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TECHNICAL AUDIT REPORT GATTI 500KV GRID STATION

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©USAID Energy Policy Program
House 4, Street 88, Sector G-6/3
Ataturk Avenue, Islamabad, Pakistan
Tel: +92 (51) 835 7072, Fax: +92 (51) 835 7071
Email: jhicks@aeai.net

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Technical Audit of Gatti 500kV Grid Station

Introduction:

This report covers the technical audit of Gatti 500kV Grid Station (GS) located at Gatti, about 10km from Faisalabad, Punjab. This GS was commissioned on 500kV level on July 22, 1979. It plays a pivotal role for the dispersal of power of Ghazi Barotha hydro power station and Rousch thermal power station. The GS has 1800MVA total transformation capacity connected to the grid, feeding Faisalabad and its surrounding areas.

There are four (04) 450MVA-500/220kV transformer banks that are owned and maintained by NTDC. There are six (06) 500kV and ten (10) 220kV transmission circuits linking this station to others. The GS is connected to Lahore Sheikhpura 500kV GS, Ghazi Barotha hydro power station, Muzaffargarh 500kV GS, Multan 500kV GS and Rousch thermal power station through 500kV transmission circuits and to Jaranwala Road 220kV GS, Yousafwala 500kV GS, Nishatabad 220kV GS, New Bandala 220kV GS and Ludewala 220kV GS through 220kV circuits. For both 500kV and 220kV switchyards one and half breaker scheme is used. Single line diagram is attached (Annex-A).

EPP audit team comprising technical experts visited this GS from June 16, 2014 to June 27, 2014. This report reflects their findings and prioritized fixes.

Findings:

Observations by technical experts are as under:

- 1) Loading condition of transformers is tabulated below:

Transformer No.	Rating			Max. Load Current Recorded (A)	Max. Percentage Loading of transformers (%)
	Voltage Ratio (kV/kV/kV)	Power (MVA)	HV/LV Current (A)		
T-1	500/220/11	450	520/1181	1080	91.4%
T-2	500/220/11	450	520/1181	1262	106.85%
T-3	500/220/11	450	520/1181	1210	102.45%
T-4	500/220/11	450	520/1181	1210	102.45%

From above, it is evident that the transformers are overloaded per NEPRA grid code clause OC 4.9.5 supported by IEC (International Electro-technical Commission), which allows up to 80% loading of transformers. According to IEC Standard 60354, continuous loading of a transformer above 80% at ambient temperature equal to or above 40°C, prohibits the transformer's short time overloading beyond its nameplate ratings. Exceeding this limit reduces the expected useful life of transformers in proportion to the amount and duration of overload. There is a 150MVA-500/220kV single phase unit present, which was procured from China few years back as a spare unit for the existing CGE make autotransformer bank, but its parameters do not match with the

Technical Audit of Gatti 500kV Grid Station

CGE units, therefore, it is redundant at this station and may be shifted to some other GS where it is compatible and needed.

- 2) The defective blue phase of shunt reactor on Gatti-Barotha CCT-2 was transported to Transformer Reclamation Workshop NKLP Lahore for internal inspection and necessary testing. Healthiness of red and yellow phase units lying at the GS is also doubtful and needs inspection. There is also excessive oil leakage from the top cover gas kit of main tank of shunt reactors of Gatti-Barotha CCT-1 and CCT-2.
- 3) The 500kV Gatti-Barotha circuits and 220kV Gatti-Nishatabad and Gatti-Jaranwala Road Circuit-2 are loaded above the prescribed limits per NEPRA grid codes i.e. 80%.
- 4) Major maintenance of eight (08) 500kV CBs is pending due to lack of spare parts. There are eleven (11) 220kV Air Blast CBs in service at the GS and adequate spares are needed for their overhaul. In case of non-availability of spares, the same have to be replaced. Spare parts are required for nine (09) 500kV and ten (10) 220kV CBs for future overhauling.
- 5) The following tests have not been performed as required per SOPs for grid system operation and maintenance:
 - a. Capacitance & dissipation factor (C&DF) test of current transformers (CTs), potential transformers (PTs) and capacitor voltage transformers (CVTs)
 - b. SF6 purity and moisture content test for circuit breakersIt is necessary to conduct all tests timely to ensure healthiness of the equipment.
- 6) The auxiliary supply of the GS is arranged through three (03) 11kV outgoing feeders one each emanating from New Nishatabad 132kV GS, Nishatabad 220kV and Chiniot road 132kV GS, Faisalabad which is not reliable. The auxiliary supply of the GS should be arranged locally by installation of a power transformer.
- 7) Auxiliary control panel for transformer T-2, T-3 and T-4 are not installed.
- 8) Tele-protection (PLC aided) and direct transfer trip (DTT) is not available on 220kV transmission circuits. DTT is required for remote end tripping on “Breaker Failure Scheme” when there is no guarantee that relaying at remote line terminals will actuate quickly enough to minimize consequential damage.
- 9) Sequential Events Recorder (SER) for 500kV and 220kV system is defective. SER is a stand-alone data logger to record and time the sequence of events duly synchronized with Atom Clock through Global Positioning System (GPS). SER plays a vital role in analyzing major system disturbances facilitating proper corrective action with regard to protective relays

Technical Audit of Gatti 500kV Grid Station

settings and coordination.

10) Fault/Disturbance recorder for 500kV and 220kV system is defective. It continuously monitors power system electrical analogue and/or digital information. It is used for verifying the proper operation of protective relays and circuit breakers and for analyzing protection problems. It captures the curve forms of the monitored quantities of the supervised object, both under normal service conditions and when the protection relay operates. Thus the relay settings can be based on the recorded information.

11) The GS is deficient of important relays such as: (For details see Annex-B and D).

