ISLANDING SCHEME FOR STATION DURING GRID BLACK-OUT

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Presentation Points

• System Description and Grid Related Protection.
• Brief Description of Present Grid Outage.
• Short Coming of Existing House Load Scheme
• Suggested Islanding Scheme for Station and Its Advantage
Approved APC by IEGC

- 6.5% for unit having TDBFPs (32.5 MW for 500 MW) and
- 8.5% for Unit have only MDBFPs (42.5 MW for 500MW).
- Sharing of APC on UT/ ST is 2.5/1
- GT CB Opening on Full Load: Turbine Speed and Stator Voltage increased by <10%.
- Amount of Steam/ MW Generation in approximately 3 T/Hr/ MW
- HP/ LP Bypass Capacity 60% of MCR, i.e. 300 MW or 936 T/Hrs out of 1560 T/Hr.
System Description and Grid Related Protection

Generator Protection (Class-A and Class-C)

1. **Under frequency** (Alarm Freq < 48.5 Hz for 2.5 sec and Open GT Breaker on Class-C protection, when Freq < 47.4 Hz for > 2.0 sec)
2. **Over fluxing** (V/f > 1.075 PU for > 5 Sec i.e. 46.51Hz on rated voltage.)
3. **Back-up Impedance Protection** (Open GT Breaker when Impedance is less than setting for > 2 sec: Long Transmission Line): Suitable for Single Unit Station but low liable for Multiple Units Station, considering outgoing feeder Distance Protection, LBB Protection and Over Current and Negative Phase Sequence Prot.
4. **Pole slipping** (Twice with in 25 sec).
5. **Over voltage protection** (>105% for > 3sec, Inst > 145%)
Brief Description of Present Grid Outage

Grid Failure on July 30, 2012 at 02:33 Hrs and repeated on July 31, 2012 at 12:30 Hrs

Both Days: NR got separated from WR due to false tripping of 400 KV Bina-Gwalior Line sensing 3rd zone distance protection, due to “Load Encroachment” i.e. high load and low voltage.

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Parameters Variation During Generator Breaker Opening

Prior to Grid Disturbance Freq was 49.6 Hz (02:33:13 Hrs ) reach to 47.4 Hz at 02:33:25 hrs  i.e. df/dt was 0.18 Hz/Sec, GT CB opened TG Speed shoot-up app. 300 RPM,  GT voltage shoot-up from 21 to 23 KV, Turbine load reduced to 30 MW from 592 MW

Time of Field Breaker Opening:
GT Terminal voltage was 11.0 KV against 21 KV and turbine speed was 1410 RPM, LT side voltage of UT was 5.8 KV and running CW pumps tripped led to LPT diaphragm ruptured on loss of circulating water.
Under Frequency ( < 47.4 Hz, time delay 2 sec)

CLASS-C Protection

Individual Unit Supply only UT i.e. 70% of Unit APC i.e. 70% of 65 MW= 45.5 MW= 142 T/Hrs BLI
Total loss of **STATION POWER**, lead to unavailability of major equipment’s like MDBFPs and CW pump-C, Hot well Make-up pump, HFO and LDO etc.

Load in individual UT is approx. 70% of 6.5% of MCR Generating Unit, i.e. **4.5 % of MCR i.e. 45 MW or BLI 140 T/hr** i.e. amount of steam, is inadequate for safe continuous running of Unit for long period in view of HPT overheating.

Due to inadequate BLI and Less Opening of Governing Valve, Turbine Speed Start reducing, resulting **VOLTAGE DROP IN UNIT BOARD** lead to tripping of Running CW pumps, PA fans, Mill Feeders etc.: Therefore chances of LPT diaphragm rupturing and Boiler tripping of loss of fuel.

Less amount of **IPT exhaust steam**, inadequate for TDBFPs, tripping of TDBFPs on low water flow < 150 T/hrs; cause Boiler Tripping on drum level low prot.

Excessive Current on running equipments due to low terminal voltage.

