



USAID
FROM THE AMERICAN PEOPLE



USAID ENERGY POLICY PROGRAM

NTDC TECHNICAL AUDIT

FINAL REPORT

March 2015

This program is made possible by the support of the American people through the United States Agency for International Development (USAID)

USAID ENERGY POLICY PROGRAM

NTDC TECHNICAL AUDIT

FINAL REPORT

Submission Date: March 5, 2015

Contract No: AID-EPP-I-00-03-00004

Order No: AID-391-TO-12-00002

©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@ep-ep.com.pk

DISCLAIMER

The contents of this report are the sole responsibility of Advanced Engineering Associates International, Inc. (AEAI) and do not necessarily reflect the views of USAID or the United States Government.

CONTENTS

ACRONYMS.....	11
INTRODUCTION	1
FINDINGS.....	2
Grid Stations.....	2
Transmission Lines	3
System Protection	3
Protection Schemes	3
System Reliability and Operations	4
General.....	4
Training	4
RECOMMENDATIONS.....	5
ANNEX I: DETAILED FINDINGS.....	6

LIST OF ANNEX TABLES

Table 1: Transformer Loading Overview.....	6
Table 2: Shunt Reactors Installed at 500kV Circuits.....	20
Table 3: Transmission Lines Loading Overview (500kV GS)	22
Table 4: Transmission Lines Loading Overview (220kV GS)	24
Table 5: 500kV, 220kV, and 132kV Circuit Breakers Overview	29
Table 6: 220kV and 132kV Circuit Breakers Overview	30
Table 7: 500kV, 220kV, and 132kV Isolators	32
Table 8: 220kV and 132kV Isolators	33
Table 9: Essential Protection Relays for 500kV Autotransformers	35
Table 10: Essential Protection Relays for 220kV Autotransformers.....	36
Table 11: Essential Protection Relays for 132kV Power Transformers	38
Table 12: Essential Protection Relays for 500kV Shunt Reactors.....	41
Table 13: Essential Protection Relays for 500kV Transmission Lines.....	42
Table 14: Essential Protection Relays for 220kV Transmission Lines.....	43
Table 15: Essential Protection Relays for 132kV Transmission Lines.....	46
Table 16: Essential Protections Schemes for 500kV System.....	48
Table 17: Essential Protection Schemes for 220kV System.....	49

ACRONYMS

AEAI	Advanced Engineering Associates International, Inc.
CB	Circuit Breaker
C&DF	Capacitance and Dissipation Factor
DISCO	Distribution Company
EPP	Energy Policy Program
GIS	Gas Insulated Substations
GS	Grid Station
GSC	Grid System Construction
GSO	Grid System Operations
kV	Kilovolt
LCM	Leakage Current Measurement
NEPRA	National Electric Power Regulatory Authority
NPCC	National Power Control Center
NTDC	National Transmission and Dispatch Company
MIS	Management Information System
SCADA	Supervisory Control and Data Acquisition
TL	Transmission Line
UFLS	Under-Frequency Load Shedding
USAID	United States Agency for International Development
USG	United States Government
WAPDA	Water and Power Development Authority

INTRODUCTION

The Energy Policy Program (EPP) is a multi-year, United States Agency for International Development (USAID) funded initiative to increase power generation, diversify the fuel supply, and improve transmission capacity and reliability across Pakistan. EPP works with selected energy enterprises to assist the Government of Pakistan's (GOP) sector reform efforts. The EPP supports the joint goals of the United States Government and GOP in reforming the power sector and is designed to address Pakistan's chronic electricity shortage.

This technical audit report presents the findings of inspections of the overall status of Pakistan's National Transmission and Despatch Company's (NTDC) transmission system components. EPP's team of grid system experts conducted inspections at 39 of the 41 NTDC 500kV and 220kV grid stations and associated transmission lines; two active grid stations could not be inspected due to security reasons. The experts performed a detailed technical review and assessment from which this report was prepared. Audits were conducted over the period of September 2013 through December 2014. The audits were conducted by two teams of engineers; each team was comprised of two senior engineers with over 30 years' experience with NTDC and one junior engineer. A questionnaire was developed to gather the information on critical equipment, including transformers, shunt reactors, circuit breakers, isolators, autotransformers, power transformers, and their associated essential protection systems. Each grid station was visited by the teams of engineers and each piece of equipment was inspected; the data was collected and logged into the technical form. The questionnaire forms were designed to identify and record the problems and status of each grid station at the time of the inspection.

The findings of these inspections are intended to provide base case asset data for a management information system (MIS) and to be a source for developing asset improvement action plans, including the identification of specific improvement projects and the capacity building needs at NTDC.

The objectives of this technical audit were to:

- Determine the existing technical and operational status of the 500kV and 220kV grid stations and associated 132kV transmission network components;
- Consolidate the findings, including shortcomings, with relevant data in a report; and
- Recommend improvements in the transmission network.

FINDINGS

After carrying out the technical audit of NTDC transmission system, the EPP team prepared a detailed report with recommendations for each grid station along with its associated transmission lines. Details of these findings are provided in the attached Annex Tables I-17. The major findings are summarized and presented below.

GRID STATIONS

- Sixteen of 31 500/220kV autotransformers are loaded above 80% during peak loading hours, whereas no 500/220kV autotransformer is loaded above 100%.
- Sixty of 103 220/132kV autotransformers are loaded above 80% and 31 are loaded above 100% for some period during peak loading hours.
- There is seepage of oil in the top plate, bushings, and radiator junctions of some 500/220kV and 220/132kV autotransformers.
- Six out of 32 shunt reactors, which are needed for voltage stability of the system, are out of service. Isolating circuit breakers are not installed at 11 shunt reactor locations.
- Major maintenance of circuit breakers has not been done as follows:
 - 500kV circuit breakers: 68 out of 141
 - 220kV circuit breakers: 237 out of 443
 - 132kV circuit breakers: 200 out of 485

In addition, 4 of the 500kV, 11 of the 220kV, and 19 of the 132kV circuit breakers have defective remote control systems and can only be operated in the switchyard.

- The following isolators have inoperative motor drive systems:
 - 500kV isolators: 45 out of 347
 - 220kV isolators: 310 out of 1110
 - 132kV isolators: 739 out of 1314
- At certain grid stations, the following tests are not being performed as per standard operating procedures for grid system operation and maintenance:
 - Purity and moisture content test of SF6 for circuit breakers;
 - Capacitance and dissipation factor (C&DF), dissolved gas analysis, and detailed oil testing of transformers;
 - Leakage current monitoring (LCM) test of lightning arresters; and
 - C&DF test of current transformers, potential transformers, and capacitor voltage transformers.

All these tests are essential to ascertain the health of the equipment.

- Many capacitor banks installed at 11kV level in NTDC grid stations are inoperative. As per the National Electric Power Regulatory Authority (NEPRA) grid code, distribution feeders were to be removed from NTDC grid stations but were not. Capacitor banks need to be made operative and installed where required to reduce losses and improve system voltage.
- Ravi 220kV gas insulated substation (GIS) has not been overhauled due to lack of spare parts and trained staff.
- Two of the 220kV and three of the 132kV bus couplers are inoperative and must be made operative to achieve the benefits of the double-bus bar system.
- The 132kV bus bars at five of the 220kV grid stations located at WAPDA Town, Bund Road, Mardan, New Kot Lakpat, and Ravi are under-rated.
- There are problems with the 220V and 110V DC batteries at six of the grid stations. Working batteries are critical for safe operation of grid stations.

TRANSMISSION LINES

- Two of the 500kV and 12 of the 220kV circuits are loaded above 80%, which is the prescribed limit under the NEPRA grid code.
- Thermo-vision survey of most of the transmission lines is not being done as required by standard operating procedures.
- Some grid stations are fed from a single source. Analysis needs to be done to determine if a single feed is still appropriate for these grid stations.
- There are various other transmission line issues, including inadequate ground clearance, foundations needing repair, tower deterioration due to age, and general lack of maintenance.

SYSTEM PROTECTION

- Thermal overload relays that protect transformers from overheating are missing in many grid stations. Overheating shortens the life of transformers in proportion to the duration and magnitude of the high temperatures they endure.
- Trip lockout relays, which work in conjunction with Differential and Mechanical Protection Relays to ensure the transformer is not damaged when closing a circuit breaker after a fault, are missing on some transformers.
- Trip circuit supervision relays are missing at most older grid stations. Trip circuit supervision in circuit breakers ensures that the tripping coils of circuit breakers are always operational. If the trip relay fails to operate, upstream tripping or damage to equipment may result.
- Some grid stations do not have accurate transformer remote oil and winding temperature indicators. Periodic calibration or replacement of these indicators is required so operators in the control room record the correct temperatures and prevent overloading of the transformers.
- Some 220kV transmission lines do not have fault locators. Accurate fault location expedites repairs and restoration of lines and ultimately reduces revenue loss caused by outages.
- Automatic reclosers on circuit breakers that protect many 132kV and 220kV transmission lines are either blocked or defective. Approximately 85% of transmission line faults are transient in nature. If a transmission line trips due to a transient fault, service can be restored more expeditiously when the circuit breaker recloses automatically, significantly reducing the outage time and providing higher service continuity to customers.

PROTECTION SCHEMES

- **Tele-protection**

Many 220kV circuits do not have tele-protection (power line carrier) tripping schemes that enable fast tripping of transmission lines and allow high speed reclosing of circuit breakers.

- **Bus Differential**

Double-bus single breaker grid stations have only a single-bus differential scheme for both buses. A two-bus differential scheme is required to ensure switching flexibility and system reliability.

- **Breaker Failure**

Breaker failure schemes are not functional in many locations due to relays either missing or out of service. Breaker failure schemes minimize the damage when a breaker fails to clear a fault by tripping all sources.

- **Direct Transfer Trip**

Direct transfer trip schemes required for remote end tripping on breaker failure are not operational on most of the 220kV transmission lines due to the missing tele-link facilities.

- **220kV Synchronizing**

Synchronizing facility, which is essential for safe switching of the circuit breakers, is missing for 220kV circuit breakers.

SYSTEM RELIABILITY AND OPERATIONS

- **Automatic Under-Frequency Load Shedding (UFLS):**

UFLS provides system integrity when load exceeds generation and frequency declines. An effective UFLS plan minimizes the risk of partial or total system collapse and prevents damage to generation and transmission facilities. The Power Planning, System Operation, and System Protection Departments are responsible for designing and updating an equitable UFLS scheme. NTDC's Grid System Operations (GSO), the National Power Control Center (NPCC), and the distribution companies (DISCOs) are responsible for its implementation. UFLS schemes require relays to be operational at generators, transmission networks, and the distribution feeders. Most of these UFLS relays were found to be either missing or blocked and need to be put into service.

- **Cross-Trip Scheme**

Cross-trip schemes are either not installed or out of service at most of the NTDC grid stations. System failures can be reduced, load flow can be studied, and better load management will be possible with the introduction of cross-trip schemes.

