MAHATRANSCO
Maharashtra State Electricity Transmission Co. Ltd.

Maharashtra State Load Despatch Centre
Airoli, Navi Mumbai

Procedure for Black Start at various Generating Stations in the state of Maharashtra

Contents

Chapter: 1

Black start capable generating stations in Maharashtra

Maharashtra has nine power stations with black start capability. The stations in Mumbai sub-system and Western sub-system who have demonstrated black start capability in recent past is given as under.

SN	Power Station	Capacity (MW)	Type	DG Set Capacity	Sub-System	Last Tested on
1	Bhivpuri HPS	3 x 24 +2 x 1.5 +2x12	Hydro	250 kW	Mumbai island	**20.12.20** 22.12.19 09.12.18 19.02.17
2	Khopoli HPS	3x24+2x12	Hydro	250 kVA	Mumbai-island	**27.12.20** 15.12.19 12.11.17 06.10.16 23.08.15 27.10.13
3	Bhira HPS	6 x 25	Hydro	250 kVA	Mumbai-island	**27.12.20** 24.11.19 06.10.16 15.10.13
4	All Hydro generating stations of TPCL	Bhira – 300MW (6 * 25MW & 1* 150MW) Bhivpuri – 75 MW (3*24MW, 1.5*2) Khopoli – 72 MW (3*24MW)	Hydro	250 KVA (Bhira OPH)	Mumbai-island	**05.12.21**

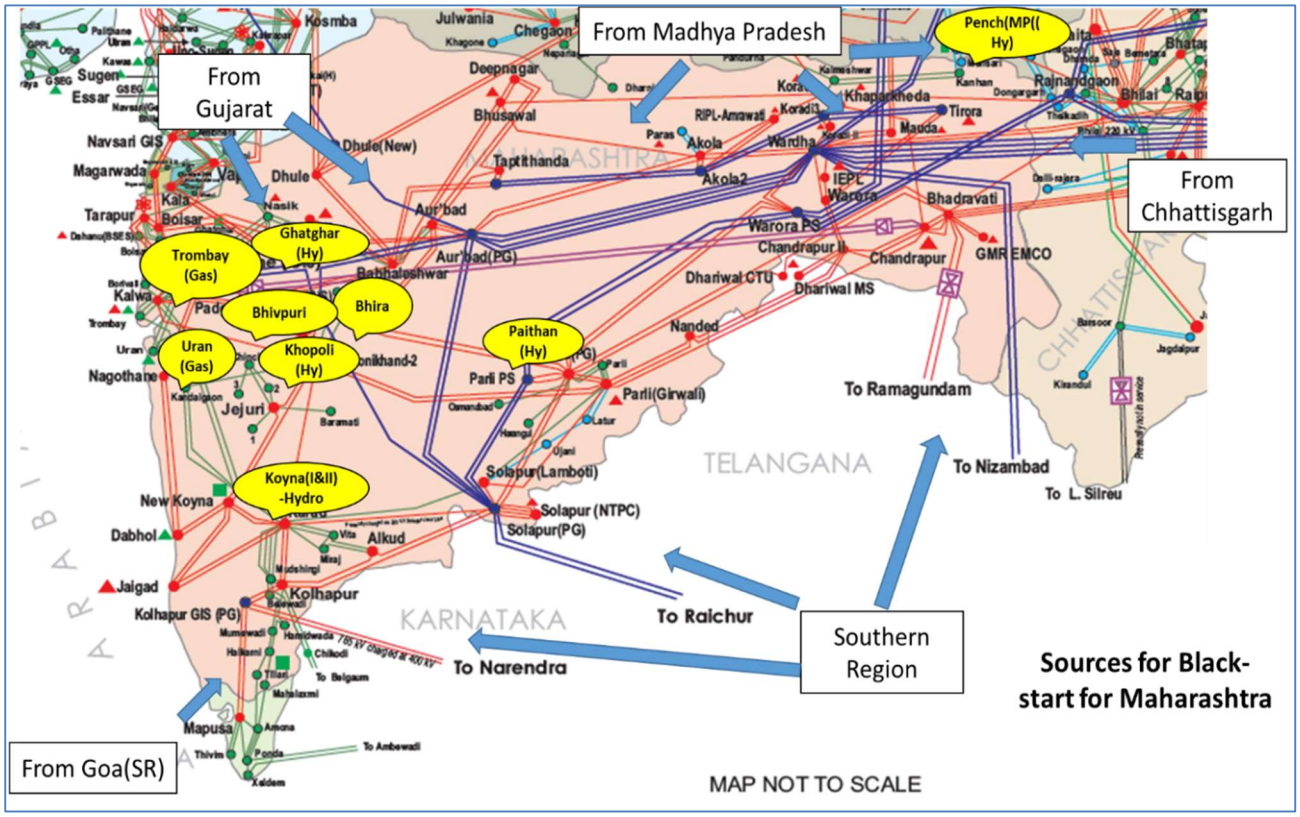
5	Uran (Gas)	4x108 (GT)+ 2x120 [Waste Heat Recovery (WHR) units]	Gas	4 MW, PH1:412kVA PH2:450kVA, WH:520kVA	West	**12.11.21** 26.12.20 28.12.19 29.12.18 29.12.15 02.12.14 16.10.12
6	Koyna I & II (Pophali) HPS	4 x 70 + 4X80	Hydro	2 MVA HG set	West	**13.12.21** 28.12.20***** 23.12.19 24.12.18 28.12.17 19.12.16 07.12.15 24.11.14 23.10.12
7	Ghatghar HPS	2x125	Hydro	2x1250 kVA	West	**25.12.20*** 08.11.19 07.09.18 04.12.15 19.12.14 05.10.12
8	Pench HPS	2x80	Hydro			**19.12.21**

*Mock drill exercise was done at Koyna, however it failed due to blast in bus coupler breaker.

* Not successful at Ghatghar, due to Unit 2 cooling water pump problem during mock drill and Unit 1 was already in running condition.

List of black start capable stations where the capability is yet to be demonstrated is given below.

SN	Power Station	Capacity (MW)	Type	DG Set Capacity	Sub-system	Issued Reported
1	Bhira PSS	1 x 150	Hydro	500 kVA	Mumbai island	As reported by TPC, minimum load required for machine is 90 MW, below which vibration issues are observed in the Penstock. Hence, Black start operation is not carried out on this Unit.



Sources of Black Start in Maharashtra

Chapter: 2

Procedure for Mock Trial of Black Start Operation

In accordance to MEGC 2020, cl. 28.2,

SLDC, in coordination with OCC, shall develop, document, and maintain detailed operating procedures for managing the InSTS. These operating procedures shall include the following:
a) Black start procedures

In compliance to above, procedure for mock trial of black start operation is prepared in consultation with the generating companies and WRLDC and has been circulated to the concerned.

2a. PROCEDURE FOR MOCK-TRIAL OF BLACK-START OPERATION OF 4 x 80 MW KOYNA STAGE-II (POPHALI) HYDRO GENERATION OF MSPGCL

Koyna is one of the biggest Hydro Generating Station of MSPGCL in the State of Maharashtra. It has four stages viz. Pophali: Stage-1 (4 x 70 MW), Stage-2 (4 x 80 MW), Pedhambe: Stage-3 (4 x 80 MW) and Stage-4 (4 x 250 MW). Black start mock trial is to be carried out for the Units at Koyna Stage-2 (Pophali).

The Pophali Plant is connected to the Grid through following lines:

- 220 kV Pophali – Kandalgaon S/C
- 220 kV Pophali – KDPH S/C
- 220 kV Pophali – Pedhambe (Stg.3) D/C
- 220 kV Pophali – Nerale (Karad) S/C
- 220 kV Pophali – New Koyna S/C

The station is having black start facility and has hydel based House Generators of capacity 2.0 MVA, for resumption of auxiliaries in case of any black out.

During Black-Start operation, the 220 kV Bus-1 of the New Koyna shall be charged through 220 kV Pophali – New Koyna S/C line and the loads in the Chiplun area shall be fed through 220/33 kV Power Transformer.

The Synchronization facility at Junction Breaker between Bus-1 & Bus-2 at Pophali is available, however, it is not been used in past. No Synchronization facility at any 220 kV lines connected to Pophali S/s is available.

The Synchronization facility at all the lines at 400/220 kV New Koyna S/s is available however it is not operational due to breaker issue.

The loading position of 220/33 kV New Koyna S/s is as follows:

There are three no. of 33 kV feeders emanating from 220 kV New Koyna Substation viz. 33 kV Chiplun-I, 33 kV Chiplun-III fed from 220/33kV, 25MVA, TF-I and 33 kV Shirgaon fed from 220/33kV, 25MVA, TF-II.

The average load during the black-start operation period (10:00 hrs to 13:00 hrs) at Neral S/s. is 5.97 MW.

Feeder-wise average demand is tabulated below:

220/33kV, 25MVA, TF-I :

Sr. No.	Name of Feeder	Average Load (MW)
1	33kV Chiplun - I	3.25
2	33kV Chiplun - III	1.22
Total		**4.47**

Further load can be increased on these feeders upto 10MW from MSEDCL end as per MSEDCL authorities.

220/33kV, 25MVA, TF-II :

Sr. No.	Name of Feeder	Average Load (MW)
1	33kV Shirgaon	1.5

- **Preparation for mock-drill for Black-start operation at various Sub-Stations:**

  MSPGCL & MSETCL: MSPGCL & MSETCL shall take appropriate steps of Black Start exercise to change the protection settings of generator / feeder / transformers at respective control area.

- The preparation shall be as under:
  - **At 400/220/33 kV New Koyna S/s:**
    - Keep all 33 kV feeders connected to TF-1 in service and on Bus-1.
    - Shift 400/220 kV ICT-2 and 220 kV New Koyna - Lote line on Bus-2.
    - Keep 220 kV Pophali – New Koyna line on Bus-1.
    - 220 kV Bus Coupler is closed.
    - All Circuit Breakers including bus coupler, recording instruments should be in healthy condition. If the SAS is not in service the readings of the parameters viz. 220kV & 33kV Bus Frequency &, Voltage, Active & Reactive Power of the Line & the power transformers shall be recorded manually at each two-minute interval or after each activity.
    - All UFR relays (if any) should be bypassed prior to the mock drill.

  - **At Pophali S/s:**
    - Keep all Units viz. Unit 5 to 8 on bar.
    - Ensure that all the 220 kV lines are in service.
    - 220 kV Bus Coupler is closed.
    - Speed Governor may be kept in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to 3% - 6%. Droop setting may be kept as low as feasible for faster primary response.
    - Over speed trip setting may be reduced so as not to let the governor go near run away speed in view of a very small sub-system.
    - Ensure that all the recording instruments are in healthy condition & if not then the readings of the parameters viz Active & Reactive Power generation and other vital parameters of the generator, 220kV Bus Frequency &,

Voltage, Active & Reactive Power flow on the Line shall be recorded manually at each two-minute interval or after each activity.

- **Step-wise Sequence of Operation of Mock-trial of Black-start operation:**
  - Ensure that all the four units i.e. Unit-5 to 8 are on bar.
  - Open 220 kV Pophali – Pedhambe-2 line from both the ends along with Unit-5.
  - Open 220 kV Pophali – Nerale line from both the ends along with Unit-6.
  - Open 220 kV Pophali – New Koyna line from both the ends along with Unit-7 & 8.
  - Open 220 kV Bus Coupler and separate Bus-1 & Bus-2 at Pophali S/s.
  - Hand-Trip 220/33 kV TF-2 at New Koyna S/s from HV & LV side along with all 33 kV feeders.
  - Open 220 kV Bus Coupler at New Koyna S/s. This shall create total de-energization of 220 kV Bus – 2 at 220 kV Pophali & Bus-1 at 400/220 kV New Koyna S/s.

  - **Initiation of Black-Start Operation:**
    - Start the In-House Generator of capacity 2 MVA and charge the auxiliary of Unit – 8.
    - Start Unit -8 in black start mode and charge 220 KV Dead Bus-2 at Pophali.
    - By maintaining the frequency in the range of 49.5 to 49.8 Hz, charge the 220 kV Pophali – New Koyna line from Pophali end.
    - Charge 220 kV Bus-1 of New Koyna S/s by closing the breaker of 220 kV Pophali – New Koyna line.
    - Charge 220/33 kV TF-1 and charge 33 kV Bus.
    - Ensure from the Discom officials that no back feeding is provided to any of the 33 kV feeders.
    - Charge 33 kV Feeders in the following sequence.
      1. 33kV Chiplun – III
      2. 33kV Shirgaon
      3. 33kV Chiplun - I
    - The generation on U-8 shall be adjusted equal to the loading at New Koyna S/s so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area.
    - The island formed shall run for at least 15 – 20 minutes at stabilized frequency and Voltage.
    - After mitigating complete loads at New Koyna S/s, operate the Unit-8 at Unity Power factor and monitor & record the System parameters.
    - Now, operate the Unit-8 at under-excitation mode with gradual change in the excitation and monitor & record the system parameters and alarms, if any.
    - With under-excitation of the Unit-8, charge the 220 kV Pophali – Pedhambe line No.2 from Pophali end and record the voltages at Pophali end.

  - **Restoration to Normalcy:**
    - Hand-trip all the 33 kV feeders connected to 220/33 kV TF-1 at New Koyna S/s.

- Hand-trip 220 kV Pophali – New Koyna line from New Koyna end and then from Pophali end.
- Close the 220 kV Bus Coupler at New Koyna S/s and restore the 33 kV feeders and shift 220 kV New Koyna – Lote line and ICT-2 on Bus-1.
- Trip Unit-8 and close 220 kV Bus Coupler at 220 kV Pophali S/s.
- Close breakers of 220 kV Pophali-Nerale, 220 kV Pophali-Pedhambe-2 & 220 kV Pophali-New Koyna lines.

➢ All the above operations shall be carried out with the instructions of the MSLDC Control room.

➢ The data with two-minute resolution at Pophali, New Koyna S/s. to be collected during black-start operation shall be as follows:
  - Active & Reactive Power, Bus Voltages, Frequency, Generator Excitation Voltage.
  - All the recorded data shall be submitted to MSLDC in soft form on the next day of trial operation of Black-start.

