PERFORMANCE EVALUATION REPORT OF TRANSMISSION COMPANIES

2023-24

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Executive Summary:

The National Electric Power Regulatory Authority (NEPRA) was established under the Regulation of Generation, Transmission, and Distribution of Electric Power Act, 1997, with the sole mandate to regulate Pakistan's electric power sector. In carrying out its responsibilities, NEPRA ensures adherence to regulatory standards and fosters a reliable and safe supply of electricity.

In accordance with Section 46 of the NEPRA Act and with the approval of the Federal Government, NEPRA notified the Performance Standards (Transmission) Rules-2005 (PSTR-2005) in the Gazette of Pakistan on 15th November 2005. These rules establish parameters to ensure the reliability and security of the transmission system. They require all transmission licensees, including Special Purpose Transmission Licensees (SPTL) and Provincial Grid Companies (PGCs), to annually report their operational performance in line with the prescribed criteria.

The Annual Performance Reports (APRs) for the fiscal year 2023-24, submitted by National Transmission & Despatch Company (NTDC), K-Electric (KE), Fatima Transmission Company Limited (FTCL), and Sindh Transmission & Despatch Company (ST&DCPL), have been reviewed in terms of system reliability, supply security, and quality of service. Based on this review, a comprehensive Performance Evaluation Report (PER) has been prepared for NEPRA's consideration and will be made publicly available on its website for stakeholder access.

Additionally, Khyber Pakhtunkhwa Transmission and Grid System Company (KPKT&GSCPL), Punjab Grid Company Limited (PGCL), and Pak Matiari Lahore Transmission Company (PMLTC) have submitted updated reports, which are also included in this review. The Performance Evaluation Report (PER) evaluates the transmission licensees' performance against the PSTR-2005 parameters, highlighting key findings related to system reliability, supply security, and transmission quality.

This report provides valuable insights into the performance and effectiveness of these standards in the transmission sector.

This report is structured into five (5) sections, including a conclusion and recommendations. A brief summary is provided below:

Section-I: Overview of NTDC Performance for FY 2023-24

A summary of NTDC's performance for the fiscal year 2023-24 is provided below:

- **System Duration of Interruption**: 0.03 hours per point.
- **System Frequency of Interruption**: 0.09 interruptions per circuit.
- **Energy Not Served (ENS)**: 4.48 GWh.
- **Loss of Supply Incidents**: 51 incidents reported.
- **Voltage Violations**: 156,534 incidents under normal conditions, where voltage exceeded permissible limits; 1,158 incidents under N-1 conditions.
- **Frequency Violations**: 7 incidents, accumulating a total duration of 49 minutes.

Reliability of Tie Lines:

- **Outages on Tie Lines**: A total of 1 outage was reported, with no recorded outage duration.
- **System Duration of Interruption**: 0 hours per point.
- **System Frequency of Interruption**: 0.25 interruptions per circuit.

Section-II: K-Electric Performance Overview for FY 2023-24

The performance of K-Electric for FY 2023-24 has been assessed based on key metrics, including System Duration of Interruption, System Frequency of Interruption, Energy Not Served (ENS), loss of supply incidents, voltage violations, and frequency violations. A summary of the findings is as follows:

- **System Duration of Interruption**: 0.01 hours per point at the 220 kV transmission network.
- **System Frequency of Interruption**: 0.02 interruptions per circuit at the 220 kV transmission network.
- **Energy Not Served (ENS)**: 0.046 GWh at the 220 kV transmission network.
- **Loss of Supply Incidents**: 1 incident reported during FY 2023-24.
- **Voltage Violations**: 38 incidents under normal conditions, where voltage exceeded permissible limits; no incidents under N-1 conditions.
- **Frequency Violations**: 1 incident, with a total duration of 5.74 minutes.

Reliability of Tie Lines:

- **Outages on Tie Lines**: 5 outages reported, totaling 11.65 hours of downtime.
- **System Duration of Interruption**: 2.91 hours per point.
- **System Frequency of Interruption**: 1.25 interruptions per circuit.

Section-III: Performance of Special Purpose Transmission Licensees (SPTLs) for FY 2023-24

This section covers the performance of Special Purpose Transmission Licensees (SPTLs), including Fatima Transmission & Company Limited (FTCL) and Pak Matiari Lahore Transmission Company Private Limited (PMLTC), for FY 2023-24. A summary of their reported performance is as follows:

Fatima Transmission & Company Limited (FTCL):

- **System Duration of Interruption**: 7.21 hours per point.
- **System Frequency of Interruption**: 3 interruptions per circuit.
- **Outages at Interconnection Points**: 6 outages, totaling 14.42 hours, with Energy Not Served (ENS) recorded at 0.886 GWh.
- **Voltage Violations**: The highest voltage violation recorded under normal conditions was 144.40 kV; no voltage violations occurred under N-1 conditions.

- **Frequency Violations**: 96 instances where frequency was outside permissible limits, totaling 489 minutes.

Pak Matiari Lahore Transmission Company Private Limited (PMLTC):

- The HVDC system remained fully operational, transmitting power within its 4000 MW capacity, and providing essential support to the AC network. No transmission line failures occurred during FY 2023-24.
- The HVDC system is connected to 10 HVAC 500 kV transmission lines at Matiari Converter Station (MCS) and 6 HVAC 500 kV transmission lines at Lahore Converter Station (LCS). A total of 106 tripping events were recorded at MCS, and 2 at LCS, primarily due to HVAC network instability.

Section-IV: Performance of Provincial Grid Companies for FY 2023-24

This section reviews the performance of provincial grid companies, including Sindh Transmission & Despatch Company (ST&DCPL), Khyber Pakhtunkhwa Transmission and Grid System Company (KPT&GSC), and Punjab Grid Company Limited (PGCL).

Sindh Transmission & Despatch Company (ST&DCPL):

- **System Duration of Interruption**: 67.13 hours per point.
- **System Frequency of Interruption**: 14 interruptions per circuit.
- **Outages at Interconnection Points**: 28 outages, totaling 134.26 hours.
- **Energy Not Served (ENS)**: 13.57 GWh.
- **Frequency Violations**: No frequency violations were recorded, and the frequency remained within permissible limits during FY 2023-24.

Khyber Pakhtunkhwa Transmission and Grid System Company (KPT&GSC):

- KPT&GSC currently does not maintain any transmission lines or grid stations.
- Ongoing projects include the 132/220 kV OHTL from Kalam to Chakdara (140 km) in the Swat region and the evacuation of 1,150 MW from 11 hydropower projects in the Swat region, expected to be completed within the next 10-15 years.

Punjab Grid Company Limited (PGCL):

- PGCL currently does not maintain any transmission lines or grid stations.
- Ongoing projects include the construction of 132 kV OHTL in the Lahore and South Punjab regions.

Section-V: Issues and Challenges of the Transmission Network

This section outlines key issues and challenges facing the transmission network. Some of the most important concerns are discussed below:

System Constraints:

NTDC's transmission system is facing long-standing and persistent constraints, many of which have been unresolved for years. These limitations are significantly impacting the power sector. The most pressing issue is the system's inability to efficiently evacuate electricity from cost-effective power plants, resulting in their underutilization. Consequently, more expensive power plants are being operated, which not only strains the financial health of the power sector but also undermines overall system reliability.

Although NEPRA has been engaged with NTDC for several years to address these challenges. To expedite the resolution of these issues, quarterly meetings are held to track the progress of NTDC's projects, particularly those aimed at removing constraints that affect the Economic Merit Order (EMO). These issues will be discussed in more detail in the relevant sections.

South-to-North Transmission Constraints:

Pakistan's cost-effective base-load power plants are primarily located in the south, utilizing indigenous resources like Thar coal, local gas, and wind power, which help conserve foreign exchange. However, the NTDC transmission system is unable to efficiently transmit electricity from these southern hubs to northern load centers, burdening consumers with higher costs.

This transmission bottleneck not only raises electricity prices but also stifles economic growth. It increases reliance on more expensive northern plants, driving up tariffs and worsening the circular debt crisis in the power sector. A more detailed discussion of these issues can be found in the relevant sections.

Frequent Tower Collapses:

In FY 2023-24, there were 27 tower collapse incidents, down from 46 in FY 2022-23. The majority of these incidents occurred in the southern regions, including Hyderabad and Quetta circles, with only one reported in the northern region (Islamabad). The primary causes of these collapses were severe weather events—such as windstorms and thunderstorms—along with sabotage and theft. These incidents disrupt the steady and cost-effective supply of electricity. The details are provided in the relevant sections.

Critical Infrastructure Assessment of NTDC Transmission Network:

NEPRA has highlighted several critical issues regarding NTDC's transmission network, including the availability of Event & Fault Recorders, time synchronization of protection relays, and the commissioning of numerical relays. Additionally, concerns were raised about the construction of firewalls around sensitive equipment, mitigation plans for power transformer overloading, and the installation of thermo-vision cameras across key transmission hubs (Islamabad, Lahore, Multan, and Hyderabad). The relevant sections contain the detailed information.

Interim Arrangements in NTDC Transmission Network:

The frequent reliance on interim arrangements, such as power evacuation from K2/K3 and Nuclear Power Plants (NPPs), Sukki Kinari, and others, highlights NTDC's challenges in meeting deadlines for critical transmission infrastructure. While these temporary measures help mitigate immediate power shortages, they underscore the urgent need to complete permanent systems. Delays in finalizing grid upgrades risk compromising system reliability, increasing transmission losses, and raising operational costs, particularly during peak demand periods. Detailed information can be found in the relevant sections.

NTDC Policies on Asset Handover and Compensation for Right of Way

It was observed that the absence of a standardized policy or SOP for asset compensation, as well as for the formal handing over and taking over of assets, was contributing to various operational challenges. In response, NEPRA directed NTDC to develop and implement the necessary policies and SOPs. Accordingly, during FY 2023-24, NTDC submitted two policies, both approved by its Board of Directors: the "Handing Over/Taking Over of NTDC Assets" policy and the "Compensation Policy for Right of Way and Land Acquisition."

Delay in Power Evacuation and Augmentation Projects of NTDC:

It has been observed that several NTDC infrastructure projects are experiencing significant delays across both northern and southern regions, with expected completion dates now extending beyond their original contractual timelines. Key projects, including new developments and augmentation works at 500kV and 220kV grid stations, are facing delays, with revised completion dates now set for late 2024 and 2025, instead of the originally planned FY 2023-24. The details are provided in the relevant sections.

Delay in Execution of SCADA-III by NTDC:

NEPRA has been closely monitoring the SCADA-III project, recognizing its critical importance to the national grid. Following targeted actions by NEPRA, the project has made significant progress, reaching approximately 65% completion within just six months, a marked improvement after two years of stagnation and slow progress. The relevant sections contain the detailed information.

Signing of EPA/PPA and CA between CPPA-G, KE, and NTDC:

Clear contractual arrangements, including EPA/PPA and CA, between CPPA-G, KE, and NTDC are essential. This issue was highlighted in the PER 2022-23, which prompted NEPRA's approval of the KE & NTDC interconnection agreement on February 15, 2024. Further details are provided in the relevant sections.

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INTRODUCTION

Introduction:
The transmission sector in Pakistan plays a key role in delivering electricity from various generation sources—thermal, hydropower, nuclear, and renewable—to load centers across the country. The network operates at 500 kV, 220 kV, 132 kV, and 66 kV, forming the backbone of the national grid. Notably, a 660 kV HVDC line has been made operational under the China-Pakistan Economic Corridor (CPEC) for facilitating long-distance transmission of power from Matiari to Lahore, helping reduce losses and enhance grid stability.

Pakistan is also expanding cross-border transmission to support regional energy trade, with interconnections to Iran supplying electricity to Balochistan and the CASA-1000 project set to import hydropower from Central Asia via Afghanistan, boosting energy security and access to clean power.

Transmission Licensees in Pakistan:
Under the NEPRA Act, licenses are issued for key activities in the electricity sector, including electric power transmission, to ensure compliance with regulatory standards and promote reliability and safety. Electric power transmission is specifically regulated under Sections 16, 17, 18(A), and 19 of the NEPRA Act, 1997 (as amended).

(a) **NTDC as the National Grid Company (NGC)**
Under Section 17 of the NEPRA Act, the National Transmission and Dispatch Company (NTDC) was granted a transmission license in December, 2002. NTDC is responsible for the efficient transmission of electricity at voltage levels of 220 kV and above. The NEPRA Act stipulates that only one National Grid Company (NGC) can operate at the national level at any given time. Currently, NTDC functions as the NGC under its NEPRA license.

(b) **K-Electric Transmission Licence**
Under Sections 16 and 25 of the NEPRA Act, NEPRA granted a transmission license to K-Electric (KE) in June, 2010. KE operates its own power plants and transmission lines, supplying electricity independently of the national grid. To meet its demand, KE has interconnections with the NTDC grid to import power.

Special Purpose Transmission Licensees:
Under Section 19 of the NEPRA Act, Special Purpose Transmission Licenses were granted to three entities: Fatima Transmission Company Limited (FTCL), Sindh Transmission and Dispatch Company (STDC), and Pak Matiari-Lahore Transmission Company (PMLTC).

Provincial Grid Company (PGC):
The NEPRA (Amendment) Act, 2018 allows Provincial Governments to establish their own Provincial Grid Company (PGC) to build powerhouses, grid stations, and transmission lines for use within their provinces. Each province can operate one PGC responsible for power transmission within its territorial limits. Under Section 18A of the NEPRA Act, NEPRA has granted Provincial Grid Company licenses to:

(a) Sindh Transmission & Dispatch Company (ST&DCPL) on November 5, 2019
(b) Khyber Pakhtunkhwa Transmission and Grid System Company (KPKT&GSCPL) on February 26, 2021
(c) Punjab Grid Company Limited (PGCL) on November 08, 2023

1.2 Performance Standards (Transmission) Rules, 2005:
In exercise of the powers conferred by Section 46 of the Generation, Transmission, and Distribution of Electric Power Act, 1997 (NEPRA Act), along with Section 7(2)(c) and Section 34, NEPRA, with the approval of the Federal Government, established the NEPRA Performance Standards (Transmission) Rules, 2005 (PSTR-2005). These rules are designed to ensure the reliability and security of the transmission system within specified parameters, and all transmission licensees must comply with the PSTR-2005.

1.3 Reporting of Performance Report:
Rule 9 of PSTR-2005 requires the licensees to submit an annual performance report to the Authority by August 31st of the following year. The report must provide all relevant information demonstrating compliance with the rules for the year, along with a comparison of the current year's performance against the previous year's compliance results.

1.4 Compliance by Transmission Licensees:
In accordance with Rule 9 of the PSTR-2005, NTDC, KE, FTCL, ST&DCPL, and PMLTC have submitted their Performance Reports for FY 2023-24. These reports have been reviewed, and a comprehensive Performance Evaluation Report has been prepared.

The evaluation covers key aspects of system reliability, security, and the quality of supply across the transmission networks of the licensees during the reporting period. Additionally, the report includes a five-year trend analysis.

Furthermore, Punjab Grid Company Limited (PGC) and Khyber Pakhtunkhwa Transmission and Grid System Company (Private) Limited (KPKT&GSCPL) have provided updated information on the activities undertaken during FY 2023-24.

SECTION I

NATIONAL TRANSMISSION & DESPATCH COMPANY LIMITED (NTDC)

2. Brief Introduction of NTDC:

NTDC was incorporated on November 6, 1998, under the Companies Ordinance 1984 (now the Companies Act 2017) and began commercial operations on December 24, 1998, following the unbundling of WAPDA into separate entities for the generation, transmission, and distribution of electricity. NTDC's primary responsibility is to design, operate, and maintain 500 kV and 220 kV transmission lines, along with their associated substations.

2.1 License:

In accordance with Section 17 of the NEPRA Act, NEPRA granted a transmission license to NTDC on December 31, 2002, authorizing it to exclusively engage in the transmission business for a period of thirty (30) years. Under the powers conferred by Section 26 of the NEPRA Act, as amended from time to time, the Authority has made several modifications to NTDC's Transmission License (No. TL/01/2002), including Modifications I (April 11, 2014), II (May 29, 2015), and III (March 21, 2023).

As per the amended NEPRA Act, NTDC operates as the National Grid Company (NGC) under its license, responsible for providing safe, reliable, and non-discriminatory transmission and interconnection services, including for Bulk Power Consumers (BPCs) seeking direct connection to its facilities.

2.2 Transmission Network:

NTDC operates and maintains 19 grid stations at 500 kV and 50 grid stations at 220 kV, with a total of 9,577 km of 500 kV transmission lines and 12,639 km of 220 kV transmission lines. The NTDC transmission network is organized into five regions: Islamabad, Lahore, Multan, Hyderabad, and Quetta. A region-wise illustration of NTDC's transmission system is provided in Figure 1.

Figure 1: NTDC Transmission System

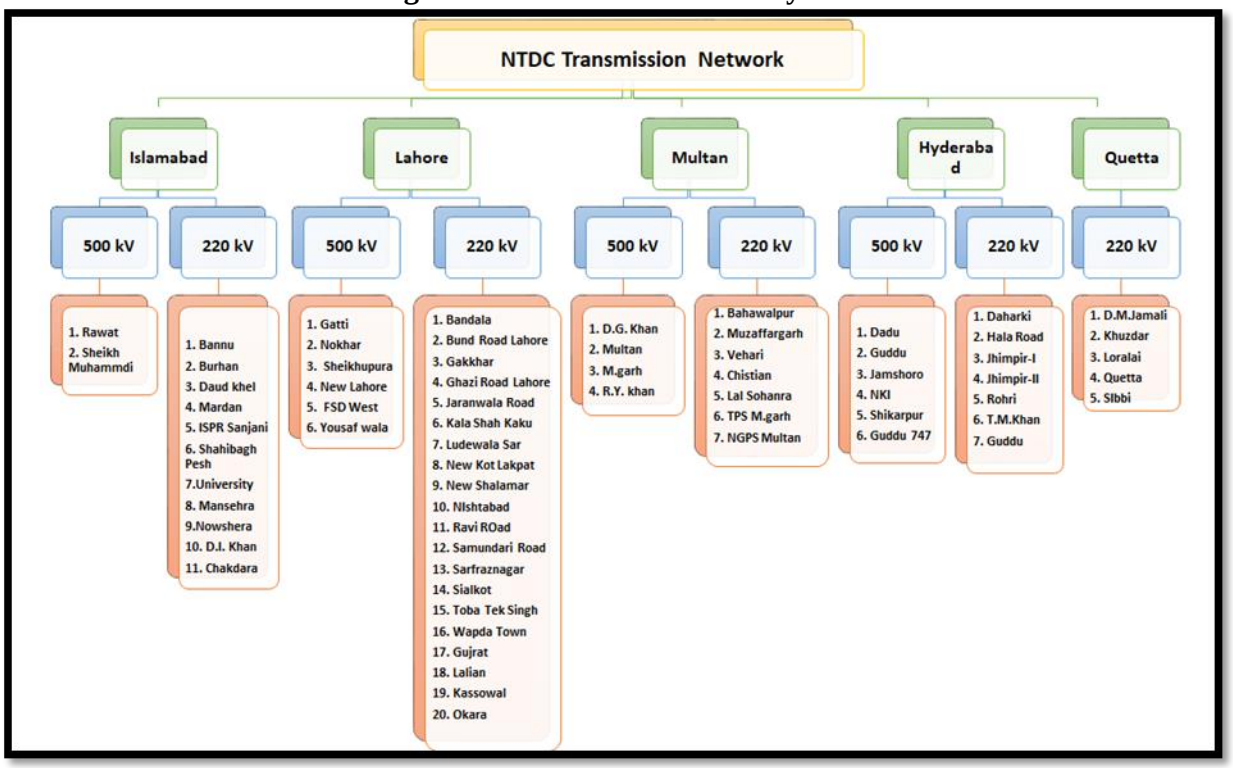


Table 1: Progressive NTDC Network Statistics

Description		2019-20	2020-21	2021-22	2022-23	2023-24
No. of Existing Grid Stations	500 kV	16	16	19	19	19
	Added	0	0	3	0	0
	220 kV	45	45	50	50	50
	Added	1	0	5	0	0
	Total	**61**	**61**	**69**	**69**	**69**
Length of Transmission Line (Circuit km)	500 kV	7,470	8,059	8,431	8,825	9,201
	Added	1,500	589	372	394	376
	220 kV	11,281	11,438	11,565	11,637	12,136
	Added	-41	157	127	72	499
	Total	**18,751**	**19,497**	**19,996**	**20,462**	**21,337**
Transformation Capacity (MVA)	500 kV	24,000	30,610	25,500	25,950	25952
	Added	1,650	6,610	-5,110	450	2
	220 kV	31,900	25,770	35,360	37,190	38,460
	Added	840	-6,130	9,590	1,830	1,270
	Total	**55,900**	**56,380**	**60,860**	**63,140**	**64,410**

During FY 2023-24, no new grid stations were added to the network. However, the length of transmission lines increased by 376 km in the 500 kV network and 499 km in the 220 kV network. There was no significant increase in the transformation capacity of the 500 kV network, but the transformation capacity of the 220 kV network grew by 1,270 MVA.