- a. Three (03) Thermal overload protection relays on all transformers except T-1
- b. Three (03) Overload protection (current based) on all transformers except T-1
- c. Three (03) Over voltage protection relays on all transformers except T-1
- d. One (01) Tertiary earth fault relay on T-1
- e. One (01) Over-excitation relay on T-1
- f. Three (03) Neutral over current relays on all 500/220kV transformers except T-1
- g. Two (02) Over current earth fault relays on shunt reactors of Gatti-Barotha Circuit-1 & 2
- h. Thirteen (13) Distance to fault locators on some transmission circuits
- i. Eighteen (18) Synchro-check relays on some transmission circuits
- j. Four (04) Tie line protection not installed on 500kV Gatti-Barotha circuits, Gatti-Lahore and Gatti-Rousch circuit.

12) Auto-reclosers on almost all 220kV transmission lines are blocked. Auto-reclosers can significantly reduce the outage time, reduce transmission line damage and thus provide higher service continuity.

13) The ground clearance of 500kV Gatti- Muzaffargarh transmission line in the span of tower No. 559/560 is critical due to raised level of bypass road near Shorkot city which may cause a serious hazard. The foundations of tower Nos. 192, 446, 672, 676 & 677 of Gatti-Barotha CCT-1 and tower Nos. 115, 222, 242, 464, 829, 830 & 831 of Gatti-Barotha CCT-2 need protection walls against excessive digging of earth around tower locations. The foundation of tower No. 215 of Gatti-Lahore Line is in danger due to cutting of earth by Qadarabad-Balloki link canal towards the tower location.

Recommendations:

Transmission and Grid			
Sr. No.	Findings	Recommendations	Remarks
1	Loading of all 500/220kV transformers is above the prescribed criteria per NEPRA grid codes i.e. 80%.	Proper load flow studies need to be conducted and necessary action to be taken to reduce the loading on these transformers	

Technical Audit of Gatti 500kV Grid Station

2	The defective blue phase of shunt reactor on Gatti-Barotha CCT-2 was transported to Transformer Reclamation Workshop NKLP Lahore for internal inspection and testing since long. Healthiness of red and yellow phase units lying at the GS is also doubtful and needs inspection.	Repair of defective shunt reactor units should be organized to put them back in the service.	
3	The 500kV Gatti-Barotha circuits and 220kV Gatti-Nishatabad and Gatti-Jaranwala Road Circuit-2 are loaded above the prescribed limits per NEPRA grid codes i.e. 80%.	Proper load flow studies need to be conducted and necessary action to be taken to reduce the loading on these circuits	
4	Spare parts for eleven (11) 220kV Air Blast CBs and Ten (10) SF6 gas CBs are not available for major overhaul.	Spare parts for the overhauling of CBs to be arranged. In case of non-availability of spares, the same have to be replaced.	NTDC have trained staff for overhauling of CBs and workshop facilities for repairing CBs
5	Unreliable auxiliary supply of the GS.	The auxiliary supply of the GS should be arranged locally by installation of a power transformer.	
6	C and DF test for CTs and CVTs and SF6 purity and moisture content test for circuit breakers is due.	These tests should be carried out per the SOPs to ensure healthiness of the equipment.	
7	Redundant 150MVA, 500/220kV Single phase Chinese transformer unit.	It may be shifted to some other GS where this unit is compatible and needed.	

Protection			
Sr. No.	Findings	Recommendations	Remarks
1	Tele-protection and direct transfer trip (DTT) facility is out of circuit on 220kV circuits.	“System Protection and telecommunication departments of NTDC” should look into it and make concerted efforts to enable “Carrier aided facility” at either ends of the transmission lines in order to clear faults rapidly.	
2	Four (04) Tie line protection not installed on 500kV Gatti-	Recommended to be installed.	

Technical Audit of Gatti 500kV Grid Station

	Barotha circuits, Gatti-Lahore and Gatti-Rousch circuit		
3	The following relays on transformers are not installed: three (03) Thermal overload protection relays on all transformers except T-1, three (03) overload protection (current based) on all transformers except T-1, three (03) over voltage protection relays on all transformers except T-1, one (01) Tertiary earth fault relay on T-1, one (01) over-excitation relay on T-1, three (03) neutral over current relays on all 500/220kV transformers except T-1	Thermal overload and overload (current based) protection has a vital role against sustained overloading. Hence recommended to be installed and configured precisely. All other missing and defective relays need to be installed. (for details see Annex-B and D)	
4	Missing auxiliary control panels for transformer T-1, T-2, T-3.	Auxiliary control panels should be installed on priority.	
5	Inoperative sequential event recorders, fault recorders and voltage recorders for 500kV and 220kV system.	It is strongly recommended to make sequential event recorders, fault recorders and voltage recorders functional. Such data helps engineers to check proper functioning of protection system and identify the components which failed to operate as expected.	
6	Some important relays are missing at this GS. (for details see Annex-B and D)	All missing and defective relays need to be installed with latest version.	
7	Auto-reclosers are blocked on all 220kV circuits	"System Protection" and "System Operations" departments have to review the matter and take appropriate action for restoration of auto-reclosers. This can significantly reduce the outage time, reduction in transmission line damage and thus provide higher service continuity.	

Technical Audit of Gatti 500kV Grid Station

General			
Sr. No.	Findings	Recommendations	Remarks
1	The ground clearance of 500kV Muzaffargarh-Gatti circuit in the span of tower No. 559/560 is critical. Cracks have developed in the pile foundations of tower Nos. 484 to 490 in the river bed at Trimu Head. Thermovision survey of all transmission lines is not done.		

www.ep-ep.com.pk
info@ep-ep.com.pk