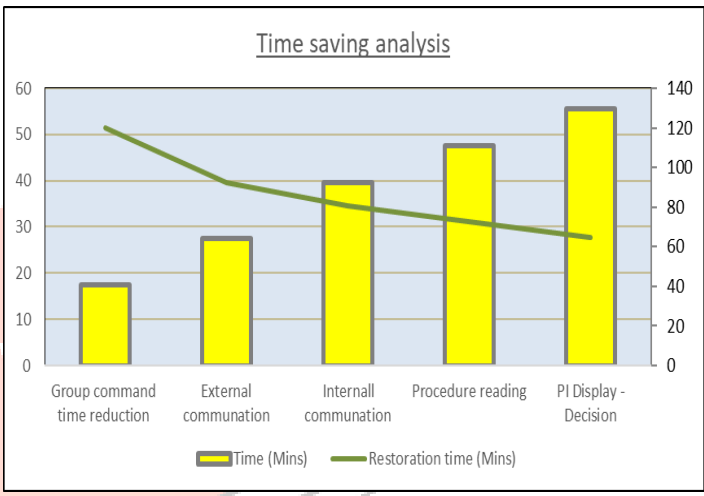


4. Implementations in SCADA – Group command execution

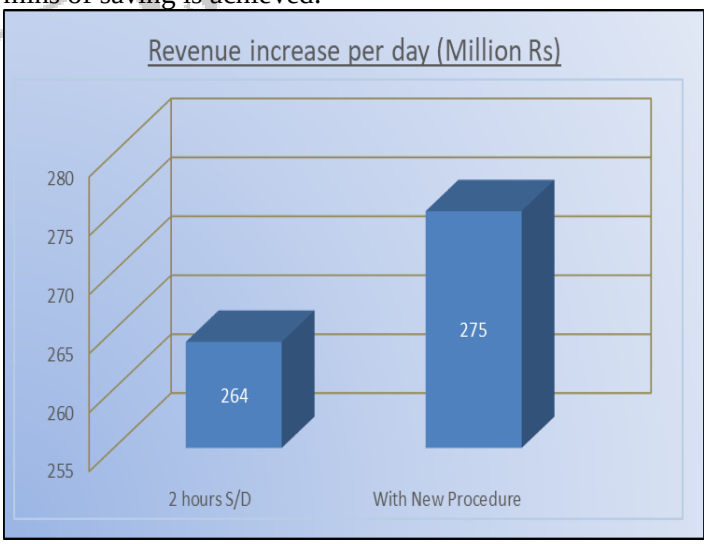


Inhouse logic & program development on SCADA for opening Groups of breakers in single click instead of individual clearing (5 Sec of each breaker operation reduced for @ 210 breakers 83 lines & 22 Interconnecting transformers)
variation:

5. KEY ACHIEVEMENTS:



- Planned activities are executed by TEAM members. In Trial Implementation, we carried out mockdrills and applied actual time saving solutions. Total 56 mins of saving is achieved.



110 Lacs of revenue saving from one shutdown can be achieved, assuming Avg 3000MW demand for 45 mins & 4 rs avg rate.

6. Conclusions

In tata power through experiences we have developed an efficient method of monitoring and operating procedure for carrying out successful blackstart, which has been appreciated by SLDCs & WRLDC. Finally, blackstart is a multiparty and multiagency setup which under adverse conditions should and must work in coordination across levels prioritizing system security over anything else. Such innovative approach would require combination of experience and new technologies for further improvement such as ,Restoration system (ERS), energy storage and micro grids to maintain continuous supply to essential utilities.

7. ACKNOWLEDGEMENTS

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8. TEAM MEMBERS

a. Pallikuth Devanand (Head PSCC -TPC PSCC)
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