- **Reliability Improvements**

The strengthening of the network, through integrated resource planning and completing the 220kV Uch II-Sibbi circuit and 500kV Shikarpur new grid station, is needed to meet a single contingency condition and to avoid possible major system collapse.

GENERAL

- **SCADA Telecom System**

- The NPCC project to upgrade the Supervisory Control and Data Acquisition (SCADA) telecom equipment had not been completed. A fully functioning SCADA is required to properly operate the system.
- SCADA telecom equipment has been installed and interfaced under the ongoing NPCC upgradation project, but it has not yet been commissioned at all of the grid stations.
- The Optical Ground Wire network has an excess of communication media capacity. Leasing that excess capacity to commercial telecom operators could be a source of increased revenue for the NTDC.

- **Energy Metering of Transmission Lines and Power Transformers**

Adequate standard metering equipment was not available on most of the transmission lines and power transformers. Without adequate metering, actual loading is unknown.

- **Sequential Event, Disturbance, Voltage, and Power Recorders**

Most sequential event, fault and disturbance, voltage, and power recorders are either not working or not installed. These devices are essential for reliable system operation by recording whether equipment was operated properly during a system disturbance.

TRAINING

To improve the operational performance of the NTDC, human resource practices and policies with regard to training, job transfers, merit pay, and promotion need to be reviewed and improvements implemented.

RECOMMENDATIONS

Several actions must be taken to resolve the issues documented in the technical audits:

- Relieve overloading on transformers, bus bars, and lines by adding transformer capacity, shifting load from overloaded to less loaded transformers, and bringing generation on line in load centers.
- Repair shunt reactors and put them in service.
- Perform necessary maintenance on circuit breakers, transformers, GIS, and other equipment.
- Procure or fabricate necessary parts to keep circuit breakers operating properly, including remote operations.
- Repair and put all motor operated isolators in service.
- Perform routine maintenance following standard operating procedures.
- Repair and place in service all system protective relays, including tele-protection, thermal overload, hand reset lockouts, breaker failure, bus differential, power line carriers, and other necessary equipment.
- Repair and place reclosers in service.
- Place full SCADA functionality in service, and appoint a qualified SCADA Project Manager, reporting directly to the Managing Director, with sufficient authority to cut across all departmental lines to get communications links, field wiring, and other required elements in service.
- Sequential event recorders and other recorders should be purchased or repaired and placed in service.
- Assess training needs across all NTDC departments.

ANNEX I: DETAILED FINDINGS

Table I: Transformer Loading Overview

Sr. No.	Name of Grid Station (GS)		500/220kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
1	Sheikhupura 500kV GS	T-1	600		✓	-	OK	OK	Remote temp. indicators are working ok.
		T-2	600		✓	-	OK	OK	Remote temp. indicators are working ok.
		T-3	600		✓	-	OK	OK	Remote temp. indicators are working ok.
		T-4	600		✓	-	OK	OK	Remote temp. indicators are working ok.
2	Yousafwala 500kV GS	T-1	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
3	Nokhar 500kV GS	T-1	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
4	Gatti Faisalabad 500kV GS	T-1	450	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-2	450	-	✓	-	OK	OK	Auxiliary control panel for transformer is not installed.
		T-3	450	-	✓	-	OK	OK	Auxiliary control panel for transformer is not installed.
		T-4	450	-	✓	-	OK	OK	Auxiliary control panel for transformer is not installed.
5	Sheikh Muhammadi 500kV GS	T-1	450	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-2	450	-	✓	-	OK	OK	Remote temp. indicators are working ok.

Sr. No.	Name of Grid Station (GS)		500/220kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-9	450	-	N/A	-	OK	OK	It was out of service due to unavailability of relay panels at the time of technical audit, but has since been placed in service.
6	Rawat 500kV GS	T-1	450	-	✓	-	OK	OK	One remote oil temp. indicator is not installed.
		T-2	450	-	✓	-	OK	OK	Three remote oil temp. indicators are defective.
		T-3	450	-	✓	-	OK	OK	Three remote oil temp. indicators are defective.
7	Multan 500kV GS	T-1	450	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	450	✓	-	-	OK	OK	Remote temp. indicators are working ok.
8	Muzaffar Garh 500kV GS	T-1	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
9	Guddu 500kV GS	T-1	450	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-2	450	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-3	450	-	✓	-	OK	OK	All remote winding and oil temp. indicators are defective.
10	Dadu 500kV GS	T-2	450	✓	-	-	OK	OK	All remote winding and oil temp. indicators are defective.
		T-4	450	✓	-	-	OK	OK	Three remote winding and three oil temp. indicators are defective.
11	NKI 500kV GS	T-1	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	600	✓	-	-	OK	OK	Remote temp. indicators are working ok.
12	Jamshoro 500kV GS	T-1	450	✓	-	-	OK	OK	All remote winding and oil temp. indicators are defective.

Sr. No.	Name of Grid Station (GS)		500/220kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-2	450	✓	-	-	OK	OK	All remote winding and oil temp. indicators are defective.
Total			15750						

Sr. No	Name of Grid Station (GS)		220/132kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
1	Sheikhupura 500kV GS	T-5	160	-	-	✓	OK	OK	One remote winding temp. indicator is defective and one remote oil temp. Indicator is not installed.
		T-6	160	-	-	✓	OK	OK	One remote winding temp. indicator is defective and one remote oil temp. Indicator is not installed.
		T-7	160	-	✓	-	OK	OK	One remote oil temp, indicating meter is defective.
2	Yousafwala 500kV GS	T-3	160	-	-	✓	OK	OK	Remote oil and winding temp. indicators are not installed.
		T-4	160	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.
		T-5	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-6	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
3	Nokhar 500kV GS	T-4	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.

Sr. No	Name of Grid Station (GS)		220/132kV						
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		Remarks
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-5	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-6	160	✓	-	-	OK	OK	Remote temp. indicators are working ok.
4	Gatti 500kV GS	No 220/132kV transformer is installed at this GS.							
5	Sheikh Muhammadi 500kV GS	T-3	0	-	-	-	-	-	Transformer was not present in the GS at the time of technical audit.
		T-4	160	-	✓	-	One gauge is defective	One gauge is defective	Remote winding temp. indicator is defective and remote oil temp. Indicator is not installed.
		T-5	160	-	-	✓	OK	OK	Both oil and winding temp. indicators are not installed.
		T-8	250	✓	-	-	OK	OK	Remote temp. indicators are working ok.
6	Rawat 500kV GS	T-4	250	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-5	160	-	✓	-	OK	OK	Remote winding temp. indicators are defective and remote oil temp. indicators are not installed.
		T-6	250	-	✓	-	OK	OK	Remote temp. indicators are working ok.
7	Multan 500kV GS	T-3	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
		T-4	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
		T-5	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
8	Muzaffargarh 500kV GS	No 220/132kV transformer is installed at this GS.							
9	Guddu 500kV GS	No 220/132kV transformer is installed at this GS.							

Sr. No	Name of Grid Station (GS)		220/132kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
10	Dadu 500kV GS	T-1	160	-	✓	-	OK	OK	All remote winding and oil temp. indicators are defective.
		T-3	160	-	✓	-	OK	OK	Only one remote winding temp. indicator is defective.
		T-5	160	-	N/A	-	OK	OK	Remote winding temp. indicators are defective and remote oil temp. Indicators are not installed.
11	NKI 500kV GS		No 220/132kV transformer is installed at this GS.						
12	Jamshoro 500kV GS	T-3	160	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-7	160	✓	-	-	OK	OK	Remote temp. indicators are working ok.
Total			4110						

Sr. No	Name of Grid Station (GS)		220/11.5kV and 132/11.5kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
1	Sheikhupura 500kV GS	T-8	20	For Auxiliary use only	-	-	OK	OK	All remote winding and oil temp. indicators are defective.

2	Yousafwala 500kV GS	T-7	13	-	-	✓	OK	Defective	Remote temp. indicators are working ok.	
		T-8	26	-	✓	-	OK	Defective	Remote temp. indicators are working ok.	
3	Nokhar 500kV GS	T-8	13	✓	-	-	OK	OK	Remote temp. indicators are working ok.	
4	Gatti Faisalabad 500kV GS	No 132/11kV transformer is installed at this GS.								
5	Sheikh Muhammadi 500kV GS	T-6	13	-	-	✓	OK	OK	Remote temp. indicators are not installed.	
		T-7	13	-	✓	-	OK	OK	Remote temp. indicators are not installed.	
6	Rawat 500kV GS	T-7	13	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.	
		T-8	13	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.	
7	Multan 500kV GS	T-6	6.3	✓	-	-	Not working	Not working	Auxiliary control panel for transformer is not installed.	
8	Muzaffar Garh 500kV GS	No 132/11kV transformer is installed at this GS.								
9	Guddu 500kV GS	No 132/11kV transformer is installed at this GS.								
10	Dadu 500kV GS	No 132/11kV transformer is installed at this GS.								
11	NKI 500kV GS	No 132/11kV transformer is installed at this GS.								
12	Jamshoro 500kV GS	No 132/11kV transformer is installed at this GS.								
Total			130.3							

Sr. No	Name of Grid Station (GS)	Rating Power (MVA)	220/132kV						Remarks
			Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status			
			Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge		
1	Bund Road 220kV GS	T-1	160	-	✓	-	OK	OK	All remote temp. indicators are defective.

Sr. No	Name of Grid Station (GS)		220/132kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
	T-2	160	-	✓	-	OK	OK	160MVA transformer was augmented with 250MVA after technical audit.	
	T-3	160	-	✓	-	Defective	OK	Remote temp. indicators are working ok.	
	T-4	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.	
2	T-1	250	-	-	✓	OK	OK	Remote temp. indicators are working ok.	
	T-2	250	-	-	✓	OK	OK	Remote temp. indicators are working ok.	
	T-3	250	-	-	✓	OK	OK	Remote temp. indicators are working ok.	
3	T-1	250	-	✓	-	OK	OK	Remote temp. indicators are working ok.	
	T-2	250	-	✓	-	OK	OK	One remote oil temp. indicator is defective.	
	T-3	250	-	✓	-	OK	OK	Remote temp. indicators are working ok.	
4	T-1	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.	
	T-2	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.	
	T-3	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.	
5	T-1	160	-	✓	-	OK	OK	Remote winding temp. indicators are defective and remote oil temp. indicators are not installed.	
	T-2	160	-	✓	-	OK	OK	All remote winding and oil temp. indicators are defective.	
	T-3	160	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.	
6	T-1	250	-	-	✓	OK	OK	Remote temp. indicators are working ok.	
	T-2	160	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.	
	T-3	160	-	-	✓	OK	OK	Remote oil temp. indicators are defective.	