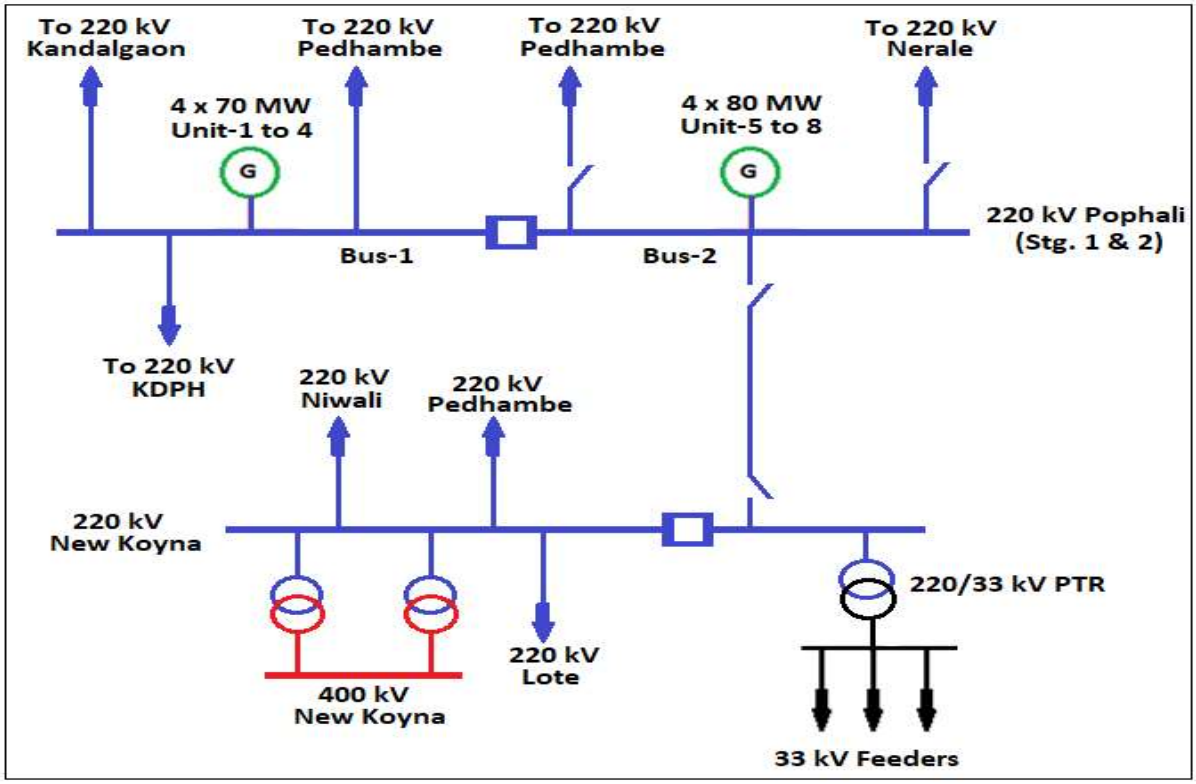
Sequence of Operations

Sr. No.	Activity	Responsibility	Time
1	Ensuring availability of 4 x 80 MW units at Pophali Stage-2 on bar along with all 220 kV lines and Bus Coupler in service.	MSPGCL	
2	Keeping Speed Governor in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to 3% - 6%. Droop setting to be kept as low as feasible for faster primary response. Over speed trip setting may be reduced so as not to let the governor go near run away speed in view of a very small sub-system.	MSPGCL	
3	Bypassing of UFR if any at New Koyna S/s and non availability of back feeding to 33 kV feeders.	MSETCL	
4	• Open 220 kV Pophali – Pedhambe-2 line from both the ends along with Unit-5. • Open 220 kV Pophali – Nerale line from both the ends along with Unit-6. • Open 220 kV Pophali – New Koyna line from both the ends along with Unit-7 & 8. • Open 220 kV Bus Coupler and separate Bus-1 & Bus-2 at Pophali S/s.	MSPGCL	
5	• Hand-Trip 220/33 kV TF-2 at New Koyna S/s from HV & LV	MSETCL	

	side along with all 33 kV feeders. • Open 220 kV Bus Coupler at New Koyna S/s. This shall create total de-energization of 220 kV Bus – 2 at 220 kV Pophali & Bus-1 at 400/220 kV New Koyna S/s.		
6	• Start the In-House Generator of capacity 2 MVA and charge the auxiliary of Unit – 8.	MSPGCL	
7	• Start Unit -8 in black start mode and charge 220 KV Dead Bus-2 at Pophali. • By maintaining the frequency in the range of 49.5 to 49.8 Hz, charge the 220 kV Pophali – New Koyna line from Pophali end.	MSPGCL	
8	• Charge 220 kV Bus-1 of New Koyna S/s by closing the breaker of 220 kV Pophali – New Koyna line. • Charge 220/33 kV TF-2 and charge 33 kV Bus. • Ensure from the Discom officials that no back feeding is provided to any of the 33 kV feeders. • Charge 33 kV Feeders sequentially.	MSETCL	
9	• The generation on U-8 shall be adjusted equal to the loading at New Koyna S/s so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area. • The island formed shall run for at least 15 – 20 minutes at stabilized frequency and Voltage.	MSPGCL	
10	• Operate the Unit-8 at under-excitation mode with gradual change in the excitation and monitor & record the system parameters and alarms, if any.	MSPGCL	
11	• With under-excitation of the Unit-8, charge the 220 kV Pophali – Pedhambe line from Pophali end and record the voltages at Pophali end.	MSPGCL & MSETCL	
12	• Hand-trip all the 33 kV feeders connected to 220/33 kV TF-1 at New Koyna S/s.	MSPGCL & MSETCL	

	• Hand-trip 220 kV Pophali – New Koyna line from New Koyna end and then from Pophali end. • Close the 220 kV Bus Coupler at New Koyna S/s and restore the 33 kV feeders and shift 220 kV New Koyna – Lote line and ICT-2 on Bus-1. • Trip Unit-8 and close 220 kV Bus Coupler at 220 kV Pophali S/s. • Close breakers of 220 kV Pophali-Nerale, 220 kV Pophali-Pedhambe-2 & 220 kV Pophali-New Koyna lines.		

Black Start Mock-Trial at 220 kV Koyna Stage-2 (Pophali)



CONTACT NUMBERS FOR THE CONCERNED PERSONS / CONTROL ROOMS

MSLDC				
SR NO	NAME	DESIGNATION	CELL NUMBER	LANDLINE
1	Mr Mahesh Bhagwat	SE- SLDC	9920499062	
2	Mr Madhav Pande	EE- SLDC	9833608212	
3	Control Room		9619892010	022 27601765
MSPGCL - Pophali				
1	Mr. Mule	Ex. Engineer	94222593537	8408886912
3	Control Room	02355235311	84088880569	02355 235005
MSETCL – New Koyna				
1	Mr. Patil Sandip	AEE (I/C EE)	9404330544	
2	Control Room	8411001892	02355 206542	7767012844
MSPGCL – Koyna Stage - III				
1	Mr. Shinde	Ex. Engineer	9421115498	
2	Control Room	8408886898	8408886891	02355 230093

2b. PROCEDURE FOR MOCK-TRIAL OF BLACK-START OPERATION OF 2 x 125MW GHATGHAR PUMPED STORAGE HYDRO GENERATION OF MSPGCL

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2 X 125 MW Ghatghar Pumped Storage Hydro generating plant is located in Thane district of Maharashtra. The power station is located between the upper and lower reservoirs. During peak electricity demand hours, water from the upper reservoir is used for generating electricity through 2 x 125 MW reversible Francis turbine-generators. When the demand is low, viz. night hours, the turbines reverse direction and pump water from the lower reservoir back to the upper one.

The said generating plant has Black Start facility. The station is having black start facility and has 2 x 1.25 MVA DG set for resumption of auxiliaries in case of any black out.

The Ghatghar Plant is connected to the Grid through following lines:

- 220 kV Ghatghar – Bapgaon – Kalwa
- 220 kV Ghatghar - Jindal – Padghe
- 220 kV Ghatghar - Washala – Raymond – Nashik (OCR)
- 220 kV Ghatghar – Nashik (GCR)

Type of load:

The load at 220kV Bapgaon S/s is predominantly industrial (Looms) & residential load with small amount of commercial load.

At 220kV Washala S/s feeds a critical load of BPCL pumping S/s and hence cannot be interrupted.

220kV Jindal S/s is an EHV Consumer having a steel rolling plant and hence is a process industry.

220kV Nashik (GCR) S/s which is directly connected to the Ghatghar generating station through a 96 km line consist of 3 x 210 MW Thermal generators connected to it's bus. This Sub-Station also feeds the Urban/Rural, Industrial & Residential load of Nashik city & adjoining areas. Presently one no of 210MW units viz Unit-4 is in service. However, in absence of arrangement of complete sectionalisation of STN TRF-IV & 220 kV Ghatghar – Nashik (GCR) line as the Unit-4 being in service it is not feasible to carry out the trial of charging generator auxiliaries in isolation through the line.

The mock trial of Black start operation shall be carried out as per following steps:

- Formation of Ghatghar-Bapgaon island & supply of complete load of Bapgaon S/s through Ghatghar unit.
- Disconnection of Bapgaon from Ghatghar thereby creating only Ghatghar island and black-out at Ghatghar & Bapgaon.
- Black starts operation of Ghatghar units and supply load of Bapgaon S/s.
- Extending supply upto Kalwa end (Keeping the Kalwa end CB open) through 220 kV Bapgaon-Kalwa line.

The loading position of 220 kV Bapgaon S/s. is as follows:

There are 12 Nos. of 22 kV feeders emanating from 220/22kV, 50MVA, TF-1 and TF-2. The feeder-wise average load during the black-start operation period (10:00 hrs to 13:00 hrs) at Bapgaon S/s. is 39.99 MW.

Feeder-wise average demand connected to **TF – 1** is tabulated below:

Sr. No.	Name of Feeder	Average Load (MW)
1	22 KV Gauripada	0.37
2	22 KV New Taloli	1.08
3	22 KV Godrej Hill	2.00
4	22 KV Durgadi	3.75
5	22kV Renaissance	5.37
6	22 kV New Rajlaxmi	7.39
Total		**19.96**

Feeder-wise average demand connected to **TF – 2** is tabulated below:

Sr. No.	Name of Feeder	Average Load (MW)
1	22 KV Tejashree	3.39
2	22 KV Umbarde	0.89
3	22 KV Sport Complex	1.94
4	22 KV Rounak No. 1	1.49
5	22kV Rounak No. 2	2.93
6	22 kV Sonale	9.38
Total		**20.03**

- Preparation for mock-drill for Black-start operation at various Sub-Stations:
  - MSPGCL & MSETCL shall take appropriate steps of Black Start exercise to change the protection settings of generator / feeder / transformers and at respective control area (Ghatghar, Bapgaon).
  - MSETCL shall ensure correct Tap position at Bapgaon S/s in view of the slightly higher Voltage condition in the island and Friday being a staggering day.
  - All the relays in the Black start path should be GPS time synchronized; if GPS is not available the time should be set manually so as to get DRs with correct time stamping in an event of a tripping during the black start mock drill exercise.
  - All the UFR relays at Bapgaon S/s (If any) should be bypassed prior to the initiation of mock drill and to be restored after the exercise.

- The preparation shall be as under:
  - **At 220 kV Bapgaon S/s:**
    - S/s in-charge should co-ordinate with the local discom authorities.
    - It is to be ensured that all the 22 kV feeder radial, i.e. there should not be any back feed supply to the feeder after the switching off of feeder from Bapgaon S/s.
    - 22kV Bus couplers connection to other EHV transformer LV side is open.
    - All Circuit Breakers including bus coupler, recording instruments should be in healthy condition. If the SAS is not in service the readings of the

parameters viz. 220kV & 22kV Bus Frequency &, Voltage, Active & Reactive Power of the Line & the power transformers shall be recorded manually at each two-minute interval or after each activity.

- 220kV Bapgaon-Ghatghar & Bapgaon-Kalwa line shall be in service.
- All UFR relays (if any) should be bypassed prior to the mock drill.

o At Ghatghar S/s:

- Unit-1 (125 MW) shall be in healthy condition and in service.
- DG Set (125MVA) both should be in healthy condition and ready to take in service.
- Speed Governor shall be kept on FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to minimum of 1% - 5%. Droop setting may be kept as low as feasible for faster primary response.
- Over speed trip setting may be reduced so as not to let the governor near run away speed in view of a very small sub-system.
- 220kV Ghatghar-Bapgaon, 220kV Ghatghar-Washala, 220kV Ghatghar-Jindal-Padghe, 220kV Ghatghar-Nashik (GCR) lines shall be in service.
- 220kV Bus Coupler in healthy condition and closed.
- Ensure that all the recording instruments are in healthy condition & if not then the readings of the parameters viz Active & Reactive Power generation and other vital parameters of the generator, 220kV Bus Frequency &, Voltage, Active & Reactive Power flow on the Line shall be recorded manually at each two-minute interval or after each activity.

➢ Step-wise Sequence of Operation of Mock-trial of Black-start operation:

- Ensure that the U-1 is in service and running in generation mode.
- Shift Nasik, Jindal & Washala feeders on Bus 2 & will be connected through Unit 2.
- Open the 220kV Bus Coupler at 220kV Bapgaon S/s. This will isolate the TF-1 & 220kV Ghatghar line from TF-2 & 220kV Kalwa line. Thus, the loads on TF-1 shall be fed from Ghatghar end whereas the loads on TF-2 shall be fed from Kalwa end.
- Open the 220kV Bus Coupler at 220kV Ghatghar S/s. Thereby creating a sub-system having Nasik (GCR), Ghatghar & Bapgaon section.
- Now monitor the load on the 220kV Ghatghar-Nashik (GCR) line and manage the generation of U-1 so as to make Ghatghar – Nashik line floating (minimum MW).
- Open the Circuit Breaker of the 220kV Nashik line at Ghatghar S/s thereby creating a Ghatghar-Bapgaon island. Now, the loads on TF-1 at Bapgaon S/s are fed through Ghatghar U-1.
- At this instance two different frequencies are observed at both the bus sections at Ghatghar S/s. At Bus section-1, the island frequency while at Bus section-2, the grid frequency.
- Now open all the 22kV feeders connected to 220/22kV, TF-1 at Bapgaon S/s and then open CB of 220kV Bapgaon-Ghatghar line from both ends. This shall create total black-out in one section of Bapgaon S/s.
- Trip U-1 at Ghatghar S/s so as to create black out condition.

o Initiation of Black-Start Operation:

A) Operations at Ghatghar S/s

- Start the DG set connected to common 220kV bus of U-1.
- Charge the 220kV dead Bus of the Ghatghar S/s.
- Extend auxiliary supply to provide excitation to the U-1.
- Take U-1(125MVA) on bar.
- Maintain the voltage at Ghatghar 220kV bus section -1 in the range of 200-205kV.
- Charge 220kV Ghatghar - Bapgaon line from Ghatghar end.
- Confirm the excitation of U-1 at 90 % and maintain the frequency in the range of 49.5 Hz to 49.8 Hz.

B) Operations at Bapgaon S/s

- Confirm that 220kV Ghatghar line is open & 220kV Bus-coupler CB is open.
- Confirm that CBs of all the 22kV feeders connected to 220/22kV, TF-1 and the HV & LV side of TF-1 are open.
- Close the CB of the 220 kV Ghatghar - Bapgaon line and charge 220kV dead bus section.
- Charge 220/22 kV TF-1 from HV side.
- Charge 22 kV Bus by closing LV side breakers of 220/22 kV TF-1.

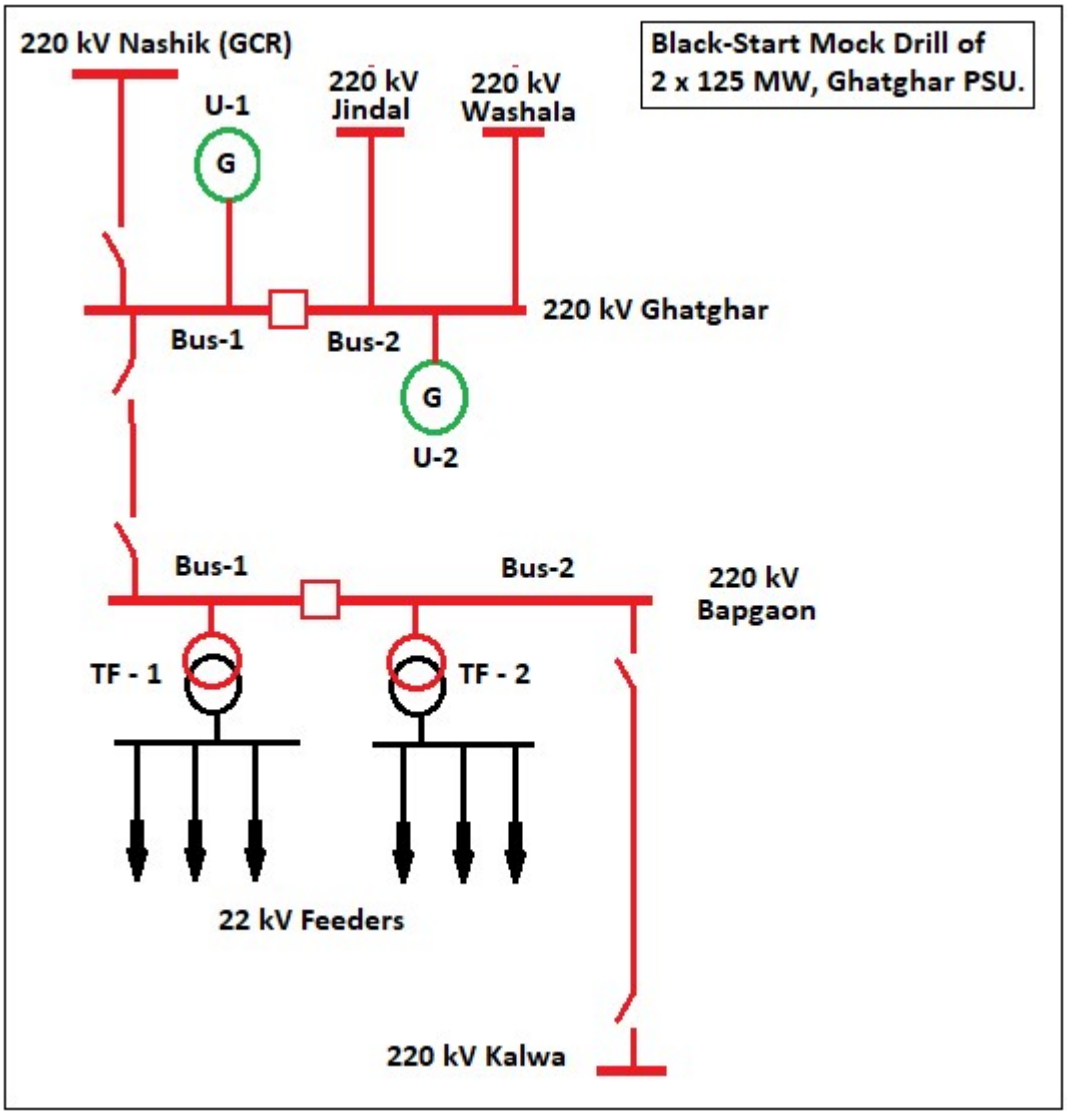
- Charge 22 kV Feeders on TF-1 at 220kV Bapgaon S/s in following sequence:
  - 22 kV Gauripada;
  - 22 kV New Taloli;
  - 22 kV Godrej Hill;
  - 22 kV Durgadi;
  - 22 kV Renaissance;
  - 22 kV New Rajlaxmi
- It should be ensured that after charging of each 22 kV feeder, frequency & Voltage should be maintained by adjusting Ghatghar U-1.
- While charging 22 kV feeders, radial load shall be ensured by concerned distribution authorities and the granularity of the step wise maintained is not more than 1 MW.
- The generation on U-1 shall be adjusted equal to the loading at Ghatghar S/s so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area.
- With above procedure, Ghatghar & Bapgaon S/s. are forming island and are not connected with the Grid.
- The island formed shall run for at least 15 – 20 minutes at stabilized frequency in the range of 49.5 Hz to 49.8 Hz.