As per last experience **Unit survived only for 90 sec**, led to total Black-outage.
Suggested House-Load/ Islanding Scheme

Under Frequency & \( \text{df/dt} \) Relay

Running Unit Supply total Station APC i.e. \( n \times 65 \text{ MW} \), \( n \) = No. of Units in Station = \( n \times 202 \text{ T/Hrs BLI} \)
Suggested House-Load/ Islanding Scheme

Existing: Under Frequency (2) (Class-C Protection) as Back-Up

Suggested House-Load

- Under Frequency (1) & df/dt Relay

  - Selected Unit
    - No Trip
    - Droop/ FGMO
    - Speed/ Freq Control
      - HP/LP BP Modulating
      - Runback
  - Rest Units
    - Class-B (Turbine Trip)

Once Unit Survived: Synchronize with Available Grid to Avoid Undesirable Power Swing.
Advantage of Suggested House-Load/Islanding Scheme

• Through One Selected Running Unit, Switchyard is in remain live condition and supplying power to **STATION TRANSFORMERS**. Hence Major Equipments like MDBFPs and CW pump-C, Hot well Make-up pump, HFO and LDO etc remain available.

• Remaining **Units Turbine Trip (Class-B)**, therefore already exist commands from Class-B trip remain there and initiate
  - Initiate Fast Unit to ST changeover signal for all units except, which on selected for house load. (Already exist: Part of Class-B Trip, initiated during Turbine tripping).
  - HPBP/LPBP fast opening signal issued, therefore “Boiler” of all units survived (Already exist: Part of Class-B Trip, initiated during Turbine tripping).
  - Run-Back Signal issued for all units and cut numbers of running mills to four (Already exist: Part of Class-B Trip, initiated during Turbine tripping).

  — **RESULTING BOILER IS REMAIN LIVE.**

• **Existing Class-C protection could be used as back-up protection.**

• Running Unit Supply total Station APC i.e. n*65 MW, n=No. of Units in Station= n*202 T/Hrs BLI. (For one 500 MW unit it will be approx. 30 to 35 % of BMCR and for One 210 MW it will be approx 71 to 83 % of BMCR.
Relay Setting for Suggested House-Load/Islanding Scheme

• **Under Frequency Relay:**
  
  – **Class-C Protection:** Freq < 47.4 Hz / for >= 2 Sec.
  
  – **Stage#1:** V/f > 1.075 PU for >= 5 Sec i.e. 46.51Hz on rated Voltage.
  
  – **Stage#1:** Islanding with HVDC and Freq < 47.7 Hz for >=0.5 Sec.
  
  – **Grid Enquiry Committee Islanding suggestion:** (Clause 5/(d)).
    
    • 47.9 Hz: More than one Generating Station with predetermined load.
    
    • 47.7 Hz: Single Generating Station with Pre-identified load.
  
  – Relay measured freq on crossing a zero i.e. 1/50=0.02 sec and Average over 3 cycle= 3/50=0.06 Sec. (Ref ABB: df/dt Relay Setting Northern region: May 2007 )
  
  – Relay may be set in between 46.51 to 47.4 Hz OR 47.4 to 47.7 Hz OR 47.4 Hz with Time Delay < 2 Sec, considering opening time of CB i.e.80 msec i.e. four cycle .
  
  – Therefore Suggested Under Setting:
    
    • 47.4 Hz/ Time Delay 1 Sec: Initiate Suggested Islanding Operation.
    
    • 47.4 Hz/ Time Delay 2 Sec: Initiate Existing “Class-C” prot as back-up.
Relay Setting for Suggested House-Load/Islanding Scheme

- df/dt Relay (For ensuring unsustainable condition of grid: leading to Black-out) Setting: (df/dt Relay Setting Northern region: May 2007)
  - 0.1 Hz/Sec at 50 Hz for Northern Region: Averaged on interval of three cycle i.e. 0.06 Sec.
  - Last Grid Outage:
    - 30/07/2012: (49.5-47.4)/(2:33:13-2:33:25)=0.175 Hz/Sec
    - 31/07/2012: (49.84-47.4)/(13:01:12-13:01:26)=0.174Hz/s

- Two out of Three Logic to be used for undesirable “Islanding operation”
Relay Setting for Suggested House-Load/Islanding Scheme