Sr. No	Name of Grid Station (GS)		220/132kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
7	Sarfaraznagar 220kV GS	T-1	160	-	✓	-	OK	OK	One remote winding and one remote oil temp. indicators are defective.
		T-2	160	-	✓	-	OK	OK	One remote oil temp. indicator is defective.
		T-3	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
8	Ghakhar 220kV GS	T-1	160	-	✓	-	OK	OK	One remote winding temp. indicator is defective and remote oil temp. indicators are not installed.
		T-2	160	-	✓	-	OK	OK	Auxiliary control panel for transformer is not installed.
		T-3	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-4	160	-	✓	-	OK	OK	One remote winding temp. indicator is defective.
9	Sialkot 220kV GS	T-1	160	-	✓	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.
		T-2	160	-	✓	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.
		T-3	160	-	✓	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.
10	Nishatabad 220kV GS	T-1	Failed	-	N/A	-	N/A	N/A	Failed
		T-2	Failed	-	N/A	-	N/A	N/A	Failed
		T-3	63.5	-	N/A	-	N/A	N/A	Failed after technical audit.
		T-4	63.5	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-5	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
11	Jaranwala Road 220kV GS	T-1	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-2	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-3	160	-	✓	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.

Sr. No	Name of Grid Station (GS)		220/132kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-4	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
12	Samundri Road 220kV GS	T-1	160	-	-	✓	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.
		T-2	160	-	-	✓	OK	OK	Remote winding temp. indicator is defective.
		T-3	160	-	-	✓	OK	OK	Remote oil temp. indicator is not installed.
13	Ludewala 220kV GS	T-1	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
		T-2	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
		T-3	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
14	ISPR (Sanjani) 220kV GS	T-1	160	-	✓	-	OK	OK	One remote oil temp. indicator is defective.
		T-2	160	-	✓	-	OK	OK	One remote oil temp. indicator is defective.
		T-3	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
15	University Islamabad 220kV GS	T-1	250	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	250	✓	-	-	OK	OK	Remote temp. indicators are working ok.
16	Shahi Bagh 220kV GS	T-1	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-2	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-3	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-4	Failed	-	N/A	-	N/A	N/A	Failed
17	Burhan 220kV GS	T-1	160	-	-	✓	OK	OK	One remote winding temp. indicator is defective and remote oil temp. indicators are not installed.
		T-2	160	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.
		T-3	160	-	-	✓	OK	OK	One remote winding temp. indicator is defective and remote oil temp. indicators are not installed.

Sr. No	Name of Grid Station (GS)		220/132kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-4	160	-	-	✓	Not installed	Defective	Remote oil temp. indicators are not installed.
18	Daud Khel 220kV GS	T-1	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
		T-2	160	-	-	✓	OK	OK	Remote winding temp. indicator is not installed.
19	Bannu 220kV GS	T-1	160	-	✓	-	OK	OK	Remote oil temp. indicator is not installed.
		T-2	160	-	✓	-	OK	OK	Remote oil temp. indicator is not installed.
		T-5	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
20	Vehari 220kV GS	T-1	160	-	-	✓	OK	OK	Remote winding temp. indicators are defective and remote oil temp. indicators are not installed.
		T-2	160	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.
		T-3	160	-	-	✓	OK	OK	One remote winding and one remote oil temp indicators are defective.
21	Muzaffargarh 220kV GS	T-1	160	-	✓	-	OK	Defective	Remote oil temp. indicators are not installed.
		T-2	160	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.
22	Bahawalpur 220kV GS	T-1	160	-	✓	-	Defective	OK	Remote oil temp. indicators are not installed.
		T-2	160	-	✓	-	Defective	OK	Remote oil temp. indicators are not installed.
		T-3	160	-	-	✓	OK	OK	Remote temp. indicators are working ok.
23	Rohri 220kV GS	T-1	250	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	250	✓	-	-	OK	OK	Remote temp. indicators are working ok.
24	Deherki 220kV GS	T-1	250	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-2	160	✓	-	-	OK	OK	Remote temp. indicators are working ok.
25	Shikarpur 220kV GS	T-1	160	-	✓	-	OK	OK	All remote winding and oil temp. indicators are defective.

Sr. No	Name of Grid Station (GS)		220/132kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-2	160	-	✓	-	OK	OK	Remote winding temp. indicators are defective and remote oil temp. indicators are not installed.
		T-3	160	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.
26	Hala Road 220kV GS	T-1	160	-	✓	-	OK	OK	All remote temp. indicators are defective.
		T-2	160	-	✓	-	OK	OK	One remote winding temp. indicator is defective and one remote oil temp. indicator is not installed.
		T-3	160	-	✓	-	OK	OK	Remote temp. indicators are working ok.
27	T.M Khan Road 220kV GS	T-1	160	-	✓	-			
		T-2	160	-	✓	-			
Total			13527						

Note: Two 220kV grid stations, i.e., Sibbi and Quetta have not been audited due to security concerns in the area.

Sr. No	Name of Grid Station (GS)		132/11.5kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
1	Bund Road 220kV GS	T-5	26	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-6	26	-	✓	-	OK	OK	Remote temp. indicators are working ok.
2	New Kotlakhpat 220kV GS	T-4	26	-	✓	-	OK	OK	Remote winding temp. indicator is defective.

Sr. No	Name of Grid Station (GS)		132/11.5kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-5	26	-	✓	-	OK	OK	Transformer auxiliary control panel is not installed.
		T-6	26	-	✓	-	OK	OK	Remote oil temp. indicator is defective.
3	Ravi 220kV GS	T-4	26	-	-	✓	OK	OK	All remote winding and oil temp. indicators are not installed.
		T-5	26	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.
4	Wapda Town 220kV GS	T-4	26	-	✓	-	OK	OK	All remote winding and oil temp. indicators are not defective.
		T-5	40	-	✓	-	OK	OK	Remote temp. indicators are working ok.
		T-6	26	-	✓	-	OK	OK	Remote temp. indicators are working ok.
5	Kala Shah Kaku 220kV GS	T-4	40	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-5	26	-	✓	-	OK	OK	Remote temp. indicators are working ok.
6	Mardan 220kV GS	T-4	26	-	-	✓	OK	OK	Remote temp. indicators are working ok.
		T-5	40	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.
7	Sarfaraznagar 220kV GS	T-4	40	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-5	26	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.
8	Ghakhar 220kV GS	T-5	26	-	-	✓	OK	OK	Remote oil temp. indicators are not installed.
		T-6	26	-	✓	-	OK	OK	Remote winding temp. indicators are defective and remote oil temp. indicators are not installed.
9	Sialkot 220kV GS	T-4	13	-	✓	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.

Sr. No	Name of Grid Station (GS)		132/11.5kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
		T-5	26	✓	-	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.
10	Nishatabad 220kV GS	T-8	13	Auxiliary load only	-	-	OK	OK	Remote winding and oil temp. indicators are not installed.
11	Jaranwala Road 220kV GS	T-5	26	-	✓	-	OK	OK	One remote winding temp. indicator is defective and remote oil temp. indicators are not installed.
		T-6	26	-	✓	-	OK	OK	One remote winding temp. indicator is defective and remote oil temp. indicators are not installed.
12	Samundri Road 220kV GS	T-4	13	-	✓	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.
		T-5	13	✓	-	-	OK	OK	Remote winding temp. indicator is defective and remote oil temp. indicator is not installed.
13	Ludewala 220kV GS	T-4	13	✓	-	-	OK	OK	One remote winding temp. indicator is defective.
14	ISPR (Sanjani) 220kV GS	T-4	13	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
		T-5	13	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
15	University Islamabad 220kV GS	T-4	26	✓	-	-	OK	OK	Remote temp. indicators are working ok.
		T-5	26	-	-	✓	OK	OK	Remote temp. indicators are working ok.
16	Shahi Bagh 220kV GS	T-5	13	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.
		T-6	13	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.
17	Burhan 220kV GS	T-5	13	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
18	Daud Khel 220kV GS	T-3	13	✓	-	-	OK	OK	Remote winding temp. indicators are not installed.

Sr. No	Name of Grid Station (GS)		132/11.5kV						Remarks
			Rating Power (MVA)	Max. Percentage Loading of Transformer Recorded			Temperature Gauges Status		
				Below 80%	Above 80%	Above 100%	Oil Temp. Gauge	Winding Temp. Gauge	
19	Bannu 220kV GS	T-3	26	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
		T-4	26	-	✓	-	OK	OK	Remote winding temp. indicators are defective and remote oil temp. indicators are not installed.
20	Vehari 220kV GS	T-4	13	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.
		T-5	26	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
21	Muzaffar Garh 220kV GS	T-3	13	✓	-	-	OK	OK	Remote temp. indicators are working ok.
22	Bahawalpur 220kV GS	T-4	26	-	✓	-	OK	OK	Remote winding temp. indicators are defective and remote oil temp. indicators are not installed.
23	Rohri 220kV GS	T-3	13	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
24	Deharki 220kV GS	No 132/11kV transformer is installed at this GS.							
25	Shikarpur 220kV GS	T-4	13	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
		T-5	13	✓	-	-	OK	OK	Remote oil temp. indicators are not installed.
26	Hala Road 220kV GS	T-4	26	-	✓	-	Defective	OK	Remote winding temp. indicators and remote oil temp. indicators are not installed.
		T-5	26	-	✓	-	OK	OK	Remote oil temp. indicators are not installed.
27	T.M Khan Road 220kV GS	T-4	13	✓	-	-			
		T-5	13	-	✓	-			
Total			1044						

Note: Two 220kV grid stations, i.e., Sibbi and Quetta have not been audited due to security concerns in the area.

Table 2: Shunt Reactors Installed at 500kV Circuits

Sr. No	Name of Grid Station (GS)	Name of 500kV Circuits	Rating Power (MVAR)	Status of Shunt Reactors	Status of Circuit Breakers	Remarks
1	Sheikhupura 500kV GS	500kV Sheikhupura-Nokhar Circuit-1	3*37	In service	Installed	Shunt reactor is working ok.
		500kV Sheikhupura-Nokhar Circuit-2	3*37	Out of service	Installed	Buchholz alarm indications usually appear on B-phase due to accumulation of air in the tank, which leads to its tripping.
		500KV Sheikhupura-Yousafwala	3*20	Out of service	Not installed	The R-phase unit is damaged.
2	Yousafwala 500kV GS	500kV Yousafwala Multan	3*37	In service	Installed	Shunt reactor is working ok.
		500kV Yousafwala-Sheikhupura Lahore	3*37	In service	Installed	Slight oil leakage exists in red and blue phases.
3	Nokhar 500kV GS	500kV Nokhar-Rawat circuit-1	3*37	In service	Installed	Shunt reactor is working ok.
		500kV Nokhar-Rawat Circuit-2	3*37	In service	Installed	Shunt reactor is working ok.
4	Gatti Faisalabad 500kV GS	500kV Gatti-Muzaffargarh	3*37	In service	Installed	Shunt reactor is working ok.
		500kV Gatti-Barotha Circuit-1	3*37	In service	Not installed	Excessive oil leakage exists in the top cover gasket of main tanks. Also, no lightning arrester is installed.
		500kV Gatti-Barotha Circuit-2	3*37	Out of service	Not installed	The Blue-phase unit is defective. Excessive oil leakage also exists in the top cover of tanks for red and yellow units. Also, no lightning arrester is installed.
		500kV Gatti-Multan Circuit	3*21.77	In service	Not installed	Lightning arrestors are not installed.
		500kV Gatti-Rousch	3*22	In service	Installed	Shunt reactor is working ok.
5	Rawat 500kV GS	500kV Rawat-Nokhar Circuit-1	3*37	In service	Installed	Shunt reactor is working ok.
		500kV Rawat-Nokhar Circuit-2	3*37	In service	Not installed	Performance of shunt reactor is ok.
6	Multan 500kV GS	500kV Multan-Guddu-1 (D.G. Khan)	3*37.1	In service	Not installed	Lightning arrestors are not installed.
		500kV Multan-Guddu 747	3*37	In service	Installed	Shunt reactor is working ok.
		500kV Multan-Muzaffargarh	3*37.1	In service	Not installed	Lightning arrestors are not installed.
		500KV Multan-Yousafwala (Sahiwal)	54	Out of service	Not installed	The reason is said to be due to nonfunctional direct transfer trip (DTT) system at Yousafwala end.
		500kV Multan-Gatti	N/A	N/A	N/A	This circuit has a length of 222 km and no shunt reactor is installed on this end.