- Extending supply to 220 kV Kalwa S/s end:
  - Ensure that 220 kV Bus Coupler at 220 kV Bapgaon end is open.
  - Hand-trip all 22 kV feeders connected to TF-2. Ensure from Discom authorities that no back feeding is provided to these 22 kV feeders.
  - Hand trip LV CB of TF-2.
  - Hand-trip 220/22 kV TF-2 from HV side and then open 220 kV Bapgaon-Kalwa line from Bapgaon end.
  - Open CB of 220 kV Bapgaon – Kalwa line from Kalwa end.
  - Now, close the 220 kV Bus coupler at Bapgaon S/s.
  - Charge 220/22 kV TF-2 from HV side.

- Charge 22 kV Bus by closing LV side breakers of 220/22 kV TF-2.
- Charge 22 kV Feeders on TF-2 at 220kV Bapgaon S/s in following sequence:
  - 22 kV Tejashree;
  - 22 kV Umbarde;
  - 22 kV Sport Complex;
  - 22 kV Rounak No. 1;
  - 22 kV Rounak No. 2;
  - 22 kV Sonale.
- Maintain the frequency in the range of 49.5 to 49.8 Hz. Ensure that the breakers of 220 kV Bapgaon – Kalwa line are open at Kalwa end.
- Charge the 220 kV Bapgaon – Kalwa line from Bapgaon end.
- Monitor the Bus voltages at Ghatghar & Bapgaon S/s.
- This island formed (along with extension upto Kalwa end) shall run for at least 15 – 20 minutes at stabilized frequency in the range of 49.5 Hz to 49.8 Hz and Bus voltages within limit.

- Normalization of the System:
  - Open the breakers of 220 kV Bapgaon – Kalwa line from Bapgaon end.
  - Switch off all the feeders connected to 220/22kV TF-2 & LV & HV CB of TF-2.
  - Open the 220 kV Bus coupler at Bapgaon S/s.
  - Close the breakers of 220 kV Bapgaon – Kalwa line from Bapgaon end and charge the 220/22 kV TF-2 at Bapgaon and charge the 22 kV feeders connected to it.
  - Now switch off all the 22kV feeders connected to 220/22kV, TF-1 at Bapgaon S/s and then open CB of 220kV Bapgaon-Ghatghar line from both ends.
  - Trip the Ghatghar U-1.
  - Charge the 220 kV bus at Ghatghar by closing the breakers of 220 kV Nashik (GCR) – Ghatghar line at Ghatghar end.
  - Close the 220 kV Bus coupler at Ghatghar S/s.
  - Normalise station auxiliary condition by taking STs in service at Ghatghar S/s.
  - Charge the 220 kV Ghatghar – Bapgaon line from Ghatghar and then from Bapgaon end.
  - Close 220 kV Bus coupler at Bapgaon S/s. thereby interconnecting Kalwa with Ghatghar S/s.
  - Charge 22 kV feeders connected to 220/22 kV TF-1 after charging TF-1.

- All the above operations shall be carried out with the instructions of the MSLDC Control room.
- The data with 2-minute resolution at Ghatghar, Bapgaon, Kalwa S/s to be collected during black-start operation shall be as follows:
  - Active & Reactive Power, Bus Voltages, Frequency, Generator Excitation Voltage.
  - All the recorded data shall be submitted to MSLDC in soft form on the next day of trial operation of Black-start.
  - The data is to be recorded for every 2 minute and/or after every step of the mock trial of black-start operation.



Sequence of Operations

Sr. No.	Activity	Responsibility	Time
Creation of Island:			
1	Ensuring availability of 1 x 125 MW Unit-1 at Ghatghar along with all 220 kV lines in service	MSETCL, MSLDC	11:00
2	Ensuring availability of all 220 kV lines and TF in service at Bapgaon S/s. Bypassing of all the UFR relays at Bapgaon S/s.	MSETCL, MSLDC	11:00
3	Keeping Speed Governor in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to 3% - 6%. Droop setting to be kept as low as feasible for faster primary response.	MSPGCL	11:00

	Over speed trip setting may be reduced so as not to let the governor go near run-away speed in view of a very small sub-system.		
4	Open 220 KV Bus Couplers at Bapgaon S/s and Ghatghar S/s.	MSETCL, MSPGCL	11:10
5	Open the Circuit Breaker of the 220kV Nashik line at Ghatghar S/s thereby creating a Ghatghar-Bapgaon island	MSETCL, MSPGCL	11:15
6	Open all the 22kV feeders connected to 220/22kV, TF-1 at Bapgaon S/s and then open CB of 220kV Bapgaon-Ghatghar line from both ends.	MSETCL, MSPGCL	11:20
7	Trip U-1 at Ghatghar S/s so as to create black out condition	MSETCL, MSPGCL	11:20
Initiation of Black Start Operation:			
8	• Start the DG set connected to common 220kV bus of U-1. • Charge the 220kV dead Bus of the Ghatghar S/s. • Extend auxiliary supply to provide excitation to the U-1. • Take U-1(125MVA) on bar.	MSPGCL	11:40
9	• Confirm the excitation of U-1 at 90 % and maintain the frequency in the range of 49.5 Hz to 49.8 Hz. • Charge 220kV Ghatghar - Bapgaon line from Ghatghar end.	MSETCL, MSPGCL	11:45
10	• Confirm that 220kV Ghatghar line is open & 220kV Bus-coupler CB is open. • Confirm that CBs of all the 22kV feeders connected to 220/22kV, TF-1 and the HV & LV side of TF-1 are open. • Close the CB of the 220 kV Ghatghar - Bapgaon line and charge 220kV dead bus section. • Charge 220/22 kV TF-1 from HV side. • Charge 22 kV Bus by closing LV side breakers of 220/22 kV TF-1.	MSETCL	11:50
11	Charge 22 kV Feeders at 220kV Bapgaon S/s connected to TF-1 sequentially and feed load through Ghatghar Unit for the period of 15-20 min. with stabilized frequency and voltages.	MSETCL	11:50 – 12:05

Extending Supply to Kalwa S/s:			
12	• Ensure that 220 kV Bus Coupler at 220 kV Bapgaon end is open. • Hand-trip 220/22 kV TF-2 from HV side. • Hand-trip all the 22 kV feeders connected to TF – 2 and ensure no back feeding to these feeders from Discom. • Open 220 kV Bapgaon-Kalwa line from Bapgaon end.	MSETCL	12:15
13	• Open CB of 220 kV Bapgaon – Kalwa line from Kalwa end. • Now, close the 220 kV Bus coupler at Bapgaon S/s and charge 220 kV Bus section. • Charge 220/22 kV TF – 2 and 22 kV bus.	MSETCL, MSPGCL	12:25
14	• Maintain the frequency in the range of 49.5 to 49.8 Hz and charge 22 kV feeders connected to TF-2 sequentially. • After charging all the feeders, charge the 220 kV Bapgaon – Kalwa line from Bapgaon end. Ensure that breakers at Kalwa end shall be open. • Record the voltage at Kalwa end. Ensure that the breakers of 220 kV Bapgaon – Kalwa line are not closed from Kalwa end.	MSETCL, MSPGCL	12:35
15	• Feed total load on TF-1 & TF-2 at Bapgaon S/s through Ghatghar U-1 under stabilized frequency and voltages by adjusting generation. Record all the required system parameters.	MSETCL, MSPGCL	12:35 to 12:45
Restoration to Normalcy:			
16	• Open the breakers of 220 kV Bapgaon – Kalwa line from Bapgaon end. • Open the 220 kV Bus coupler at Bapgaon S/s. • Close the breakers of 220 kV Bapgaon – Kalwa line from Bapgaon end and then from Kalwa end and charge the 220/22 kV TF-2 at Bapgaon and charge the 22 kV feeders connected to it.	MSETCL, MSPGCL	12:55

	• Now open all the 22kV feeders connected to 220/22kV, TF-1 at Bapgaon S/s and then open CB of 220kV Bapgaon-Ghatghar line from both ends.		
17	• Trip the Ghatghar U-1 and shutdown DG sets. • Charge the 220 kV bus at Ghatghar by closing the breakers of 220 kV Nashik (GCR) – Ghatghar line at Ghatghar end. • Close the 220 kV Bus coupler at Ghatghar S/s. • Normalise station auxiliary condition by taking STs in service at Ghatghar S/s.	MSETCL, MSPGCL	13:05
18	• Charge the 220 kV Ghatghar – Bapgaon line from Ghatghar and then from Bapgaon end. • Close 220 kV Bus coupler at Bapgaon S/s. thereby interconnecting Kalwa with Ghatghar S/s. • Charge 22 kV feeders connected to 220/22 kV TF-1 after charging TF-1.	MSETCL, MSPGCL	13:15

Reading format (Bapgaon/Ghatghar as applicable)

Following readings to be taken with 2 min. Resolution:

Time	220kV Line		Gen Unit		Power Transformer				220 & 22kV Bus	
	MW	MVAR	MW	MVAR	TF1 MW	TF1 MVAR	TF2 MW	TF2 MVAR	Voltage (kV)	Freq(Hz)

CONTACT NUMBERS FOR THE CONCERNED PERSONS / CONTROL ROOMS

MSLDC				
SR NO	NAME	DESIGNATION	CELL NUMBER	LANDLINE
1	Mr Mahesh Bhagwat	SE- SLDC	9920499062	
2	Mr Madhav Pande	EE- SLDC	9833608212	
3	Control Room		9619892010	27601765
MSETCL - BAPGAON				
1	Mr.Ashwajit Gaikwad	AEE	9619136346	
2	Control room		9619347195	
MSPGCL - GHATGHAR				
1	Mr. Madavi	Station Head	8108446652	
2	Mr. Pankaj Kashiv	AEE	8411968792	
3	Control Room		7620033238	798810641

2c. PROCEDURE FOR MOCK-TRIAL OF BLACK-START OPERATION OF 4 x 108 MW & 2 x 120 MW URAN GAS GENERATION OF MSPGCL

The 4 X 108 MW (Unit-GT 5 to 8) & 2 X 120 MW (Unit – A0 & B0) Uran Gas generating plant is located in Raigad district of Maharashtra. The fuel used for generation of the power is Natural Gas. The said generating plant has Black Start facility. The station is having black start facility and has 1 x 4.0MW DG set for resumption of auxiliaries in case of any black out.

The Uran Plant is connected to the Grid through following lines:

- 220 kV Uran – Apta Ckt. 1 to 4 (29kM)
- 220 kV Uran – Kharghar Ckt. 1 to 2 (22kM)
- 220 kV Uran – ONGC (Uran) (6.6kM)
- 220 kV Uran – JNPT (7kM)

Type of load:

The load at 220kV Uran S/s mostly residential load with small amount of industrial and commercial load.

At 220kV Apta S/s feeds RCF and industrial load which cannot be interrupted.

400kV Kharghar S/s is an EHV Receiving station which is on of the main source for Mumbai metropolitan city through 220kV Network. Hence it is not feasible to separate out 220kV Bus for black start mock drill.

In view of the above black start operation is decided to be carried out at 220kV Uran Substation with available load.

The mock trial of Black start operation shall be carried out as per following steps:

- Formation of island with GT-6 (108MW) unit and load on 220/22kV, 50 MVA, TF-1 & Station Transformer-1.
- Disconnection of load from TF-1 and taking out GT-6 thereby creating total black out condition.
- Black start operation of GT-6 unit and supply load of TF-1 of the Uran Substation.
- Synchronization will be done at Uran end through 220 kV Uran-Apta Ckt-4 line.

The loading position of 220 kV Uran S/s. is as follows:

There are 4 Nos. of 22 kV feeders emanating from 220/22kV, 50MVA, TF-1. The feeder-wise average load during the black-start operation period (10:00 hrs to 13:00 hrs) at Uran S/s is 14.22 MW.

Feeder-wise average demand connected to TF – 1 is tabulated below:

Sr. No.	Name of Feeder	Average Load (MW)
1	22KV ONGC-2	1.34
2	22KV JNPT	2.96
3	22KV KOTNAKA	4.28
4	22KV Uran	5.64
Total		14.22

- Preparation for mock-drill for Black-start operation at various Sub-Stations:
  - MSPGCL & MSETCL shall take appropriate steps of Black Start exercise to change the protection settings of generator / feeder / transformers and at respective control area (Uran, Apta).
  - All the relays in the Black start path should be GPS time synchronized; if GPS is not available the time should be set manually so as to get DRs with correct time stamping in an event of a tripping during the black start mock drill exercise.
  - All the UFR relays at Uran S/s (If any) should be bypassed prior to the initiation of mock drill and to be restored after the exercise.

The preparation shall be as under:

At 220 kV Uran S/s: MSETCL end;

S/s in-charge should co-ordinate with the local discom authorities.

It is to be ensured that all the 22 kV feeder radial, i.e. there should not be any back feed supply to the feeder after the switching off of feeder from Uran S/s.

22kV Bus couplers connection to other EHV transformer LV side is open.

220kV Bus Coupler in healthy condition and closed.

Shift all the 220 kV lines from Bus-1 on Bus-2 except 220 kV Uran – Apta Ckt.-4 line, 220/22 kV TF-1 & Station Transformer-1 (ST-1).

All Circuit Breakers including bus coupler, recording instruments should be in healthy condition. If the SAS is not in service the readings of the parameters viz. 220kV & 22kV Bus Frequency &, Voltage, Active & Reactive Power of the Line & the power transformers shall be recorded manually at each two-minute interval or after each activity.

All UFR relays (if any) should be bypassed prior to the mock drill.

At Uran S/s: Generation end

Unit-6 (108 MW) shall be in healthy condition and in service.

DG Set (1 x 4 MW) both should be in healthy condition and ready to take in service.

Speed Governor shall be kept on FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to minimum of 1% - 5%. Droop setting may be kept as low as feasible for faster primary response.

Over speed trip setting may be reduced so as not to let the governor near run away speed in view of a very small sub-system.

Ensure that all the recording instruments are in healthy condition & if not then the readings of the parameters viz Active & Reactive Power generation and other vital parameters of the generator, 220kV Bus Frequency &, Voltage, Active & Reactive Power flow on the Line shall be recorded manually at each two-minute interval or after each activity.