Over the past five years, a total of three 500 kV and six 220 kV grid stations were added and the length of 500 kV & 220 kV transmission lines increased by 3,231 km and 814 km, respectively. During the same period, the transformation capacity of the 500 kV network increased by 3,602 MVA, while the 220 kV network saw an increase of 7,400 MVA in transformation capacity.

2.3 Performance of NTDC under PSTR - 2005:

The comprehensive assessment of NTDC's performance in terms of System Reliability, System Security, and Quality of Supply. Each of the performance parameter is discussed below:

2.4 System Reliability:

2.4.1 Average Duration of Interruption:

(a) Total outage hours recorded at all interconnection points (excluding 132 kV line tripping) = 18.66 Hrs.
(b) Total number of interconnection points = 538
(c) System duration of interruption = 0.03 Hrs. /point i.e. 1.8 min. 75% decrease to the previous year i.e. 0.12 Hrs. /point

During the reporting period, the total outage duration at all interconnection points (excluding 132 kV line trippings) was 18.66 hours, reflecting a 70% decrease compared to the previous year's 62.48 hours. Additionally, four new interconnection points were added, bringing the total to 538, as shown in Figure 1. Notably, NTDC reported the lowest interruption duration in the last five years during this reported period.

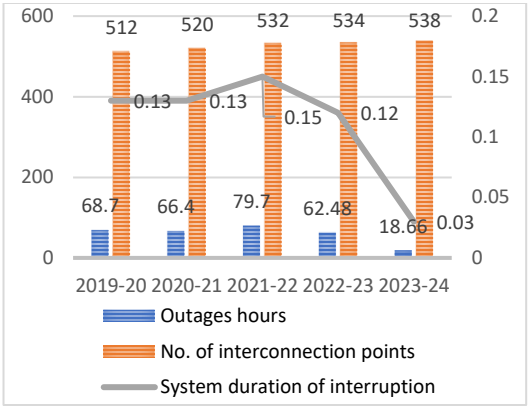


Figure 2: System duration of interruption

As shown in Figure 2, the number of outage hours has fluctuated over the past five years, with the highest recorded in 2021-22 at 79.7 hours. However, the number of interconnection points has consistently increased each year, reflecting ongoing growth and expansion of the network.

2.4.2 System Frequency of Interruption:

(a) Total number of outages recorded at all 132 kV outgoing circuits (excluding 132 kV line tripping) = 51
(b) Total number of 132 kV circuits = 538
(c) System frequency of interruption = 0.09 No./circuit.

A 10% decrease has been observed in the present figure i.e. 0.09 No./circuit in comparison to the previous year i.e. 0.10 nos. /circuit.

During FY 2023-24, a total of 51 outages were reported, reflecting an approximately 8% decrease compared to the 55 outages experienced in the previous year, as shown in Figure 3. Over the past five years, the data indicates a consistent downward trend in outage frequency.

Figure 3 further highlights that the continuous reduction in interruptions over this period suggests that NTDC has implemented effective measures to enhance system reliability.

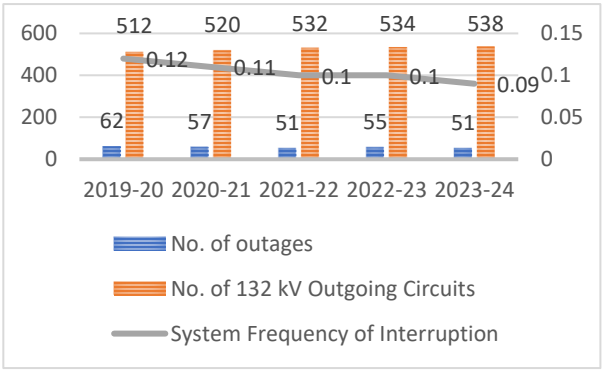


Figure 3: No of Outage & No. of 132 kV4 outgoing circuits

2.5 System Security:

2.5.1 Energy Not Served (ENS):

(a) Total ENS = 4.48 Million kWh
(b) Number of incidents, where there has been a loss of supply = 51
(c) Average ENS per incident = 0.088 Million kWh
(d) Average duration per incident = 0.366 Hrs (22 mins)

Table 2: Loss of Supply Incidents, Average ENS, Duration & Financial Impact per Incident

Description / Unit / Year	Unit	2019-20	2020-21	2021-22	2022-23	2023-24
Loss of Supply Incidents	Nos.	62	57	51	55	51
Average ENS per Incident	Mil. kWh	0.3	2.3	0.2	2.50	0.088
Average Duration per Incident	Hrs. : Min	01: 06	01: 12	01: 36	1.136	0.366
Financial Impact per Incident	Rs. (Mil)	1.4	15.6	1.8	22.69	

Figure 4 shows a decrease in Energy Not Served (ENS) to 4.48 GWh, compared to 137.7 GWh reported in the previous year. Notably, during FY 2023-24, no major breakdowns occurred on the NTDC network, contributing to this significant reduction in ENS.

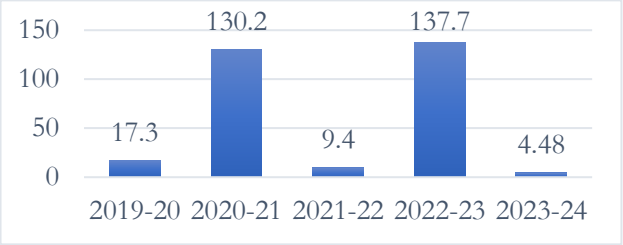


Figure 4: Energy not served in GWH

Figure 5 shows a decrease in the number of loss-of-supply incidents, dropping to 51 in FY 2023-24, compared to 55 incidents in FY 2022-23. Additionally, the average duration per incident decreased to 0.36 hours, a significant improvement from the 1.14 hours reported in the previous year.

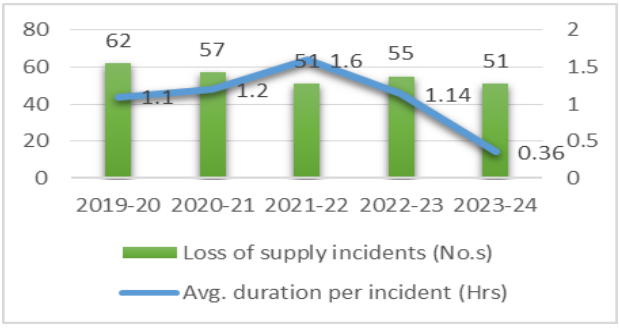


Figure 5: Loss of supply incidents & duration per incident

2.5.2 Region wise loss of supply incidents

As shown in Figure 6, over the past five years, the Lahore and Hyderabad regions have consistently experienced the highest number of incidents. In FY 2023-24, Lahore reported 10 incidents, while the Hyderabad region reported 34 incidents. In contrast, the Multan region recorded the lowest incidents. Although the number of incidents in Multan has varied over the years, the highest was 14 incidents in FY 2021-22.

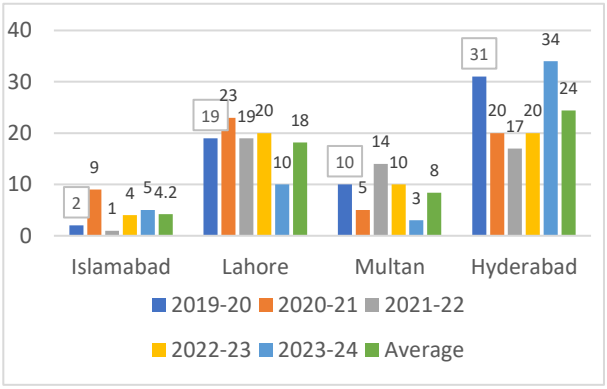


Figure 6: Region wise loss of supply incidents

2.5.3 Seasonal trend of loss of supply incidents:

Figure 7 illustrates the seasonal trend of loss-of-supply incidents, with noticeable variations in incident numbers from month to month. May appears to have the highest number of incidents in FY 2023-24. The figure also presents the seasonal trends over the past five years. To enhance incident management and prevention strategies, NTDC should conduct a detailed analysis of the underlying causes of these trends, taking into account seasonal factors and potential external influences.

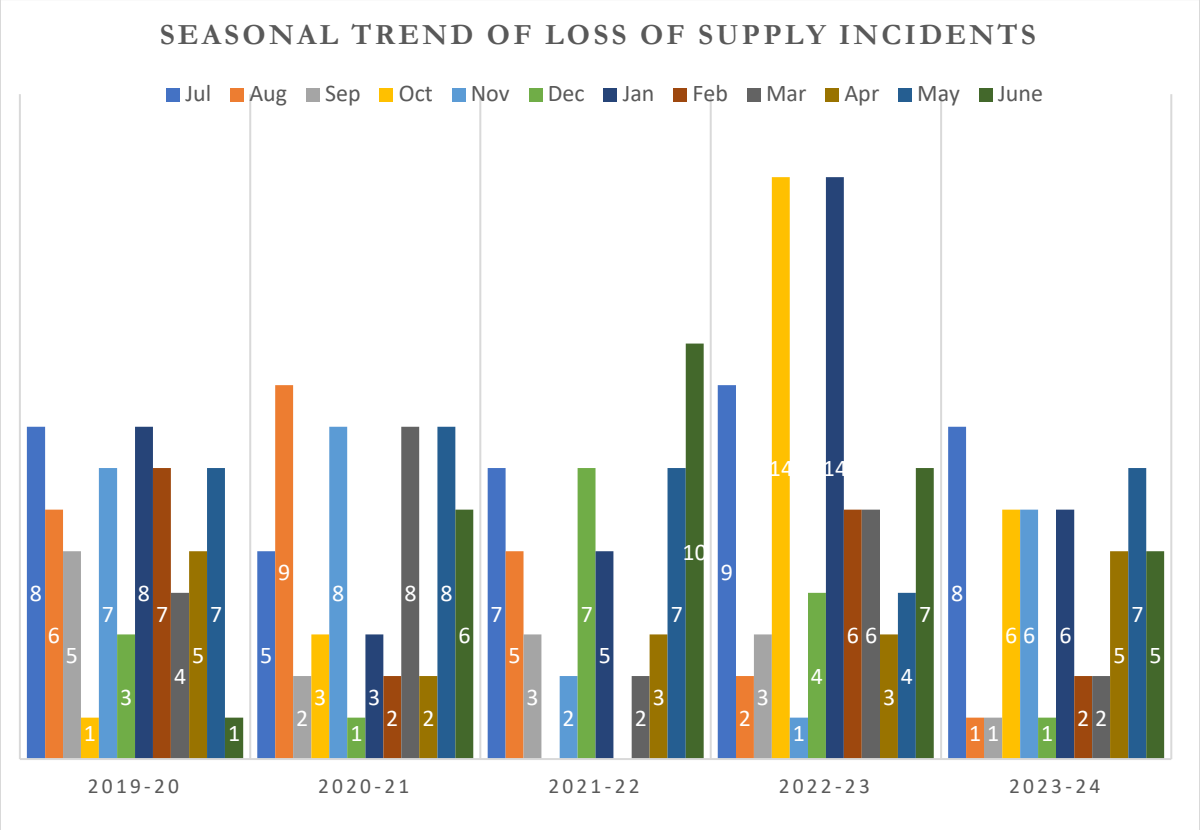


Figure 7: Seasonal trend of loss of supply incidents

2.5.4 Details of Loss of Supply Incident along with Location, Time, Duration of Incident and Maximum Demand Lost:

A total of 51 loss-of-supply incidents were recorded, of which 42 occurred on the transmission lines and 9 occurred on the transformers.

Table 3: Tripping's occurred on Transmission lines

Sr. No.	Grid Name	Transmission Line	Trip date	Duration (hr:mm)	Affected area	Energy not served (kWHr)
1	220 kV Hala Road	220 kV Jamshoro - Hala Road Circuit No. 1 220 kV Jamshoro - Hala Road Circuit No. 2	7/7/2023	12:27:00	HESCO	54,000
2	220 kV Loralai	220 kV DG Khan - Loralai Circuit No. 1 & 2	7/9/2023	77:36:00	QESCO	58,333
3	220 kV Khuzdar	220 kV Dadu - Khuzdar Circuit No. 1 & 2	7/17/2023	1:45:00	HESCO & QESCO	133,300
4	220 kV Khuzdar	220 kV Dadu - Khuzdar Circuit No. 1 & 2	9/28/2023	0:29:00	HESCO & QESCO	31,900
5	220 kV Jaranwala Road	220 kV Gatti - Jaranwala circuit No. 1 & 2	10/2/2023	13:25:00	FESCO	151,667
6	220 kV Khuzdar	220 kV Khuzdar - Dadu Circuit No. 01	10/2/2023	30:32:00	QESCO	17,267
7	220 kV Khuzdar	220 kV Khuzdar - Dadu circuit No. 1	10/6/2023	0:19:00	QESCO	8,223
8	220 kV Dharki	220 kV Dharki - Engro circuit & 220 kV Dharki - Foundation circuit	10/18/2023	3:04:00	SEPCO	6,000
9	220 kV New Shalamar	220 kV New Shalamar - Ravi circuit	10/18/2023	0:33:00	LESCO	30,000
10	220 kV Nishatabad	220kV Gatti-Nishatabad circuit No. 01 220kV Gatti-Nishatabad circuit No. 02 220kV Nishatabad-Sammundri Road circuit No. 01 220kV Nishatabad-Sammundri Road circuit No. 02	11/5/2023	1:41:00	FESCO	59,750
11	220 kV Rohri	220kV Shikarpur Rohri cct. 02	11/7/2023	0:27:00	SEPCO	27,720
12	500 kV Peshawar	500kV Tarbela-Sheikh Muhammadi circuit 220 kV Sheikh Muhammadi-Daudkhel cct.# 01 220 kV Sheikh Muhammadi-Daudkhel cct.# 02 220 kV Sheikh Muhammadi-Shahi Bagh cct 220 kV Sheikh Muhammadi-Nowshera cct 220 kV Ludewala-Lalian cct # 01 220 kV Ludewala-Lalian cct # 02	11/21/2023	1:36:00	PESCO, FESCO	676,800
13	220 kV Khuzdar	220kV Dadu-Khuzdar circuit No. 01	11/25/2023	0:44:00	QESCO, HESCO	110,880
14	220 kV Khuzdar	220kV Dadu-Khuzdar circuit No. 02	11/27/2023	0:07:00	QESCO, HESCO	41,000
15	220 kV Khuzdar	220kV Dadu-Khuzdar circuit No. 02	11/27/2023	15:34:00	QESCO, HESCO	58,240
16	500 kV Peshawar	500kV Sheikh Muhammadi-Tarbela circuit 220KV Sheikh Muhammadi-Daudkhel circuit No. 01 & 02 220KV Sheikh Muhammadi-Mowshera circuit 220kV Sheikh Muhammadi-Shahibagh circuit 500/220kV 450MVA Auto Transformers T-3 at Sheikh Muhammandi	12/11/2023	1:14:00	PESCO	161,216
17	500 kV Multan	220kV Multan- Kapco circuit No. 03 220kV Multan- Kapco circuit No. 06 220kV Pakgen- Kapco circuit	1/8/2024	0:43:00	MEPCO	41,067
18	220 kV Khuzdar	220kV Dadu-Khuzdar circuit No. 01	1/18/2024	19:27:00	QESCO, HESCO	9,890
19	220 kV T. M. Khan Road	220kV Jhimpir I-TM Khan circuit No. 02 220kV Jamshoro-TM Khan circuit No. 01	1/24/2024	0:17:00	HESCO	14,560

Sr. No.	Grid Name	Transmission Line	Trip date	Duration (hr:mm)	Affected area	Energy not served (kWHr)
		alongwith 220kV Busbar No. 02 at TM Khan 220kV Jamshoro-TM Khan circuit No. 02				
20	220 kV Khuzdar	220kV Dadu-Khuzdar circuit No. 02	1/28/2024	7:12:00	QESCO, HESCO	6,201
21	220 kV Quetta	220kV Sibbi-Quetta circuit No. 01 220kV Sibbi-Quetta circuit No. 02	2/1/2024	6:37:00	Qesco	514,710
22	220 kV Khuzdar	220kV Dadu-Khuzdar circuit No. 01	2/20/2024	0:16:00	Qesco, Hesco	9,313
23	220 kV Quetta	220kV Sibbi-Quetta circuit No. 01 220kV Sibbi-Quetta circuit No. 02	3/2/2024	2:15:00	Qesco	323,000
24	220 kV Khuzdar	220kV Dadu-Khuzdar circuit No. 02	3/18/2024	0:06:00	Qesco, Hesco	5,300
25	Khuzdar	220kV Dadu-Khuzdar circuit No. 01	4/7/2024	11:58	Qesco, Hesco	9900
26	Khuzdar	220kV Dadu-Khuzdar circuit No. 01	4/9/2024	0:06	Qesco, Hesco	6600
27	220kV Okara New	220kV Yousafwala- Okara New circuit No.01	4/15/2024	1:27	LESCO	120991
		220kV Yousafwala- Okara New circuit No.02		1:31	LESCO	
		220kV Sarfaraz Nagar- Okara New circuit No.01		1:38	LESCO	
		220kV Sarfaraz Nagar- Okara New circuit No.02		17:20	LESCO	
28	Khuzdar	220kV Dadu-Khuzdar circuit No. 01	4/17/2024	0:19	QESCO, HESCO	1400
29	Khuzdar	220kV Dadu-Khuzdar circuit No. 01	4/19/2024	4:46	QESCO, HESCO	4583.333
30	khuzdar	220kV Dadu-Khuzdar circuit No. 01	5/7/2024	16:35	QESCO, HESCO	7150
31	Quetta Industrial	220kV Sibbi-Quetta Industrial circuit No. 01	5/8/2024	2:54	QESCO	64200
		220kV Sibbi-Quetta Industrial circuit No. 02		2:19	QESCO	
32	khuzdar	220kV Dadu-Khuzdar circuit No. 01	5/8/2024	0:13	QESCO, HESCO	5866.667
33	NGPS	220kV New Multan-NPGS circuit No. 01	5/9/2024	1:00	MEPCO	69300
		220kV New Multan-NPGS circuit No. 02		1:12	MEPCO	
34	khuzdar	220kV Dadu-Khuzdar circuit No. 01	5/8/2024	2:17	QESCO, HESCO	17500
35	khuzdar	220kV Dadu-Khuzdar circuit No. 02		0:48	QESCO, HESCO	55480
36	Bund Road	220kV Sheikhupura-Bund Road circuit No. 01	5/19/2024	4:29	LESCO	235866.7
		220kV Sheikhupura-Bund Road circuit No. 02		4:30	LESCO	
		220kV Sheikhupura-Bund Road circuit No. 03		04:32	LESCO	
		220kV Sheikhupura-Bund Road circuit No. 04		04:30	LESCO	
		220kV Bund Road -Kala Shah Kaku circuit No. 01		04:36	LESCO	
		220kV Bund Road-Kala Shah Kaku circuit No. 02		04:35	LESCO	
		220kV Bund Road-New Kotlakhpat circuit No. 01		04:33	LESCO	
		220kV Bund Road-New Kotlakhpat circuit No. 02		04:32	LESCO	