Sr. No	Name of Grid Station (GS)	Name of 500kV Circuits	Rating Power (MVAR)	Status of Shunt Reactors	Status of Circuit Breakers	Remarks
7	Muzaffar Garh 500kV GS	500kV Muzaffar Garh-Guddu	3*37	In service	Installed	Shunt reactor is working ok.
		500kV Muzaffar Garh-Gatti	3*37	In service	Installed	Shunt reactor is working ok.
8	Guddu 500kV GS	500kV Guddu-Dadu Circuit-2	3*37.1	In service	Not installed	Seepage exists in Buchholz relay and radiator to body junction of yellow phase unit. Also, no lightning arrester is installed.
		500kV Guddu-Dadu Circuit-1	3*37.1	In service	Not installed	Seepage exists in body to radiator junction of yellow phase unit. Also, no lightning arrester is installed.
		500kV Guddu-D.G. Khan	3*37.1	In service	Not installed	Leakage exists in radiator to body junctions of yellow and blue phase units. Also, no lightning arrester is installed.
		500kV Guddu-Muzaffar Garh	3*37.1	In service	Installed	Shunt reactor is working ok.
9	Dadu 500kV GS	500kV Dadu-Jamshoro Circuit-1	3*22	In service	Installed	Water storage tank for fire protection system installed on this shunt reactor is damaged.
		500kV Dadu-Jamshoro Circuit-2	3*22	Out of service	Installed	The shunt reactor is out of service.
		500kV Dadu-Guddu Circuit-1	3*37	Out of service	Installed	The shunt reactor is out of service due to its damaged blue phase unit whereas red phase unit is out of circuit due to damaged bushing.
		500kV Dadu-Guddu Circuit-2	3*37	In service	Installed	Water storage tank for fire protection system installed on this shunt reactor is damaged.
10	Jamshoro 500kV GS	500kV Jamshoro-Hub	3*22	In service	Installed	Shunt reactors are working ok. However, water storage tank for fire protection system installed on all four shunt reactors is damaged.
		500kV Jamshoro-NKI	3*22	In service	Installed	
		500kV Jamshoro-Dadu Circuit-1	3*22	In service	Installed	
		500kV Jamshoro-Dadu Circuit-2	3*22	In service	Installed	

Table 3: Transmission Lines Loading Overview (500kV GS)

Sr. No.	Name of Grid Station (GS)	Total No. of Circuits			Total No. of Circuits Loaded Above 80%			Name of 500kV and 220kV Circuits Loaded Above 80%	Remarks
		500k V	220k V	132k V	500k V	220k V	132k V		
1	Sheikhupura 500kV GS	4	8	8	0	0	2	-	NTDC needs to take up the matter of 132kV overloaded lines with concern DISCO.
2	Yousafwala 500kV GS	2	6	8	0	0	5	-	NTDC needs to take up the matter of 132kV overloaded lines with concern DISCO.
3	Nokhar 500kV GS	4	2	6	0	0	2	-	NTDC needs to take up the matter of 132kV overloaded lines with concern DISCO.
4	Gatti Faisalabad 500kV GS	6	10	N/A	2	-	N/A	500kV Gatti-Ghazi Barotha HPS circuits	For 500kV Gatti-Muzaffargarh circuit, ground clearance in the span of tower Numbers 559 & 560 is critical and dangerous due to raising of road. Also, some 220kV circuits and 500kV Gatti-Barotha circuits need protection wall around the towers for plinth protection or due to excessive digging of earth around the towers.
					-	2		220kV Gatti-Nishatabad circuits	
					-	2		220kV Gatti-Jaranwala Road circuits	
5	Sheikh Muhammadi 500kV GS	1	4	8	0	0	0	-	There is only one 500kV source for this GS (Tarbela HPS) and the outage of this circuit creates low voltage problem in the area that is being fed from this station.
6	Rawat 500kV GS	5	6	13	0	0	3	-	NTDC needs to take up the matter of 132kV overloaded lines with concern DISCO.
7	Multan 500kV GS	6	14	6	0	0	2	-	NTDC needs to take up the matter of 132kV overloaded lines with concern DISCO. Moreover, 220kV Multan – NGPS circuits are passing over residential buildings at certain locations, which need to be checked for proper clearance.
8	Muzaffargarh 500kV GS	3	14	N/A	0	0	N/A	-	For 500kV Gatti-Muzaffargarh circuit, ground clearance in the span of tower Numbers 559 & 560 is critical and dangerous due to raising of road.

Sr. No.	Name of Grid Station (GS)	Total No. of Circuits			Total No. of Circuits Loaded Above 80%			Name of 500kV and 220kV Circuits Loaded Above 80%	Remarks
		500k V	220k V	132k V	500k V	220k V	132k V		
9	Guddu 500kV GS	5	3	N/A	0	1	N/A	220kV Guddu-Uch circuit	For 500kV Guddu-Dadu circuits, line to ground clearance between locations 325-326 for circuit-1 and 454- 55 for circuit-2 have decreased due to construction of Sukkar-Shikarpur road. Several foundations are in the vicinity of fish farms. For 220kV Guddu-Sibbi and Guddu-Uch circuits, sky wire is missing at a few locations. Moreover, for 220kV Guddu-Shikarpur circuit, 50% guy wires of the line are missing and clearance of the line between spans 56-57, 124-125, and 625-626 has decreased.
10	Dadu 500kV GS	4	2	7	0	0	1	-	On 500kV Dadu-Jamshoro circuits, cracks have been developed in tower foundation at location Nos. 41, 67, 104, 106, and 114 of circuit-1 and at location no. 42 for circuit-2. Appropriate measures need to be taken for repair of affected foundations. Stubs and main members of few tower are also rusted/damaged. Also, the newly constructed 220kV Dadu-Khuzdar circuits are full of discrepancies, such as shortage of braces, missing split pins, arcing horns, phase plates, number plates, danger plates, nuts/bolts, joint boxes of OPGW, and other accessories etc. at various locations.
11	NKI 500kV GS	2	2	N/A	0	0	N/A	-	The towers and hardware of first 10 towers of 500kV NKI-Hub circuit have rusted due to severe humid environment along the seashore. Shield wire from locations 1 to 35 is also damaged. Moreover, at certain locations of 500kV NKI-Jamshoro transmission circuit, spacers are damaged and affecting the conductor.
12	Jamshoro 500kV GS	4	6	6	0	0	2	-	On 500kV Jamshoro-Hub circuit, complete towers and hardware are rusted from tower no. 1 to 10 near Hub and shielding wire is also damaged from tower no. 1 to 35. Spacer dampers along with conductor are damaged from tower no. 390 to 430. On 220kV Jamshoro-KDA circuits, conductor is corroded between tower numbers 150 to 383 near KDA 33kV grid station and needs replacement on both circuits along with hardware.

Table 4: Transmission Lines Loading Overview (220kV GS)

Sr. No	Name of Grid Station (GS)	Total No. of Circuits		Total No. of Circuits Loaded Above 80%		Names of 220kV Circuits Loaded Above 80% During Peak Season	Remarks
		220kV	132kV	220kV	132kV		
1	Bund Road 220kV GS	8	10	2	0	220kV Bund Road-NKLP circuits	These 220kV circuits were commissioned in early 1970's, so the condition of conductor and allied material of the line have deteriorated. The capacity of conductor needs to be enhanced. The old critical 32 towers need to be replaced with tubular poles. Also, missing conductor from some spans of 132kV Bund Road-Ravi double circuit transmission line need to be completed as it is a vital 132kV link between the two GSs.
2	New Kotlakhpat 220kV GS	6	10	2	2	220kV NKLP-Bund Road circuits	These circuits were commissioned in early 1970's; the condition of conductor and towers is critical. The old critical 32 towers need to be replaced along with changing conductor to twin-bundled conductors. Two 132kV circuits, NKLP-DHA-1 and NKLP-DHA-5, are overloaded.
3	Ravi 220kV GS	4	12	1	0	220kV Ravi-ATLAS thermal power station circuit	The 220kV Ravi-KSK and Ravi-Sheikhupura circuits are passing through the bed of Ravi River and the towers are in deteriorated condition. The conductor is damaged and braces are also missing.
4	WAPDA Town 220kV GS	2	8	0	0	-	-
5	Kala Shah Kaku 220kV GS	10	11	0	6	-	The 132kV double circuit transmission line linking KSK and Ravi 220kV GSs is energized on no load.
6	Mardan 220kV GS	4	10	2	6	220kV Mardan-Tarbela circuits	Six 132kV circuits Mardan-Nowshera Industrial, Mardan-Nowshera City, Mardan-Dargai, Mardan Swabi, Mardan-Katlang, and Mardan-Jalala are loaded above the prescribed limits as per NEPRA grid code, i.e., 80%.
7	Sarfaraznagar 220kV GS	4	8	0	2	-	Two 132kV Sarfaraz Nagar-Bhaiperu and Sarfaraz Nagar-Kot Radha Kishan circuits are overloaded.
8	Gakhar 220kV GS	4	13	1	2	220kV Gakhar-	-