- Step-wise Sequence of Operation of Mock-trial of Black-start operation:
  - Formation of Island:
    - Ensure that the GT-6(108MW) is in service and running in generation mode. 4MW DG set is ready to start.
    - Ensure that all lines except 220kV Apta-4 line, Station Transformer-1 & 220/33 kV TF-1 in service with connected load and are shifted on 220kV Bus-2.
    - Open the 220kV Apta-4 line at 220kV Uran S/s.
    - Now adjust the generation to meet the load on the 220/22kV, TF-1 so as to bring loading on 220kV Bus coupler to minimum.
    - Open the 220kV Bus Coupler at 220kV Uran S/s thereby creating an island. Now, the loads on TF-1 at Uran S/s are fed through GT-6.
    - At this instance two different frequencies are observed at both the bus sections at Uran S/s. At Bus section-1, the island frequency while at Bus section-2, the grid frequency.
    - Now trip 220/22 kV TF-1 so as to create sudden load throw-off condition. Monitor the behaviour of GT-6 unit. The unit should run in spinning mode.
    - Now take the GT-6 out of service so as to create black out condition.

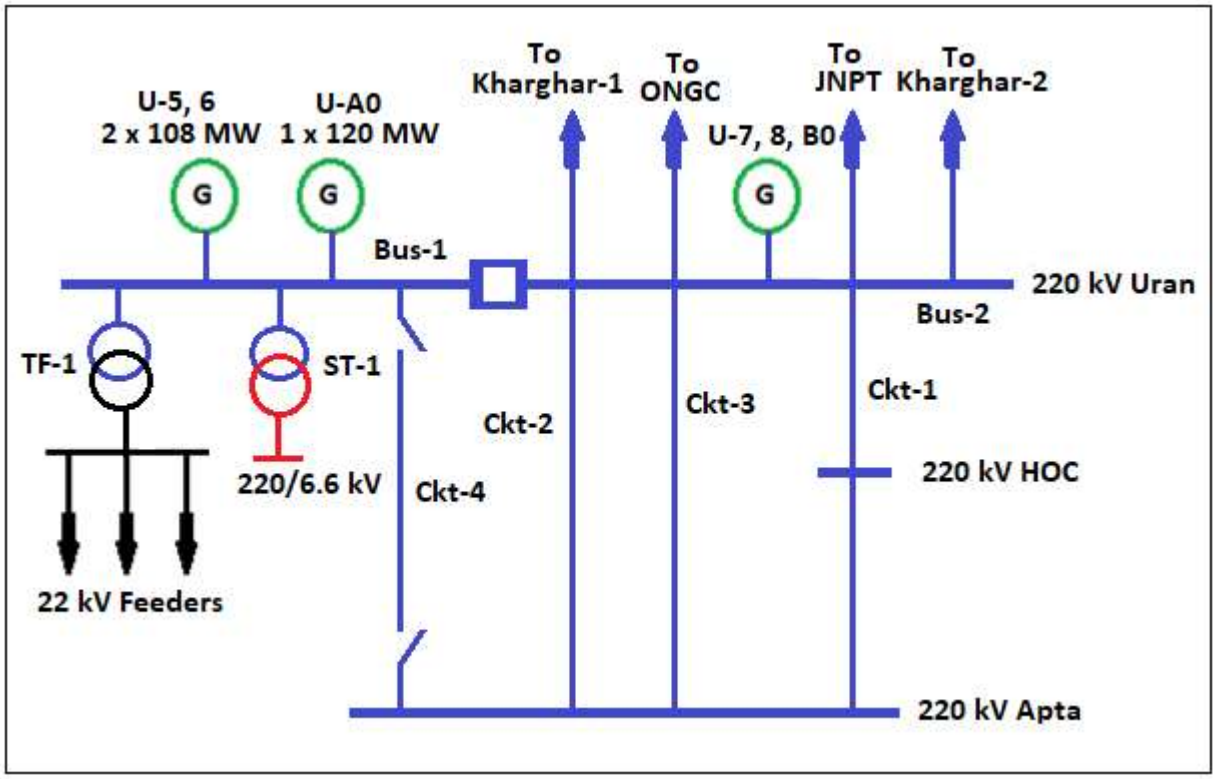
  - Initiation of Black-Start Operation:
    - With the tripping of GT-6, the DG (6.6kV, 4MW) set shall auto start.
    - Extend auxiliary supply to provide excitation to the GT-6.
    - Take GT-6 (108MW) on bar.
    - Charge the 220kV dead Bus-I of the Uran S/s
    - Confirm the excitation of U-1 at 90 % and maintain the frequency in the range of 49.5 Hz to 49.8 Hz.
    - Confirm that CBs of all the 22kV feeders connected to 220/22kV, TF-1 and the HV & LV side of TF-1 are open.
    - Charge 220/22 kV TF-1 from HV side.
    - Charge 22 kV Bus by closing LV side breakers of 220/22 kV TF-1.
    - Charge 22 kV Feeders on TF-1 at 220kV Uran S/s in following sequence:
      - 22 kV ONGC-2;
      - 22 kV JNPT;
      - 22 kV KOTNAKA;
      - 22 kV Uran

- It should be ensured that after charging of each 22 kV feeder, frequency & Voltage should be maintained by adjusting Uran GT-6.
- While charging 22 kV feeders, radial load shall be ensured by concerned distribution authorities.
- The generation on GT-6 shall be adjusted equal to the loading at Uran TF-1 so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area.
- With above procedure, Uran Generation and loads on Uran TF-1 are forming island and are not connected with the Grid.
- The island formed shall run for at least 15 – 20 minutes at stabilized frequency in the range of 49.5 Hz to 49.8 Hz.

o Synchronization with the Grid:
- Charge 220 kV Uran – Apta Ckt-4 line from Apta end.
- Monitor the line voltages at Apta and by adjusting the frequency and voltages through Uran GT-6 unit, synchronize the Uran island with the Grid through 220 kV Uran – Apta Ckt-4 line by closing the breakers at Uran end.

o Normalization of the System:
- After synchronization with the Grid, close the 220 kV Bus coupler at Uran end.
- Shift 220 kV Uran – Kharghar Ckt-1, 220 kV Uran – Apta Ckt-2, 220 kV Uran – ONGC lines from Bus-2 to Bus-1.

➢ All the above operations shall be carried out with the instructions of the MSLDC Control room.
➢ The data with two-minute resolution at Uran, Apta S/s to be collected during black-start operation shall be as follows:
  o Active & Reactive Power, Bus Voltages, Frequency, Generator Excitation Voltage.
  o All the recorded data shall be submitted to MSLDC in soft form on the next day of trial operation of Black-start.
  o The data is to be recorded for every 2 minute and/or after every step of the mock trial of black-start operation.



Sequence of Operations

Sr. No.	Activity	Responsibility	Time
Creation of Island:			
1	Ensuring availability of 1 x 108 MW Unit-GT6 at Uran along with DG Set.	MSPGCL	11:00
2	• Ensuring shifting of all the 220 kV from Bus-1 on Bus-2 except 220 kV Uran – Apta Ckt-4 line, TF-1 & ST-1. • 22kV Bus couplers connection to other EHV transformer LV side is open. • 220kV Bus Coupler in healthy condition and closed. • Bypassing of all the UFR relays at Uran S/s.	MSETCL	11:00
3	Keeping Speed Governor in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to 3% - 6%. Droop setting to be kept as low as feasible for faster primary response. Over speed trip setting may be reduced so as not to let the governor go near run-away speed in view of a very small sub-system.	MSPGCL	11:00

4	• Open the 220kV Apta-4 line at 220kV Uran end only. • Now adjust the generation to meet the load on the 220/22kV, TF-1 so as to bring loading on 220kV Bus coupler to minimum.	MSETCL, MSPGCL	11:05
5	Open the 220kV Bus Coupler at 220kV Uran S/s thereby creating an island. Now, the loads on TF-1 & ST-1 at Uran S/s are fed through GT-6.	MSETCL	11:07
6	• Hand-trip 220/22 kV TF-1 so as to create sudden load throw-off condition. Monitor the behaviour of GT-6 unit. The unit should run in spinning mode. • Now take the GT-6 out of service so as to create black out condition.	MSETCL, MSPGCL	11:10
Initiation of Black Start Operation:			
7	• With the tripping of GT-6, the DG (6.6kV, 4MW) set shall auto start. • Extend auxiliary supply to provide excitation to the GT-6. • Take GT-6 (108MW) on bar. • Charge the 220kV dead Bus-I of the Uran S/s • Confirm the excitation of U-1 at 90 % and maintain the frequency in the range of 49.5 Hz to 49.8 Hz.	MSPGCL	11:15
8	• Confirm that CBs of all the 22kV feeders connected to 220/22kV, TF-1 and the HV & LV side of TF-1 & ST-1 are open. • Charge 220/22 kV TF-1 & ST-1 from HV side. • Charge 22 kV Bus by closing LV side breakers of 220/22 kV TF-1. • Charge LV side of ST-1.	MSETCL, MSPGCL	11:20
9	Charge 22 kV Feeders on TF-1 at 220kV Uran S/s sequentially.	MSETCL	11:35
10	• The generation on GT-6 shall be adjusted equal to the loading at Uran TF-1 so as to maintain the frequency in the	MSETCL, MSPGCL	11:40

	range of 49.5 Hz to 49.8 Hz. in the islanded area. • With above procedure, Uran Generation and loads on Uran TF-1 are forming island and are not connected with the Grid.		
11	Feed total load on TF-1 at Uran S/s through Uran GT-6 under stabilized frequency and voltages by adjusting generation. Record all the required system parameters.	MSETCL, MSPGCL	11:40 to 12:00
Synchronization with the Grid:			
12	Synchronize the Uran island with the Grid through 220 kV Uran – Apta Ckt-4 line by adjusting Frequency & voltages at Uran GT-6 and closing the breakers at Uran end.	MSPGCL, MSETCL	12:10
Restoration to Normalcy:			
13	• After synchronization with the Grid, close the 220 kV Bus coupler at Uran end. • Shift 220 kV URan – Kharghar Ckt-1, 220 kV Uran – Apta Ckt-2, 220 kV Uran – ONGC lines from Bus-2 to Bus-1. • Normalise station auxiliary condition by taking STs in service at Uran S/s.	MSETCL, MSPGCL	12:15

Reading format

Following readings to be taken with 2 min. Resolution:

Time	MW	MVAR	Bus voltage	Frequency
Name of Sub-Station:				

CONTACT NUMBERS FOR THE CONCERNED PERSONS / CONTROL ROOMS

MSLDC				
SR NO	NAME	DESIGNATION	CELL NUMBER	LANDLINE
1	Mr Mahesh Bhagwat	SE- SLDC	9920499062	
2	Mr Madhav Pande	EE- SLDC	9833608212	
3	Control Room		9619892010	27601765
MSETCL - URAN				
1	Mr. Manoj Joshi	EE	9769213824	
2	Mr. Manoj Borse	AEE	9763638004	8879695319
3	Control room		9769213887	022 27222270
MSETCL-TESTING				
1	Mr. Jagtap	EE (Testing)	9930667505	
MSPGCL - URAN				
1	Mr. Nagdeote	SE (I/C CE)	9930144834	
2	Mr. Pawar	EE-MSPGCL	8879620040	
3	Mr. Nilawar	EE-MSPGCL	9167007846	
3	Control Room	8879620048	022 27222235	

2d. PROCEDURE FOR MOCK-TRIAL OF BLACK-START OPERATION OF HYDRO GENERATION 6 x 25MW AT BHIRA AND 3 x 24 MW AT KHOPOLI OF TPCL

Bhira Hydro Generating station is situated in Raigad District and has total generating capacity of 300 MW. The break-up of installed capacity at Bhira is 6 x 25 MW and 1 x 150 MW Pumped storage generations.

Khopoli Hydro Generating station is situated in Raigad District and has generating capacity of 72 MW comprising of 3 x 24 MW units.

The Grid interconnections of Bhira & Khopoli are as follows:

Bhira old power house (6 x 25 MW):

- 110 KV Bhira – Khopoli line-2
- 110 KV Bhira – Davdi

Bhira Pumped Storage Unit (BPSU) (1 x 150 MW):

- 220 KV Bhira – Karanjade line-7
- 220 KV Bhira – Karanjade line-8

KhopoliHydro Plant (3 x 24 MW):

- 110 KV Khopoli – Bhivpuri line-1
- 110 KV Khopoli – Bhivpuri line-2
- 110 KV Khopoli – Karanjade
- 110 KV Khopoli – Bhokarpada

Bhira Old Power Plant and Khopoli Power House have black start facility having1 x 250 KVA DG sets at each plant for resumption of auxiliaries in case of any black out.

During the Black start trial at Bhira&Khopoli, Bhira and Khopoli stations are connected during black start and supply will be extended to MSETCL Neral S/S through Bhivpuri 110 KV Bus-2 and radial load of MSECL Neral will be restored.

The loading position of 110 kV Neral S/s. is as follows:

There are six no. of 22 kV feeders emanating from 110 kV Feeders viz. 22 kV Kadav, 22 kV Anjap, 22 kV Neral, 22 kV Kashele, 22 kV Karjat& 22 kV Karjat Neal.

The average load during the black-start operation period (10:00 hrs to 13:00 hrs) at Neral S/s. is 15 MW.Feeder-wise average demand is tabulated below:

Sr. No.	Name of Feeder	Average Load (MW)
1	22 kV Kadav	0.71
2	22 kV Anjap	0.11
3	22 kV Neral	4.99
4	22 kV Kashele	3.86
5	22 kV Karjat	4.74
6	22 kV Karjat Neal	0.71
Total		15.12

- Preparation for mock-drill for Black-start operation at various Sub-Stations:
  - TPC & MSETCL shall take appropriate steps of Black Start exercise to change the protection settings of generator / feeder / transformers at respective control area.

- All the relays should be GPS time synchronized; if GPS is not available the time should be set manually as per GPS time.
- All the UFR relays should be bypassed prior to the initiation of mock drill.

- **The preparation shall be as under:**
  - **At 110 kV Neral S/s:**
    - Substation in-charge should co-ordinate with the local discom authorities.
    - Keep all 22 kV feeder radial, there should not be any back-feed supply.
    - 22kV Bus couplers connection to other EHV transformer LV side are open.
    - All Circuit Breakers including bus coupler, recording instruments should be in healthy condition.
    - 110 kV Bhivpuri – Neral and 110 kV Neral – Ambernath lines shall be in service.
    - All UFR relays should be bypassed prior to the mock drill.

  - **At Bhira (Old and BPSU) S/s:**
    - All the 6 x 25 MW & 1 x 150 MW BPSU Units shall be out of service.
    - DG Set (125MVA) should be in healthy condition and ready to take in service.
    - Speed Governor may be kept in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to minimum of 1% - 5%. Droop setting may be kept as low as feasible for faster primary response.
    - Over speed trip setting may be reduced so as not to let the governor go near run-away speed in view of a very small sub-system.
    - All the 220kV & 110 kV lines shall be in service.
    - 220kV Bus Coupler in healthy condition.
    - All the recording instruments (Viz. Frequency, Voltage, Active & Reactive Power) are in healthy condition, if not then for recording, the responsibility is to be given to separate person for each parameter and they are in ready condition front of meter.

  - **At Khopoli S/s:**
    - All the 3 x 24 MW Units shall be out of service.
    - DG Set (125MVA) should be in healthy condition and ready to take in service.
    - Speed Governor may be kept in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to minimum of 1% - 5%. Droop setting may be kept as low as feasible for faster primary response.
    - Over speed trip setting may be reduced so as not to let the governor go near run away speed in view of a very small sub-system.
    - All the 110 kV lines shall be in service.
    - 220kV Bus Coupler in healthy condition.
    - All the recording instruments (Viz. Frequency, Voltage, Active & Reactive Power) are in healthy condition, if not then for recording, the responsibility is to be given to separate person for each parameter and they are in ready condition front of meter.
- **Step-wise Sequence of Operation of Mock-trial of Black-start operation:**
  - **Formation of Island& Black-start operation at Bhira old power house:**
    - Ensure that all the units (6 x 25 MW; 1 x 150 MW) are out of service.