Sr. No.	Grid Name	Transmission Line	Trip date	Duration (hr:mm)	Affected area	Energy not served (kWHr)
37	khuzdar	220kV Dadu-Khuzdar circuit No. 01	5/26/2024	0:26	QESCO, HESCO	18920
38	220kV Ludewala	220kV Ludewala-Lalian circuit No. 01	6/11/2024	0:51	LESCO	144033.3
		220kV Ludewala-Lalian circuit No. 02		0:54	LESCO	
		220kV Ludewala-C1C2 circuit		1:06	LESCO	
		220kV Ludewala-C3C24 circuit		0:49	LESCO	
39	220kV Khuzdar	220kV Dadu -Khuzdar circuit No. 01	6/12/2024	1:25	QESCO, HESCO	16033.33
		220kV Dadu -Khuzdar circuit No. 02		2:04	QESCO, HESCO	
40	220kV Dera Ghazi Khan	220kV Dera Ghazi Khan-Loralai circuit No. 01	6/13/2024	78:05:00	MEPCO	50400
		220kV Dera Ghazi Khan-Loralai circuit No. 02			MEPCO	
41	220kV Khuzdar	220kV Dadu -Khuzdar circuit No. 01	6/17/2024	12:49	QESCO	14133.33
		220kV Dadu -Khuzdar circuit No. 02		273:57:00	QESCO	
42	220kV Sahuwala Sialkot	220kV Sahuwala Sialkot -Kala Shah Kaku circuit	6/30/2024	1:39	LESCO	161700
		220kV Sahuwala Sialkot -Ghakhar circuit		1:34	LESCO	

Table 4: Tripping's occurred on transformers

Sr. No.	Grid Name	Equipment Name	Trip date	Duration	Affected area	Energy Not Served (kWHr)
1	220 kV Ravi	Auto Transformers 250MVA, 220/132kV T-1, T-2 & T-3	2023-07-03	00:36:00	LESCO	62,400
2	220 kV Sarfraznagar	Auto Transformers 220/132kV 160MVA T-1, T-2 & T-3	2023-07-14	01:00:00	LESCO	528,000
3	500 kV Dadu	Auto Transformer 220/132kV 160MVA T-1	2023-07-16	03:39:00	HESCO	23,750
4	220 kV Ravi	Auto Transformers 220/132kV 250MVA T-1, T-2, T-3	2023-07-20	12:26:00	LESCO	133,467
5	500 kV Guddu	220/132kv T-13	2023-07-25	11:52:00	Sepco	7,083
6	220 kV Loralai	220/132kV T-1, T-2	2023-08-12	00:28:00	Qesco	93,333
7	220 kV ISPR (Sangjani)	220/132kV 160MVA, Auto Transformers T-2,T-3,T-4,T-5	2023-10-16	00:59:00	IESCO	53,333
8	220 kV ISPR (Sangjani)	220/132kV 160MVA, Auto Transformers T-1,T-2,T-3,T-4 & T-7	2024-01-07	02:21:00	IESCO	17,200
9	500 kV Dadu	220/132kV 160MVA Auto Transformer T-1	2024-01-09	02:24:00	HESCO	9,690

The above data reflects that the highest Energy Not Served during FY 2023-24 was recorded on November 21, 2023, on the 500 kV Peshawar circuit (includes the 500 kV Tarbela-Sheikh Muhammadi transmission line, along with several 220 kV lines (Sheikh Muhammadi-Daudkhel circuits i & ii, Sheikh Muhammadi-Nowshera, Sheikh Muhammadi-Shahi Bagh, and Ludewala-Lalian circuits). This outage lasted for 1 hour and 36 minutes and resulted in a total of 676,800 kWh of Energy Not Served. Furthermore out of 51 incidents total 21 power outage incidents occurred only on the 220 kV Dadu-Khuzdar circuit No. i & ii that effected the consumers of QESCO and HESCO. Overall energy not served amounts to 5,89,081 kWHr, with some incidents lasting only minutes but still leading to considerable energy losses The longest outage lasted for over 273 hours on 220 kV Dadu-Khuzdar Circuit-II, causing significant disruption.

2.6. Quality of Supply:

The Quality of Supply (QOS) is assessed based on two key parameters: System Voltage and System Frequency. The following is an analysis of the data submitted by NTDC regarding these parameters:

2.6.1 System Frequency:

The data reveals that the system frequency exceeded the permissible limits on 7 occasions, with a total duration of 49 minutes. The highest frequency recorded for the year was 50.62 Hz, reflecting a maximum variation of 1.24%. Month-wise details of the system frequency are provided in Table 5 below:

Table 5: System frequency statistics

Month	Number of days/hours for a month over a year		Frequency violation recorded (Hz)		Duration of variation		Variation (%)			Number of times frequency remained outside the limits
	Days	Hours	Highest	Lowest	Mins	Hrs	Highest	Lowest	Period	Nos.
1	**2**	**3**	**4**	**5**	**6**	**7**	**8=(450)/ 50*100**	**9=(550)/ 50*100**	**10=7/3 *100**	**11**
July	31	744	50.61	Nil	6	0.1	1.22	Nil	0.01	3
Aug	31	744	50.55	Nil	13	0.22	1.1	Nil	0.03	1
Sep	30	720	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Oct	31	744	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Nov	30	720	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Dec	31	744	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Jan	31	744	50.54	Nil	6	0.1	1.08	Nil	0.01	1
Feb	29	696	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Mar	31	744	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Apr	30	720	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
May	31	744	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
June	30	720	50.62	Nil	12	0.2	1.24	Nil	0.03	2
Year	**366**	**8784**	**50.62**	**Nil**	**49**	**0.82**	**1.24**	**Nil**	**0.01**	**7**

Table 6 presents five years' worth of data on the average number of occurrences and the average duration for which the frequency remained outside the permissible limits.

Table 6: System frequency details with comparison

Description / Unit / Year	Unit	2019-20	2020-21	2021-22	2022-23	2023-24
Number of times Frequency remained outside the Limits in a Year	In a year	9	4	3	15	7
	Average/month	0.8	0.3	0.25	1.25	0.58
	Average/day	0.024	0.01	0.01	0.04	0.02
Time duration the Frequency remained outside the Limits in a Year	Days	0.03	0.02	0.02	0.07	0.03
	Hours	0.8	0.6	0.4	1.7	0.82
	%age of year	0.009	0.007	0.005	0.02	0.01

Overall, the table demonstrates an improvement in the stability of the power supply system during FY 2023-24. A closer look at the five-year record shows that the lowest number of instances occurred in FY 2020-21 and FY 2021-22.

Figure 8 illustrates the months with the highest frequency of incidents where the frequency exceeded the permissible limit during FY 2023-24. The dotted orange line represents the allowed limit of 50.5 Hz, while the blue dotted line indicates instances when the frequency crossed this threshold.

The highest frequency recorded was 50.62 Hz in June 2024.

According to NTDC, the lower frequency limit was not violated during this period.

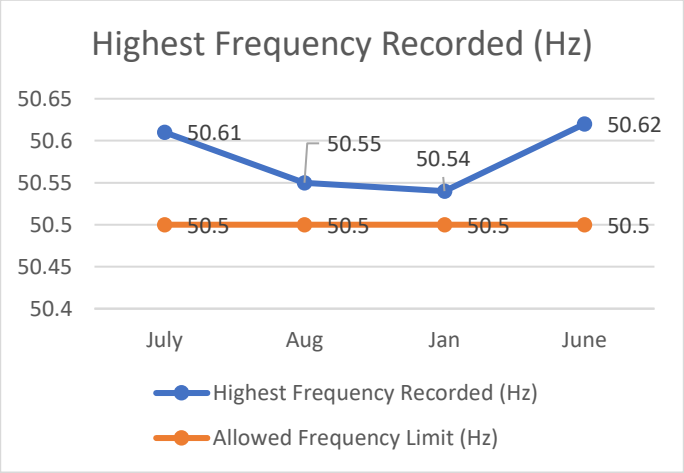


Figure 8: Highest frequency recorded (Hz)

2.6.2 System Voltage:

According to Rule 7 of PSTR-2005, voltage variations of ±5% are allowed under normal conditions, while under (N-1) contingency conditions, variations of ±10% are permissible. Voltage variations outside these limits, as specified in Sub-Rules (2) and (3) of PSTR-2005, must be reported only if the duration of the variation exceeds a continuous period of thirty (30) minutes.

During FY 2023-24, NTDC reported a total of 157,692 voltage variations, which represents a 24.26% increase compared to the previous year.

Figure 9 illustrates the five-year trend of voltage violations. It is observed that the highest number of voltage variations in the past five years occurred in FY 2021-22, with a total of 185,497 violations.

In comparison, FY 2023-24 saw 157,692 voltage violations, an increase from the 126,899 violations recorded in FY 2022-23.

This indicates a decline in NTDC's performance with respect to voltage violations in FY 2023-24 compared to the previous year.

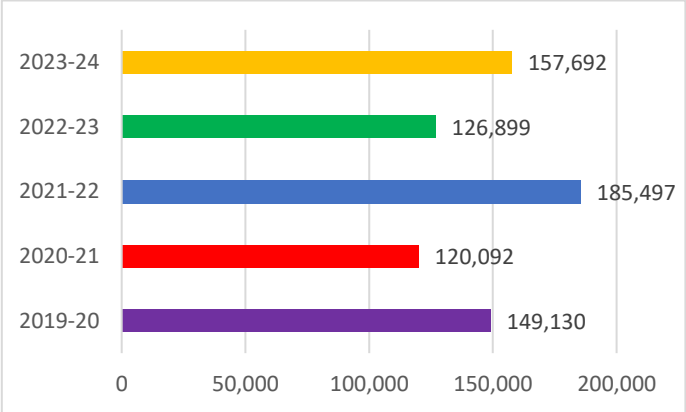


Figure 9: Number of voltage violations

2.6.3 Region-wise voltage violations: Region-wise detail of voltage violations is given hereunder:

Table 7: Number of voltage violations

System Condition	NTDC Region	2019-20	2020-21	2021-22	2022-23	2023-24
x	Islamabad	29,577	21,710	28,147	18,101	9,644
	Lahore	50,776	53,741	73,697	38,974	29,588
Normal	Multan	9,048	5,493	7,949	6,805	9,509
	Hyderabad	52,698	38,811	70,304	61,548	107,793
Total (Normal)		**142,099**	**119,755**	**180,097**	**125,428**	**156,534**
	Islamabad	–	–	–	–	–
	Lahore	5,017	–	444	43	49
N-1	Multan	1,762	203	1,805	548	186
	Hyderabad	252	134	3,151	880	923
Total (N-1)		**7,031**	**337**	**5,400**	**1,471**	**1,158**
Total (Normal & N-1)		**149,130**	**120,092**	**185,497**	**126,899**	**157,692**

The table above shows that under "Normal" system conditions, the total number of voltage violations increased in the Hyderabad and Multan regions compared to the previous year.

However, under "N-1" system conditions, the total number of voltage violations decreased from 1,471 in the previous year to 1,158 in FY 2023-24, indicating an overall improvement in voltage stability. Despite this improvement, there was a slight increase in voltage violations in the Hyderabad region during FY 2023-24.

2.6.4. Grid-wise voltage violation of each region:
The grid station-wise breakup for each region is given below:

Table 8: Number of voltage violations (Islamabad Region)

Sr. No.	Grid Station	2019-20	2020-21	2021-22	2022-23	2023-24
1	500kV Rawat	6,768	4,298	3,464	2,048	2156
2	500kV Sheikh Muhammadi Peshawar	2,275	1,417	4,357	3,491	1494
3	220 kV Bannu	716	664	1,915	3,787	1966
4	220 kV Burhan	1,032	644	468	72	16
5	220 kV Daudkhel	684	243	12	399	186
6	220kV ISPR (Sangjani)	1,364	582	1,422	533	277
7	220kV Mardan	5,460	3,999	6,279	3,907	1916
8	220kV Nowshera	1,357	628	2,301	1,264	327
9	220kV New Shahibagh Peshawar	3,620	4,350	4,770	1,74	701
10	220kV University	2,541	2,363	1,469	618	257
11	220kV Mansehra	56	312	178	54	154
12	220kV Chakdara	578	368	366	170	56
13	220kV D. I. Khan	3,126	1,842	1,146	44	138
Total		**29,577**	**21,710**	**28,147**	**18,101**	**9,644**

During FY 2023-24, the 500 kV Rawat grid station recorded the highest number of voltage violations, totaling 2,156 incidents. However, over the past five years, in the 500 kV grid stations, the 500kV Rawat grid station has also been the worst performer, with a cumulative total of 18,734 violations. For the 220 kV grid stations, the 220 kV Bannu grid station reported a significant number of violations in FY 2023-24, with 1,966 incidents. Moreover, over the past five years, the 220 kV Mardan grid station also showed a high cumulative number of violations, totaling 21,561. This highlights a critical issue with voltage stability at both 500 Rawat & 220 kV Mardan grid stations, warranting focused attention and corrective measures.

Table 9: Number of voltage violations (Lahore Region)

Sr. No.	Grid Station	2019-20	2020-21	2021-22	2022-23	2023-24
1	500 kV Gatti	1,026	254	871	833	567
2	500 kV Nokhar	3,012	602	245	1655	1,528
3	500 kV Shiekhupura	693	173	356	100	177
4	500 kV New Lahore	3,694	886	1,566	2,545	1099
5	500 kV West FSD	-	-	1,496	7,982	2977
6	220 kV Bund	6,450	3,420	8,412	2,248	1524
7	220 kV Ghakkar	661	6,584	3,526	236	89
8	220 kV Jaranwala	4,219	52	268	3	Nil
9	220 kV Kala Shah Kaku	411	4,454	6,471	639	1237
10	220 kV Ludewala	3,822	157	757	285	178
11	220 kV New Kot lakhpat	1,559	4,735	4,649	1,787	1390
12	220 kV Shalamar	268	1,902	1,897	1,232	912
13	220 kV Nishatabad	4,746	28	12	6	6
14	220 kV Ravi	606	2,912	3,493	538	345
15	220 kV Samundari	3,266	224	1,552	350	83
16	220 kV Safraznagar	2,420	6,162	7,460	4,441	3183
17	220 kV Sialkot	960	2,350	2,833	1,454	844
18	220 kV Wapda Town	8,932	1,238	937	412	136
19	220 kV Ghazi Road	1,800	12,862	12,085	8,806	6674
20	220 kV Bandala	940	656	456	134	490
21	220 kV T.T.Singh	2,632	448	3,171	1,470	2663
22	220 kV Gujrat	1,026	3,294	3,696	1,851	951
23	220 kV Lalian	-	-	-	10	81
24	500 kV Yousafwala	1,320	–	6,126	2993	1417
25	220 kV Kassowal	1,100	144	1,200	520	477
26	220 kV Okara	408	204	606	606	609
Total		**55,971**	**53,741**	**74,141**	**43,136**	**29,637**

The table above shows that the 500 kV Faisalabad West grid station reported the highest number of voltage violations in FY 2023-24, with a total of 2,977 incidents. Over the past five years, this station has also recorded the highest cumulative number of violations, totaling 12,455.

For the 220 kV grid stations, the 220 kV Ghazi Road grid station reported a significant number of violations in FY 2023-24, with 6,674 incidents. This station also experienced a high cumulative total of 42,227 violations over the last five years. These figures highlight a critical issue with voltage stability at both the Faisalabad West and Ghazi Road grid stations, signaling the need for focused corrective action to address the ongoing voltage instability at these locations.

Table 10: Number of voltage violations (Multan Region)

Sr. No.	Grid Station	2019-20	2020-21	2021-22	2022-23	2022-23
1	500 kV Multan	28	55	24	851	4653
2	500 kV Muzaffargarh	–	–	–	–	–
3	500 kV D.G.Khan	225	185	233	133	1052
4	500 kV Rahimyar Khan	–	–	–	–	567
5	220 kV Bahawalpur	1,673	833	1,502	641	178
6	220 kV Muzzaffargarh	416	329	462	371	191
7	220 kV Vehari	2,870	1,659	2,279	2,048	1,332
8	220 kV Chistian	4,867	2,427	5,054	3,210	1,667
9	220 kV Lal Sohanra	731	208	202	99	55
Total		**10,810**	**5,696**	**9,756**	**7,353**	**9,695**

During FY 2022-23, the 500 kV Multan grid station reported the highest number of voltage violations, totaling 851 incidents, while the 220 kV Chishtian grid station recorded 3,210 violations.

Looking at the period from 2019-20 to 2023-24, the 500 kV Multan grid station accumulated the highest total number of violations, with 5,611 incidents. During the same period, the 220 kV Chishtian grid station reported a significantly higher cumulative total of 17,225 voltage violations. These figures highlight persistent issues with voltage stability at both stations, indicating the need for targeted measures to address the ongoing violations.

Table 11: Number of voltage violations (Hyderabad Region)

Sr. No.	Grid Station	2019-20	2020-21	2021-22	2022-23	2023-24
1	500kV Dadu	113	53	10	44	1,915
2	500kV Guddu	260	114	165	1,646	7,438
3	500kV Jamshoro	4,583	6,086	16,220	7,141	15,424
4	500kV NKI Karachi	106	-	-	123	6,149
5	500kV Shikarpur	9,602	10,311	13,494	11,270	13,515
6	500kV 747 MW Guddu	-	-	-	17,878	18,250
7	220kV Hala road	10	2	-	1	230
8	220 kV Rohri	968	1,500	5,104	2,597	3,776
9	220 kV T.M.Khan Road	5,208	1,824	2,372	1,430	1,945
10	220kV Daharki	1,912	1,165	1,178	1,245	2,116
11	220 kV Jhimpir 1	-	-	-	303	5,415
12	220 kV Jhimpir 2	-	-	-	396	821
13	220kV Switchyard Guddu	-	-	-	3,230	4,356
Total		**22,762**	**21,055**	**38,543**	**47,304**	**81,350**

The data in the table shows that during FY 2023-24, the 500 kV Guddu grid station (747 MW) reported the highest number of voltage violations, totaling 18,250 incidents. Over the last five years, the 500 kV Shikarpur grid station also recorded a high number of violations, with a cumulative total of 58,192 violations.

In FY 2023-24, the 220 kV Jhimpir-I station experienced the highest number of voltage violations, with a total of 5,415 incidents. Over the past five years, the 220 kV Rohri grid station recorded a significant number of violations, totaling 13,945 incidents. These figures highlight persistent voltage stability issues at both the Guddu and Shikarpur stations, as well as at Jhimpir-I and Rohri, indicatesthe need for focused interventions to improve voltage control and system reliability.

Table 12: Number of voltage violations (Quetta Region)

Sr. No.	Grid Station	2019-20	2020-21	2021-22	2022-23	2023-24
1	220kV Quetta Industrial-II	10,936	5,702	15,034	1,948	3,223
2	220 kV Sibbi	9,186	7,200	9,407	8,375	15,785
3	220kV Khuzdar	1,966	2,722	4	1,100	757
4	220kV Loralai	2,440	2,064	3,266	2,204	1,909
5	220kV Dera Murad Jamali	4,830	NP	3,275	1,497	5,692
Total		**29,358**	**17,688**	**30,986**	**15,124**	**27,366**

During FY 2023-24, the 220 kV Sibbi station recorded the highest number of voltage violations, totaling 15,785 incidents. Over the past five years, Sibbi has also experienced a significant number of violations, with a cumulative total of 49,953 violations. This indicates a recurring issue with voltage stability at the Sibbi station, highlighting the need for targeted measures to address these persistent violations.