Sr. No	Name of Grid Station (GS)	Total No. of Circuits		Total No. of Circuits Loaded Above 80%		Names of 220kV Circuits Loaded Above 80% During Peak Season	Remarks
		220kV	132kV	220kV	132kV		
						Sahuwala circuit	
9	Sahuwala Sialkot 220kV GS	2	10	1	4	220kV Sahuwala-Gakhar circuit	The existing sources, i.e., Kala Shah Kaku and Gakkhar 220kV single circuits are insufficient in case of an outage of any one of these sources. Also, four 132 kV circuits are loaded above the prescribed limits as per NEPRA grid code, i.e., 80%.
10	Nishatabad 220kV GS	4	11	2	2	220kV Nishatabad-Gatti circuits	Tower Nos. 2, 3, 4, 5, 7, and 8 of 220kV Nishatabad-Gatti circuits require retaining walls for protection of tower foundations affected due to water flow and encroachment of residents as the line passes through thickly populated area. The clearance of 220kV Nishatabad-Sumandry road circuits is inadequate and dangerous in the spans of tower Nos. 597/598, 599/600, 610/611, and 611/612. The line from tower No. 590 to 616 passes through thickly populated area and needs re-routing. The tower foundations at location No. 579, 580, and 587 are vulnerable and require protection walls.
11	Jaranwala Road 220kV GS	2	8	2	3	220kV Jaranwala Road-Gatti circuit	The capacity of conductor of existing 220kV feeding circuits needs to be enhanced or at least one more 220kV circuit from any source other than Gatti needs to be constructed to share load of the existing ones. Also, the 132kV Satiana and old thermal circuits are loaded above the prescribed limits as per NEPRA grid code, i.e., 80%.
12	Samundry Road 220kV GS	4	6	0	2	-	The clearance of 220kV Samundry Road-Nishatabad circuits is inadequate in the spans of tower No. 597/598, 599/600, 610/611, and 611/612, which needs to be improved by installation of extended towers. The transmission line from tower No. 590 to 616 passes through thickly populated area and needs re-routing using tubular poles. The tower foundations at location No. 579, 580, and 587 are vulnerable and require protection walls. The clearance of 220kV Samundry Road-Multan circuits is inadequate and dangerous in the spans of tower Nos. 306/307, 317/318, 422/423, 513/514, and 521/522.

Sr. No	Name of Grid Station (GS)	Total No. of Circuits		Total No. of Circuits Loaded Above 80%		Names of 220kV Circuits Loaded Above 80% During Peak Season	Remarks
		220kV	132kV	220kV	132kV		
13	Ludewala 220kV GS	4	6	0	3	-	The 132kV Ludewala-Joharabad, old Ludewala-1, and old Ludewala-2 circuits are loaded above the prescribed limits, i.e., 80%.
14	ISPR (Sanjani) 220kV GS	6	11	0	1	-	The 132kV ISPR-Pirwadhay circuit is loaded above the prescribed limits, i.e., 80%.
15	University Islamabad 220kV GS	2	7	0	0	-	The GS is being fed radially from Rawat 500kV GS. In case of an outage, the supply to the GS will be interrupted. Retaining walls are required at tower Nos. 63, 66, 79, 81, 82, 88, 95, 100, 110, and 123 of 220kV Rawat-University line for protection against flowing water. Tower No. 26 to 45 lie in Bahria Town where surrounding level has been raised and stagnant water causes erosion of tower members. Tree topping from tower Nos. 130 to 164 is required, which needs to be taken up with Capital Development Authority (CDA).
16	Shahi Bagh 220kV GS	2	4	0	4	-	Both circuits from Ghazi Barotha HPS are not directly connected to this GS due to right of way issue and one of the circuits has been diverted to Sheikh Muhammadi 500kV GS by linking to an already existing 220kV circuit between Shahibagh and Sheikh Muhammadi. Due to this, the existing sources are not properly utilized. Also, all four 132kV circuits are loaded above the prescribed limits, i.e., 80%.
17	Burhan 220kV GS	4	11	0	3	-	For 220KV Burhan-Tarbela circuits, retaining walls are required at tower Nos. 33, 42, 52, and 72 of Burhan-Tarbela circuit and at tower No. 7 and 36 of 220kV Burhan-ISPR circuit. The conductor from tower Nos. 9 to 11 is in deteriorated condition and requires attention.
18	Daudkhel 220kV GS	6	6	0	2	-	The 132kV circuits for Kohat are maintained by FESCO and PESCO jointly. Due to poor coordination between these DISCOs the line is poorly maintained. Also, retaining walls at locations 6, 26, 34, 281, 282, 283, 299,330, 337, 338, 339, 342, 344, and 345 of 220kV Daudkhel-Sheikh Muhammadi circuit need to be constructed. Braces are short at certain locations of 220kV transmission lines emanating from the GS.

Sr. No	Name of Grid Station (GS)	Total No. of Circuits		Total No. of Circuits Loaded Above 80%		Names of 220kV Circuits Loaded Above 80% During Peak Season	Remarks
		220kV	132kV	220kV	132kV		
19	Domail (Bannu) 220kV GS	2	6	0	1	-	Presently, this GS is being fed from Daud Khel 220kV GS only through double circuit transmission line. Two other circuits from Chash NUP are also under construction; the work needs to be completed without any delay. The loading of 132kV Domail Bannu-Gurguri circuit is loaded above the prescribed limits as per NEPRA grid code, i.e., 80%.
20	Vehari 220kV GS	4	7	0	2	-	Two 132kV circuits Vehari-Burewala and Vehari-Ludden are loaded above the prescribed limits, i.e., 80%.
21	Muzaffargarh 220kV GS	2	6	0	4	-	Four 132kV circuits are loaded above the prescribed limits, i.e., 80%.
22	Bahawalpur 220kV GS	2	5	0	4	-	Four 132kV circuits are overloaded as per NEPRA grid code.
23	Rohri 220kV GS	2	4	0	0	-	OPGW of 220kV Rohri-Shikarpur circuit is missing from tower Nos. 38 to 84, 121 to 135, 154 to 174, and 192 to 206, while peaks at tower Nos. 68 to 77 have not been provided.
24	Daherki 220kV GS	2	2	0	1	-	One 132kV Daharki-Sadiqabad circuit-I is loaded above the prescribed limits, i.e., 80%.
25	Shikarpur 220kV GS	4	5	1	3	220kV Shikarpur-Uch circuit	Three 132kV Shikarpur-Garhi yasin, Shikarpur-Larkana, and Shikarpur-Humayun circuits are overloaded. Also, inadequate clearance on Shikarpur-Guddu Line between tower Nos. 55/56, 56/57, and 124/125, and between 625/626, 630/631, 670/671, 748/749, 775/776, and 780/781 for Shikarpur-Uch line. OPGW from tower No. 38 to 84, 121 to 135, 154 to 174, and 192 to 206 is missing while peaks at tower Nos. 68 to 77 have not been provided for 220kV Shikarpur-Rohri circuits.

Sr. No	Name of Grid Station (GS)	Total No. of Circuits		Total No. of Circuits Loaded Above 80%		Names of 220kV Circuits Loaded Above 80% During Peak Season	Remarks
		220kV	132kV	220kV	132kV		
26	Hala Road 220kV GS	2	8	0	2	220kV Jamshoro-Hala Road circuits	One additional 220kV feeding source is needed as the existing radially fed 220kV Jamshoro-Hala Road circuits are insufficient. Loading of both 220kV circuits is such that outage of any one affects the other. On 220kV circuits, several discrepancies exist, i.e., missing sky wire at certain locations, deteriorated conductor, excessive number of joints, absence of a number of dampers, and clearance problems due to construction of new houses. Also, two 132kV Hala Road-Tando Jam and Hala Road-Hala (Old) circuits are overloaded.
27	T.M Khan Road 220kV GS	2	5	0	1	-	One additional 220kV feeding source is needed as the existing source is insufficient. Also, the 132kV TM Khan Road-Hyderabad circuit is overloaded.

Note: Two 220kV grid stations, i.e., Sibbi and Quetta have not been audited due to security concerns in the area.

Table 5: 500kV, 220kV, and 132kV Circuit Breakers Overview

Sr. No.	Name of Grid Station (GS)	Total Number of Circuit Breakers (CB)			Number of CB with due Overhauling			No. of CB with defective remote operation			Remarks
		500kV	220kV	132kV	500kV	220kV	132kV	500kV	220kV	132kV	
1	Sheikhupura 500kV GS	14	24	12	10	21	11	3	1	0	Leakage occurs frequently in controlling valves of 18 of the 220kV pneumatic CBs. SF6 purity and moisture content test for CBs need to be done as per SOP.
2	Yousafwala 500kV GS	8	18	15	0	6	1	0	0	0	-
3	Nokhar 500kV GS	11	12	13	0	0	0	0	0	0	-
4	Gatti Faisalabad 500kV GS	17	21	0	8	11	0	0	0	0	SF6 purity and moisture content test for CBs need to be done as per SOP.
5	Sheikh Muhammadi 500kV GS	7	17	17	5	14	13	0	5	14	Leakage exists in controlling valves of one 220kV pneumatic CB. SF6 purity and moisture content tests for CBs need to be done as per SOP. The 132kV bus coupler is inoperative due to defective wiring and some parts of CB mechanism are missing.
6	Rawat 500kV GS	13	20	19	9	14	5	0	0	0	The insulator jacket of interrupting chamber of AEG make 500kV CBs gets cracked over the passage of time. Three or four instances of such failures had taken place in the past and were replaced with the available spares. Any such happening in future will result in the breakdown of these CBs. SF6 purity and moisture content tests for 220kV and 132kV CBs need to be done as per SOP.
7	Multan 500kV GS	14	29	11	2	19	0	0	0	0	-
8	Muzaffargarh 500kV GS	11	N/A	N/A	0	N/A	N/A	0	N/A	N/A	The 220kV switchyard is owned and maintained by GENCO.
9	Guddu 500kV GS	13	N/A	N/A	13	N/A	N/A	0	N/A	N/A	The 220kV switchyard is owned and maintained by GENCO.
10	Dadu 500kV GS	13	11	11	13	5	4	1	1	0	Opening/closing time and contact resistance test for CBs need to be done as per SOP.
11	NKI 500kV GS	4	4	0	0	0	0	0	0	0	Opening/closing time and contact resistance test for CBs need to be done as per SOP.
12	Jamshoro 500kV GS	16	24	10	8	14	6	0	0	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
Total		141	180	108	68	104	40	4	7	14	

Table 6: 220kV and 132kV Circuit Breakers Overview

Sr. No	Name of Grid Station (GS)	Total Number of CB		Number of CB With Overhauling Due		No. of CB with defective remote operation		Remarks
		220k V	132k V	220k V	132k V	220k V	132k V	
1	Bund Road 220kV GS	18	17	18	16	0	0	-
2	New Kotlakhpat 220kV GS	9	17	8	4	0	0	-
3	Ravi 220kV GS	8	18	8	3	0	0	Gas leakage exists in the chamber of 220kV breaker D6Q1 and isolator D6Q11. NTDC has no expertise and spare parts. Approximately 3 kg gas is being refilled after every three days.
4	WAPDA Town 220kV GS	8	15	0	2	0	0	-
5	Kala Shah Kaku 220kV GS	20	17	16	4	0	0	-
6	Mardan 220kV GS	8	17	6	8	0	0	The 132kV bus coupler is out of circuit. The 132kV bus coupler is inoperative due to fault in the mechanism of circuit breaker.
7	Sarfaraznagar 220kV GS	12	12	6	9	0	0	-
8	Gakhar 220kV GS	9	22	7	16	0	1	Remote operating system of one 132kV CB is not working and is operated locally in the switchyard.
9	Sahuwala 220kV GS	8	14	6	12	0	0	-
10	Nishatabad 220kV GS	10	21	0	0	0	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
11	Jaranwala Road 220kV GS	7	15	6	5	0	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
12	Samundri Road 220kV GS	11	12	6	5	0	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
13	Ludewala 220kV GS	11	12	0	5	0	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
14	ISPR (Sanjani) 220kV GS	14	17	9	15	0	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
15	University Islamabad 220kV GS	5	12	0	0	0	0	-