- Open 110 KV breakers of 155 MVA, 220 / 110 KV ICT-1 & 2. Both the ICTs shall be charged from 220 kV side.
- Open 110 KV Bhira – Davdi line at both ends. Thus, 110 KV Bhira – Khopoli line-2 is feeding Bhira 110 KV Bus.
- Open 110 KV Bhira – Khopoli line -2 from Bhira end thereby creating 110 KV Bus shutdown at Bhira old power house 110 KV Bus.
- Open 110 KV Bhira – Khopoli line -2 from Khopoli end.
- Open 110/11 KV GT-2 and GT-5 110 KV breakers at Bhira.
- Due to under-voltage on 440 V auxiliary bus, 250 KVA DG set gets auto started and charging 440 V auxiliary bus.
- Start auxiliaries and start any of the Unit (U-3 or U-4 or U-6) in black start mode and close respective 110 KV GT breaker there by charging 110 KV Bus at Bhira. (synchronise other two sets out of U-3 or U-4 or U-6).
- Charge GT-2 and GT-5 and charge 11 KV Buses.
- Charge DT-1 and DT-2 also charge ST-1 and ST-2.
- Charge 22 KV Headwork line-1, 2 and Sr Camp line.
- Inform 110 kV Lavasa and open 110 KV Davdi – Lavasa -1 & 2 at both ends.
- Open 110 KV Khopoli – Davdi at both ends. 110 KV Davdi Bus will be de-energized.

- **Formation of Island & Black-start operation at Khopoli:**
  - Ensure that all the 3 x 24 MW units are out of service.
  - Open 110 KV Khopoli – Bhokarpada and Khopoli – Karanjade lines fromKhopoli end.
  - Open 110 KV Khopoli – Bhivpuri- 2 fromKhopoli end. Thus, 110 KV Khopoli – Bhivpuri -1 line is feeding 110 KV Khopoli Generating station.
  - Open 110 KV KhopoliBhivpuri line -1 at Khopoli thereby creating 110 KV Bus shutdown at Khopoli 110 KV Bus.
  - Open 110 KV Khopoli - Bhivpuri line -1 at Bhivpuri.
  - Open 110 KV Breaker of DT-5 and DT-7 at Khopoli.
  - Khopoli will clear 22 KV Bus. (22 KV Bus section breaker will remain close)
  - Due to undervoltage on 440 V auxiliary bus, 250 KVA DG set gets auto started and charging 440 V auxiliary bus.
  - Khopoli will start any two units and the units will be kept ready for synchronising. (No discharge will be given from Walwhan).

- **Synchronization of Bhira Old Power house & Khopoli:**
  - Keep excitation at about 90 % on the units at Bhira and charge 110 KV Bhira - Khopoli-2 from Bhira end.
  - Observe 110 KV Bus voltages at Bhira and Khopoli.
  - Take 110 KV Bhira – Khopoli line-2 in service at Khopoli end there by charging 110 KV Dead bus at Khopoli.
  - Khopoli will synchronise identified two units on 110 KV Bus.
  - Charge DT-5,7 at Khopoli.
  - Charge 22 KV Headworks-1 and 2 lines at Khopoli.
  - Bhira will charge 110 KV Bhira – Davdi line
  - Take 110 KV Bhira – Davdi line in service at Davdi
  - Charge 110 KV Khopoli – Davdi line from Davdi and take the line in service at Khopoli.

- **Formation of island at Neral and feeding loads through Bhira & Khopoli units:**
  - Ensure that 110 kV Bus Section breaker at Bhivpuri S/s is open so that Bus 'Zone-1' is connected to 110 kV Ambernath S/s through 110 kV Bhivpuri – Ambernath line.
  - Open breakers of Unit – 9 at Bhivpuri.
  - Open 110 kV Bhivpuri – Neral line and Power Transformer – 2 at Bhivpuri.
  - Open all 22 kV Feeders at Neral S/s and ensure from Discom that no back feeding is provided to these feeders.
  - Open breakers of both the 110/22 kV Transformers from HV & LV side at Neral.
  - Open 110 kV Bhivpuri – Neral line from Neral end.
  - Open 110 kV Neral – Ambernath line from Neral end. This shall create total de-energization of Neral S/s.
  - Adjust Bhivpuri 110 KV Bus voltage at around 105 KV by adjusting excitation on Khopoli units and charge 110 KV Bhivpuri – Neral line from Bhivpuri end.
  - Take 110 KV Bhivpuri – Neral line in service at Neralend there by charging 110 KV Bus at Neral S/s.
  - Charge 2 x 25 MVA 110/22 kV transformers at 110 kV Neral S/s and charge 22 kV bus.
  - Charge 22 kV Feeders in following sequence:
    - 22 kV Kadav;
    - 22 kV Anjap;
    - 22 kV Neral;
    - 22 kV Kashele;
    - 22 kV Karjat;
    - 22 kV Karjat Neal.
  - While charging 22 kV feeders, radial load shall be ensured by concerned distribution authorities.
  - It should be ensured that after charging of each 22 kV feeder, frequency & Voltage should be maintained by adjusting the generation so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area.
  - Observe load sharing on two units at Khopoli and three units at Bhira.
  - If Khopoli units are sharing more and Forebay level is dropping, cut out both the units at Khopoli. (This is due to restriction of sudden generation pick up at Khopoli because of long duct line).
  - The island formed shall run for at least 15 – 20 minutes at stabilized frequency in the range of 49.5 Hz to 49.8 Hz. Record all the system parameters with two-minute resolution.

- **Synchronization of Bhira, Khopoli & Neral island with the Grid:**
  - Adjust frequency & voltage on units at Bhira and Synchronise the island with the Grid through 110 KV ICT-1 or 2 (ICT-1 & 2 are kept charged from 220 KV system).
  - Charge 110 KV Davdi – Lavasa line-1 & 2 and take the lines in service at Lavasa.
  - Take 110 KV Ambernath – Neral line in service at Neral end.
  - Close 110 KV Bus section breaker at Bhivpuri.

- Charge Transformer-2 and take the transformer in service at Bhivpuri.
- Normalise station auxiliary condition by taking STs in service and shutdown DG set at Khopoli and Bhira.
- Take 110 KV Khopoli – Bhokarpada and Khopoli – Karanjade lines in service at Khopoli.

- All the above operations shall be carried out with the instructions of the MSLDC Control room.
- The data with two-minute resolution to be collected during black-start operation shall be as follows:
  - Active & Reactive Power, Bus Voltages, Frequency, Generator Excitation Voltage.
  - All the recorded data shall be submitted to MSLDC in soft form on the next day of trial operation of Black-start.
  - The data is to be recorded for every 2 minute and/or after every step of the mock trial of black-start operation.

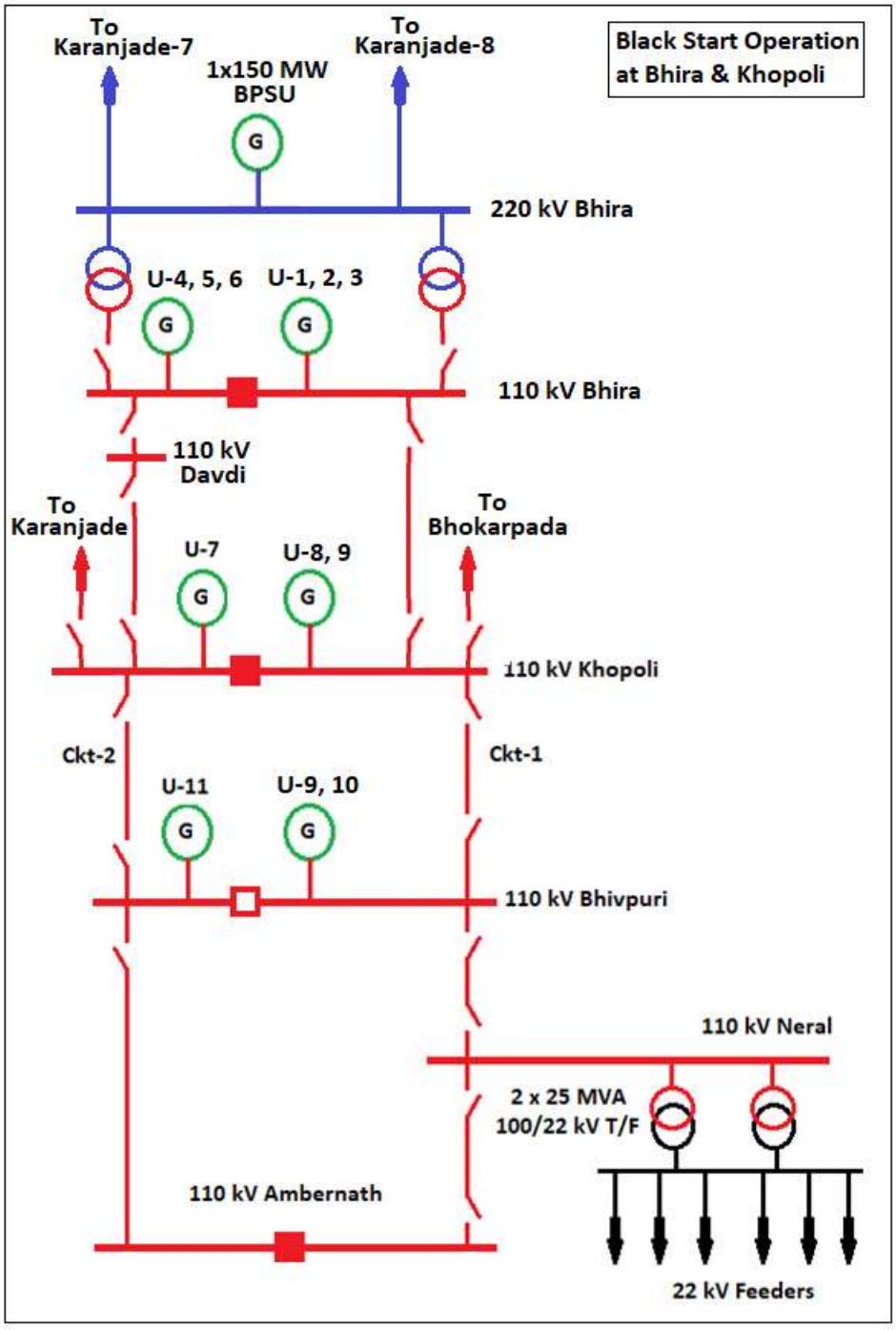
Sequence of Operations

Sr. No.	Activity	Responsibility	Time
Preliminary Checks:			
1	Ensuring all the units at Bhira&Khopoli are out of service and all the 220 kV & 110 kV lines connected to Bhira&Khopoli are in service.	TPC, MSETCL	11:00
2	Ensuring availability of all 110 kV lines, TF& 22 kV feeders at Neral S/s are in service. Bypassing of all the UFR relays at Neral S/s.	MSETCL	11:00
3	Keeping Speed Governor in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to 3% - 6%. Droop setting to be kept as low as feasible for faster primary response. Over speed trip setting may be reduced so as not to let the governor go near run-away speed in view of a very small sub-system.	MSPGCL	11:00
Formation of Island at Bhira& initiate Black start operation:			
4	• Open 110 KV breakers of 155 MVA, 220 / 110 KV ICT-1 & 2. Both the ICTs shall be charged from 220 kV side. • Open 110 KV Bhira – Davdi line at both ends. Thus, 110 KV Bhira – Khopoli line-2 is feeding Bhira 110 KV Bus.	TPC	11:05
5	• Open 110 KV Bhira – Khopoli line -2 fromBhiraend thereby creating 110 KV Bus shutdown at Bhira old power house 110 KV Bus. • Open 110 KV Bhira – Khopoli line -2 from Khopoli end. • Open 110/11 KV GT-2 and GT-5 110 KV breakers at Bhira.	TPC	11:10

	• Due to undervoltage on 440 V auxiliary bus, 250 KVA DG set gets auto started and charging 440 V auxiliary bus.		
6	• Start auxiliaries and start any of the Unit (U-3 or U-4 or U-6) in black start mode and close respective 110 KV GT breaker there by charging 110 KV Bus at Bhira. (synchronise other two sets out of U-3 or U-4 or U-6). • Charge GT-2 and GT-5 and charge 11 KV Buses. • Charge DT-1 and DT-2 also charge ST-1 and ST-2. • Charge 22 KV Headwork line-1, 2 and Sr Camp line. • Inform 110 kV Lavasa and open 110 KV Davdi – Lavasa -1 & 2 at both ends. • Open 110 KV Khopoli – Davdi at both ends. 110 KV Davdi Bus will be de-energized.	TPC	11:15
Formation of Island at Khopoli& initiate Black start operation:			
7	• Open 110 KV Khopoli – Bhokarpada and Khopoli – Karanjade lines from Khopoli end. • Open 110 KV Khopoli – Bhivpuri- 2 from Khopoli end. Thus, 110 KV Khopoli – Bhivpuri -1 line is feeding 110 KV Khopoli Generating station. • Open 110 KV KhopoliBhivpuri line -1 at Khopoli thereby creating 110 KV Bus shutdown at Khopoli 110 KV Bus.	TPC	11:15
8	• Open 110 KV Khopoli - Bhivpuri line -1 at Bhivpuri. • Open 110 KV Breaker of DT-5 and DT-7 at Khopoli. • Khopoli will clear 22 KV Bus. (22 KV Bus section breaker will remain close) • Due to undervoltage on 440 V auxiliary bus, 250 KVA DG set gets auto started and charging 440 V auxiliary bus. • Khopoli will start any two units and the units will be kept ready for synchronising. (No discharge will be given from Walwhan).	TPC	11:20
Synchronization of Bhira&Khopoli Units:			
9	• Keep excitation at about 90 % on the units at Bhira and charge 110 KV Bhira - Khopoli-2 from Bhira end. • Observe 110 KV Bus voltages at Bhira and Khopoli. • Take 110 KV Bhira – Khopoli line-2 in service at Khopoli end there by charging 110 KV Dead bus at Khopoli.	TPC	11:25
10	• Khopoli will synchronise identified two units on 110 KV Bus.	TPC	11:30

	• Charge DT-5,7 at Khopoli. • Charge 22 KV Headworks-1 and 2 lines at Khopoli. • Bhira will charge 110 KV Bhira – Davdi line • Take 110 KV Bhira – Davdi line in service at Davdi • Charge 110 KV Khopoli – Davdi line from Davdi and take the line in service at Khopoli.		
Creation of Bhira-Khopoli-Bhivpuri-Neral Island:			
11	• Ensure that 110 kV Bus Section breaker at Bhivpuri S/s is open so that Bus 'Zone-1' is connected to 110 kV Ambernath S/s through 110 kV Bhivpuri – Ambernath line. • Open breakers of Unit – 9 at Bhivpuri. • Open 110 kV Bhivpuri – Neral line and Power Transformer – 2 at Bhivpuri.	TPC	11:35
12	• Open 110 kV Bhivpuri – Neral line and Power Transformer – 2 at Bhivpuri. • Open all 22 kV Feeders at Neral S/s and ensure from Discom that no back feeding is provided to these feeders. • Open breakers of both the 110/22 kV Transformers from HV & LV side at Neral. • Open 110 kV Bhivpuri – Neral line from Neral end. • Open 110 kV Neral – Ambernath line from Neral end. This shall create total de-energization of Neral S/s.	MSETCL	11:40
13	• Adjust Bhivpuri 110 KV Bus voltage at around 105 KV by adjusting excitation on Khopoli units and charge 110 KV Bhivpuri – Neral line from Bhivpuri end. • Take 110 KV Bhivpuri – Neral line in service at Neralend there by charging 110 KV Bus at Neral S/s. • Charge 2 x 25 MVA 110/22 kV transformers at 110 kV Neral S/s and charge 22 kV bus.	TPC, MSETCL	11:45
14	• While charging 22 kV feeders, radial load shall be ensured by concerned distribution authorities. • It should be ensured that after charging of each 22 kV feeder, frequency & Voltage should be maintained by adjusting the generation so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area.	MSETCL, TPC	11:50
15	• Observe load sharing on two units at Khopoli and three units at Bhira. • If Khopoli units are sharing more and Forebay level is dropping, cut out both the units at Khopoli. (This is due to restriction	TPC, MSETCL	11:50 to 12:05

	of sudden generation pick up at Khopoli because of long duct line). • The island formed shall run for at least 15 – 20 minutes at stabilized frequency in the range of 49.5 Hz to 49.8 Hz. Record all the system parameters with two-minute resolution.		
Synchronization of Bhira-Khopoli-Bhivpuri-Neral Island with the Grid:			
16	Adjust frequency & voltage on units at Bhira and Synchronise the island with the Grid through 110 KV ICT-1 or 2 (ICT-1 & 2 are kept charged from 220 KV system).	TPC	12:05
Restoration to Normalcy:			
17	• Charge 110 KV Davdi – Lavasa line-1 & 2 and take the lines in service at Lavasa. • Take 110 KV Ambernath – Neral line in service at Neral end. • Close 110 KV Bus section breaker at Bhivpuri. • Charge Transformer-2 and take the transformer in service at Bhivpuri. • Normalise station auxiliary condition by taking STs in service and shutdown DG set at Khopoli and Bhira. • Take 110 KV Khopoli – Bhokarpada and Khopoli –Karanjade lines in service at Khopoli.	TPC, MSETCL	12:10