- **Freq < 47.4 Hz**
  - Time Delay 1 Sec
  - Time Delay 2 Sec

- **df/dt > 0.1 Hz/sec**
  - &
  - &
  - OR

- **Suggested Island Class**
  - C

- **Class-C**
Conclusion

• The suggested islanding system is additional protection for existing system and take care of all safe condition required running of unit/ units i.e. sufficient steam follows from turbine of running unit avoid HPT overheating. The suggested system save the Station from total outage, One Unit of particular station supplying to house load and remaining units Boiler remains on running condition, there are no tripping of Circulating water pumps, hence eliminated rupturing of LPT diaphragm. Suggested Islanding system help to restoration of grids with in minimum duration and also provide start-up power to other station. This scheme could be easy implemented in all station and it is also fulfilling recommendation of enquiry committee, constituted for analyzing recent Grid blackout.
Thanking You
RELAY TAGS

37G1 / 37G2 - Low ForeWard Rower
(Time Delay - 30 Sec.)
50GDM - Dead Machine Relay
98G - Pole Slipping
21G - Gen. Backup Indipendence
27G1 / 27G2 -
59G1 - Gen. Over Voltage
81G1 - Under Frequency
87G1 / 87G2 - Differential
64Gi - 95% Earth Fault
64GII - Inter Turn Fault
99G - Over Fluxing
46G - Negative PH - Sequence
40G1 / 40G2 - Field Failure
96G - 100% Stator Earth Fault
Rotor E / F
Over Voltage
51NGT - StandBy E / F - Gt
**GENERATOR PROTECTIONS - TRIPPING LOGIC**

**GROUP - 1**

**CLASS - A1**
- 50GDM, 51NGT, 87HV, 21G, 87TL, 50GLBB, 87T1, 87TT2, 87UTA, 87UTB, 51NUT A, 51NUT B, GT-A/B/C FIRE PROT RIP (30 BA/30 BB/30C)
- GT-A/B/C BOTH COOLER SUPPLY FAIL
- GT-A/B/C BUCHHOLTZ - I (30A K/LM)
- GT-A/B/C PRV - 1 TRIP (30 R/S/T)
- UT- A OLT CT BUCHHOLTZ/PRV1 (30UA J/K)
- UT- B OLT CT BUCHHOLTZ/PRV1 (30UB J/K)
- LBB RELAY OF MAIN OR TIE 400KV CB

**GROUP - 2**

**CLASS - A1**
- 64GT, 87GT, 99GT, 51UT A, 87NUT A, 51UTB, 87NUT B
- GT-A/B/C BOTH COOLER SUPPLY FAIL
- GT-A/B/C BUCHHOLTZ - II (30A N/P/Q)
- GT-A/B/C SPR TRIP (30 X/Y/Z)
- GT-A/B/C PRV - 2TRIP (30 U/V/W)
- GT-A/B/C OLT TRIP (30E/30J/30N)
- UT- A BUCHHOLTZ/PRV2 (30UA Q/R)
- UT- B BUCHHOLTZ/PRV2 (30UB Q/R)
- UT- A FIRE PROT TRIP. (30FPA)
- LBB RELAY OF MAIN OR TIE 400KV CB

**CLASS - A2**
- 37G1(30SEC DELAY), 40G1, 59G1, 98G, 64G1, 64GIT, 87G1, 99G

**CLASS - B**
- LOW FORWARD POWER RELAY 37G1 (SHORT TIME DELAY OF 2 SEC. AFTER TURBINE TRIP)

**CLASS - C**
- GEN. UNDER FREQUENCY (81G1)

**TRIPS 400KV CBS**
- TRIPS GCB
- TRIPS FIELD CB
- TRIPS TURBINE
- TRIPS UT 11KV INCOMER CBSs

**CLASS - A2**
- 37G2(30 SEC DELAY), 40G2, 46G, 87G, 96G (MULTI-FUNCTION RELAY)

**CLASS - B**
- LOW FORWARD POWER RELAY 37G2 (SHORT TIME DELAY OF 2 SEC. AFTER TURBINE TRIP)

**CLASS - C**
- 96G - UNDER FREQUENCY

*UT-A/B WTI & OTI TRIP RELAYS WILL TRIP THE CORRESPONDING 11KV INCOMER CB IN 1BA/1BB, 2BA/2BB BUSES WITH CONSEQUENT SUPPLY CHANGE OVER TO STAND-BY TRANSFORMER AS PER FAST AUTOMATIC CHANGE OVER SCHEME (FACOS).*