Sr. No	Name of Grid Station (GS)	Total Number of CB		Number of CB With Overhauling Due		No. of CB with defective remote operation		Remarks
		220k V	132k V	220k V	132k V	220k V	132k V	
16	Shahibagh 220kV GS	12	13	0	0	2	2	SF6 purity and moisture content test for CBs need to be done as per SOP.
17	Burhan 220kV GS	12	17	0	5	0	0	Five 132kV BBC make Minimum Oil Circuit Breakers (MOCB) are excessively leaking, very old, and worn out beyond repairs. The CBs are also under-rated and in deteriorated condition.
18	Daud Khel 220kV GS	12	10	12	10	0	0	Gas leakage exists in one 220kV and one 132kV CB
19	Bannu 220kV GS	8	12	6	8	2	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
20	Vehari 220kV GS	11	14	9	9	0	0	-
21	Muzaffargarh 220kV GS	5	10	5	10	0	0	-
22	Bahawalpur 220kV GS	8	11	0	0	0	0	-
23	Rohri 220kV GS	9	10	0	0	0	0	-
24	Daherki 220kV GS	4	4	0	0	0	1	-
25	Shikarpur 220kV GS	12	12	0	0	0	1	One 220kV CB is out of service since December 16, 2013 due to operational problems. Remote operation of one 132kV CB is not functional.
26	Hala Road 220kV GS	6	15	3	9	0	0	Both 220kV and 132kV bus couplers are out of circuit. The 220kV bus coupler is not yet commissioned whereas 132kV bus coupler is inoperative due to fault in the mechanism of its CB.
27	T.M Khan Road 220kV GS	6	11	2	5	0	0	SF6 purity and moisture content tests for CBs need to be done as per SOP.
Total		263	377	133	160	4	5	

Note: Two 220kV grid stations, i.e., Sibbi and Quetta have not been audited due to security concerns in the area.

Table 7: 500kV, 220kV, and 132kV Isolators

Sr. No	Name of Grid Station (GS)	Total Number of Isolators			Number of Isolators with Inoperative Motor Drive			Remarks
		500kV	220kV	132kV	500kV	220kV	132kV	
1	Sheikhupura 500kV GS	35	64	34	0	0	30	-
2	Yousafwala 500kV GS	18	47	40	2	4	0	-
3	Nokhar 500kV GS	26	31	42	0	0	0	-
4	Gatti Faisalabad 500kV GS	45	56	0	0	0	0	-
5	Sheikh Muhammadi 500kV GS	18	11	38	0	0	0	-
6	Rawat 500kV GS	34	55	53	0	0	53	Grounding mats of 132kV isolators are either missing or damaged and those available are not grounded properly.
7	Multan 500kV GS	38	50	30	2	11	22	-
8	Muzaffar Garh 500kV GS	25	N/A	N/A	0	N/A	N/A	The 220kV switchyard is owned and maintained by GENCO.
9	Guddu 500kV GS	36	N/A	N/A	0	N/A	N/A	The 220kV switchyard is owned and maintained by GENCO.
10	Dadu 500kV GS	28	29	33	25	11	24	-
11	NKI 500kV GS	10	12	0	0	0	0	-
12	Jamshoro 500kV GS	34	64	29	16	47	7	-
Total		347	419	299	45	73	136	

Table 8: 220kV and 132kV Isolators

Sr. No	Name of Grid Station (GS)	Total Number of Isolators		Number of Isolators with Inoperative Motor Drive		Remarks
		220kV	132kV	220kV	132kV	
1	Bund Road 220kV GS	48	46	48	46	Due to severely polluted environment of the surroundings, isolator's blades have been affected badly and contacts of isolators are losing their grip and being damaged frequently.
2	New Kotlakhpat 220kV GS	24	46	24	39	Few 132kV Siemens make isolators are very old and need replacement.
3	Ravi 220kV GS	23	48	0	48	For all 220kV isolators (GIS), overhauling is required.
4	WAPDA Town 220kV GS	23	40	0	32	All 132kV isolators do not have the motor drive mechanism.
5	Kala Shah Kaku 220kV GS	53	46	51	46	The 132kV KSK-Shahdra circuit is fed from bus bars-2 only. Isolator for bus bars-1 is not installed.
6	Mardan 220kV GS	20	38	15	32	Some 132kV Hapam and Asea make isolators do not have motor drive mechanism.
7	Sarfraznagar 220kV GS	32	30	0	0	-
8	Ghakar 220kV GS	22	61	12	37	Twenty-four 132kV isolators do not have motor drive mechanism.
9	Sialkot 220kV GS	21	44	5	44	All 132kV isolators are operated manually in the switchyard due to weak mechanical strength of post structures.
10	Nishatabad 220kV GS	26	57	26	44	Nineteen 220kV and 44 of the 132kV isolators are under rated and do not have motor drive mechanism.
11	Jaranwala Road 220kV GS	18	40	8	30	All 132kV Hapam make isolators do not have motor drive mechanism.
12	Samundri Road 220kV GS	29	32	0	32	-
13	Ludewala 220kV GS	29	32	0	0	-
14	ISPR (Sanjani) 220kV GS	37	47	1	47	-
15	University Islamabad 220kV GS	14	33	0	0	-
16	Shahi Bagh 220kV GS	32	34	0	0	-

Sr. No	Name of Grid Station (GS)	Total Number of Isolators		Number of Isolators with Inoperative Motor Drive		Remarks
		220kV	132kV	220kV	132kV	
17	Burhan 220kV GS	32	45	0	41	-
18	Daud Khel 220kV GS	32	28	16	28	-
19	Bannu 220kV GS	21	32	0	0	-
20	Vehari 220kV GS	29	38	4	0	-
21	Muzaffar Garh 220kV GS	14	28	0	0	-
22	Bahawalpur 220kV GS	21	32	12	20	-
23	Rohri 220kV GS	24	28	0	0	-
24	Daherki 220kV GS	6	7	4	7	-
25	Shikarpur 220kV GS	31	32	0	0	-
26	Hala Road 220kV GS	14	41	11	30	-
27	T.M Khan Road 220kV GS	16	30	0	0	-
Total		691	1015	237	603	

Note: Two 220kV grid stations, i.e., Sibbi and Qetta have not been audited due to security concerns in the area.

Table 9: Essential Protection Relays for 500kV Autotransformers

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff, REF, RB, HVCD, LVCD)	No. of Over Excitation Relays Not Installed/ Defective	No. of Over Current/ Earth Fault Relays (HV, LV) Not Installed/ Defective	No. of Neutral Over Current Relays Not Installed/ Defective	No. of Tertiary Over Current/ Earth Fault Relays Not Installed/ Defective	No. of Thermal Overload Protection Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
1	Sheikhupura 500kV GS	-	-	-	-	-	4	-	
2	Yousafwala 500kV GS	-	-	-	-	-	-	-	
3	Nokhar 500kV GS	-	-	-	-	-	-	-	
4	Gatti Faisalabad 500kV GS	-	1	-	3	1	3	-	
5	Sheikh Muhammadi 500kV GS	-	-	-	-	-	2	-	
6	Rawat 500kV GS	-	-	-	-	3	3	-	
7	Multan 500kV GS	4	2	-	-	-	2	24	
8	Muzaffar Garh 500kV GS	-	-	-	-	1	1	-	
9	Guddu 500kV GS	4	2	-	-	-	3	-	
10	Dadu 500kV GS	-	-	-	-	2	1	48	
11	NKI 500kV GS	-	-	-	-	-	-	-	
12	Jamshoro 500kV GS	-	-	-	-	2	2	48	
Total		8	5	0	3	9	21	120	

Table 10: Essential Protection Relays for 220kV Autotransformers

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff, REF, RB, HVCD, LVCD)	No. of Over Excitation Relays Not Installed/ Defective	No. of Over Current/ Earth Fault Relays (HV, LV) Not Installed/ Defective	No. of Neutral Over Current Relays Not Installed/ Defective	No. of Tertiary Over Current/ Earth Fault Relays Not Installed/ Defective	No. of Thermal Overload Protection Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
1	Sheikhupura 500kV GS	12	1	-	3	1	4	-	
2	Yousafwala 500kV GS	9	2	-	-	-	-	-	
3	Nokhar 500kV GS	3	-	-	-	-	-	-	
4	Gatti Faisalabad 500kV GS								
5	Sheikh Muhammadi 500kV GS	3	-	-	3	-	4		
6	Rawat 500kV GS	9	-	-	3	3	3	-	
7	Multan 500kV GS	-	-	-	-	-	3	-	
8	Muzaffar Garh 500kV GS	-	-	-	-	-	-	-	
9	Guddu 500kV GS	-	-	-	-	-	-	-	
10	Dadu 500kV GS	6	2	-	1	3	2	8	
11	NKI 500kV GS	-	-	-	-	-	-	-	
12	Jamshoro 500kV GS	5	1	-	1	2	2	14	
13	Bund Road 220kV GS	12	4	-	3	-	3	-	
14	New Kotlakhpat 220kV GS	2	-	-	1	-	-	1	
15	Ravi 220kV GS	12	3	-	3	-	3	-	
16	WAPDA Town 220kV GS	-	-	-	-	-	3	-	
17	Kala Shah Kaku 220kV GS	14	3	1	3	2	3	30	
18	Mardan 220kV GS	9	1	-	3	-	3	15	
19	Sarfaraznagar 220kV GS	9	3	-	3	3	3	-	