Reading format

Following readings to be taken with 2 min. Resolution:

Time	MW	MVAR	Bus voltage	Frequency
Name of Sub-Station:				

CONTACT NUMBERS FOR THE CONCERNED PERSONS / CONTROL ROOMS

MSLDC				
SR NO	NAME	DESIGNATION	CELL NUMBER	LANDLINE
1	Mr Mahesh Bhagwat	SE- SLDC	9920499062	
2	Mr Madhav Pande	EE- SLDC	9833608212	
3	Control Room		9619892010	27601765
MSETCL - NERAL				
1	Mr Rahul Bawangade	Dy EE	9766572280	
2	Control Room		9769398666	
TATA POWER COMPANY - PSCC				
1	Mr P Devanand	Head - PSCC	9871800506	
2	Mr M L Gole	Head - Operations	9820868264	
3	Control Room		9769281234	25543331
TATA POWER - BHIRA, KHOPOLI				
1	Mr Prabhakar Kale	Chief - Hydro	9324446404	
2	Mr Ganesh Deshmukh	Head - Bhira	9223550656	
3	Mr Dhrandhar Phulendra	Head - Khopoli	9687955222	
4	Mr Abhijeet Patil	Group Head - Hydro	8149095272	
5	Control Room Bhira		8956578261	8991122694
6	Control Room Khopoli		8956578259	8991122699

2e. PROCEDURE FOR MOCK-TRIAL OF BLACK-START OPERATION OF BHIVPURI HYDRO GENERATION 3 x 24 & 2 x 1.5 MW OF TPCL

Bhivpuri Generating station is situated in Raigad District and has generating capacity of 75 MW There are three machines of 24 MW capacity and two units of 1.5 MW capacity running on Tail race.

The Bhivpuri Plant is connected to the Grid through following lines:

- 110 kV Bhivpuri – Khopoli D/C
- 110 kV Bhivpuri – Neral (M) – Ambernath (T) S/C
- 110 kV Bhivpuri– Ambernath (T) S/C

The station is having black start facility and has 1 x 250 KVA DG set for resumption of auxiliaries in case of any black out.

110 kV Khopoli is a hydro generation station having installed capacity of 3 x 24 MW. The 110 kV Khopoli is connected to the grid through 110 kV Khopoli – Karanjade – Chembur lines.

During Black-Start operation, the 110 kV Neral S/s shall be charged and the loads shall be fed through Bhivpuri Generators. The 110 kV Bhivpuri – Ambernath S/C and 110 kV Neral – Ambernath lines shall be charged. The Synchronization with the grid shall be achieved through 110 kV Bhivpuri – Khopoli lines as synchronization facility is available at Bhivpuri & Khopoli S/s.

The loading position of 110 kV Neral S/s. is as follows:

There are six no. of 22 kV feeders emanating from 110 kV Feeders viz. 22 kV Kadav, 22 kV Anjap, 22 kV Neral, 22 kV Kashele, 22 kV Karjat& 22 kV Karjat Neal.

The average load during the black-start operation period (10:00 hrs to 13:00 hrs) at Neral S/s. is 15 MW.

Feeder-wise average demand is tabulated below:

Sr. No.	**Name of Feeder**	**Average Load (MW)**
1	22 kV Kadav	0.71
2	22 kV Anjap	0.11
3	22 kV Neral	4.99
4	22 kV Kashele	3.86
5	22 kV Karjat	4.74
6	22 kV Karjat Neal	0.71
Total		**15.12**

- Preparation for mock-drill for Black-start operation at various Sub-Stations:

  TPCL & MSETCL: TPCL & MSETCL shall take appropriate steps of Black Start exercise to change the protection settings of generator / feeder / transformers at respective control area.
- The preparation shall be as under:
  - **At 110 kV Neral S/s:**

- Keep all 22 kV feeder out.
- Keep 110 kV Neral Bus charged.
- 110 kV Bhivpuri – Neral and 110 kV Neral – Ambernath line shall be in service.

- **At Khopoli S/s:**
  - Keep 2 x 24 MW Units on bar.
  - All 110 KV Lines i.e. Khopoli – Davdi, Bhira – Khopoli-2, Khopoli – Karanjade, Khopoli – Bhokarpada and Khopoli – Bhivpuri line 1 & 2 shall be are in service.

- **At Bhivpuri S/s:**
  - Unit-10 (24 MW) shall be out of service.
  - Unit-9&11 (2 x 24 MW) shall be shut down.
  - 2 x 1.5 MW trail race units shall be shut down.
  - 110 kV Bhivpuri bus shall be charged.
  - Speed Governor may be kept in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to 3% - 6%. Droop setting may be kept as low as feasible for faster primary response.
  - Over speed trip setting may be reduced so as not to let the governor go near run-away speed in view of a very small sub-system.

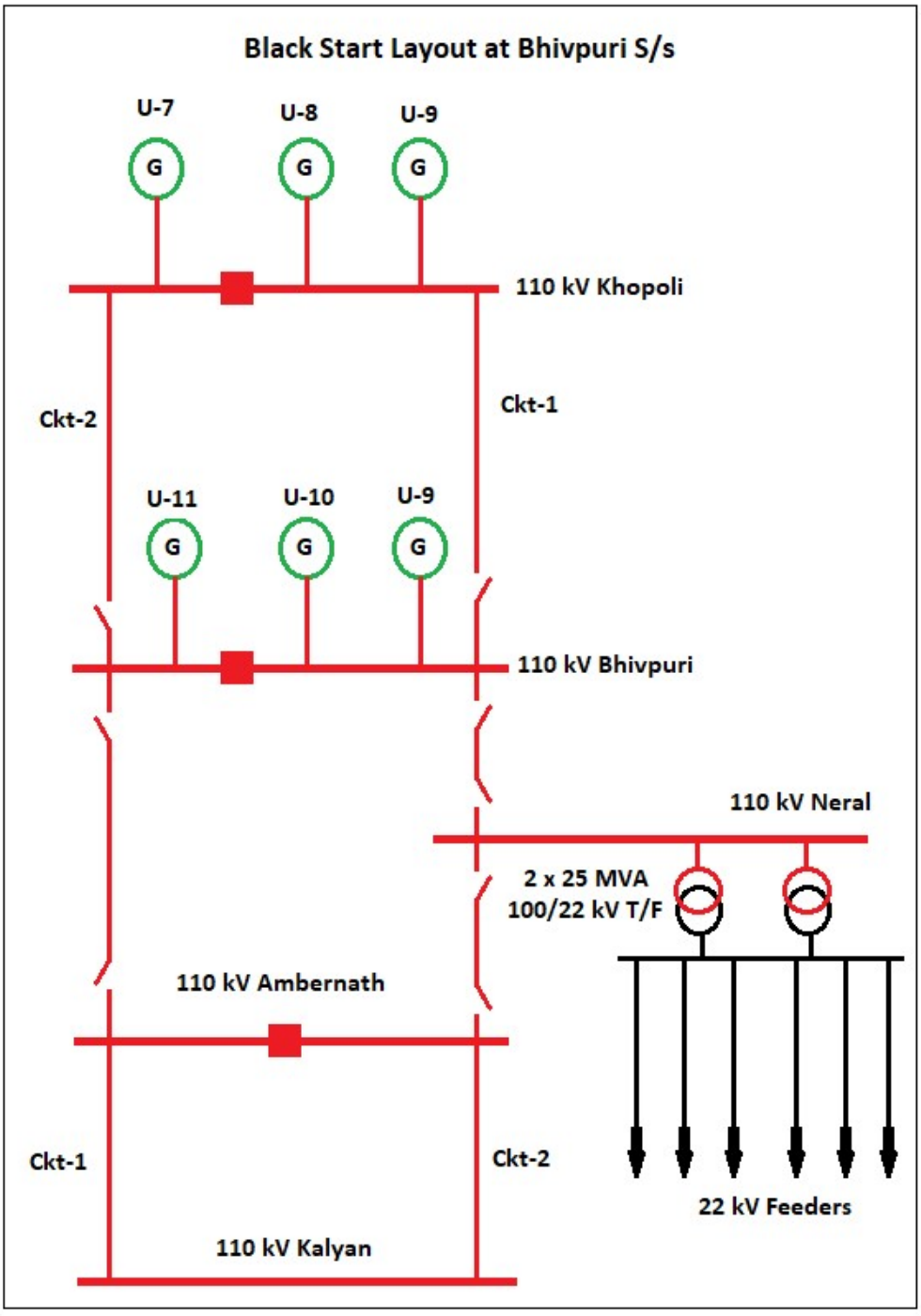
- **Step-wise Sequence of Operation of Mock-trial of Black-start operation:**
  - **Formation of Island:**
    - Ensure that all the three units i.e. Unit-9,10 & 11 and 2 x 1.5 MW Tailrace Units are shutdown.
    - Open 110 KV Ambernath –Neral line from both ends.
    - Open 110 KV Bhivpuri –Neral line from both ends. With this, 110 KV Neral Bus shall get de-energized. (110 KV Bus section breaker at Neral will remain close)
    - Open 110 KV Bhivpuri – Ambernath line from both ends.

    Operations at 110 kV Bhivpuri S/s:
    - Open 110 KV Khopoli – Bhivpuri Ckt - 1 at Bhivpuri end.Thus 110 kV Khopoli – Bhivpuri Ckt – 2 shall be feeding Bhivpuri S/s.
    - Open 110 KV Khopoli – Bhivpuri Ckt – 2 line at Bhivpuri end. This shall completely de-energize 110 KV Bus.
  - **Initiation of Black-Start Operation (Operations at Bhivpuri S/s):**
    - Due to undervoltage on 440 V auxiliary bus, 250 KVA DG set at Bhivpuri S/s shallauto start and charge 440 V auxiliary bus.
    - Extend auxiliary supply to Unit MCC Bus.
    - Open 110/5 KV Transformer-1 and 2.
    - Start Unit -11 in black start mode (2 needle operation) also keep 90% of excitation on the unit and close its 110 KV GT breaker there by charging 110 KV Dead Bus.
    - Start and synchronise Unit-9 with 110 KV Bus (Unit-9 and 11 in speed control mode).
    - Charge 110 / 5 KV Transformer-1 & 2 and charge 5 KV Bus.
    - Charge 5 KV Headwork line-1 and 2.

- Confirm excitation on the unit at 90% and close breaker of 110 kV Bhivpuri – Neral line at Bhivpuri end.

  - Close the breaker of 110 kV Bhivpuri – Neral line at Neral end thereby charging the 110 kV bus of Neral S/s.
  - Charge 2 x 25 MVA 110/22 kV transformers at 110 kV Neral S/s and charge 22 kV bus.
  - Charge 22 kV Feeders in following sequence:
    - 22 kV Kadav;
    - 22 kV Anjap;
    - 22 kV Neral;
    - 22 kV Kashele;
    - 22 kV Karjat;
    - 22 kV Karjat Neal.
  - While charging 22 kV feeders, radial load shall be ensured by MSETCL.
  - The generation on units shall be adjusted equal to the loading at Neral S/s.
  - Adjust the generation so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area.
  - The islanded portion shall be run for 10 minutes in stabilized condition. Observe load sharing on Bhivpuri units and adjust the generation accordingly.
  - Charge 110 KV Neral – Ambernath line from Neral.
  - Reduce excitation on Bhivpuri units to minimum (within safe limit considering unit parameters) and charge 110 KV Bhivpuri – Ambernath line from Bhivpuri end. Breakers of the 110 KV Bhivpuri – Ambernath line at Ambernath end shall be kept open (As 110 kV Ambernath Bus is connected to the grid.
  - Note down bus voltages at Bhivpuri and Ambernath S/s.
  - Wait for 10 minutes.
  - With above procedure, Bhivpuri, Neral S/s. are forming island and are not connected with the Grid.
  - The island formed shall run for at least 15 – 20 minutes at stabilized frequency in the range of 49.5 Hz to 49.8 Hz.
  - **Synchronization with the Grid:**
    - Ensure that 2 x 24 MW units at Khopoli are running.
    - Adjust frequency & voltage and close breaker of 110 KV Khopoli - Bhivpuri line Ckt – 1 at Bhivpuri end. This shall synchronise the Bhivpuri island with the Grid through 110 KV Khopoli - Bhivpuri line Ckt - 1.
    - Close breaker of 110 KV Khopoli - Bhivpuri line Ckt – 2 at Bhivpuri end.
    - Close breaker of 110 KV Bhivpuri – Ambernath and 110 kV Neral – Ambernath lines at Ambernath end.
    - Normalise station auxiliary condition by taking STs in service and shutdown DG set at Bhivpuri S/s.

- All the above operations shall be carried out with the instructions of the MSLDC Control room.
- The data with 1 minute resolution at Bhivpuri, Neral, Khopoli, Ambernath S/s. to be collected during black-start operation shall be as follows:
  - Active & Reactive Power, Bus Voltages, Frequency, Generator Excitation Voltage.
  - All the recorded data shall be submitted to MSLDC in soft form on the next day of trial operation of Black-start.