2.6.5. Grid wise voltage variation of 500 kV and 220 kV grid stations under Normal & N-1 condition:
The permissible voltage limits for 500 kV and 220 kV grid stations under normal and (N-1) contingency conditions are as follows:

For 500 kV Grid Stations:

- **Normal Condition:** Voltage variation of ±5%, i.e., between 525 kV and 475 kV, is allowed for up to 30 minutes.
- **(N-1) Contingency Condition:** Voltage variation of ±10%, i.e., between 550 kV and 450 kV, is permissible for up to 30 minutes.

For 220 kV Grid Stations:

- **Normal Condition:** Voltage variation of ±5%, i.e., between 231 kV and 209 kV, is allowed for up to 30 minutes.
- **(N-1) Contingency Condition:** Voltage variation of ±10%, i.e., between 242 kV and 198 kV, is permissible for up to 30 minutes.

Table 13: Highest voltage incidents recorded at 500 kV grid station under Normal condition

Region	Grid Station	Voltage (kV)	Duration (min)	Maximum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
Multan	500 kV Multan	580	180	525	10.48
	500 kV D.G. Khan	559	1260	525	6.48
	500 kV RY Khan	552	1350	525	5.14
	500kV Muzaffargarh	-	-	-	-
Lahore	500KV WFSD	546	540	525	4.00
	500kV Gatti	545	180	525	3.81
	500 kV Yousafwala	546	90	525	3.62
	500 kV Sheikhupura	532	60	525	1.33
	500 kV Nokhar	538	240	525	2.48
	500 kV New Lahore	538	180	525	2.48
Islamabad	500 kV Tarbela	543	180	525	3.43
	500 kV Sheikh Muhammadi	543	180	525	3.43
Hyderabad	500KV 747 Guddu	551	60	525	4.95
	500 kV Guddu	549	60	525	4.57
	500 kV Dadu	545	60	525	3.81
	500 kV Shikarpur	549	180	525	4.57
	500 kV NKI Karachi	543	30	525	3.43
	500 kV Jamshoro	545	30	525	3.81

The highest voltage violation recorded was 580 kV at the Multan 500 kV grid station, representing a deviation of 10.48% from the allowed +5% limit (525 kV) under normal conditions. Details of the highest voltage incidents at 500 kV grid stations under normal conditions are provided in the table above.

Additionally, it is important to note that no instances of excessive voltage violations were recorded at 500 kV grid stations under (N-1) contingency conditions.

Table 14: Highest voltage (kV) recorded at 220 kV grid stations under Normal condition

Region	Grid Stations	Voltage (kV)	Duration (min)	Maximum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
Multan	220 kV D.G. Khan	250	600	231	8.23
	220KV Muzaffargarh	248	180	231	7.36
	220 kV Multan	248	1440	231	7.36
	220 kV Bahawalpur	242	30	231	4.76
	220 kV Vehari	246	90	231	6.49
	220 kV Chishtian	242	540	231	4.76
	220 kV Lal Sohanra	242	90	231	4.76
Lahore	220KV Toba Tek Singh	250	1410	231	8.23
	220KV WFSD	249	600	231	7.79
	220 kV Gujrat	242	360	231	4.76
	220 kV Samundri Road	235	300	231	1.73
	220 kV Nishatabad	234	60	231	1.30
	220 kV Lalian	240	90	231	3.90
	220 kV Ludewala	241	90	231	4.33
	220 kV Bandala	238	60	231	3.03
	220 kV Sheikhupura	240	90	231	3.90
	220 kV Gatti	235	90	231	1.73
	220 kV Yousafwala	240	240	231	3.90
	220 kV Ravi	233	90	231	0.87
	220 kV Okara	239	390	231	3.46
	220 kV Nokhar	242	360	231	4.76
	220 kV New Kot Lakhpat	238	90	231	3.03
	220 kV Kassowal	242	120	231	4.76
	220 kV New Lahore	236	270	231	2.16
Islamabad	220 kV Rawat	248	60	231	7.36
	220 Kv University	245	300	231	6.06
	220 kV Bannu	243	1440	231	5.19
	220 kV Sheikh Muhammadi	236	300	231	2.16
	220 kV Burhan	240	60	231	3.90
	220 kV Daud khel	238	60	231	3.03
	220 kV ISPR	240	240	231	3.90
	220 kV Mardan	236	300	231	2.16
	220 kV Nowshera	237	60	231	2.60
	220 kV Mansehra	241	120	231	4.33
	220 kV Chakdara	237	90	231	2.60
	220 kV D.I.Khan	241	60	231	4.33
Hyderabad	220kV Jamshoro	253	60	231	9.52
	220kV Guddu	247	210	231	6.93
	220 kV Jhimpir II	244	60	231	5.63
	220 kV Jhimpir I	245	60	231	6.06
	220 kV T.M. Khan	243	60	231	5.19
	220 kV Rohri	246	120	231	6.49
	220 kV Khuzdar	248	60	231	7.36
	220 kV Hala Road	245	180	231	6.06
	220 kV Daharki	246	180	231	6.49
	220 kV Shikarpur	248	120	231	7.36
	220 kV NKI Karachi	238	30	231	3.03
	220 kV Dadu	240	180	231	3.90
	220KV Sibbi	247	60	231	6.93
Quetta	220 kV Loralai	270	60	231	16.88
	220 kV D. M. Jamali	256	60	231	10.82

Region	Grid Stations	Voltage (kV)	Duration (min)	Maximum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
	220 kV Quetta	254	60	231	9.96

The 220 kV D.G. Khan grid station recorded the highest voltage of 270 kV, representing a deviation of 16.88% from the allowed limit of 231 kV (with a +5% tolerance). The graphical and tabular representation of these incidents is provided in Table 14 and Figure 10.

Figure 10: Highest voltage (kV) recorded at 220 kV grid stations under N-1 condition

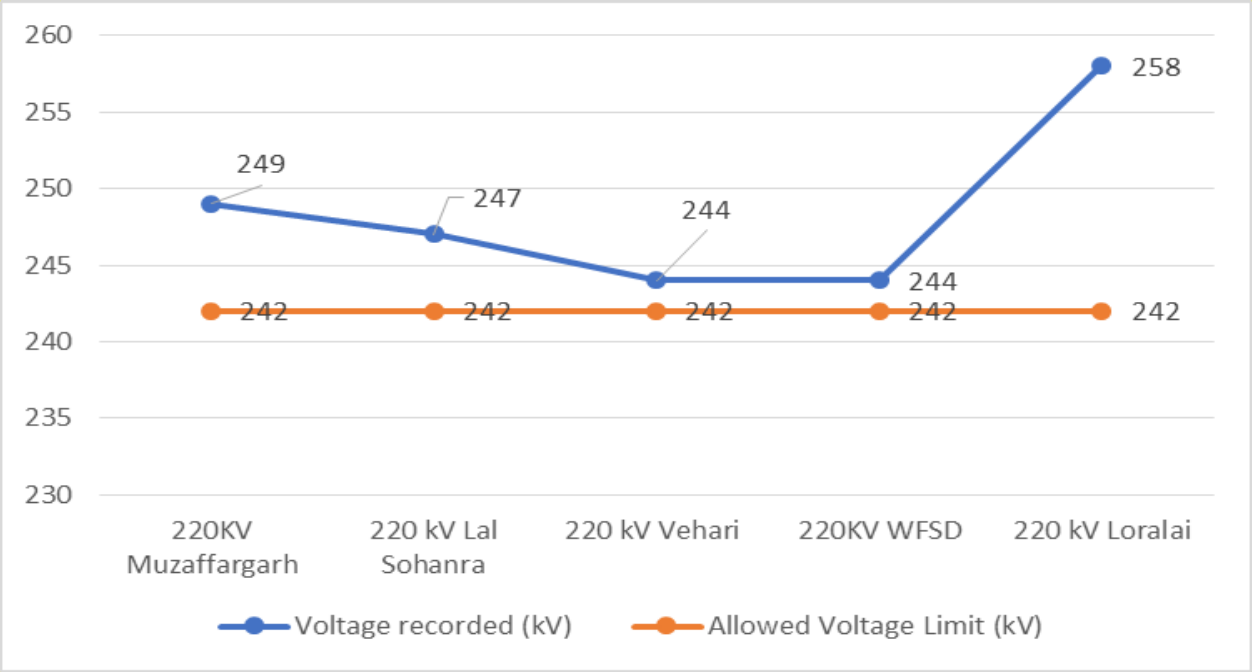


Table 15: Highest voltage (kV) recorded at 220 kV grid stations under N-1 condition

Region	Grid Stations	Voltage (kV)	Duration (min)	Maximum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
Multan	220KV Muzaffargarh	249	90	242	2.89
	220 kV Lal Sohanra	247	60	242	2.07
	220 kV Chistian (N-1)	243	180	242	0.41
	220 kV Vehari	244	90	242	0.83
Lahore	220KV WFSD	244	60	242	0.83
Islamabad	Nil	Nil	Nil	Nil	Nil
Hyderabad	Nil	Nil	Nil	Nil	Nil
Quetta	220 kV Loralai	258	180	242	6.61

The table and figure above show the highest voltage recorded at 220 kV grid stations under (N-1) conditions. The highest voltage of 258 kV was recorded at Loralai, representing a 6.61% deviation from the allowed limit of 242 kV (with a +10% tolerance). The table provides a detailed overview of the highest voltage incidents at 220 kV grid stations under (N-1) conditions.

Table 16: Lowest voltage (kV) recorded at 500 kV grid stations under Normal condition

Sr. No.	Grid Stations	Lowest Voltage (kV)	Duration	Deviation w.r.t Allowed Limit (%)
Islamabad	500kV Sheikh Muhammadi Peshawar	473	60	0.42

At 500kV Sheikh Muhammadi Peshawar grid station, the lowest recorded voltage was 473 kV, representing a deviation of 0.42% from the allowed limit of 475 kV (with a -5% tolerance). The duration of this incident was 60 seconds. Here it is pertinent to mention that this is the only low voltage violation recorded at 500kV grid stations throughout the transmission network of NTDC for FY 2023-24.

Figure 11: Lowest voltage (kV) recorded at 220 kV grid stations under Normal condition

Table 17: Lowest voltage (kV) recorded at 220 kV grid stations under Normal condition

Region	Grid Stations	Voltage (kV)	Duration (min)	Minimum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
Multan	220 kV Vehari	200	90	209	4.31
	220 kV Chishtian	199	120	209	4.78
	220 kV Bahawalpur	199	30	209	4.78
Lahore	220 kV Ghazi	188	60	209	10.05
	220 kV Sarfraz Nagar	189	60	209	9.57
	220 kV Shalamar	192	90	209	8.13
	220 kV Ludewala	203	90	209	2.87
	220 kV Sheikhupura	200	90	209	4.31
	220 kV Yousafwala	199	120	209	4.78
	220 kV Wapda Town	202	90	209	3.35
	220 kV Sialkot	198	210	209	5.26
	220 kV Ravi	200	210	209	4.31
	220 kV Okara	194	600	209	7.18
	220 kV Nokhar	195	150	209	6.70
	220 kV New Kot Lakhpat	195	150	209	6.70
	220 kV Kassowal	195	60	209	6.70
	220 kV Gujrat	204	60	209	2.39
	220 kV Ghakkar	202	60	209	3.35
	220 kV Kala Shah Kaku	199	90	209	4.78
	220 kV Bund Road	194	150	209	7.18
Islamabad	220 kV Shahibagh	190	60	209	9.09

Region	Grid Stations	Voltage (kV)	Duration (min)	Minimum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
	220 kV Mardan	194	60	209	7.18
	220 kV Bannu	200	60	209	4.31
	220 kV Sheikh Muhammadi	202	60	209	3.35
	220 kV ISPR	202	240	209	3.35
	220 kV Chakdara	200	60	209	4.31
Hyderabad	220 kV Jhimpir I	137	60	209	34.45
Quetta	220 kV Khuzdar	180	35	209	13.88
	220 kV Quetta	175	60	209	16.27
	220 kV Loralai	137	60	209	34.45

The lowest voltage of 137 kV was recorded at both the 220 kV Loralai and 220 kV Jhimpir-I grid stations, resulting in a 34.45% deviation from the allowed limit of 209 kV (with a -5% tolerance) at both stations. The graphical and tabular representation of similar incidents across other grid stations and regions is provided in Table 17 and Figure 11 above.

Figure 12: Lowest voltage (kV) recorded at 220 kV grid stations under N-1 condition

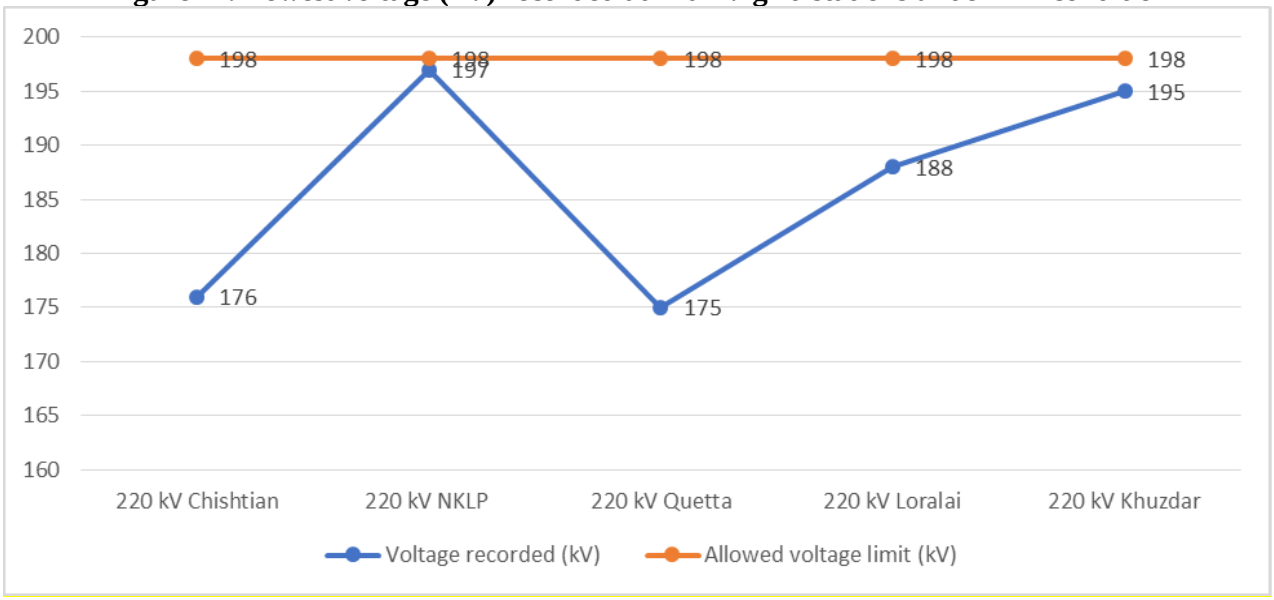


Table 18: Lowest voltage (kV) recorded at 220 kV grid stations under N-1 condition

Region	Grid Stations	Voltage (kV)	Duration (min)	Minimum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
Multan	220 kV Chishtian	176	30	198	11.11
Lahore	220 kV NKLP	197	90	198	0.51
Islamabad	Nil	Nil	Nil	Nil	Nil
Hyderabad	Nil	Nil	Nil	Nil	Nil
Quetta	220 kV Quetta	175	60	198	11.62
	220 kV Loralai	188	60	198	5.05
	220 kV Khuzdar	195	30	198	1.52

The lowest voltage recorded at the 220 kV Quetta grid station was 175 kV, indicating an 11.62% deviation from the allowed limit of 198 kV (with a -10% tolerance). As shown in the table above, the deviations from the allowed limits ranged from 0.51% to 11.62%, with the highest deviation occurring at 220 kV Quetta (lasting 60 minutes). Conversely, the lowest deviation of 0.51% was recorded at 220 kV NKPL, with a duration of 90 minutes.

2.7 Performance of Tie Lines Submitted by NTDC:
To meet the power demand of K-Electric (KE), NTDC has established interconnections with KE's grid system. These interconnections are facilitated through four 220 kV transmission circuits, as follows:

(a) NKI-KDA
(b) NKI-Baldia
(c) Jhimpir II-I-KDA
(d) Jhimpir II-II-KDA

These tie lines enable the export of electricity from NTDC to KE's grid, supporting the stability and reliability of power supply to KE's service areas.

2.7 Performance of Tie Lines Submitted by NTDC:
NTDC maintains interconnections with K-Electric (KE) grids through four 220 kV transmission circuits for power export. Of these, the following circuits are maintained by NTDC:

(a) 220 kV Jhimpir-II Circuit 1 - KDA
(b) 220 kV Jhimpir-II Circuit 2 - KDA

The remaining two circuits, 220 kV KDA-NKI and 220 kV Balidia-NKI, are maintained by K-Electric as they fall under KE's jurisdiction.

2.8 System Reliability:
2.8.1 Average Duration of Interruption:

(a) Total outage hours at all interconnection points (excluding 132 kV line tripping): 0 hours
(b) Total number of interconnection points: 4
(c) System duration of interruption: 0 hours

2.8.2 Average Frequency of Interruption:

(a) Number of outages at all 132 kV outgoing circuits (excluding 132kV line tripping): 1
(b) Total number of 132 kV circuits: 4
(c) System frequency of interruption: 0.25 outages per circuit

These figures demonstrate a high level of reliability in the system, with minimal interruptions recorded across both the interconnection points and 132 kV outgoing circuits.

SECTION II

K - ELECTRIC

3. Brief Introduction of K-Electric:

K-Electric (KE) is a vertically integrated utility company in Pakistan, responsible for the generation, transmission, and distribution of electricity to Karachi. The company was originally established on September 13, 1913, as Karachi Electric Supply Corporation (KESC) under the Indian Companies Act of 1882. It was privatized on November 29, 2005, and subsequently rebranded in September 2008 to Karachi Electric Supply Company (KESC). In celebration of its 100th anniversary during the 2013-14 period, the company was renamed K-Electric Limited (KEL).

3.1 License:

In accordance with Section 16 and Section 25 of the NEPRA Act, 1997, NEPRA granted K-Electric (KE) a transmission license in June 2010, authorizing the company to carry out transmission activities within the specified territory for a duration of thirty (30) years.

3.2 KE Transmission Network:

As of June 2024, the K-Electric (KE) transmission system consists of a total of 74 grid stations (66 kV, 132 kV, and 220 kV), 1,393.62 km of transmission lines, and a transformation capacity of 12,695 MVA. KE's grid system is connected to the NTDC network through four 220 kV transmission circuits, as follows:

(a) KDA-NKI
(b) Baldia-NKI
(c) KDA-Jhimpir 2 -1
(d) KDA-Jhimpir 2 -2

These circuits facilitate the transfer of power between KE's grid and NTDC, supporting the electricity supply to Karachi.