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff, REF, RB, HVCD, LVCD)	No. of Over Excitation Relays Not Installed/ Defective	No. of Over Current/ Earth Fault Relays (HV, LV) Not Installed/ Defective	No. of Neutral Over Current Relays Not Installed/ Defective	No. of Tertiary Over Current/ Earth Fault Relays Not Installed/ Defective	No. of Thermal Overload Protection Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
20	Ghakhar 220kV GS	12	2	-	4	4	4	15	
21	Sialkot 220kV GS	9	-	-	3	-	3	-	
22	Nishatabad 220kV GS	18	4	-	5	5	5	40	
23	Jaranwala Road 220kV GS	12	-	-	4	4	4	4	
24	Samundri Road 220kV GS	9	-	-	3	3	3	-	
25	Ludewala 220kV GS	6	-	-	2	-	2	3	
26	ISPR (Sanjani) 220kV GS	9	-	-	2	3	3	-	
27	University Islamabad 220kV GS	3	-	-	2	2	-	-	
28	Shahi Bagh 220kV GS	4	-	-	4	-	4	-	
29	Burhan 220kV GS	11	3	-	3	3	3	30	
30	Daud Khel 220kV GS	6	-	-	2	-	-	-	
31	Bannu 220kV GS	6	-	-	2	-	-	-	
32	Vehari 220kV GS	10	-	-	3	-	3	-	
33	Muzaffar Garh 220kV GS	4	-	-	2	2	-	-	
34	Bahawalpur 220kV GS	6	-	-	3	3	3	-	
35	Rohri 220kV GS	-	-	-	-	2	-	-	
36	Daherki 220kV GS	3	-	-	1	2	2	-	
37	Shikarpur 220kV GS	6	-	-	2	3	2	-	
38	Hala Road 220kV GS	5	1	-	2	3	3	8	
39	TM Khan Road 220kV GS	6	-	-	2	1	-	-	

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff, REF, RB, HVCD, LVCD)	No. of Over Excitation Relays Not Installed/ Defective	No. of Over Current/ Earth Fault Relays (HV, LV) Not Installed/ Defective	No. of Neutral Over Current Relays Not Installed/ Defective	No. of Tertiary Over Current/ Earth Fault Relays Not Installed/ Defective	No. of Thermal Overload Protection Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
Total		250	30	1	78	54	80	168	

Table II: Essential Protection Relays for 132kV Power Transformers

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff)	No. of Over Current Relays Not Installed/ Defective (HV, LV)	No. of Thermal Overload Protection Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
1	Sheikhupura 500kV GS	-	-	1	1	
2	Yousafwala 500kV GS	2	-	-	2	
3	Nokhar 500kV GS	-	-	-	-	
4	Gatti Faisalabad 500kV GS	-	-	-	-	
5	Sheikh Muhammadi 500kV GS	-	-	-	-	
6	Rawat 500kV GS	-	-	-	-	
7	Multan 500kV GS	-	-	-	-	
8	Muzaffar Garh 500kV GS	-	-	-	-	
9	Guddu 500kV GS	-	-	-	-	
10	Dadu 500kV GS	-	-	-	-	
11	NKI 500kV GS	-	-	-	-	
12	Jamshoro 500kV GS	-	-	-	-	

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff)	No. of Over Current Relays Not Installed/ Defective (HV, LV)	No. of Thermal Overload Protection Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
13	Bund Road 220kV GS	-	-	-	-	
14	New Kotlakhpat 220kV GS	-	-	-	-	
15	Ravi 220kV GS	-	-	-	2	
16	WAPDA Town 220kV GS	-	-	-	3	
17	Kala Shah Kaku 220kV GS	-	-	-	1	
18	Mardan 220kV GS	-	-	-	-	
19	Sarfaraznagar 220kV GS	-	-	-	-	
20	Ghakhar 220kV GS	-	-	-	2	
21	Sialkot 220kV GS	-	-	-	2	
22	Nishatabad 220kV GS	-	-	-	-	
23	Jaranwala Road 220kV GS	-	-	2	2	
24	Samundri Road 220kV GS	-	-	-	-	
25	Ludewala 220kV GS	-	-	1	-	
26	ISPR (Sanjani) 220kV GS	-	-	2	1	
27	University Islamabad 220kV GS	-	-	-	-	
28	Shahi Bagh 220kV GS	-	-	2	-	
29	Burhan 220kV GS	-	-	-	2	
30	Daud Khel 220kV GS	-	-	1	-	
31	Bannu 220kV GS	-	-	-	-	
32	Vehari 220kV GS	-	-	2	-	
33	Muzaffar Garh 220kV GS	-	-	-	-	

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff)	No. of Over Current Relays Not Installed/ Defective (HV, LV)	No. of Thermal Overload Protection Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
34	Bahawalpur 220kV GS	-	-	2	-	
35	Rohri 220kV GS	-	-	-	-	
36	Daherki 220kV GS	-	-	-	-	
37	Shikarpur 220kV GS	-	-	-	-	
38	Hala Road 220kV GS	-	-	2	2	
39	TM Khan Road 220kV GS	-	-	-	-	
Total		2	0	15	20	

Table 12: Essential Protection Relays for 500kV Shunt Reactors

Sr. No	Name of Grid Station (GS)	No. of Differential Protection Relays Not Installed/ Defective (Main diff, REF)	No. of Phase Synchronizing Device/ Switch Synchronizing Relay Not Installed/Defective	No. of Over Current Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective (If CB is installed)	Remarks
1	Sheikhupura 500kV GS	-	3	-	-	
2	Yousafwala 500kV GS	-	-	-	-	
3	Nokhar 500kV GS	-	-	-	-	
4	Gatti Faisalabad 500kV GS	3	2	3	-	
5	Sheikh Muhammadi 500kV GS	-	-	-	-	
6	Rawat 500kV GS	-	-	-	-	
7	Multan 500kV GS	3	4	-	-	
8	Muzaffar Garh 500kV GS	-	-	-	-	
9	Guddu 500kV GS	3	4	-	-	
10	Dadu 500kV GS	-	4	-	8	
11	NKI 500kV GS	-	-	-	-	
12	Jamshoro 500kV GS	-	4	-	4	
Total		9	21	3	12	

Table 13: Essential Protection Relays for 500kV Transmission Lines

Sr. No	Name of Grid Station (GS)	No. of Distance Protection Relays Not Installed/ Defective (set-1 & set-2)	No. of Distance to Fault Locators Not Installed/ Defective (set-1 & set-2)	No. of Auto Reclosers Not Installed/ Blocked (set-1 & set-2)	No. of Tie Line Protection Relays Not Installed / Defective	No. of Synchro Check Relays Not Installed/ Defective (set-1 & set-2)	No. of Backup O/C-E/F Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Status of 500kV Tele-Protection Scheme (set-1 & set-2)
1	Sheikhupura 500kV GS	-	-	-	4	1	-	-	Active
2	Yousafwala 500kV GS	-	-	-	-	-	-	-	Active
3	Nokhar 500kV GS	1	-	-	-	-	-	-	Active
4	Gatti Faisalabad 500kV GS	-	2	3	4	-	-	-	Active
5	Sheikh Muhammadi 500kV GS	-	-	2	1	-	-	-	Inactive
6	Rawat 500kV GS	-	2	-	-	-	-	-	Active
7	Multan 500kV GS	-	-	-	6	-	-	-	Active
8	Muzaffar Garh 500kV GS	-	2	-	-	-	-	-	Active
9	Guddu 500kV GS	-	4	3	5	-	-	-	Active
10	Dadu 500kV GS	-	4	-	4	-	-	24	Active
11	NKI 500kV GS	-	-	-	-	-	-	-	Active
12	Jamshoro 500kV GS	-	4	-	5	-	-	12	Active
Total		1	18	8	29	1	0	36	

Table 14: Essential Protection Relays for 220kV Transmission Lines

Sr. No.	Name of Grid Station (GS)	No. of Distance Protection Relays Not Installed/ Defective (set-1 & set-2)	No. of Distance to Fault Locators Not Installed/ Defective (set-1 & set-2)	No. of Auto Reclosers Not Installed/ Blocked (set-1 & set-2)	No. of Tie Line Protection Relays Not Installed / Defective	No. of Synchro Check Relays Not Installed/ Defective (set-1 & set-2)	No. of Backup O/C-E/F Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Status of 500kV Tele-Protection Scheme (set-1 & set-2)
1	Sheikhupura 500kV GS	3	-	-	8	-	-	-	Active for 6 out of 9 TLs
2	Yousafwala 500kV GS	2	5	12	6	6	-	-	Inactive
3	Nokhar 500kV GS	-	-	4	-	-	-	-	Inactive
4	Gatti Faisalabad 500kV GS	-	11	20	8	18	6	-	Inactive
5	Sheikh Muhammadi 500kV GS	2	-	8	4	-	-	-	Inactive
6	Rawat 500kV GS	-	4	12	4	-	-	-	Inactive
7	Multan 500kV GS	-	-	28	14	4	-	30	Inactive
8	Muzaffar Garh 500kV GS	-	-	-	-	-	-	-	-
9	Guddu 500kV GS	-	-	-	-	-	-	-	-
10	Dadu 500kV GS	-	-	-	2	-	-	-	Inactive
11	NKI 500kV GS	-	-	-	-	-	-	-	Active
12	Jamshoro 500kV GS	-	5	-	6	-	-	48	Inactive
13	Bund Road 220kV GS	4	8	16	8	4	-	-	Active for 4 out of 8 TLs
14	New Kotlakhpat 220kV GS	6	8	12	6	10	-	15	Inactive
15	Ravi 220kV GS	2	2	8	4	5	-	-	Active for 1 out of 4 TLs
16	WAPDA Town 220kV GS	-	-	4	2	4	-	-	Inactive
17	Kala Shah Kaku 220kV GS	3	12	20	10	8	-	63	Inactive
18	Mardan 220kV GS	5	7	8	4	8	-	3	Active for 1

Sr. No.	Name of Grid Station (GS)	No. of Distance Protection Relays Not Installed/ Defective (set-1 & set-2)	No. of Distance to Fault Locators Not Installed/ Defective (set-1 & set-2)	No. of Auto Reclosers Not Installed/ Blocked (set-1 & set-2)	No. of Tie Line Protection Relays Not Installed / Defective	No. of Synchro Check Relays Not Installed/ Defective (set-1 & set-2)	No. of Backup O/C-E/F Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Status of 500kV Tele-Protection Scheme (set-1 & set-2)
									out of 4 TLs
19	Sarfaraznagar 220kV GS	-	7	8	4	8	-	-	Inactive
20	Ghakhar 220kV GS	-	5	8	-	4	-	9	Inactive
21	Sialkot 220kV GS	-	-	2	2	3	-	-	Inactive
22	Nishatabad 220kV GS	4	7	8	-	4	4	24	Inactive
23	Jaranwala Road 220kV GS	-	2	4	-	2	2	12	Inactive
24	Samundri Road 220kV GS	-	2	8	4	-	-	-	Inactive
25	Ludewala 220kV GS	-	-	8	2	-	2	-	Inactive
26	ISPR (Sanjani) 220kV GS	1	-	12	6	6	2	-	Inactive
27	University Islamabad 220kV GS	-	-	4	-	-	-	-	Inactive
28	Shahi Bagh 220kV GS	-	-	8	4	-	-	-	Inactive
29	Burhan 220kV GS	-	6	9	4	-	2	12	Inactive
30	Daud Khel 220kV GS	-	-	12	5	-	5	-	Active for 4 out of 6 TLs
31	Bannu 220kV GS	-	2	4	2	2	2	-	Inactive
32	Vehari 220kV GS	3	-	8	4	-	4	-	Inactive
33	Muzaffar Garh 220kV GS	-	-	4	-	-	-	-	Inactive
34	Bahawalpur 220kV GS	-	-	4	2	-	-	-	Inactive
35	Rohri 220kV GS	1	-	8	4	-	-	-	Inactive
36	Daherki 220kV GS	-	-	2	-	-	-	-	Inactive
37	Shikarpur 220kV GS	-	4	6	4	-	-	-	Inactive
38	Hala Road 220kV GS	-	4	-	2	-	-	12	Inactive
39	TM Khan Road 220kV GS	-	4	2	2	-	-	-	Inactive