Black Start Layout at Bhivpuri S/s
U-7
U-8
U-9
G
G
G
110 kV Khopoli
Ckt-2
Ckt-1
U-11
U-10
U-9
G
G
G
110 kV Bhivpuri
110 kV Neral
2 x 25 MVA
100/22 kV T/F
110 kV Ambernath
Ckt-1
Ckt-2
22 kV Feeders
110 kV Kalyan

Sequence of Operations

Sr. No.	Activity	Responsibility	Time
1	Ensuring availability of 2 x 24 MW units at Khopoli on bar along with all 110 kV lines in service	TPC, MSLDC	11:00
2	Ensuring shut-down of all the units in Bhivpuri	TPC, MSLDC	11:00
3	Ensuring disconnection of 22 kV feeders at 110 kV Neral S/s.	MSETCL, MSLDC	11:00
4	Keeping Speed Governor in FGMO mode and the droop setting of the generator under Black Start Mock Drill shall be adjusted to 3% - 6%. Droop setting to be kept as low as feasible for faster primary response. Over speed trip setting may be reduced so as not to let the governor go near run-away speed in view of a very small sub-system.	TPC	11:00
5	• Open 110 KV Ambernath – Neral line from both ends. • Open 110 KV Bhivpuri –Neral line from both ends. With this, 110 KV Neral Bus shall get de-energized. (110 KV Bus section breaker at Neral will remain close) • Open 110 KV Bhivpuri – Ambernath line from both ends.	TPC, MSLDC	11:10
6	Open 110 KV Khopoli – Bhivpuri Ckt - 1 at Bhivpuri end.	TPC	11:15
7	Open 110 KV Khopoli – Bhivpuri Ckt - 2 at Bhivpuri end.	TPC	11:18
8	• Ensuring auto start of 250 KVA DG set at Bhivpuri S/s and charging of 440 V auxiliary bus. • Extending auxiliary supply to Unit MCC Bus. • Open 110/5 KV Transformer-1 and 2.	TPC	11:20
9	• Start Unit -11 in black start mode (2 needle operation) also keep 90% of excitation on the unit and close its 110 KV GT breaker there by charging 110 KV Dead Bus. • Start and synchronise Unit-9 with 110 KV Bus (Unit-9 and 11 in speed control mode).	TPC	11:25

	• Charge 110 / 5 KV Transformer-1 & 2 and charge 5 KV Bus. • Charge 5 KV Headwork line-1 and 2.		
10	Confirm excitation on the unit at 90% and close breaker of 110 kV Bhivpuri – Neral line at Bhivpuri end.	TPC	11:30
11	Close the breaker of 110 kV Bhivpuri – Neral line at Neral end thereby charging the 110 kV bus of Neral S/s.	MSETCL	11:35
12	• Charge 2 x 25 MVA 110/22 kV transformers at 110 kV Neral S/s and charge 22 kV bus.	MSETCL	11:40
13	• Charge 22 kV Feeders in sequence.	MSETCL	11:40 to 11:45
14	• The generation on units shall be adjusted equal to the loading at Neral S/s. • Adjust the generation so as to maintain the frequency in the range of 49.5 Hz to 49.8 Hz. in the islanded area. • The islanded portion shall be run for 10 minutes in stabilized condition. Observe load sharing on Bhivpuri units and adjust the generation accordingly.	TPC, MSETCL, MSLDC	11:45 to 12:00
15	• Charge 110 KV Neral – Ambernath line from Neral. • Reduce excitation on Bhivpuri units to minimum (within safe limit considering unit parameters) and charge 110 KV Bhivpuri – Ambernath line from Bhivpuri end. Breakers of the 110 KV Bhivpuri – Ambernath line at Ambernath end shall be kept open (As 110 kV Ambernath Bus is connected to the grid.	TPC	11:55
16	Adjust frequency & voltage and close breaker of 110 KV Khopoli - Bhivpuri line Ckt – 1 at Bhivpuri end and synchronize Bhivpuri island with the Grid through 110 KV Khopoli - Bhivpuri line Ckt - 1.	TPC	12:00
17	• Close breaker of 110 KV Khopoli - Bhivpuri line Ckt – 2 at Bhivpuri end.	TPC	12:02
18	• Close breaker of 110 KV Bhivpuri – Ambernath and 110	TPC	12:05

	kV Neral – Ambernath lines at Ambernath end.		
19	Normalise station auxiliary condition by taking STs in service and shutdown DG set at Bhivpuri S/s.	TPC	12:10

CONTACT NUMBERS FOR THE CONCERNED PERSONS / CONTROL ROOMS

MSLDC				
SR NO	NAME	DESIGNATION	CELL NUMBER	LANDLINE
1	Mr Mahesh Bhagwat	SE- SLDC	9920499062	
2	Mr Madhav Pande	EE- SLDC	9833608212	
3	Control Room		9619892010	27601765
NERAL				
1	Control Room		9769398666	
TATA POWER COMPANY - PSCC				
1	Mr P Devanand	Head - PSCC	9871800506	
2	Mr M L Gole	Head - Operations	9820868264	
3	Control Room		9769281234	25543331
TATA POWER - BHIVPURI				
1	Mr Dheeraj Kamath	Head - Bhivpuri	9223214975	
2	Mr Santosh Shinde	Group Head - Bhivpuri	9223550692	
3	Mr Abhijeet Patil	Group Head - Hydro	8149095272	
4	Control Room		8956578259	

2f. PROCEDURE FOR MOCK-TRIAL OF BLACK-START OPERATION OF TATA POWER HYDRO GENERATING STATION AND CHARGING 110 KV BUS AT SALSETTE

During the Black start trial total shutdown of 110 KV bus at Bhira will be availed. After starting one unit in black start mode, 110 KV Dead bus at Bhira will be charged. Further half Bus shutdown at 110 KV at Khopoli, Bhivpuri, Ambernath, Kalyan will be availed. The island will be built by connecting all three hydro stations as 110 KV Bhira – 110 KV Khopoli Bus zone-2 and 110 KV Bhivpuri Bus zone-2. The supply will be further extended from Bhivpuri 110 KV Bus zone-2 to 110 KV MSETCL Neral Bus (Load of about 15 MW will be taken at Neral) to Ambernath Bus Zone-1 to Kalyan Bus zone-2 to Salsette -110 KV Bus zone-2.

Further the formed island of Hydro – Ambernath – Kalyan - Salsette will be synchronised with the Grid on 110 KV breaker of ICT at Bhira.

Step by Step Procedure for Black start trials

1) All 25 MW six units at Bhira i.e. Unit-1,2,3,4,5 & 6 are shutdown
2) Bhira Pumped Storage Unit is shutdown. The unit will be available connected to 220 KV Grid i.e Bhira – Karanjade 7 & 8 lines.
3) All 24 MW Units at Khopoli i.e Unit-7,8 & 9 are shutdown
4) All 24 MW Units at Bhivpuri i.e Unit-9,10 & 11 are shutdown
5) Open 110 KV breaker of 155 MVA, 220 / 110 KV ICT-1 & 2
6) Open 110 KV Bhira – Davdi line at both ends. Thus 110 KV Bhira – Khopoli line-2 is feeding Bhira 110 KV Bus.
7) Open 110 KV breaker of Bhira – Khopoli line -2 at Bhira thereby creating 110 KV Bus shutdown at Bhira old power house.
8) Open 110 KV breaker of Bhira – Khopoli line -2 at Khopoli.
9) Open 110/11 KV GT-2 and GT-5 110 KV breakers at Bhira
10) Due to undervoltage on 440 V auxiliary bus, 250 KVA DG set gets auto started and charging 440 V auxiliary bus.
11) Start auxiliaries and start Unit 3 or 4 or 6 in black start mode and close respective 110 KV GT breaker there by charging 110 KV Bus at Bhira. (synchronise other two sets out of 3,4 and 6)
12) Charge GT-2 and GT-5 and charge 11 KV Buses
13) Charge DT-1 and DT-2 also charge ST-1 and ST-2.
14) Charge 22 KV Headwork line-1, 2 and Sr Camp line

Availing 110 KV Bus zone-2 shutdown at Khopoli

15) Open 110 KV Khopoli – Bhokarpada and Khopoli – Bhivpuri-1 lines at Khopoli. Thus all lines connected on 110 KV Zone-2 at Khopoli are open at Khopoli.
16) Open DT-7 LT, HT breakers at Khopoli.
17) Open 110 KV Bus section breaker at Khopoli thus 110 KV Bus zone-2 at Khopoli will get shutdown.
18) Open 110 KV Khopoli Bhivpuri line -1 at Bhivpuri.

19) Khopoli will start unit no. 8 & 9 connected on 110 Bus zone-2 and the units will be kept ready for synchronising.(No discharge will be given from Walwhan)

20)Keep minimum possible excitation on the units at Bhira and charge 110 KV Bhira Khopoli-2 from Bhira.
21)Observe 110 KV Bus voltages at Bhira and Khopoli Bus zone-2.
22)Khopoli will take 110 KV Bhira – Khopoli line-2 in service there by charging 110 KV bus zone-2 at Khopoli.
23)Khopoli will synchronise unit 8 & 9 on 110 KV Bus zone-2.

Availing 110 KV Bus zone-2 shutdown at Bhivpuri

24)Open 110 KV Bhivpuri – Neral line at both ends.
25)Open 110 KV breaker of Power Transformer-2 at Bhivpuri.
26)Open SAT-4 LT,HT breakers at Bhivpuri.
27)Open 110 KV Bus section breaker at Bhivpuri thus 110 KV Bus zone-2 at Bhivpuri will get shutdown.
28)Bhivpuri will start unit- 9 & 10 and the units will be kept ready for synchronising.
29)Adjust excitation on Bhira & Khopoli units to minimum and charge 110 KV Khopoli – Bhivpuri-1 line from Khopoli.
30)Bhivpuri will take 110 KV Khopoli – Bhivpuri-1 line in service there by charging 110 KV Bus zone-2 at Bhivpuri.
31)Bhivpuri will synchronise unit-9 & 10 on 110 KV Bus.
32)With this Bhira old Power House, 110 KV Khopoli Bus zone-2 and 110 KV Bhivpuri Bus zone-2 are connected together.
33)Avail total shutdown at MSETCL Neral by opening Transformer-1 & 2 LT,HT breakers.
34)Open 110 KV Ambernath – Neral line at both ends. MSETCL Neral 110 KV Bus will get shutdown.
35)Adjust excitation on Bhira, Khopoli and Bhivpuri units to minimum and charge 110 KV Bhivpuri – MSETCL Neral line from Bhivpuri.
36)Take 110 KV Bhivpuri – MSETCL Neral line in service at MSETCL Neral there by charging 110 KV Bus at Neral.
37)Charge Power Transformer-1 & 2 at Neral.
38)Charge 22 KV Feeders in increment of 1-2 MW at Neral.
39)Wait for 10 minutes, if everything is normal.

Availing 110 KV Bus zone-1 shutdown at Ambernath

40)Open LT,HT breakers of Transformer-2 at Ambernath.
41)Open 110 KV Ambernath – Kalyan -1 at both ends.
42)Open 110 KV Bus section breaker at Ambernath thereby giving shutdown to 110 KV Bus zone-1 at Ambernath.
43)Adjust excitation on Bhira, Khopoli and Bhivpuri units to minimum and charge 110 KV Ambernath - MSETCL Neral line from Neral.
44)Take 110 KV Ambernath - MSETCL Neral line in service at Ambernath there by charging 110 KV Bus zone-1 at Ambernath.
45)If required, charge Transformer- 2 at Ambernath for voltage control.

Availing 110 KV Bus zone-2 shutdown at Kalyan

46)Open Transformer-3 LT,HT breakers at Kalyan.

47) Open 110 KV Kalyan – Kalwa – Salsette line-1 at MSETCL Kalwa and Kalyan.
48) Open 110 KV Kalwa – Kalyan line at MSETCL Kalwa and Kalyan.
49) Open 110 KV Chola – Kalyan-2 at both ends.
50) Open 110 KV Bus section breaker at Kalyan thus 110 KV Kalyan Bus zone-2 will get shutdown.
51) Adjust excitation on Bhira, Khopoli and Bhivpuri units to minimum and charge 110 KV Ambernath – Kalyan -1 line from Ambernath.
52) Take 110 KV Ambernath – Kalyan-1 line in service at Kalyan there by charging 110 KV Bus zone-2 at Kalyan.
53) If required, charge Transformer- 3 at Kalyan for voltage control.

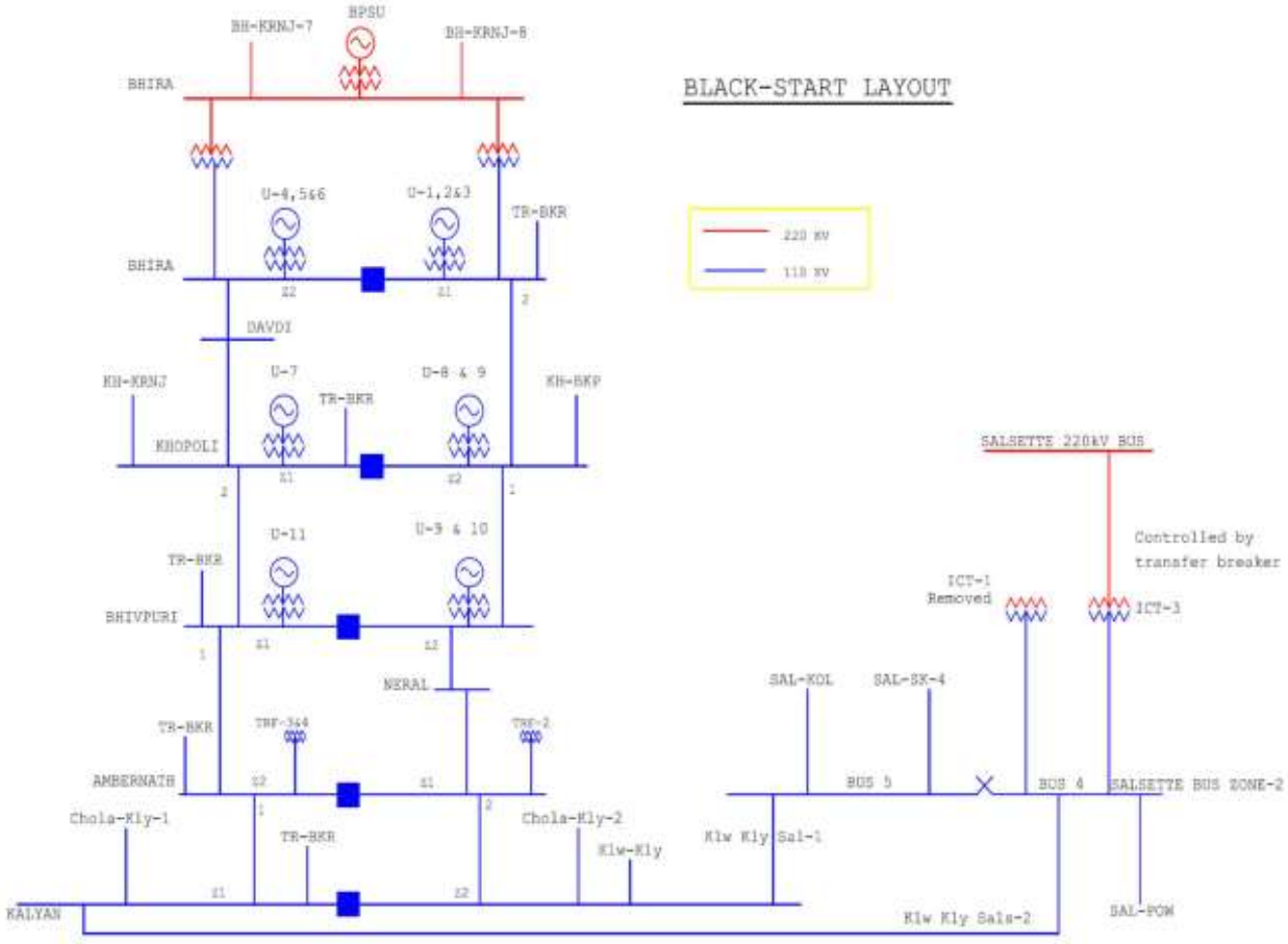
Availing 110 KV Bus zone-2 shutdown at Salsette

54) Open 110 KV Salsette – Saki-4 line at both ends.
55) Open 110 KV Salsette – Kolshet line at both ends.
56) Open 110 KV Salsette – Powai line at both ends.
57) Open 110 KV Centarl Railway-2 feeder at Salsette.
58) Open 110 KV Transfer Breaker – 1 & 2 at Salsette.
59) 110 KV Kalyan – Kalwa – Salsette line-1 & 2 and ICT-1 breakers are already open at Salsette.
60) Ensure that 110 KV Kalyan – Kalwa – Salsette-1 line are open at MSETCL Kalwa.
61) Charge 110 KV Kalyan – Kalwa – Salsette-1 line from Kalyan.
62) Take 110 KV Kalyan – Kalwa – Salsette-1 line in service at Salsette there by charging 110 KV Bus zone-2 at Salsette.
63) Wait for 10 minutes if everything is normal.
64) Finally Bhira will adjust frequency and voltage on the sets with Grid frequency and voltage and will synchronise Hydro island (Bhira – Part Khopoli – Part Bhivpuri-MSETCL Neral – Part Ambernath – Part Kalyan – Part Salsette) with rest of the Grid over 110 KV breaker of ICT-1.

Key Points need to be noted –

- Total Hydro Generation of 447 MW will remain out during the drill.
- Ambernath which feeds continuous process industries, Kalyan RSS, and OFA, Central Railway Chola station which feed traction Ghat load, Kolshet and Powai RSS will be hanging on single feed.

Note - Tata Power Salsette Receiving Station receives power on 220 KV MSETCL Kalwa – Salsette lines and Salsette – Borivli lines. The black start path from Hydro to Trombay has Salsette ICT as one of the element from where the Hydro power is extended from Salsette 110 KV Bus to Salsette 220 KV bus for further extension to Trombay. At present 250 MVA ICT-1 is remaining out whereas ICT-2 & 3 are in service. Tata Power is of the opinion that the power extension from Hydro to Trombay may be limited to Salsette 110 KV Bus so as to avoid any stress on, in service ICTs and maintaining availability of ICTs in summer peak load.