Figure 13: KE transmission system

Table 19: KE Network Statistics

Description		2019-20	2020-21	2021-22	2022-23	2023-24
No. of Grid Stations	220 kV	10	10	10	10	11
	Added	1	0	0	0	1
	132 kV	57	58	58	58	60
	Added	1	0	0	0	2
	66 kV	3	3	3	3	3
	Added	0	0	0	0	0
	Total	**70**	**71**	**71**	**71**	**74**
Length of Transmission Line (Circuit km)	220 kV	365	365	364	364	435.682
	Added	29	-1	0	0	72
	132 kV	801	833	838	838	805.306
	Added	3	35	2	0	-33
	66 kV	153	153	153	153	152.632
	Added	3	-1	1	0	0
	Total	**1,319**	**1,352**	**1,355**	**1,355**	**1393.62**
Transformation Capacity (MVA)	220 kV	4,500	4,500	4,500	4,500	5500
	Added	1000	0	0	0	1000
	132 kV	6,373	6,557	6,824	6,986	7116
	Added	264	301	150	162	30
	66 kV	79	79	79	79	79
	Added	10	0	0	0	0
	Total	**10,952**	**11,136**	**11,403**	**11,565**	**12,695**

As shown in the table above, three new grid stations were added to the K-Electric (KE) network in FY 2023-24—one 220 kV grid station and two 132 kV grid stations. Additionally, 39 km of transmission line was added, whereas the transformation capacity increased by 1,030 MVA.

Over the past five years, KE has expanded its network with the addition of five grid stations i.e. (Two - 220 kV & Three - 132 kV), 110 km of transmission lines, and a total of 2,917 MVA in transformation capacity. This growth reflects KE's ongoing efforts to enhance its transmission infrastructure and capacity.

3.3 Performance of K-Electric under PSTR-2005:

This section provides a comprehensive evaluation of K-Electric's (KE) performance in key areas: System Reliability, System Security, and Quality of Supply. Each of these performance parameters is examined in detail below:

3.4. System Reliability:

3.4.1 Average Duration of Interruption:

(a) Total outage hours recorded at all interconnection points (excluding 132 kV line tripping): 0.08 hours
(b) Total number of interconnection points: 10
(c) Average system duration of interruption: 0.01 hours per point

The interconnection points reported an average interruption duration of 0 hours, consistent with the previous year. As shown in Figure 14, this marks no change compared to the prior year. Looking at the trend over the last five years, the average interruption duration was 0.06 hours in FY 2020-21 and 0.12 hours in FY 2019-20, indicating a significant improvement in system reliability.

During FY 2023-24, KE reported a total of 0.08 outage hours. Notably, one additional interconnection point was added compared to the previous year, bringing the total to 10.

Consequently, the system duration of interruption saw a slight increase, with an average of 0.01 hours per interconnection point.

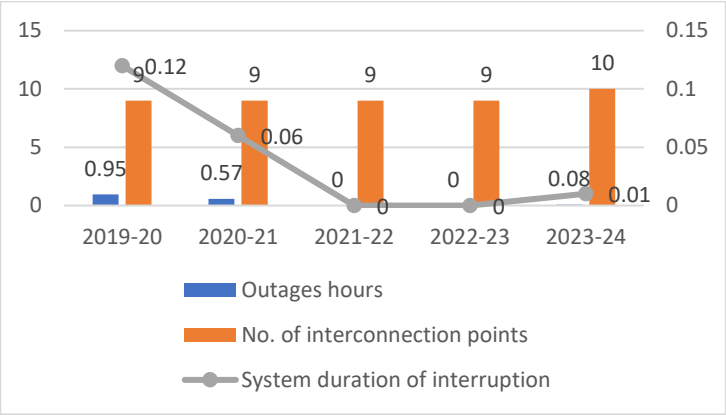


Figure 14: Outage hours, number of interconnection points and System Duration of Interruption (No.s/circuit)

3.4.2 Average Frequency of Interruption:

(a) Total number of outages recorded at all 132 kV outgoing circuits (excluding 132 kV line tripping): 1
(b) Total number of 132 kV circuits: 53
(c) System frequency of interruption: 0.02 outages per circuit, reflecting the same result as the previous year (0 outages per circuit).

As shown in the figure below, the total number of outages remained at 1 during FY 2023-24, compared to 0 outages in the previous year. Additionally, two outgoing circuits were added during the reporting period.

The average number of interruptions per circuit has seen a slight increase, rising to 0.02 outages per circuit, compared to 0 outages per circuit reported in the previous year by KE.

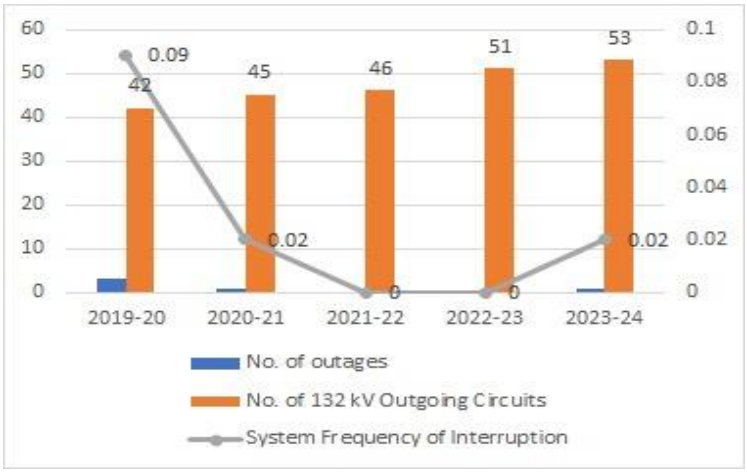


Figure 15: Number of outages and number of 132 kV outgoing circuits

3.5. Tie Line Reliability submitted by KE:

The tie lines in K-Electric's (KE) transmission system consist of four 220 kV circuits that connect KE's network with NTDC's network. These circuits are:

(a) KDA-NKI
(b) Baldia-NKI
(c) KDA-Jhimpir2-I
(d) KDA-Jhimpir2-II

Out of these, the 220 kV KDA-Jhimpir2 Circuits I and II are maintained by NTDC, while the 220 kV KDA-NKI and Baldia-NKI circuits are under KE's jurisdiction and are maintained by KE.

3.5.1 System Duration of Interruption of Tie Lines:

The system duration of Interruption of Tie Lines between NTDC & KE is as under:

Table 20: System Duration of Interruption of Tie Line

Months	Total outages hours recorded on all tie line circuit	Total number of tie lines circuit	System Duration of Interruption
	-1	-2	(3=1/2)
Jul-24	0.3	4	0.07
Aug-24	--	4	--
Sep-24	--	4	--
Oct-24	--	4	--
Nov-24	--	4	--
Dec-24	--	4	--
Jan-24	6	4	1.5
Feb-24	2.4	4	0.6
Mar-24	--	4	--
Apr-24	--	4	--
May-24	--	4	--
Jun-24	3	4	0.74
Total	**11.65**	**4**	**2.91**

Based on the table above, it is observed that in FY 2023-24, all tie lines experienced a total of 11.65 hours of outages, with a System Duration of Interruption averaging 2.91 hours.

During the same period, the total number of outages reported on tie lines was 5, resulting in a System Frequency of Interruption of 1.25 outages per tie line.

KE maintained tie lines:
Out of the total five (05) outages, three (03) occurred on the KE-maintained tie lines. These outages were transient in nature and had a combined duration of 8.40 hours. However, it is noteworthy that no unserved energy was recorded as a result of these outages.

NTDC maintained tie lines
On the NTDC-maintained tie lines, two (02) outages occurred, resulting in a total duration of 3.25 hours. These outages led to a total unserved energy of 74.8 MWh in the system.

3.6. System Security:

3.6.1 Energy Not Served (ENS):

(a) Total ENS = 0.046 MkWh
(b) Number of incidents, where there has been a loss of supply = 1
(c) Average ENS per incident = 0.046 MkWh
(d) Average duration per incident = 0.08 hrs

According to KE, the total Energy Not Served (ENS) for FY 2023-24 amounted to 0.046 million kWh, compared to zero ENS in the previous year. Additionally, there was one incident of loss of supply.

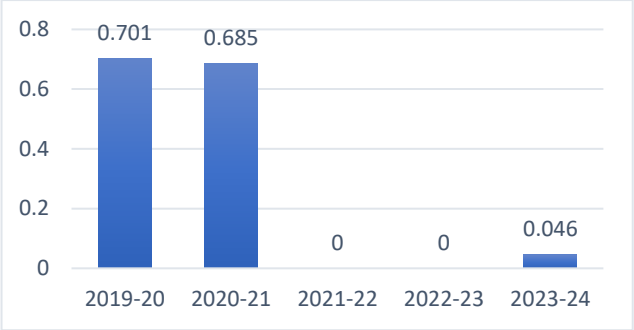


Figure 16: Reported Energy not served

The data presented in Figure 15 shows an increase in Energy Not Served (ENS) to 0.046 million kWh in FY 2023-24, compared to zero ENS in the previous year.

This indicates a decline in KE's performance relative to ENS data over the past two years with an average duration per incident of 0.08 hours.

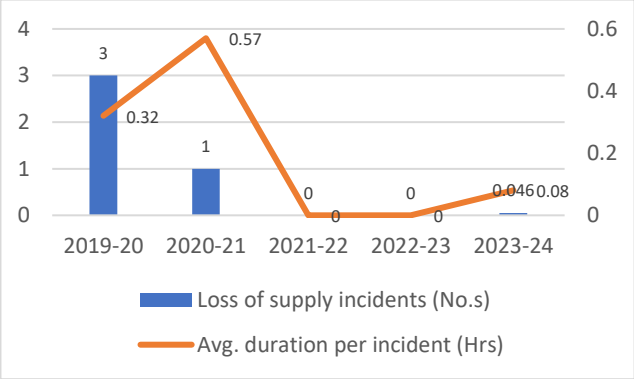


Figure 17: Loss of supply incidents and duration per incident

Table 21: Loss of supply incidents, average ENS, duration & financial impact per incident

Description	2019-20	2020-21	2021-22	2022-23	2023-24
Loss of Supply Incidents (Nos.)	3	1	0	0	1
Average ENS per Incident (Million kWh)	0.234	0.685	0	0	0.046
Average Duration per Incident (Hrs.: Min)	0:19	0.57	0	0	0.08

3.7. Quality of Supply:

3.7.1 System Voltage:

(a) Total number of violations under Normal conditions = 38
(b) Total number of violations under N-1 conditions = Nil
(c) Total number of violations under Normal & N-1 conditions = 38

Compared to the previous year, KE reported 38 voltage violations under normal conditions, reflecting a 13.6% decrease. Figure 18 illustrates the trend of voltage violations over the past five years.

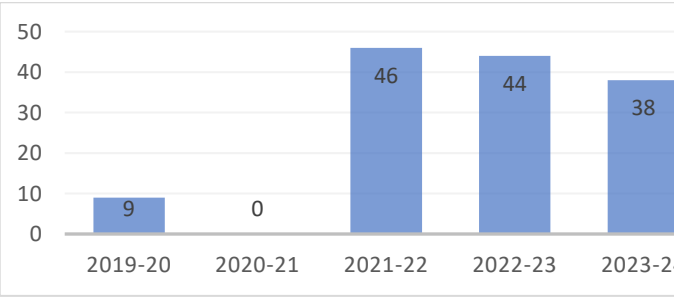


Figure 18: No. of voltage violations

The detail of the incidents of highest voltage violations recorded on the grid stations of KE are given in the Table 22 below. A total of thirty-five (35) incidents of high voltage violations were recorded on the grid stations of KE under Normal Condition during the FY 2023-24, however, no such incidents occurred under N-1 condition. A highest voltage of 234.56 kV was recorded on the Pipi West Grid Station.

Table: 22 Highest voltage violations during the FY 2023-24 (Under Normal Condition)

FY	Condition	Grid Station	Voltage (kV)	Duration (min)	Maximum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
FY2023-24	Normal	KCR	232	74	231	0.43%
FY2023-24	Normal	KCR	232	52	231	0.43%
FY2023-24	Normal	Mauripur	232	74	231	0.43%
FY2023-24	Normal	Mauripur	232	43	231	0.43%
FY2023-24	Normal	Mauripur	232	44	231	0.43%
FY2023-24	Normal	Mauripur	232	55	231	0.43%
FY2023-24	Normal	Mauripur	232	37	231	0.43%
FY2023-24	Normal	Mauripur	232	127	231	0.43%
FY2023-24	Normal	Mauripur	232	181	231	0.43%
FY2023-24	Normal	Mauripur	232	41	231	0.43%
FY2023-24	Normal	NPQ	232	46	231	0.43%
FY2023-24	Normal	NPQ	232	44	231	0.43%
FY2023-24	Normal	NPQ	232	32	231	0.43%
FY2023-24	Normal	NPQ	231.51	114	231	0.22%
FY2023-24	Normal	NPQ	233.66	31	231	1.15%
FY2023-24	Normal	KCR	232	36	231	0.43%
FY2023-24	Normal	KCR	231.53	383	231	0.23%
FY2023-24	Normal	KCR	232	77	231	0.43%
FY2023-24	Normal	KCR	232.15	101	231	0.50%
FY2023-24	Normal	KCR	232	74	231	0.43%
FY2023-24	Normal	Lalazar	232	51	231	0.43%
FY2023-24	Normal	Lalazar	232.18	79	231	0.51%
FY2023-24	Normal	Lalazar	232	70	231	0.43%
FY2023-24	Normal	Mauripur	232	82	231	0.43%
FY2023-24	Normal	Mauripur	232	374	231	0.43%
FY2023-24	Normal	Mauripur	232	49	231	0.43%
FY2023-24	Normal	NPQ	232.86	31	231	0.81%
FY2023-24	Normal	NPQ	232	40	231	0.43%
FY2023-24	Normal	NPQ	232	33	231	0.43%
FY2023-24	Normal	NPQ	233.13	110	231	0.92%
FY2023-24	Normal	NPQ	232.98	482	231	0.86%
FY2023-24	Normal	NPQ	232	42	231	0.43%
FY2023-24	Normal	NPQ	233.03	199	231	0.88%
FY2023-24	Normal	Pipri West	231.54	32	231	0.23%
FY2023-24	Normal	Pipri West	234.56	98	231	1.54%

A record and trend of the highest voltage incidents occurred on the KE grid stations in last five years under Normal and N-1 condition are given below in the table 23. If you see the trend of past five years it has been observed that the highest voltage violation incidents of thirty-six (36) occurred on the 220kV Mauripur Grid under Normal condition wherein nil violations were recorded under N-1 condition during the past five years.

Table: 23 Highest voltage violations in the past five (5) years

Condition	Sr. No.	Region & Grid Station	2019-20	2020-21	2021-22	2022-23	2023-24
Normal	1	KCR Grid	-	-	5	4	7
	2	Lalazar Grid	-	-	3	2	3
	3	Mauripur Grid	-	-	-	25	11
	4	NPQ Grid	-	-	2	4	12
	5	Pipri West	-	-	2	-	2
N-1	Nil						
Total Normal High Voltage Violations*			**-**	**-**	**12**	**35**	**35**
Total N-1 High Voltage Violations*			Nil				
Total High Voltage Violations N & N-1*			**-**	**-**	**12**	**35**	**35**

*Please note these violations are in line with the earlier submission of TPS forms against respective years

The detail of the incidents of lowest voltage violations recorded on the grid stations of KE are given below in the Table 24. A total of three (03) incidents of low voltage violations were recorded on the grid stations of KE under Normal Condition during the FY 2023-24, however, no such incidents occurred under N-1 condition. A lowest voltage of 208.08 kV was recorded on the Lalzar Grid Station

Table: 24 Lowest voltage violations during the FY 2023-24

FY	Condition	Grid Station	Voltage (kV)	Duration (min)	Maximum Allowed Limit for voltage (kV)	Deviation w.r.t allowed Limit (%)
FY 2023-24	Normal	Lalazar	208.43	33	209	-0.27%
FY 2023-24	Normal	Lalazar	208.08	31	209	-0.44%
FY 2023-24	Normal	Lalazar	208.39	99	209	-0.29%

A record and trend of the lowest voltage incidents occurred on the KE grid stations in last five years under Normal and N-1 condition are given below in the table 25. If you see the trend of past five years it has been observed that the lowest voltage violation incidents of thirty (30) occurred on the Lalazar Grid under Normal condition wherein nil violations were recorded under N-1 condition during the past five years.

Table: 25 Lowest voltage violations in the past five (5) years

Condition	Sr. No.	Region & Grid Station	2019-20	2020-21	2021-22	2022-23	2023-24
Normal	1	ICI Grid	-	-	-	1	-
	2	KCR Grid	-	-	11	1	-
	3	Lalazar Grid	-	-	20	7	3
	4	Mauripur Grid	1	-	2	-	-
	5	NPQ Grid	-	-	1	-	-
	6	Queens Road Grid	1	-	-	-	-
	7	Surjani Grid	1	-	-	-	-
N-1	Nil						
Total Normal Low Voltage Violations*			**3**	**0**	**34**	**9**	**3**
Total N-1 Low Voltage Violations*			Nil				
Total Low Voltage Violations (Normal & N-1)*			**3**	**0**	**34**	**9**	**3**

*Please note these violations are in line with the earlier submission of TPS forms against respective years

3.7.2 System Frequency:

(a) Number of times frequency remained outside the limits in a year = 1
(b) Time duration the frequency remained outside the limits in a year = 5.74 min.
(c) % age time of the year the frequency remained outside the limits = 0.01% time of the year.

(d) Highest frequency recorded = 50.51 Hz
(e) No violation at the lower end.
(f) Allowable limits: 49.5 Hz – 50.5 Hz

The data submitted by KE was analyzed and it was revealed that only 1 time frequency remained outside the prescribed limit for 5.47 minutes.

3.8 System Reliability of 132 kV & 66 kV network of KE

3.8.1 System Duration of Interruption on 132 kV and 66 kV transmission network:

The system duration of interruption on 132 kV and 66 kV network combined is recorded as 3.42 hours during the FY 2023-24.

Table: 26 Month wise System Duration of Interruption on 132 kV and 66 kV transmission

Months	System duration of interruption on transmission consumers in hours (excluding external trips)
Jul-23	0.17
Aug-23	0.08
Sep-23	0.26
Oct-23	0.25
Nov-23	0.14
Dec-23	0.08
Jan-24	0.07
Feb-24	0.07
Mar-24	0.05
Apr-24	0.22
May-24	1.59
Jun-24	0.45
Total	**3.42**

3.8.2 System Frequency of Interruption on 132 kV and 66 kV transmission network:

The system frequency of interruption on 132 kV and 66 kV network combined is recorded as 1.93 during the FY 2023-24.

Table: 27 System Frequency of Interruption on 132 kV and 66 kV transmission network

Months	System Frequency of Interruption on Transmission consumers (excluding external trips)
Jul-23	0.12
Aug-23	0.15
Sep-23	0.15
Oct-23	0.17
Nov-23	0.16
Dec-23	0.16
Jan-24	0.1
Feb-24	0.09
Mar-24	0.15
Apr-24	0.17
May-24	0.37
Jun-24	0.15
Total	**1.93**

SECTION III

SPECIAL PURPOSE TRANSMISSION LICENSEE
FATIMA TRANSMISSION COMPANY LIMITED (FTCL)

4. Brief Introduction of FTCL:

Fatima Transmission Company Limited (FTCL) is a public, non-listed company incorporated under Section 32 of the Companies Ordinance, 1984. The company was established to develop and operate specialized transmission infrastructure, connecting the generation facility of Fatima Energy Limited (a co-generation power plant located in Sanawan, Kot Addu, Punjab) to the new 220/132 kV Muzaffargarh grid station in Punjab.

4.1 License:

Under Section 19 of the NEPRA Act, the Authority is empowered to grant a Special Purpose Transmission License to any entity, authorizing it to engage in the construction, ownership, maintenance, and operation of designated transmission facilities within the exclusive territory of NTDC. Exercising these powers, NEPRA granted a Special Purpose Transmission License to Fatima Transmission Company Limited (FTCL) for the development and operation of its transmission facilities. This license allows FTCL to engage in the transmission of electricity for a term of thirty (30) years.

