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## TECHNICAL AUDIT REPORT MARDAN 220KV GRID STATION

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## TECHNICAL AUDIT REPORT

# MARDAN 220KV GRID STATION

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## Technical Audit of Mardan 220kV Grid Station

### Introduction:

This report covers the technical audit of Mardan 220kV Grid Station (GS) located on Mardan-Nowshera road in the southern part of Mardan, KPK. This GS was commissioned in 1983. It has a total of 570MVA transformation capacity and feeds a vast area of Mardan and Peshawar divisions.

There are one (01) 250MVA 220/132kV, two (02) 160MVA 220/132kV autotransformers, one (01) 20/26MVA 132/11kV and one (01) 40MVA 132/11kV power transformers installed at this GS that are owned and maintained by NTDC. Four (04) 220kV and ten (10) 132kV circuits link this station to others. The GS is connected to Tarbela hydro power station, Ghazi Barotha hydro power station and Shahi Bagh 220kV GS through 220kV circuits. For 220kV and 132kV switchyards, double bus single breaker scheme is used. Single line diagram is attached (Annex-A).

EPP audit team comprising transmission and protection experts visited this GS from December 16, 2013 to December 26, 2013. This report reflects their findings and prioritized fixes.

### Findings:

Observations of technical experts are given below:

1. The loading condition of transformers is tabulated below:

Transformer No.	Rating			Max. Load Current Recorded (A)	Max. Percentage Loading of transformer (%)
	Voltage Ratio (kV/ kV/ kV)	Power (MVA)	HV/LV Current (A)		
T-1	220/132/11	250	656/1095	1150	105.0
T-2	220/132/11	160	420/700	753	107.6
T-3	220/132/11	160	420/700	720	102.9
T-4	132/11.5	26	113/1305	1495	114.6
T-5	132/11.5	40	175/2008	2052	102.19

From above, it is evident that all 220/132kV and 132/11.5kV transformers are overloaded as 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 transformer above 80% at ambient temperature equal to or above 40°C, prohibits the transformer's short time loading beyond its nameplate ratings. Exceeding this limit reduces the expected useful life of transformers in proportion to the amount and duration of overload.

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2. Both 220kV Mardan-Tarbela circuits are overloaded continuously per NEPRA prescribed limits i.e. 80%.
3. The 132kV bus coupler is out of circuit. The 132kV bus coupler is inoperative due to fault in the mechanism of circuit breaker.
4. Major maintenance of six (06) 220kV and eight (08) 132kV circuit breakers is pending due to unavailability of spare parts.  
Also, major maintenance of two (02) 220kV and three (03) 132kV circuit breakers will be due in near future. Moreover, operating mechanism of one (01) 132kV breaker is problematic. (For details see Annex-B)
5. The six (06) 132kV circuits Mardan-Nowshera Industrial, Mardan-Nowshera City, Mardan-Dargai, Mardan Swabi, Mardan-Katlang and Mardan-Jalala are overloaded per NEPRA prescribed limits i.e. 80%..
6. Fifteen (15) 220kV and thirty two (32) 132kV isolators are operated manually in the switchyard. Also, some of the 132kV isolators have improper alignment. (For details see Annex-B)
7. Only one set of station battery of 220VDC and 110VDC is available. Also another battery room is required to be constructed to accommodate the battery sets properly.
8. The 132KV capacitor banks exist but are out of the system since July,2008.
9. Lightning arrestors are not installed on all 220kV circuits.
10. The following tests are not being performed as required per SOPs for grid system operation and maintenance:
  - a. Purity and moisture content test of SF6 for circuit breakers
  - b. Leakage current measurement (LCM) test of lightning arresters
  - c. Capacitance & dissipation factor (C&DF) test of current transformers (CTs), potential transformers (PTs) and capacitor voltage transformers (CVTs)

It is necessary to conduct all tests timely to ensure healthiness of the equipment.

11. The old portions of 132kV bus bars are underrated and needs remodeling to cater for rapidly growing load.
12. Tele-protection on 220kV Ghazi Barotha and Shahi Bagh circuits is out of circuit. Also, direct transfer trip (DTT) facility is not available in 220kV system.