2g. PROCEDURE FOR BLACK START MOCK DRILL AT PENCH HYDEL POWER STATION (2*80MW)

In compliance to clause 5.8 (6) of Indian Electricity Grid Code (IEGC), 2010 and clause 43.1 of Maharashtra Electricity Grid Code (MEGC), 2020 the detailed plan and procedure for restoration after black out should be planned. Accordingly the proposal is prepared considering Pench Hydel Project.

Pench Hydel Project is a joint venture of Maharashtra and Madhya Pradesh. capacity of the plant is 2*80 MW. Share of Maharashtra in Pench Hydel is 1/3rd (53 MW) and share of Madhya Pradesh is 2/3rd (107 MW). Pench HPS is connected with 132kV Pench-Kanhan and 132kV Pench-Mansar line in Maharashtra and to 132kV Seoni S/s with D/C Line in M.P. In case of outage on 132kV Kanhan-Mansar line, 132kV Mansar S/s can be fed by Pench Hydro Generator.

In this procedure we will be feeding the auxiliary supply to 220kV Khaperkheda available 210 MW generator unit (out of 4*210MW) by Pench HPS via 132kV Kanhan S/s – 220kV Kanhan S/s – 400kV Khaperkheda – 220kV Khaperkheda bus.

The Date proposed for mock drill is 19/01/2022 Wednesday (Staggering day of Nagpur zone)

PART A

Preparation for Mock drill at different Sub-stations:

At 132kV Pench HPS: It shall be ensured that the Generator Unit – 1 ,132kV Pench-Mansar line, 132kV Pench-Seoni Ckt. 1 and 2 along with 20MVA Station Transformer should be kept on Main Bus II, while Generator Unit - 2 and 132kV Pench -Kanhan Line on Main Bus I in addition to this 132kV Bus Coupler should be kept in ON position. This scheme will ensure availability of Generator Unit -2 at Pench HPS with 132kV Pench-Kanhan Line.

At 220kV Kanhan S/s:

132kV Side: It shall be ensured that 132kV Pench-Kanhan line,220/132kV ICT II and 132/33kV 25 MVA T/f - I will be shifted on 132 Kv Bus II. 132/33kV T/f - I load to be shifted on 132/33kV T/f - II further, 132kV Bus Coupler to be kept in ON position while remaining ckts and, 132/33kV T/f II will be kept on Main Bus I.

220kV Side: It shall be ensured that 220kV Kanhan-Khaperkheda(new), 220/132kV ICT II should be kept on 220 KV bus section - I while remaining ckts and 220/132kV ICT I to be kept on 220 Kv Bus section - II along with this hybrid bus-sectionalizer to be kept in ON position.

At 400kV Khaperkheda S/s:

220kV side: It shall be ensured that 220kV Kanhan - Khaperkheda(new), 220kV Khaperkheda(new) - Khaperkheda(old) Ckt. I will be kept on 220 Kv Main Bus I and

remaining ckts and ICT's to be kept on 220 Kv Main Bus II along with this the Bus Coupler to be kept in ON position.

At 220kV Khaperkheda S/s (old):

220kV Khaperkheda(new)-Khaperkheda(old) Ckt. I and Station Transformer (of available unit for black start) will be kept on Main Bus I while remaining ckts, station transformers and GT's to be kept on Main Bus II with Bus coupler to be kept in ON position.

PART B

Pre-requisite for Black Start Mock Drill Procedure:

Following activities shall be performed sequentially for black start mock drill at Pench Hydel Power Station on dt. 12/01/2022.

1) **At 220kV Khaperkheda(old):** 220kV Khaperkheda(new)-Khaperkheda(old) Ckt. I, Station Transformer and Bus-coupler circuit breakers shall be opened on issue of instructions by ALDC, Ambazari.

2) **At 400kV Khaperkheda:**

   220kV side:220kVKhaperkheda(new)-Khaperkheda(old) Ckt. I, 220kV Khaperkheda-Kanhan line and Bus-coupler circuit breakers shall be opened on issue of instructions by ALDC, Ambazari.

3) **At 220kV Kanhan:**

   220kV side:220kV Kanhan-Khaperkheda(new) line, 220/132kV ICT II and Hybrid Bus-Sectionalizer circuit breakers shall be opened on issue of instructions by ALDC, Ambazari.

   132kV side:132kV Pench-Kanhan line, 220/132kV ICT II, 132/33kV 25 MVA T/f - I and Bus coupler circuit breakers shall be opened on issue of instructions by ALDC, Ambazari.

4) **At 132kV Pench HPS:** In order to create islanding, 132kV Bus Coupler circuit breaker shall be opened on issue of instructions by ALDC Ambazari.

   The unit running under islanded portion should offer primary response (governor action) for stabilizing the frequency around 50Hz. If primary response is not possible, the mechanical power input to the governor shall be controlled manually to match the electrical load to stabilize the frequency around 50Hz.

   Speed governor may be kept in FGMO mode and the droop setting of the generator under black start mock drill shall be adjusted 3% - 6%. Droop setting may be kept as low as possible for faster primary response.

Over-speed trip setting may be reduced so as not to let the governor go near runaway speed in view of very small sub-system.

5) Overvoltage setting of all the line feeders will be kept around 108%, 5 sec delay during the complete mock drill procedure.

PART C

Procedure for Black Start Mock Drill:

1) With the help of DG set auxiliary supply of Generator Unit to be started and allowed to run the unit for 10-15 minutes. Monitor Bus voltage and frequency.
2) Charge 132kV Pench-Kanhan line.
3) Charge 132/33 Kv 25 MVA TF – 1 and take the load as per schedule (Annexure - 1)
4) 220/132kV ICT II at 220kV Kanhan S/s to be charged from LV and HV side.
5) Charge 220kV Kanhan-Khaperkheda(new) line.

For 220kV Unit 1-4 (210MW each) trial:

1. 220kVKhaperkheda(new)-Khaperkheda(old) Ckt. I line to be charged.
2. Station transformer of available generator unit to be charged and accordingly auxiliary load to be taken as per schedule. (Schedule annexure - 2)

Synchronization

1. At Pench, Islanding system to be synchronized with the national grid at 132 Kv Pench substation by closing bus coupler between bus 1 and bus 2.
2. Close the bus coupler at 132 Kv Kanhan
3. Close the Hybrid bus sectionalizer at 220 kv Kanhan
4. Close the 220 Kv bus coupler at 400 Kv Khaparkheda s/s
5. Bus coupler at 220 Kv Khaparkheda to be closed.

Following Data will be collected for Analysis.

1. MRI (Annexure – 3 shows mri loactions)
2. Disturbance Recorder (DR) (Annexure – 4 DR locations)
3. SCADA data

List of Contact persons

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	Lines			
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2h. PROCEDURE FOR BLACK START MOCK DRILL AT TPCL TROMBAY GTPS (U#7)

During mockdrill of Trombay Unit-7, the unit will be started after its scheduled outage. 220 KV Trombay Bus-6 will be kept in de-energized condition.
Following 220 KV lines will be kept charged from remote end;
220 KV Trombay - Salsette-2
220 KV Trombay - Dharavi-5
220 KV Trombay – Carnac-7
220 KV Trombay - Carnac-6 will be transferred to Transfer breaker-2

Further 220 KV Breaker of ST-7 will be opened to create Unit-7 black start.
6.6 KV Trombay Unit-7 station & unit buses will get shutdown.
2.5 MVA DG set will get auto cut in & will charge Unit-7 station and unit buses.
Trombay Unit-7 willl be started in black start mode. By keeping excitation to minimum, 220 KV Unit-7A breaker-2 will be closed to charge 220 KV Bus-6 dead bus.
Unit-7 will then be synchronized with the grid over 220 KV Trombay - Salsette-2

Pre-requisites:

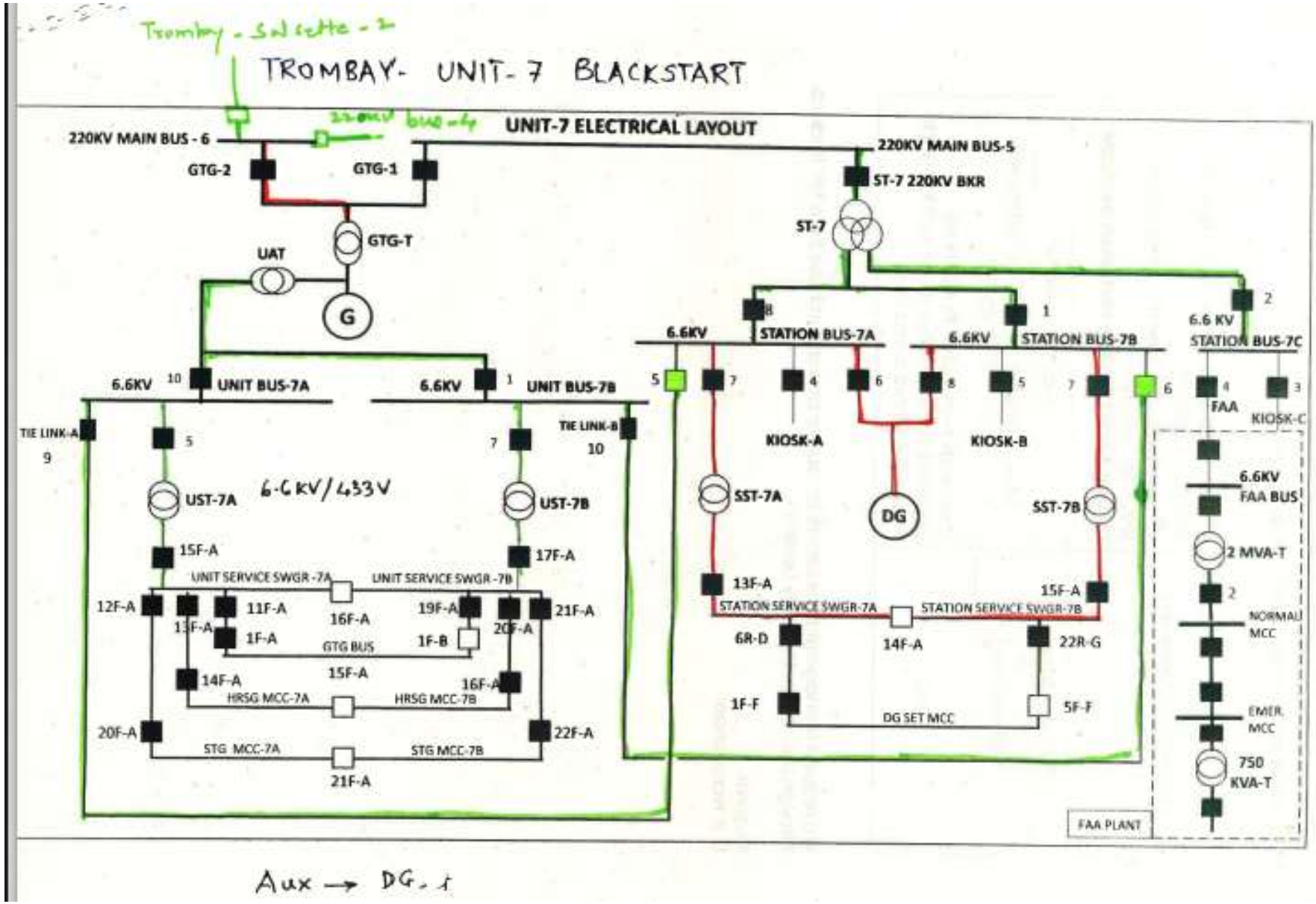
All Permits on GTG, Fuel Gas System, GTG main Transformer, Switchyard are cleared.

1 DG set available on AUTO
2 Confirm GTG (Unit-7A)& STG (Unit-7B) both 220 kV breakers in open condition
3 ST-7 is in service feeding to station & unit buses 7A & 7B
4 Confirm that fuel gas system is available & charged
5 Generator relay panel in Reset Condition.
6 Confirm that 220 kV bus VI is available for dead bus closing i.e.220 KV Bus-6 is kept deenergised (220 KV Trombay - Carnac-7, Trombay - Dharavi-5 & Trombay - Salsette-2 lines will remain charged from remote end and Trombay - Carnac-6 line will be controlled by Transfer breaker-2)
7 Simulate 220 kV Bus V dead to protection panel for achieving Black start.

Procedure:

1. Inform PSCC about GTG Black start Trial
2. Inform HOD Operation and all other Dept. HODs.
3. To simulate black start condition Open ST7 220 kV breaker manually, all station buses and unit buses will get shutdown
4. DG set black start SGC program will get activated on AUTO
5. Confirm DG set has established supply to 6.6 kV Station and Unit Buses & all 415 V buses
6. Take battery charger & UPS in service
7. Take GTG cooling water system in service
8. Ensure following GTG selections are adopted to run GTG on Black start mode
   SFC: Black Start Mode
   Speed/Load Controller: Speed Mode

9. Activate SGC Gas Turbine startup
10. During GT rolling observe DG set loading, GTG Vibrations, Lube Oil Temp
11. At machine speed on 3000 rpm, GTG will be continued on speed control
12. Switch ON GTG Breaker-2 key-2(On Bus-VI) for dead bus closing. Keep excitation of Unit-7A to Minimum.
13. Ensure that machine speed should be higher than grid
14. Inform PSCC & close GTG (Unit-7A)220 kV breaker 2
15. Check 220kV bus VI voltage on SCADA.
16. Ensure that 220 KV Trombay -Salsette 2 line is kept charged from Salsette end.
17. Ensure that 220 kV Trombay -Salsette 2 breaker is lined up with AC/DC supply ON at Trombay.
18. Ensure that 220 kV Trombay -Salsette 2 breaker selection should be on back up panel at Trombay.
19. Switch ON Sychroscope in 220 kV Trombay -Salsette 2 relay panel at relay room in Trombay.
20. Adjust speed of U7 GTG machine close to grid frequency and adjust 220 KV Bus-6 voltage by varying Unit-7A excitation.
21. Synchronize Trombay Unit-7 with the Grid on 220 KV Trombay - Salsette-2 breaker at Salsette
22. Observe GTG (Unit-7A) load to avoid reverse power.
23. Match actual load and Load setpoint and put machine on Load control.
24. Close 220 kV BS 4 breaker at Trombay thereby connecting U7 with Trombay 220 kV Bus.
25. Normalize 220 KV Bus-6 condition at Trombay.
26. Take generation schedule of U7 GTG from PSCC and load U7 GTG accordingly.
27. Take ST-7 in service by closing ST-7 220 kV breaker.
28. Synchronize S7A or 7B incomer with DG set.
29. Carry Out Aux Changeover by closing Unit Bus-7A & 7B incomer breakers.
30. Stop DG set and keep on it Auto mode.


Trombay - Salsette - 2
TROMBAY- UNIT-7 BLACKSTART
UNIT-7 ELECTRICAL LAYOUT
220KV MAIN BUS - 6
220KV MAIN BUS-5
GTG-2
GTG-1
GTG-T
UAT
G
ST-7 220KV BKR
ST-7
6.6KV
UNIT BUS-7A
6.6KV
UNIT BUS-7B
TIE LINK-A
TIE LINK-B
6.6KV/433V
UST-7A
UST-7B
15F-A
17F-A
UNIT SERVICE SWGR -7A
UNIT SERVICE SWGR -7B
12F-A
11F-A
16F-A
19F-A
21F-A
1F-A
GTG BUS
1F-B
14F-A
15F-A
16F-A
HRSG MCC-7A
HRSG MCC-7B
20F-A
22F-A
STG MCC-7A
STG MCC-7B
21F-A
6.6KV
STATION BUS-7A
6.6KV
STATION BUS-7B
6.6 KV
STATION BUS-7C
KIOSK-A
KIOSK-B
SST-7A
SST-7B
DG
13F-A
15F-A
STATION SERVICE SWGR-7A
STATION SERVICE SWGR-7B
6R-D
14F-A
22R-G
1F-F
DG SET MCC
5F-F
FAA
KIOSK-C
6.6KV
FAA BUS
2 MVA-T
NORMAL MCC
EMER. MCC
750 KVA-T
FAA PLANT
Aux → DG-1