Sr. No.	Name of Grid Station (GS)	No. of Distance Protection Relays Not Installed/ Defective (set-1 & set-2)	No. of Distance to Fault Locators Not Installed/ Defective (set-1 & set-2)	No. of Auto Reclosers Not Installed/ Blocked (set-1 & set-2)	No. of Tie Line Protection Relays Not Installed / Defective	No. of Synchro Check Relays Not Installed/ Defective (set-1 & set-2)	No. of Backup O/C-E/F Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Status of 500kV Tele-Protection Scheme (set-1 & set-2)
Total		36	105	281	137	96	29	228	

Table 15: Essential Protection Relays for 132kV Transmission Lines

Sr. No	Name of Grid Station (GS)	No. of Distance Protection Relays Not Installed/ Defective	No. of Backup O/C-E/F Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
1	Sheikhupura 500kV GS	-	-	-	
2	Yousafwala 500kV GS	6	-	8	
3	Nokhar 500kV GS	-	-	-	
4	Gatti Faisalabad 500kV GS	-	-	-	
5	Sheikh Muhammadi 500kV GS	-	-	-	
6	Rawat 500kV GS	-	-	-	
7	Multan 500kV GS	-	-	-	
8	Muzaffar Garh 500kV GS	-	-	-	
9	Guddu 500kV GS	-	-	-	
10	Dadu 500kV GS	-	-	11	
11	NKI 500kV GS	-	-	-	
12	Jamshoro 500kV GS	-	-	10	
13	Bund Road 220kV GS	4	-	-	
14	New Kotlakhpat 220kV GS	4	-	-	
15	Ravi 220kV GS	1	9	6	
16	WAPDA Town 220kV GS	2	-	3	
17	Kala Shah Kaku 220kV GS	-	2	16	
18	Mardan 220kV GS	6	8	8	
19	Sarfaraznagar 220kV GS	-	-	-	
20	Ghakhar 220kV GS	1	4	12	
21	Sialkot 220kV GS	-	-	-	

Sr. No	Name of Grid Station (GS)	No. of Distance Protection Relays Not Installed/ Defective	No. of Backup O/C-E/F Relays Not Installed/ Defective	No. of Trip Circuit Supervision Relays Not Installed/ Defective	Remarks
22	Nishatabad 220kV GS	9	9	18	
23	Jaranwala Road 220kV GS	-	6	6	
24	Samundri Road 220kV GS	-	-	-	
25	Ludewala 220kV GS	-	6	-	
26	ISPR (Sanjani) 220kV GS	4	11	-	
27	University Islamabad 220kV GS	-	-	-	
28	Shahi Bagh 220kV GS	-	-	-	
29	Burhan 220kV GS	2	7	16	
30	Daud Khel 220kV GS	1	5	-	
31	Bannu 220kV GS	-	6	-	
32	Vehari 220kV GS	1	1	-	
33	Muzaffar Garh 220kV GS	-	-	-	
34	Bahawalpur 220kV GS	-	1	-	
35	Rohri 220kV GS	-	-	-	
36	Daherki 220kV GS	-	-	-	
37	Shikarpur 220kV GS	-	-	-	
38	Hala Road 220kV GS	-	5	12	
39	TM Khan Road 220kV GS	-	6	-	
Total		41	86	126	

Table 16: Essential Protections Schemes for 500kV System

Sr. No.	Name of Grid Station (GS)	500kV Breaker Failure Scheme		Status of 500kV Bus Differential Scheme	Status of 500kV Cross Trip Scheme	500kV Recorders				Status of 500kV Synchronizing Scheme	Status of 500kV Under Frequency Scheme
		Scheme Status	DTT Status			SER	Fault	Voltage	Power		
1	Sheikhupura 500kV GS	Active	Active	Active	Blocked	Defective	Defective	Defective	Defective	Active	Not installed
2	Yousafwala 500kV GS	Active	Active	Active	Not available	Active	Active	Defective	Defective	Active	Not installed
3	Nokhar 500kV GS	Active	Inactive	Active	Not available	Active	Active	Defective	Defective	Active	Not installed
4	Gatti Faisalabad 500kV GS	Active	Active	Active	Active	Defective	Defective	Not installed	Not installed	Active	Not installed
5	Sheikh Muhammadi 500kV GS	Defective	Inactive	Defective	Not available			Defective	Defective	Active	Not installed
6	Rawat 500kV GS	Active	Active	Active	Active	Defective	Defective	Defective	Defective	Active	Not installed
7	Multan 500kV GS	Active	Active	Active	Not available	Defective	Defective	Not installed	Not installed	Active	Not installed
8	Muzaffar Garh 500kV GS	Active	Active	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
9	Guddu 500kV GS	Active	Active	Active	Not available	Defective	Defective	Not installed	Not installed	Active	Not installed
10	Dadu 500kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
11	NKI 500kV GS	Active	Active	Active	Not available	Active	Defective	Defective	Defective	Active	Not installed
12	Jamshoro 500kV GS	Active	Active	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed

Table 17: Essential Protection Schemes for 220kV System

Sr. No.	Name of Grid Station (GS)	220kV Breaker Failure Scheme		Status of 220kV Bus Differential Scheme	Status of 220kV Cross Trip Scheme	220kV Recorders				Status of 220kV Synchronizing Scheme	Status of 220kV Under Frequency Scheme
		Scheme Status	DTT Status			SER	Fault	Voltage	Power		
1	Sheikhupura 500kV GS	Active	Active	Active	Blocked	Defective	Defective	Defective	Defective	Active	Not installed
2	Yousafwala 500kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Inactive	Blocked
3	Nokhar 500kV GS	Active	Active	Active	Not available	Active	Active	Defective	Defective	Active	Not installed
4	Gatti Faisalabad 500kV GS	Active	Inactive	Active	Active	Not installed	Not installed	Not installed	Not installed	Active	Blocked
5	Sheikh Muhammadi 500kV GS	Defective	Inactive	Active on 1 out of 2 Bus bars	Not available	Defective	Defective	Not installed	Defective	Inactive	Not installed
6	Rawat 500kV GS	Active	Active	Active	Active	Defective	Defective	Defective	Defective	Active	Blocked
7	Multan 500kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Partially active	Not installed
8	Muzaffar Garh 500kV GS	Active	Owned by GENCO-III					Defective	Defective	Active	Not installed
9	Guddu 500kV GS	Owned by GENCO-II									
10	Dadu 500kV GS	Active	Active	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
11	NKI 500kV GS	Active	Active	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
12	Jamshoro 500kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Active	Active
13	Bund Road 220kV GS	Active	Active on 4 out of 8 TLs	Active	Not available	Defective	Defective	Defective	Defective	Partially active	Not installed
14	New Kotlakhpat 220kV GS	Blocked	Inactive	Blocked due to Inadequacy	Not available	Not installed	Not installed	Not installed	Not installed	Not installed	Not installed

Sr. No.	Name of Grid Station (GS)	220kV Breaker Failure Scheme		Status of 220kV Bus Differential Scheme	Status of 220kV Cross Trip Scheme	220kV Recorders				Status of 220kV Synchronizing Scheme	Status of 220kV Under Frequency Scheme
		Scheme Status	DTT Status			SER	Fault	Voltage	Power		
15	Ravi 220kV GS	Active	Inactive	Active on 1 out of 2 bus bars	Not available	Defective	Defective	Defective	Defective	Not installed	Active
16	WAPDA Town 220kV GS	Active	Inactive	Active on 1 out of 2 bus bars	Not available	Active	Active	Active	Active	Not installed	Not installed
17	Kala Shah Kaku 220kV GS	Active	Inactive	Active	Not available	Not installed	Active				
18	Mardan 220kV GS	Blocked	Inactive	Blocked due to Inadequacy	Not available	Not installed	Not installed				
19	Sarfaraznagar 220kV GS	Active	Inactive	Active	Not available	Not installed	Defective	Defective	Defective	Active	Not installed
20	Ghakhar 220kV GS	Active	Inactive	Active on 1 out of 2 bus bars	Not available	Defective	Defective	Defective	Defective	Not installed	Active
21	Sialkot 220kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Partially active	Active
22	Nishatabad 220kV GS	Not available	Inactive	Blocked	Active	Defective	Not installed	Defective	Defective	Not installed	Active
23	Jaranwala Road 220kV GS	Partially active	Inactive	Active on 1 out of 2 bus bars	Inactive	Not installed	Active				
24	Samundri Road 220kV GS	Active	Inactive	Active	Not available	Not installed	Not installed	Not installed	Not installed	Inactive	Not installed
25	Ludewala 220kV GS	Active	Partially active	Active	Not available	Partially working	Partially working	Partially working	Partially working	Active	Not installed

Sr. No.	Name of Grid Station (GS)	220kV Breaker Failure Scheme		Status of 220kV Bus Differential Scheme	Status of 220kV Cross Trip Scheme	220kV Recorders				Status of 220kV Synchronizing Scheme	Status of 220kV Under Frequency Scheme
		Scheme Status	DTT Status			SER	Fault	Voltage	Power		
26	ISPR (Sanjani) 220kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
27	University Islamabad 220kV GS	Active	Inactive	Active	Not available	Active	Active	Not installed	Not installed	Active	Not installed
28	Shahi Bagh 220kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
29	Burhan 220kV GS	Active	Inactive	Defective	Not available	Not installed	Defective	Defective	Defective	Inactive	Not installed
30	Daud Khel 220kV GS	Active	Partially active	Active	Not available	Defective	Defective	Defective	Defective	Inactive	Not installed
31	Bannu 220kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Inactive	Not installed
32	Vehari 220kV GS	Active	Inactive	Active	Not available	Not installed	Not installed	Not installed	Not installed	Partially active	Not installed
33	Muzaffar Garh 220kV GS	Active	Inactive	Active	Not available	Not installed	Not installed	Not installed	Not installed	Active	Not installed
34	Bahawalpur 220kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
35	Rohri 220kV GS	Active	Inactive	Active	Not available	Not installed	Not installed	Not installed	Not installed	Active	Not installed
36	Daherki 220kV GS	Inactive	Inactive	Not Installed	Not available	Not installed	Not installed	Not installed	Not installed	Not installed	Not installed
37	Shikarpur 220kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Active	Not installed
38	Hala Road 220kV GS	Active	Inactive	Inactive	Not available	Defective	Defective	Defective	Defective	Active	Not installed
39	TM Khan Road 220kV GS	Active	Inactive	Active	Not available	Defective	Defective	Defective	Defective	Not installed	Not installed

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