4.2 Transmission Network

FTCL operates a 37 km long, 132 kV double-circuit transmission line, specifically designed to evacuate power from the 120 MW Fatima Energy power plant to the Muzaffargarh 220 kV Grid Station. Each circuit of the transmission line is fully capable of handling the entire power output of the plant, ensuring efficient and reliable transmission of electricity from the power generation facility to the grid.

4.3 Performance of FTCL under PSTR-2005:

This section provides a comprehensive assessment of FTCL's performance in key areas: System Reliability, System Security, and Quality of Supply. Each of these performance parameters is analyzed in detail below:

4.4. System Reliability:

4.4.1 System Duration of Interruption:

(a) Total outage hours recorded at all interconnection points = 14.42 Hrs.
(b) Total number of interconnection points = 2
(c) System duration of interruption = 7.21 Hrs. /point i.e. 10% decrease as compared to the previous year which was reported as 8.5 Hrs. / point.

4.4.2 System Frequency of Interruption:

i. Total number of outages recorded at all interconnection points= 6
ii. Total number of 132 kV circuits = 2
iii. System frequency of interruption = 3 no. /circuit i.e. 20% increase as compare to the previous year i.e. 2.5 no. / circuit.

4.5. System Security:

4.5.1 Energy Not Served (ENS):

i. Total ENS = 0.886 MkWh
ii. Number of incidents, where there has been a loss of supply = 6
iii. Average ENS per incident = 0.15 MWh
iv. Average duration per incident = 2.40 hrs

4.6. Quality of Supply:

The Quality of Supply (QoS) is evaluated based on two key parameters: System Voltage and System Frequency. The following analysis presents the data submitted by FTCL in relation to these parameters:

4.6.1 System Voltage:

The highest voltage violation recorded under normal conditions was 144.40 kV. However, no highest voltage violations were observed under N-1 conditions. Additionally, there were no instances of the lowest voltage recorded under either normal or N-1 conditions.

Table 28: Voltage Violations of FTCL

Sr. No.	Voltage Class (132 KV)	Highest voltage recorded (kV)	Duration of variation (hrs:min)	% Variation	Lowest voltage recorded	Duration of variation	% Variation
1	Normal	144.40	15:86	18.1%	Nil	Nil	Nil
2	N-1	Nil	Nil	0.0%	Nil	Nil	Nil

4.6.2. System Frequency:

The data reveals that the system frequency exceeded the permissible limits on 96 occasions, with a total duration of 489 minutes. The highest frequency recorded during the year was 51.03 Hz, representing a variation of +2.06%, while the lowest frequency recorded was 49.26 Hz, with a variation of -1.48%.

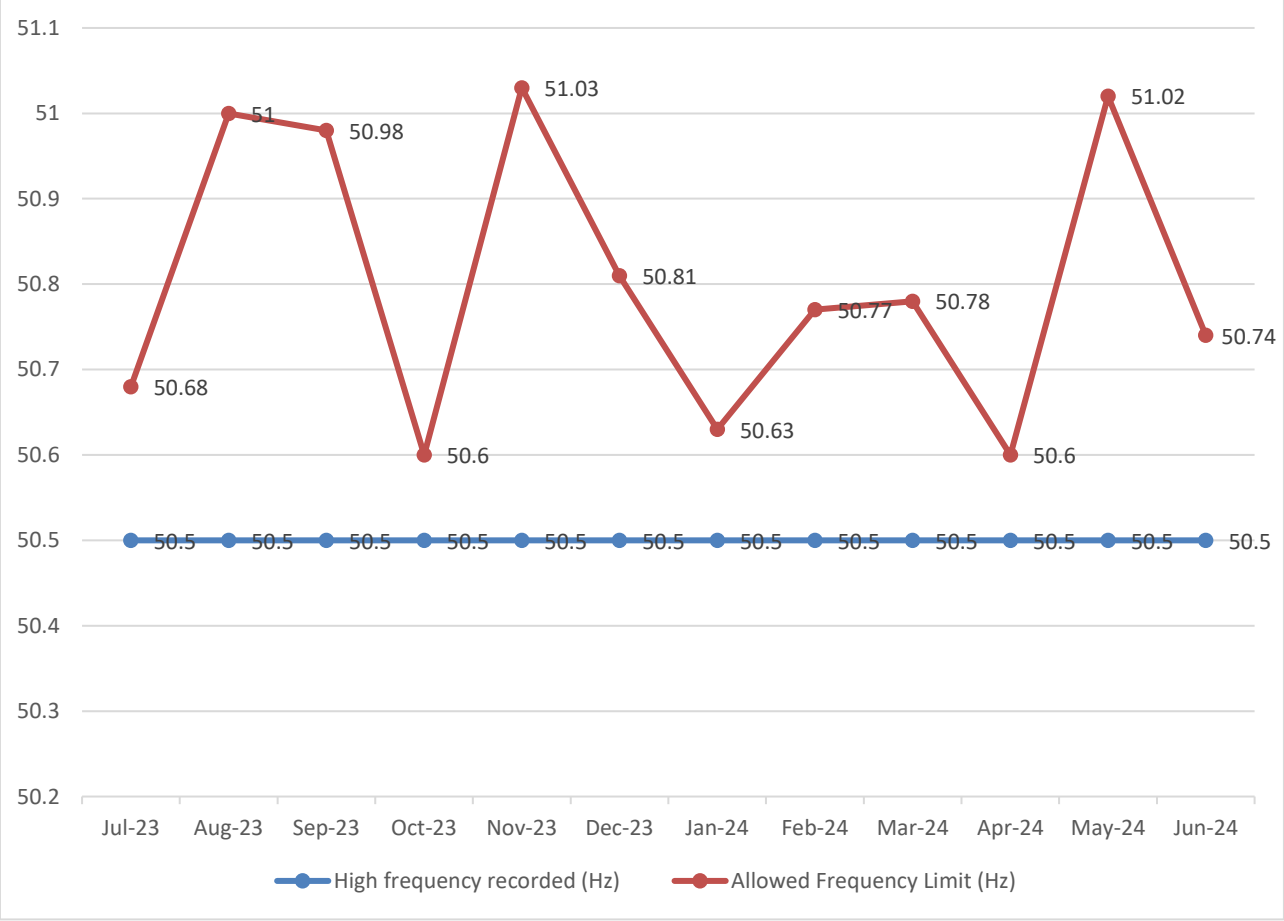
Table 29: Frequency violations of FTCL

Sr. No.	Month	Number of days/hours for a month over a year		Frequency Violation recorded (Hz)		Duration of variation		% variation			Number of times frequency remained outside the limits
		Days	Hours	Highest	Lowest	Mins	Hrs	Highest	Lowest	Period	Nos.
	1	2	3	4	5	6	7	8=(4-50)/50*100	9=(5-50)/50*100	10=7/3*100	11
1	Jul-23	31.00	744	50.68	49.33	36	0.60	1.36	-1.34	0.08	6
2	Aug-23	31.00	744	51.00	49.29	17	0.28	2.00	-1.42	0.04	4
3	Sep-23	30.00	720	50.98	49.26	39	0.65	1.96	-1.48	0.09	6
4	Oct-23	31.00	744	50.60	49.49	24	0.40	1.20	-1.02	0.05	5
5	Nov-23	30.00	720	51.03	49.32	41	0.68	2.06	-1.36	0.09	7
6	Dec-23	31.00	744	50.81	49.31	56	0.93	1.62	-1.38	0.13	11
7	Jan-24	31.00	744	50.63	49.32	52	0.87	1.26	-1.36	0.12	11
8	Feb-24	29.00	696	50.77	49.29	55	0.92	1.54	-1.42	0.13	12
9	Mar-24	31.00	744	50.78	49.28	62	1.03	1.56	-1.44	0.14	12
10	Apr-24	30.00	720	50.60	49.27	34	0.57	1.20	-1.46	0.08	7
11	May-24	31.00	744	51.02	49.35	41	0.68	2.04	-1.30	0.09	8
12	Jun-24	30.00	720	50.74	49.33	32	0.53	1.48	-1.34	0.07	7

Sr. No.	Month	Number of days/hours for a month over a year		Frequency Violation recorded (Hz)		Duration of variation		% variation			Number of times frequency remained outside the limits
		Days	Hours	Highest	Lowest	Mins	Hrs	Highest	Lowest	Period	Nos.
	1	2	3	4	5	6	7	8=(4-50)/50*100	9=(5-50)/50*100	10=7/3*100	11
Year		366.00	8760	51.03	49.26	489	8.15	2.06	-1.48	0.09	96

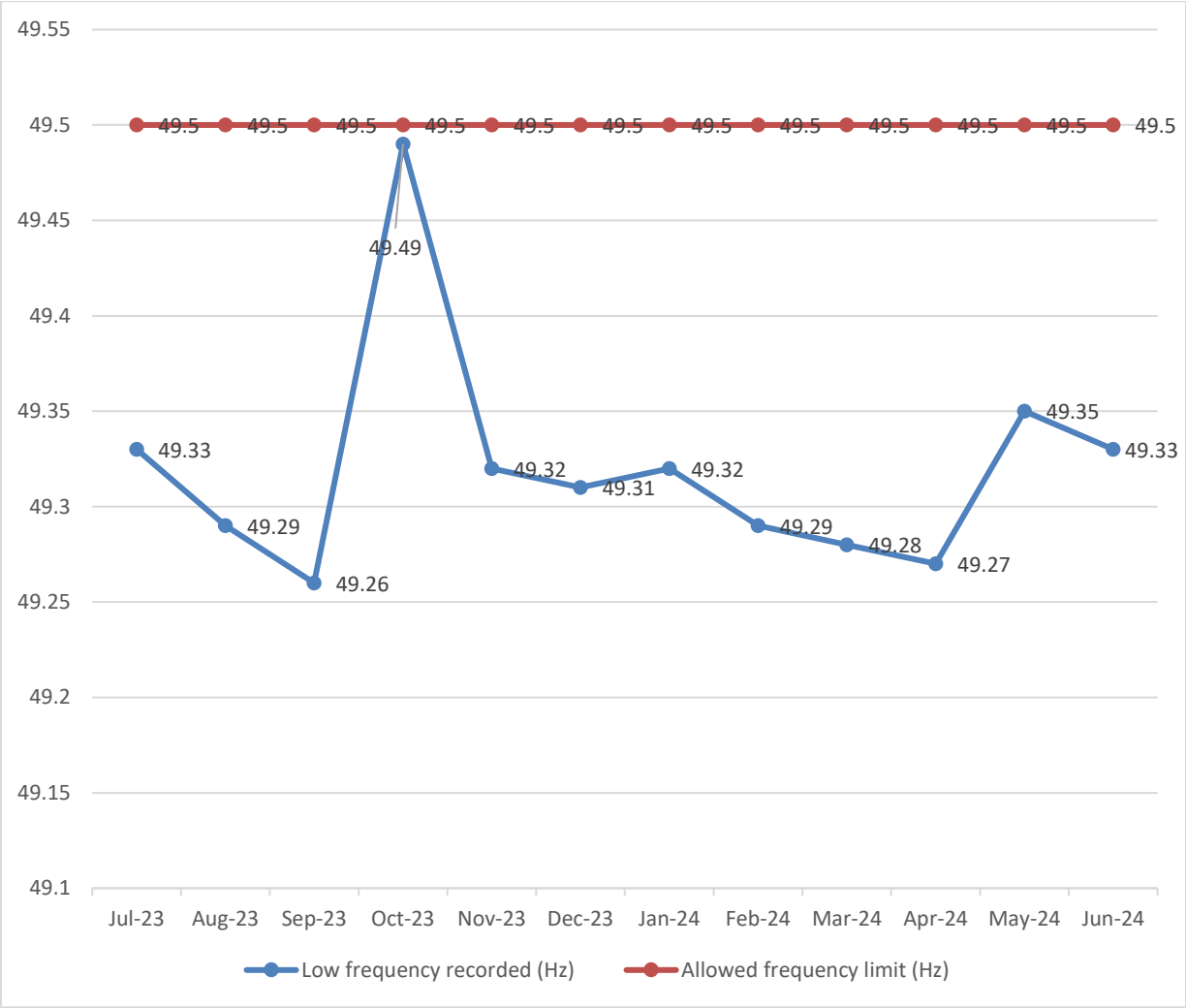
The high frequencies recorded during the FY 2023-24 is shown below in the graph:

Figure 19: Month-wise Highest Frequency Recorded (Hz)



The lowest frequencies recorded during the FY FY 2023-24 is shown below in the graph:

Figure 20: Lowest frequency recorded (Hz)



PAK MATIARI LAHORE TRANSMISSION COMPANY PRIVATE LIMITED (PMLTC)

5. Brief Introduction of Pak Matiari Lahore Transmission Company Private Limited (PMLTC)

To facilitate the transmission and distribution of electricity generated from a diverse mix of imported, indigenous coal, nuclear, and renewable energy (RE) sources to the upcountry, the Government of Pakistan planned construction of a High Voltage Direct Current (HVDC) transmission line. As part of this initiative, the government introduced the "Private Sector Transmission Line Project 2015 Policy" to provide a framework for private sector involvement in transmission infrastructure development.

In line with this policy, the National Transmission and Dispatch Company (NTDC) entered into a Transmission Service Agreement (TSA) with the State Grid Corporation of China (SGCC) for the construction of the Matiari-Lahore HVDC transmission line. Under this agreement, SGCC appointed China Electric Power Equipment and Technology Company Limited (CET) to develop the project on a Build, Own, Operate, and Transfer (BOOT) basis.

5.2 License:

Pursuant to Section 19 of the NEPRA Act, 1997, the National Electric Power Regulatory Authority (NEPRA) is empowered to grant a Special Purpose Transmission License (SPTL) to any entity. This license authorizes the entity to construct, own, maintain, and operate specific transmission facilities within the exclusive territory of the NTDC.

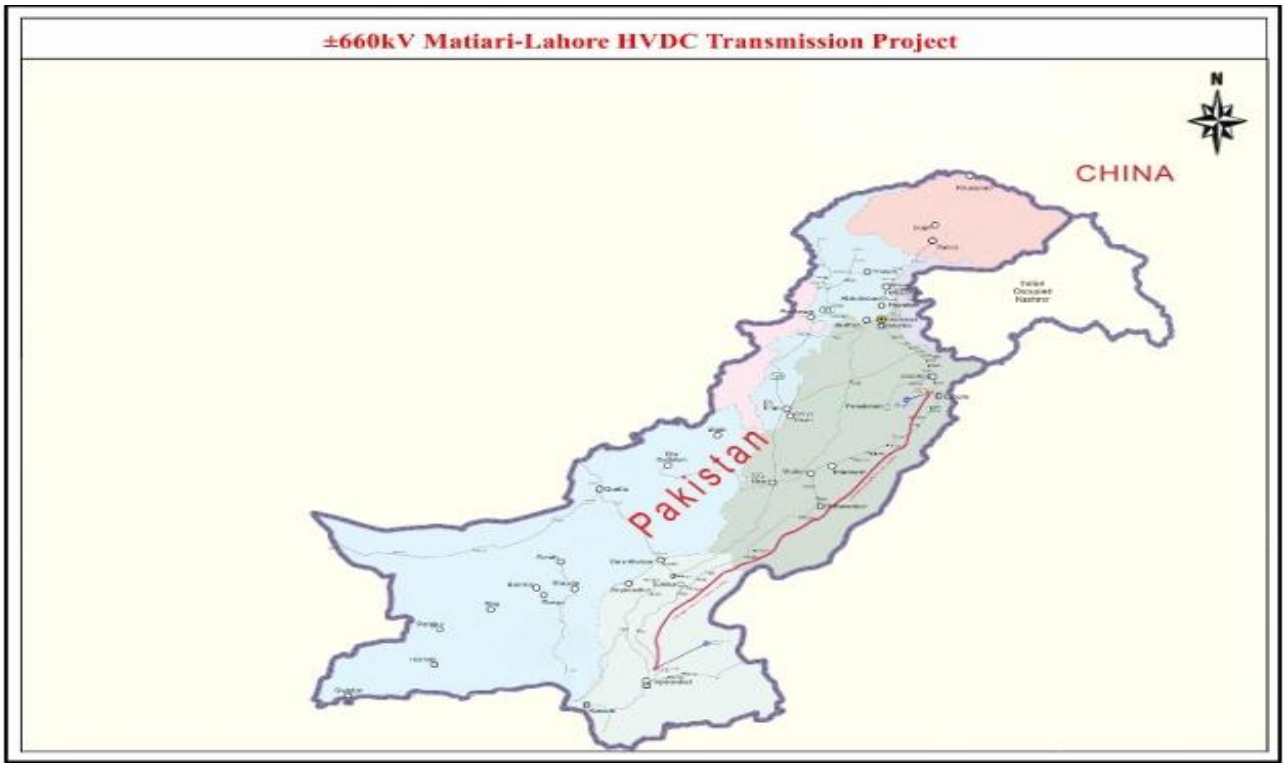
In exercise of these powers, NEPRA issued Special Purpose Transmission License (SPTL/03/2018) to Pak Matiari – ±660kV Lahore to Matiari HVDC Transmission Line Company (PMLTC), granting it the authority to undertake special-purpose power transmission operations. The license is valid for a term of twenty-five (25) years, commencing from the Commercial Operations Date (COD) of the Matiari-Lahore HVDC Transmission Line.

5.3 Transmission Network of ±660kV Matiari to Lahore HVDC Transmission

The Pak Matiari – ±660kV Lahore HVDC Transmission Line (PMLTC) is designed to facilitate the evacuation of power from a number of key power generation facilities to the load centers in the northern region of Pakistan. The transmission line will transport electricity generated from the following power plants:

(a) HUBCO – 1,292 MW
(b) HUBCO CFPP (Coal Fired Power Plant) – 2 x 660 MW
(c) Port Qasim – 2 x 660 MW
(d) Thal Nova – 1 x 330 MW
(e) EPTL– 2 x 330 MW
(f) TEL (Thar Energy Limited) – 1 x 330 MW
(g) SSRL/SECL– 2 x 660 MW
(h) The HVDC line will play a critical role in connecting these power plants to the national grid, ensuring efficient power transmission from the generation sources to meet the demand in the northern regions of Pakistan.

5.4 Project Geographical Information:



5.5 Facilities of the Project:

i. **Matiari Converter Station**:
The Matiari Converter Station is situated approximately 38 km northeast of Hyderabad city, near the village of Moldino Sahito, to the east of the National Highway N-5 in the Matiari district of Sindh Province. The station occupies a total area of 188 acres and plays a crucial role in converting high-voltage DC (HVDC) to AC for integration with the national grid.

ii. **Matiari Ground Electrode Site:**
The Matiari Ground Electrode Site is located around 17 km northwest of Khipro, near the village of Ismail Mahar in the Sanghar district of Sindh Province. The site covers an area of 110.16 acres, and features a shallowly buried electrode station design. This electrode station is connected to the Matiari Converter Station by an 80 km electrode line.

iii. **Lahore Converter Station**:
The Lahore Converter Station is located approximately 60 km southwest of Lahore, near the village of Asalpar, to the west of the Bhai Pheru-Mor Khunda Road, in the Nankana Sahib district of Punjab Province. The station spans an area of 177 acres and is responsible for converting DC power back to AC for distribution across the northern regions of Pakistan.

iv. **Lahore Ground Electrode Station**:
The Lahore Ground Electrode Site is situated about 13 km southwest of Syedwala, near the village of Pindi Chery in the Nankana Sahib district of Punjab. The total area of this electrode station is 108 acres, and like its counterpart at Matiari, it is a shallowly buried electrode station. The Lahore Ground Electrode Station is connected to the Lahore Converter Station by a 50 km electrode line.

v. **±660kV HVDC Transmission Line**:
The Matiari-Lahore ±660kV HVDC transmission line spans a total length of 886.12 km, stretching from the Matiari Converter Station in Sindh to the Lahore Converter Station in Punjab. The line runs in a southwest to northeast direction, crossing both Sindh and Punjab provinces, and serves as a key infrastructure component to evacuate electricity from power plants in the southern regions to load centers in the north.

vi. **Repeater Stations**:
To ensure seamless telecommunications across the entire transmission system, the project includes a total of three repeater stations. These are strategically located at:

(a) Sukkur
(b) Rahim Yar Khan
(c) Hasilpur

These repeater stations ensure reliable communication between the various components of the HVDC transmission system, supporting efficient operation and monitoring.