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- 13.** Auto reclosers on 220kV transmission circuits are blocked. Auto-reclosers can significantly reduce the outage time, reduction in transmission line damages and thus provide higher service continuity.
- 14.** The following protective relays on 220kV circuits are either defective or not installed:
- Four (04) distance to fault locators are not installed.
  - Two (02) backup earth fault relays are not installed on both Tarbela circuits
  - Six (06) synchro check relays are not installed.
  - Twenty four (24) trip circuit supervision relays are not installed.
  - Four (04) alarm supply supervision relays are not installed.
  - Four (04) closing supply supervision relays are not installed.
- 15.** The following relays are either defective or not installed or on 132kV circuits:
- Six (06) distance relays are defective.
  - Seven (07) trip circuit supervision relays are not installed.
  - Eight (08) backup earth fault protection relays are not installed.
  - Ten (10) alarm supply supervision relays are not installed.
  - Ten (10) closing supply supervision relays are not installed.
- 16.** Rough balance, HV connection and LV connection differential relays are not installed on transformer T-1 and T-2 to sectionalize the differential zones. Moreover, cross trip scheme is not installed on all 220/132kV transformers. (For details see Annex-B)
- 17.** The following relays are either defective or not installed on 220/132kV and 132/11kV transformers:
- Three (03) Over load (current based) relays.
  - Three (03) thermal overload protection relays.
  - Three (03) neutral over current relays.
  - One (01) oil temperature protection (Electronic).
  - Five (05) overload (current based) protection.
  - Three (03) trip lockout relays on 132/11kV transformer.
  - Two (02) HV winding temperature protection relays.
  - One (01) LV winding temperature protection relay.
  - Two (02) oil temperature protection relays.
  - Two (02) remote oil temperature indicators
- 18.** Breaker failure scheme in 220 kV system is inoperative due to missing of two (02) relays. Differential protection for 220kV bus bar-1 and 2 is not in circuit. For 220kV breaker failure scheme, 220kV bus coupler has not been included in the scheme without that breaker failure scheme is incomplete. Moreover, differential protection

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for 220kV bus bar-1 is blocked and is not installed on bus bar-2. Also, bus coupler protection is missing.

19. Sequential event recorders, fault recorders and Voltage/power recorders are not installed. This data helps engineers to check proper functioning of the protection system and identify components that failed to operate as required per scheme.
20. The 220kV synchronizing system is not installed. The 220kV breakers are closed without synchro-check.
21. The SCADA system needs to be implemented.
22. Testing equipment for protective relays is not available at the GS.
23. List of missing relays and other defective equipment is attached. (Annex-D)

### **Recommendations:**

<b>Transmission and Grid</b>			
<b>Sr. No.</b>	<b>Findings</b>	<b>Recommendations</b>	<b>Remarks</b>
1	Overloading of transformers	Both 160MVA transformers need to be augmented.	
2	Overloaded 220kV Mardan-Tarbela circuits	Twin bundling of existing line or an additional line is required to give relief on these overloaded circuits.	
3	Six (06) overloaded 132 kV transmission circuits.	NTDC needs to address this matter with PESCO.	
4	Inoperative 132kV bus couplers	The 132kV bus coupler's breaker should be checked thoroughly for rectification of the fault and brought back into service.	
5	Delay in overhauling of six (06) 220kV and eight (08) 132kV circuit breakers. (For details see Annex-B)	Six (06) 220kV and eight (09) 132kV circuit breakers need spare parts for major maintenance.	
6	Underrated 132kV bus bar	Remodeling and replacement of old portion of 132kV bus bars is required to meet future loading conditions.	
7	Unavailability of 220V and 110V station battery (set-2). Need of separate room for battery housing.	For 220V, new battery bank needs to be provided along with charger.	
8	Lightning arrestors are not installed on 220kV circuits.	Need to be installed.	

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9	Manual operation of forty one (41) isolators in the switchyard.	Eleven (11) 220kV and thirty (30) 132kV isolators are operated manually in the switchyard. Such switches should be made functional for remote operations. Also, improper alignment of some 132kV isolators needs to be set right.	
10	Leakage current measurement (LCM) test of lightning arresters, C&DF test of CTs, PTs and CVTs are not being done.	All these tests should be carried out to ensure healthiness of the equipment.	

<b>Protection</b>			
Sr. No.	Findings	Recommendations	Remarks
1	Tele-protection on 220kV Ghazi Barotha and Shahi Bagh circuits is out of circuit. Also, direct transfer trip (DTT) facility is not available in 220kV system.	System Protection and telecommunication departments of NTDC should look into it and make efforts to enable carrier aided facility at either ends of the transmission lines to clear faults rapidly.	
2	Absence of sequential event recorders, fault recorders and voltage/power recorders for 220kV system.	It is recommended to install sequential event recorders, fault recorders and voltage/power recorders. Such data helps engineers to check proper functioning of protection system and identify the components which failed to operate as expected.	
3	The following relays are either defective or not installed on transformers: three (03) over load (current based) relays, three (03) thermal overload protection relays, one (01) oil temperature protection (Electronic), five (05) overload (current based) protection, two (02) HV winding temperature protection relays, one (01) LV winding	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 relays need to be installed. (for details see Annex-B and D)	

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	temperature protection relay, two (02) oil temperature protection relays		
4	Absence of HV connection, LV connection and rough balance differential relays on all 220/132kV transformers.	Needs to be installed to sectionalize the differential zones.	
5	In-operative breaker failure and bus differential schemes in 220kV system.	NTDC needs to look into the matter.	
6	Blocked auto-reclosers on all 220kV and 132kV transmission lines.	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 damages and thus provide higher service continuity.	
7	Replacement of faulty, blocked and missing relays.	Needs replacement with latest version. For details see Annex-B and D.	
8	Erratic analogue meters installed in control room.	Need to be replaced with digital multi-function meters.	

<b>General</b>			
Sr. No.	Findings	Recommendations	Remarks
1	The SCADA system not installed	The SCADA system needs to be installed and made functional.	
2	Non-availability of testing equipment.	Universal testing sets need to be provided for appropriate testing of protection system.	

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