This comprehensive infrastructure is pivotal in ensuring the successful operation of the Matiari-Lahore HVDC Transmission Project, improving the transmission capacity between the southern and northern regions of Pakistan.

5.6 System Availability and Reliability:

As per the available record, in the fiscal year 2023-24, the Matiari-Lahore HVDC system remained fully operational and capable of transmitting up to 4000 MW of power. Moreover, from September 1, 2023, to August 31, 2024, the HVDC system maintained at state of hot standby, ensuring that it was always prepared to manage power flow within its maximum capacity of 4000 MW.

As reported by PMLTC, there were no transmission line failures reported in 2024 within its system. The system achieved an availability rate of 98.5636% during the reporting period. Correspondingly, the system's unavailability for the year, from September 1, 2023, to August 31, 2024, was 1.4364%.

5.6 System Interruption:

Network Hotspots:
Several critical hotspots within the AC network have been identified as primary sources of disturbance and commutation failures by PMLTC.

5.7 Frequent Line Tripping Events:

The HVDC system, connected to 10 x 500 kV transmission lines at the Matiari Converter Station (MCS) and 6 x 500 kV transmission lines at the Lahore Converter Station (LCS), experienced a total of 106 line tripping events at the MCS & 2 incidents at the LCS. As per the PMLTC, these disruptions were caused by AC network instability, including issues such as conductor breaks, tower collapses, and foggy weather conditions. PMLTC has further opined that these frequent tripping incidents adversely impacted the stability of both AC voltage and frequency, leading to sudden "jerks" in the HVDC system. In response, the NPCC was forced to reduce power flows on both the HVDC and AC networks to maintain overall system stability.

5.8 Impact of Unstable AC System:

As per PMLTC, the instability in the AC network and frequent commutation failures have had several detrimental effects on the performance and reliability of its system, including but not limited to:

- **Voltage and Frequency Instability**: Each commutation failure and line tripping event caused sharp drops in AC voltage and frequency, leading to disruptions in the overall system stability and reliability. These fluctuations not only affected the HVDC system but also posed a challenge for grid synchronization and power flow management.

- **Thyristor Wear and Deterioration**: The recurring AC network failures placed substantial stress on the thyristors in the HVDC system. This resulted in accelerated wear and tear, necessitating more frequent replacements and maintenance to ensure continuous operation. The strain on these critical components also contributed to a higher risk of system malfunctions.

- **Operational Constraints and Reduced Power Flow**: In response to the ongoing line tripping incidents, the NPCC was compelled to reduce power flows on both the HVDC and AC networks. This reactive measure highlighted the underlying vulnerabilities in the AC network, restricting the full potential of the HVDC system and limiting its ability to operate at optimal capacity.

SECTION IV

PROVINCIAL GRID COMPANIES

SINDH TRANSMISSION & DISPATCH COMPANY (PVT) LIMITED (ST&DCPL)

6. Brief Introduction of ST&DCPL:

Sindh Transmission & Dispatch Company (Pvt.) Limited (ST&DCPL) was incorporated on January 7, 2015, under the Securities & Exchange Commission of Pakistan (SECP) and the Companies Ordinance, 1984, with the primary objective of developing and operating electric power transmission infrastructure in the region.

ST&DCPL plays a pivotal role in Pakistan's energy sector by facilitating the evacuation of 100 MW of power from Sindh Nooriabad Power Company and ensuring its reliable delivery to K-Electric. Since achieving commercial operation in January 2018, the company has consistently prioritized the steady and uninterrupted transmission of power. ST&DCPL upholds a rigorous operation and maintenance policy to maximize the efficiency, safety, and reliability of its transmission network, ensuring that the power supply remains stable and dependable for its customers.

6.1 License:

Pursuant to Section 19 of the NEPRA Act, 1997, the National Electric Power Regulatory Authority (NEPRA) granted a Special Purpose Transmission Line (SPTL) license to Sindh Transmission & Dispatch Company (Pvt.) Ltd (ST&DCPL) on December 17, 2015. This license authorizes ST&DCPL to engage in the transmission of power for a period of thirty (30) years.

Subsequent to the amendment of the NEPRA Act in 2018, and under the provisions of Section 18-A, NEPRA granted ST&DCPL a Provincial Grid Company License on November 5, 2019. This license, also for a term of thirty (30) years, empowers ST&DCPL to operate as a transmission service provider within the province, further solidifying its role in the power transmission sector.

6.2 Transmission Network

Sindh Transmission & Dispatch Company (Pvt.) Ltd (ST&DCPL) operates a transmission system consisting of a total of 95.4 km of 132 kV double-circuit transmission lines. The ST&DCPL transmission network is interconnected with the K-Electric grid system through two (02) 132 kV transmission line circuits, ensuring reliable power transfer between the two systems.

6.3 Performance of STDC under PSTR - 2005:

The Annual Performance Report (APR) submitted by Sindh Transmission & Dispatch Company (Pvt.) Ltd (ST&DCPL) has been thoroughly evaluated in accordance with the guidelines set forth in the PSTR 2005. The evaluation is detailed below:

6.4. System Reliability:

6.4.1. System Duration of Interruption:

(a) Total outage hours recorded at all interconnection points = 134.26 Hrs.
(b) Total number of interconnection points = 2
(c) System duration of interruption = 67.13 Hrs. /point i.e. 292.6% increased as compared to the previous year i.e. 17.71 Hrs. / point.

6.4.2 System Duration of Frequency:

(a) Total number of outages recorded at all interconnection points= 28
(b) Total number of 132 kV circuits = 2
(c) System frequency of interruption = 14 no. /circuit. i.e. 300% increased as compared to the previous year i.e. 3.5 no. / circuit.

The total number of outages recorded was 28, with a system frequency of interruption observed at 14 incidents per circuit.

6.5 Tie lines Reliability:

Sindh Transmission & Dispatch Company Pvt. Ltd., along with its interconnected partners, SNPC and K-Electric, have mutually agreed to undertake work simultaneously during scheduled outage/maintenance periods. This collaborative approach aims to enhance system efficiency and minimize availability losses by coordinating activities on their respective assets.

6.6. System Security:

To enhance system security, an analysis has been conducted on the total Energy Not Served (ENS) during the reported period for SNPCL and SNPC–II. According to STDC's report, the total ENS for the 2023-2024 operational period is approximately 13.57 MkWh. In comparison, the total ENS for FY 2022-2023 was 3,579.21 MWh. This analysis provides valuable insights into system performance and helps identify areas for improvement in energy distribution and reliability.

6.7. Quality of Supply (QoS)

The quality of supply (QoS) is assessed based on system voltage and frequency parameters. Below is the analysis of the QoS data as reported by ST&DCPL:

6.7.1 System Voltage

It was observed that during the reported period, no voltage violations occurred under either normal conditions or N-1 contingency conditions.

6.7.2 System Frequency

It is noted that no frequency violations were recorded during FY 2023-2024. In contrast, four frequency violation incidents were reported by STDC in the previous year.

KHYBER PAKHTUNKHAWA TRANSMISSION & GRID SYSTEM COMPANY (KPT&GSC)

7. Brief Introduction of KPT & GSC

The KP Transmission and Grid System Company (Pvt.) Limited (KPT&GSC) was incorporated on September 9, 2020, under the Securities & Exchange Commission of Pakistan (SECP) Companies Ordinance, 1984, to develop and operate transmission infrastructure in the province of Khyber Pakhtunkhwa (KPK). KPT&GSC was granted its Provincial Grid Company (PGC) license by the National Electric Power Regulatory Authority (NEPRA) on February 26, 2021, for a term of 30 years.

7.1 Updated Status of Projects undertaken by KPT&GSC:

KPT&GSC's proposed transmission network includes 500 kV, 220 kV, and 132 kV overhead transmission lines (OHTLs) and grid stations, spanning across five regions in Khyber Pakhtunkhwa (KP): Chitral, Dir, Swat, Kohistan, and Mansehra. The proposed network is designed to facilitate the transmission of 7,385 MW of electricity generated from hydropower projects (HPPs) located in these regions. The construction of this transmission infrastructure is planned over the next 20-25 years. A detailed breakdown of the available MW capacity by region is provided below.

(a) Chitral Region: 2946 MW
(b) Dir region: 508 MW
(c) Kohistan Region: 2054 MW
(d) Swat Region: 1150 MW
(e) Mansehra Region: 736 MW

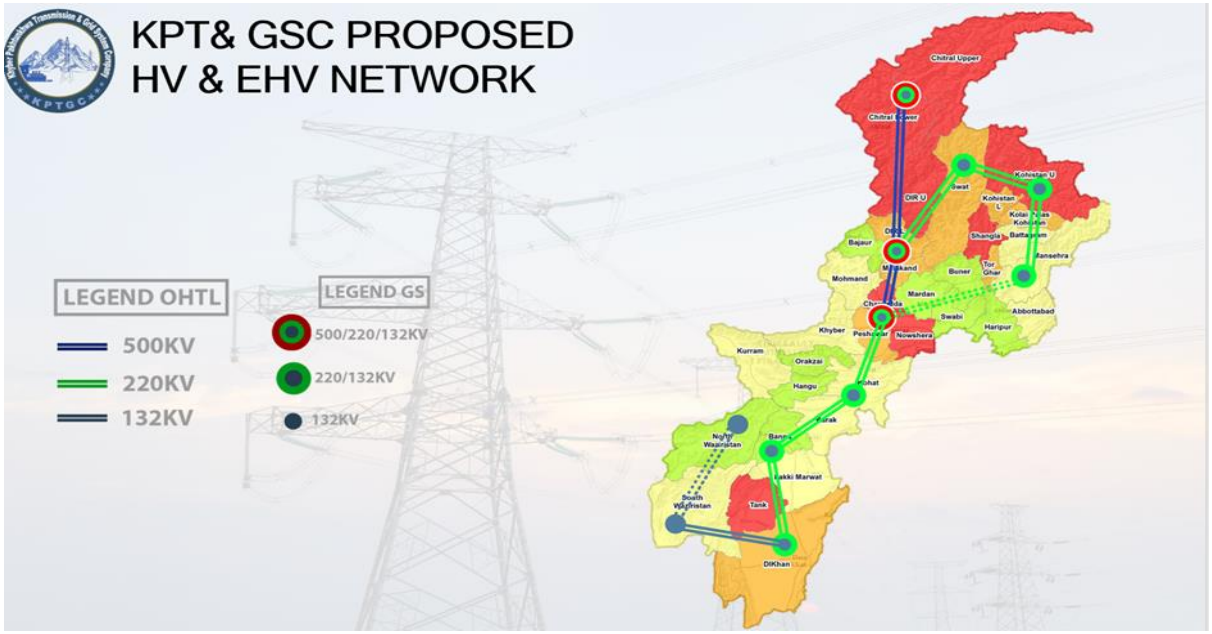


Figure: 21 KPT &GSC proposed HV & EHV transmission network

7.2 Updated Status of Transmission Projects in pipe line:

Project 01: Construction of 132/220 kV OHTL in Swat Region

The proposed 132/220 kV overhead transmission line (OHTL) in the Swat region of Khyber Pakhtunkhwa (KP) will run from Kalam to Chakdara, covering a distance of approximately 140 km. This project is a key initiative by KPT&GSC to facilitate the evacuation of power from eleven (11) hydropower projects (HPPs) in the Swat region, with a total expected capacity of 1,150 MW to be available over the next 10-15 years.

The total estimated cost of the project is approximately US $115 million. It includes the construction of a 132/220 kV transmission line with a route length of about 140 km from Kalam to Chakdara, as well as the development of a 220/132 kV grid station at Chakdara.

Project Completion Targets:

(a) **Lot 01:** June 2026 (Lead time: 24 months)
(b) **Lot 02:** June 2030 (Lead time: 48 months)

Figure 22: SWAT Corridor HPPS- Proposed O/H Transmission Network

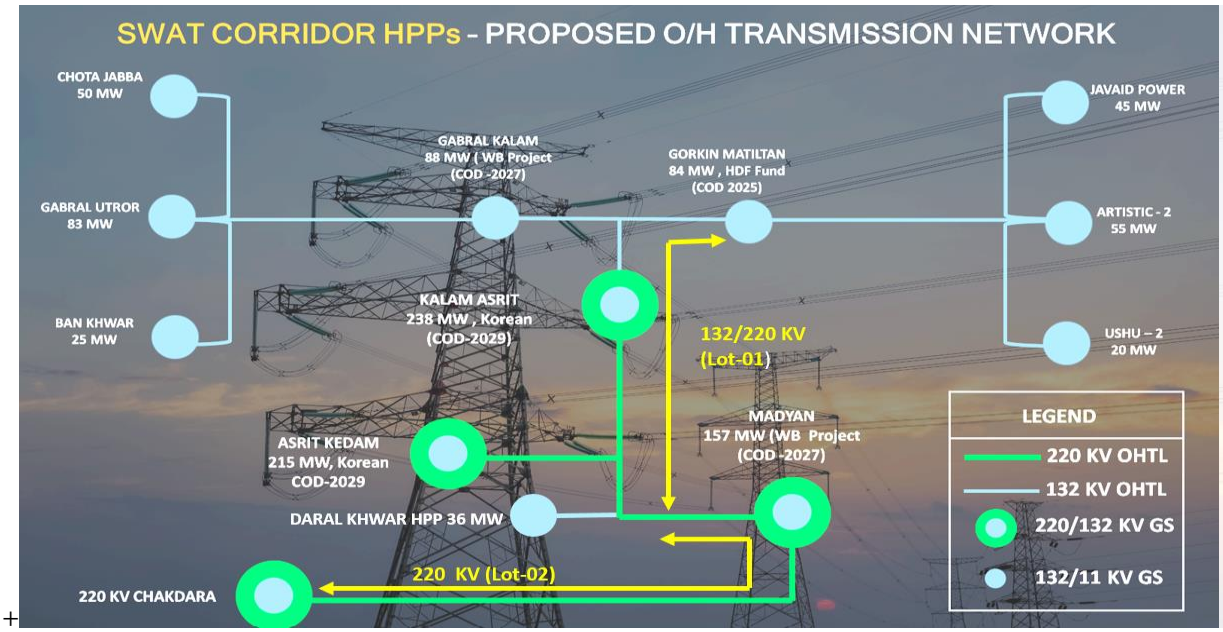
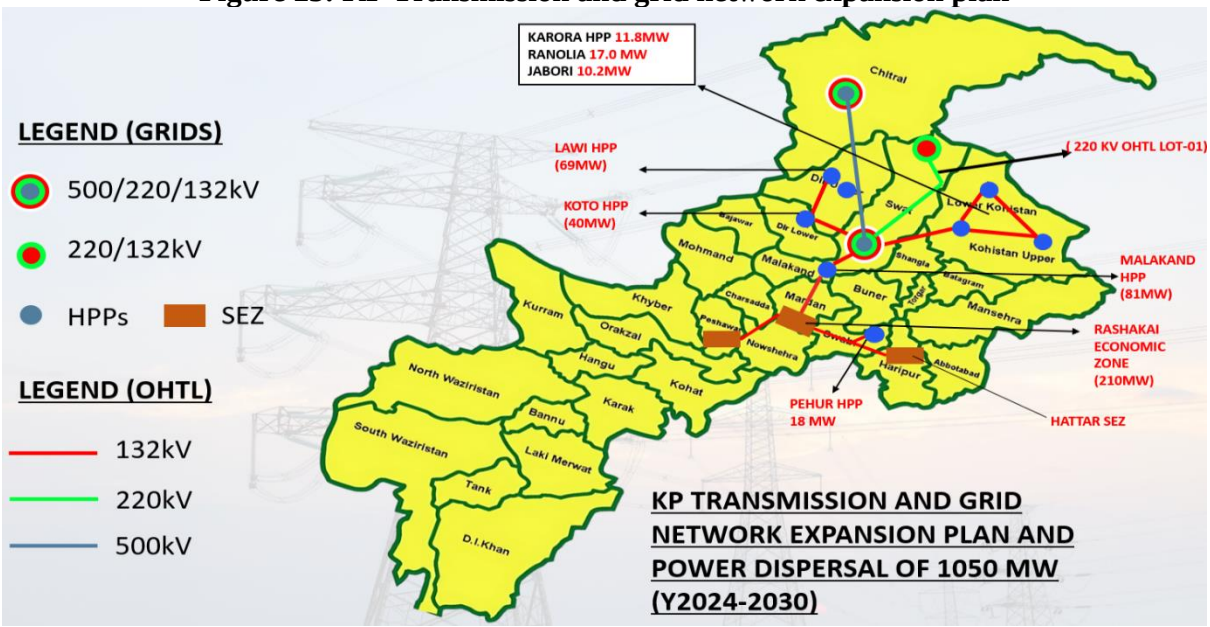


Figure 23: KP Transmission and grid network expansion plan



7.3 PEDO HPPs to be looped

(a) Pehur HPP: 18.0 MW
(b) Jabori HPP: 10.2 MW
(c) Malakand III HPP: 81.0 MW
(d) Karora HPP: 11.8 MW
(e) Koto HPP: 40.0 MW
(f) Ranolia HPP: 17.0 MW
(g) Lawi HPP: 69.0 MW
(h) Daral Khwar HPP: 36.6 MW

Goals of Proposed KPT&GSC's Power Evacuation Projects from KP's Northern Regions:

- **Enhanced Power Security and Reliability for PESCO:** The 132/220 kV overhead transmission line (OHTL) will significantly improve the PESCO network, enabling better management of power security, reliability, and quality at the consumer level. The integration of low-cost electricity from the hydropower projects (HPPs) will also strengthen PESCO's financial position, improving its balance sheet.

- **Relief for NTDC's Northern Network:** The evacuation of 1,150 MW of power from KP's northern regions will provide relief to the National Transmission and Despatch Company (NTDC), allowing it to divert this power to other parts of the country. This will ease the burden on the northern grid while ensuring a more balanced distribution of electricity across the national network.

- **Economic Boost for KP and the National Industrial Sector:** The availability of affordable, clean energy from the northern hydropower plants will be a major boon for the KP economic zone, as well as the broader industrial sector of Pakistan. This will enhance the competitiveness of local industries in the international market, driving growth and attracting investment.

- **Revenue Generation for Social and Economic Development:** The project will generate substantial revenue, benefiting both the provincial government of KP and the federal government. This revenue can be reinvested into the region to support social development, infrastructure improvements, industrial growth, and tourism, contributing to the overall economic uplift of the area

PUNJAB GRID COMPANY LIMITED (PGCL)

8. Brief Introduction of PGCL:

Punjab Grid Company Limited (PGCL) is a newly established entity, fully owned by the Government of Punjab (GoPb). The company was registered with the Securities & Exchange Commission of Pakistan (SECP) on January 3, 2023. On November 8, 2023, PGCL was awarded a transmission license by the National Electric Power Regulatory Authority (NEPRA), granting it the authority to transmit electrical energy within its designated territorial boundaries for a term of 30 years.

8.1 Updated Status of Projects undertaken by PGCL:

PGCL's proposed transmission network will include 500 kV, 220 kV, and 132 kV overhead transmission lines (OHTLs) and grid stations, covering the entire Punjab province. The network is designed to support both current and future power generation projects in Punjab, including solar, waste-to-energy (WtE), hydropower (HPPs), and other renewable and conventional energy sources. This infrastructure will enable the efficient transmission of electricity and help meet the growing energy demands of the region.

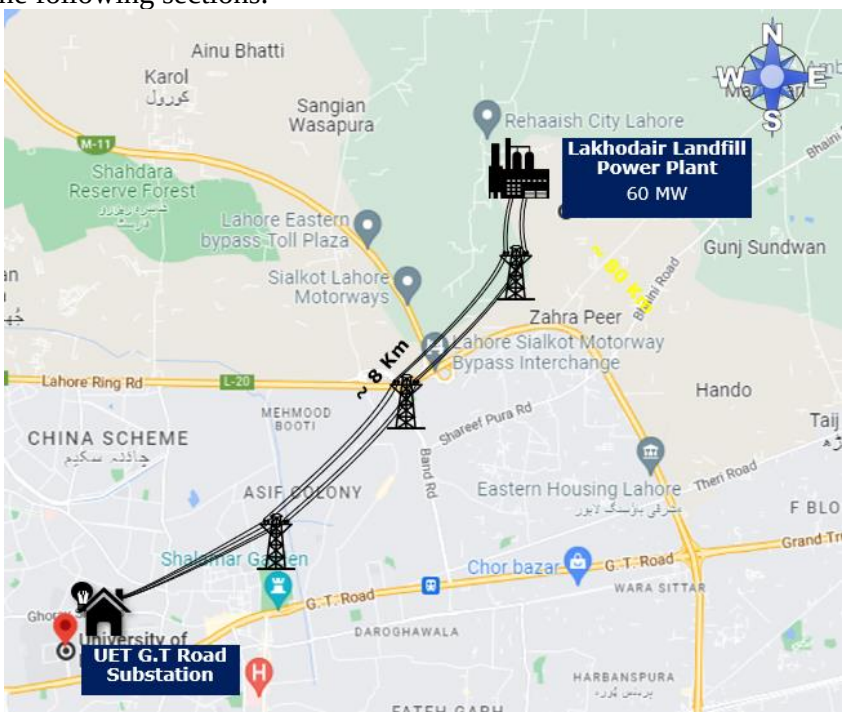
8.2 Updated Status of Transmission Projects in pipe line:

Project 01: Construction of 132 kV OHTL in Lahore Region: The proposed 132 kV overhead transmission line (OHTL) in the Lahore region will extend from Lakhodair to key consumers, including the Orange Line Metro, Lahore Knowledge Park, Central Business District (CBD), Sundar Industrial Estate, and other potential hubs. This project will ensure reliable electricity supply to critical infrastructure, facilitating scientific waste disposal, and meeting the growing energy needs of the region.

To support the development of Waste-to-Energy (WtE) projects in Punjab, the Punjab Power Development Board (PPDB), a sister entity of PGCL, has engaged consultants to prepare bidding documents and formulate a security package.

Proposed Project Details:

Further project details, including timelines, cost estimates, and specific deliverables, will be provided in the following sections.



Volage Level
– 132 kV

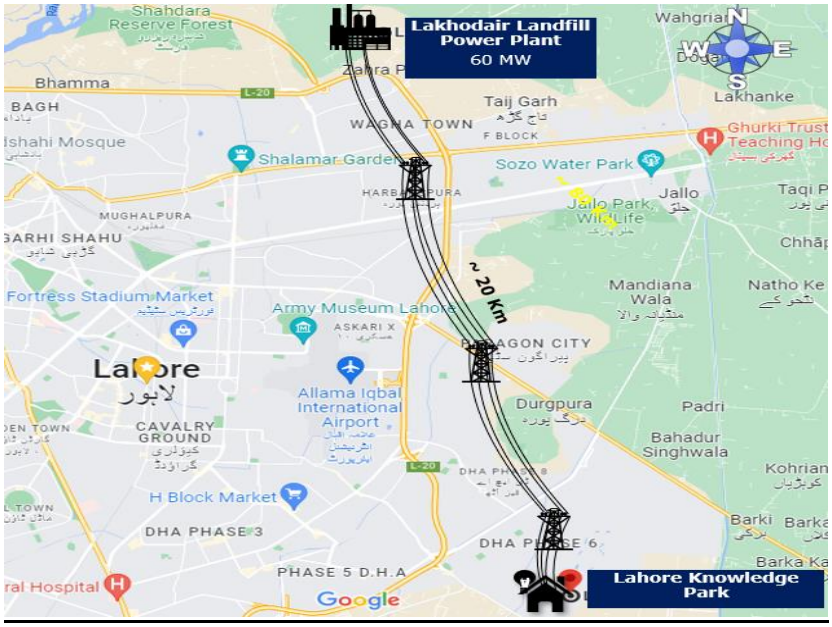
Length of Transmission Line
– 8 km

Project Cost
– PKR 1.5 billion

Cost calculation based on
NTDC BoQ -2024-45

Completion Date
- Dec 2027

Figure: 24 Proposed 132 kV line from Lakhodair to Orange Line substation



Volage Level
– 132 kV

Length of Transmission Line
– 20 km

Project Cost
– PKR 3.2 billion

Cost calculation based on
NTDC BoQ -2024-45

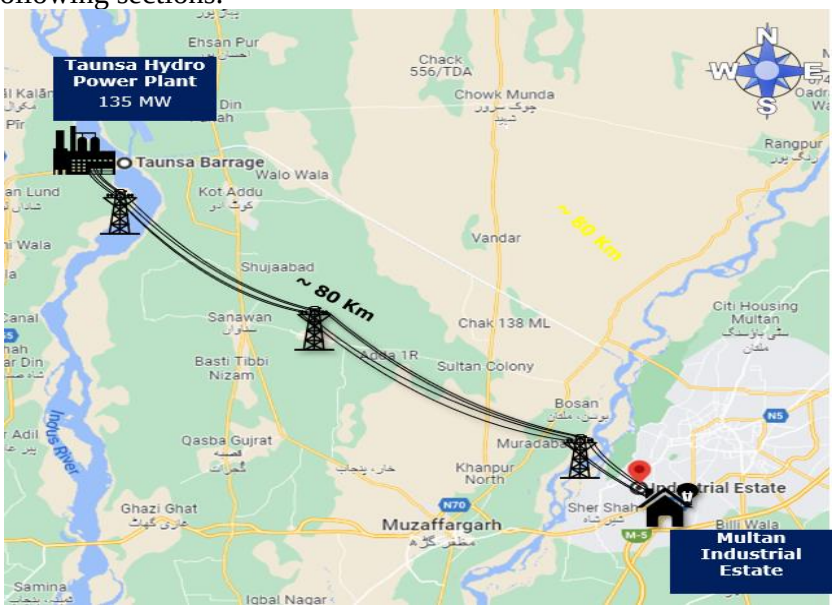
Completion Date
- Dec 2027

Figure: 25 Proposed 132 kV line from Lakhodair to Lahore Knowledge Park

8.2.2 Construction of 132 kV OHTL South Punjab Region

Project 02: Transmission of Electric Power from 135 MW Taunsa Hydro Power Project
The second proposed project involves the transmission of 135 MW of electricity from the Taunsa Hydro Power Project to nearby industrial estates, including Multan Industrial Estate, Rahim Yar Khan Industrial Estate, Bahawalpur Industrial Estate, and other key industrial hubs, via a 132 kV overhead transmission line (OHTL). Since the evacuation of power from the Taunsa Hydro Power Project is not currently under consideration by the national grid, therefore, this project presents a significant opportunity to harness and distribute clean energy to support regional industrial growth.

Proposed Project Details:
Further details, including timelines, cost estimates, and technical specifications, will be outlined in the following sections.



Volage Level
– 132 kV

Length of Transmission Line
– 80 km

Project Cost
– PKR 6.23 billion

Cost calculation based on NTDC
BoQ -2024-45

Completion Date
- Nov 2029

Figure: 21 Proposed 132 kV line from Taunsa HPP to Multan Industrial Estate

Proposed PGCL's Major Contributions and Benefits of Power Evacuation:

- **Boost to Regional and National Industrial Growth:** The availability of affordable, clean energy will significantly benefit the Punjab Economic Zone and industrial zones across the country. Access to low-cost electricity will enhance the competitiveness of local industries in the international market, driving growth, attracting investment, and fostering industrial development in both Punjab and nationwide.

- **Revenue Generation for Socio-Economic Development:** The revenue generated from the project will provide a valuable source of funding for both the Punjab and federal governments. This will help support social uplift programs, infrastructure development, industrial growth, and other key initiatives in the region, contributing to the overall economic and social development of the area.

SECTION V

OTHER TECHNICAL ISSUES OF TRANSMISSION LICENSEES

9. Progress of System Constraints Removal Projects:

To address the challenges obstructing the efficient evacuation of power from various power plants, NEPRA has implemented proactive measures to ensure that NTDC takes prompt and effective action. This includes initiating monthly and quarterly meetings, along with ongoing correspondence, to closely track the progress of projects aimed at resolving these constraints.

As a result of consistent monitoring and follow-up, several constraints have been successfully addressed. However, several critical issues remain unresolved. Below are the details of the outstanding constraints concerning the 500 kV and 220 kV transmission lines and transformers:

9.1. Overloading constraints of 500/220 kV Transformers:

i. 500 kV New Rawat Grid Station:

The overloading of the 500 kV New Rawat Grid Station has been a persistent issue since June 2017. To address this, NTDC has proposed the construction of two new grid stations—500 kV Chakwal and 500 kV Islamabad West—along with the installation of a 1x160 MVA transformer at the New Rawat Grid Station, which was completed in March 2021. These projects are expected to be completed by 2024-25. However, both projects are currently in the early stages of construction, and their progress has been notably slow.

For the Chakwal Grid Station, a detailed survey and soil investigation for the associated transmission lines are underway, and the plan and profile for the sub-soil investigation have been approved. As for the Islamabad West Grid Station, NTDC has signed a contract with the NWEPDI-TBEA joint venture for its development.

The ongoing constraints at New Rawat have forced the operation of costly RFO-based generation at Attock Gen, which is having a negative impact on the power sector by increasing costs and reducing efficiency. The timely completion of these projects is critical to alleviating these challenges and ensuring the stability of the transmission network.

ii. 500 kV Gatti Grid station

To mitigate the overloading of the 500/220 kV (4x450 MVA) auto transformers at the 500 kV Gatti Grid Station, three key projects have been initiated:

a) Completion of 500 kV Faisalabad West Grid Station

This project involves the construction of the 500 kV Faisalabad West Grid Station, along with two 220 kV and three 132 kV transmission lines.. As per the record, the project is scheduled for completion by October 2024.

b) Second Supply Source to Jaranwala Road, Faisalabad

This project includes the extension of the grid station at Jaranwala Road and the associated transmission lines. The completion date for the grid station extension is set for December 2025, while the transmission line is expected to be completed by June 2026. The grid station is currently under construction, but the tender process for the transmission line has been delayed twice.

c) Commissioning of a Third 750 MVA Auto Transformer at 500 kV Faisalabad West

The addition of a third 750 MVA auto transformer at the Faisalabad West Grid Station is expected to be completed by December 2025. However, the project is still in its early stages, approval of re-bidding documents from the ADB is pending.

These projects are crucial for relieving the overloading issue at Gatti Grid Station and ensuring the reliable transmission of power in the region. Timely completion and resolution of pending approvals are essential to meeting the set deadlines.

iii. 500 kV Multan Grid station:

One of the key issues at the 500 kV Multan Grid Station is the overloading of the 500/220 kV (2x450 MVA) transformers. To address this, an upgrade of the Vehari Grid Station from 220 kV to 500 kV is planned, with a completion deadline set for January 2027. The tender for this project is currently under preparation.

Additionally, there is an ongoing constraint due to the overloading of Auto Transformers (T-1, T-2) at the Multan Substation. To resolve this, the existing 450 MVA auto transformer (ATB) will be replaced with a new one at the 500 kV Multan Substation by December 2025. However, the initial tender for this replacement was scrapped, and the approval of the rebidding documents from the Asian Development Bank (ADB) is still pending.

These upgrades are crucial to enhancing the capacity and reliability of the Multan Grid Station, ensuring it can efficiently handle the growing load demands in the region. Timely resolution of the tender and approval processes is essential to meet the project deadlines.

iv & v. 500 kV Muzaffargarh and 500 kV Yousafwala Grid station:

The 500 kV Muzaffargarh Grid Station is facing a constraint due to the overloading of its 500/220 kV (2x600 MVA) auto transformers. Similarly, the 500 kV Yousafwala Grid Station is experiencing overloading of its 500/220 kV (3x600 MVA) auto transformers (T1, T2, and T3).

To address these issues, the proposed solution is to upgrade the Vehari Grid Station from 220 kV to 500 kV, as previously outlined. This upgrade will help alleviate the overload at both Muzaffargarh and Yousafwala grid stations by enhancing the overall transmission capacity in the region. The details of this upgrade, including project timelines and implementation plans, have been discussed above.

vi. 500 kV Jamshoro Grid station:

The 500 kV Jamshoro Grid Station is facing several significant constraints, including:

i. Overloading of its 500/220 kV (3x450 MVA) auto transformers,
ii. Power flow challenges from low voltage (LV) to high voltage (HV) during high wind conditions,
iii. Power flow from HV to LV during low wind conditions.

To address these issues, several projects have been initiated:

a. Construction of 220 kV Dhabeji SEZ Substation

This project aims to alleviate some of the constraints by constructing a new 220 kV substation at Dhabeji Special Economic Zone (SEZ). The project is scheduled for completion by February 2025, with a reported progress of 40.11% to date.

b. Completion of 220 kV Mirpur Khas Substation

To enhance the grid stability and power distribution, the 220 kV Mirpur Khas substation is under development, with a completion deadline set for August 2025. As of June 2024, the project is 78.13% complete.

c. Construction of 500 kV Lahore North Substation and Associated Transmission Lines

This project includes the construction of the 500 kV Lahore North substation and the associated transmission lines. The substation and transmission lines are as follows:

i. 500 kV substation,
ii. 500 kV transmission line,
iii. 220 kV transmission line,

d. Completion of 500 kV KKI Substation

The 500 kV KKI Substation, which is part of the scope of work for K-Electric, is also being developed to help ease the power flow challenges at Jamshoro.

These projects are vital for addressing the ongoing constraints at Jamshoro Grid Station, improving power flow management, and enhancing the overall reliability of the transmission network in the region.

vii. 500kV Sheikh Mohammadi Peshawar:

The 500 kV Sheikh Mohammadi Peshawar Substation is experiencing overloading issues with its 500/220 kV (3x450 MVA) autotransformers (T1, T2, and T3). To address this, NTDC has planned the addition of a 4th 450 MVA transformer (500/220 kV), with an expected completion deadline in 2026. However, NTDC is currently reassessing the need for this additional transformer based on updated load forecasts and system requirements.

In parallel, the construction of the HVDC 500/220 kV Nowshera Substation is underway to help alleviate the overload at Sheikh Mohammadi. This project is expected to be completed by October 2024. The Nowshera substation will play a critical role in balancing power flow and relieving pressure on the Sheikh Mohammadi substation.

viii. 500kV Lahore Sheikhupura Grid Station:

The 500kV Lahore Sheikhupura grid station is currently facing significant operational challenges due to overloading on its 500/220kV Auto Transformers (ATBs). The grid station is equipped with four 600 MVA transformers (T1, T2, T3, and T4), but the overloading issue stems from the existing 450 MVA ATB, which has been struggling to meet the growing demand. To address this, NTDC has planned to replace the 450 MVA Auto Transformer with a 600 MVA unit, with a completion deadline of August 2025. The contract for the replacement has already been awarded, ensuring progress on this key initiative.

In addition, the grid station faces another critical issue involving the 450 MVA T-10 transformer, which is currently under fault. To mitigate this, NTDC is also focused on the completion of the 500kV Lahore North Substation, which will provide additional capacity to relieve the burden on the 500kV Lahore Sheikhupura grid station. The first transformer installation at the Lahore North Substation is expected to be completed by December 10, 2024, with the remaining transformers slated for completion by January 31, 2025.

These combined efforts—replacing the overloaded 450 MVA ATB at Lahore Sheikhupura with a higher-capacity 600 MVA transformer, and the development of the 500kV Lahore North Substation—will significantly improve the network capacity and reliability. The completion of these projects is critical to ensuring a more stable and efficient power supply in the region.

9.2 <u>Overloading constraints of 220/132 kV Transformers</u>:

i. 220 kV Islamabad University Grid Stations:

Since 2018, the 220 kV Islamabad University Grid Station has been grappling with persistent overloading issues on its 220/132 kV Auto Transformers. To address these constraints, NTDC has initiated plans to

enhance the grid's capacity by including the addition of a new 1x250 MVA transformer, expected to significantly alleviate the current overload situation and improve the reliability.

In parallel, NTDC is also working on the development of the 765/500/220/132 kV Islamabad West Grid Station, which will further strengthen the regional transmission network. This new grid station is designed to provide additional capacity and redundancy, helping to meet the growing demand in the Islamabad area and reduce the pressure on existing infrastructure.

ii. 220 kV Sahuwala Sialkot Grid Station:

At the 220 kV Sahuwala Sialkot substation, the three 220/132 kV transformers (T-1, T-2, T-3, each 160 MVA) are facing significant overloading. To address this, NTDC has outlined two key projects:

a. **500/220/132 kV Sialkot Substation**: This new substation will enhance capacity and alleviate the overload at Sahuwala Sialkot. The project is slated for completion by May 2027.
b. **220/132 kV Gujranwala-II Substation**: This project aims to further strengthen the regional network. It has a completion deadline of June 2026.

iii. 220 kV Sarfaraz Nagar Grid Stations:

The 220 kV Sarfraz Nagar grid station has been facing persistent transformer overloading since 2018, prompting NTDC to propose two key projects to resolve this issue:

a. **220 kV Sundar Grid Station**: Initially, the management of the industrial estate resisted providing land for the Sundar grid station. However, this issue has now been resolved, and the project is expected to be completed soon. Once operational, it will significantly alleviate the load at Sarfraz Nagar.

b. **220 kV Kasur Grid Station**: Originally planned as a critical addition to the network, NTDC has revised its approach following planning studies, which indicate that the 220 kV Kasur grid station may no longer be necessary. This is due to a significant reduction in load demand resulting from the construction of the 220 kV Sundar grid station. The Kasur project is now planned for completion by 2024-25, but its scope may be reconsidered based on ongoing studies.

As a result of these constraints, expensive RFO-based generation from Nishat Chunian, Nishat Power, and Kohinoor Power Plants has been required since June 2018 to meet demand. The completion of the Sundar grid station will reduce reliance on costly fuel-based generation, improving efficiency and lowering operational costs.

iv. 220 kV Kot Lakhpat Grid Station:

The 220 kV New Kot Lakhpat substation is experiencing overloading on its three 250 MVA transformers. To address this, NTDC has proposed adding a 1x250 MVA transformer. Originally scheduled for completion by February 8, 2024, the project’s deadline was revised to June 30, 2024. However, NTDC has not met this revised deadline.
Additionally, the completion of the 220/132 kV Punjab University grid station is part of the broader initiative to improve capacity in the region. However, this project has been delayed due to land acquisition issue with Punjab University.

v. 220kV Switchyard of 500 kV Sheikhupura Grid Station:

The 500 kV Lahore Sheikhupura grid station has been facing overloading issues on its 220/132 kV transformers (4x160 MVA) since 2019. To address this, NTDC has proposed augmenting the transformers from 4x160 MVA to 4x250 MVA at the Sheikhupura grid station. Initially, the project had an expected completion date of September 2023, but this has been revised twice—first to March 31, 2024, and then to June 30, 2024. As of the latest update, NTDC has not met the revised deadline.

In parallel, the completion of the 500 kV Lahore North Substation is part of the broader plan to address the overloading issue at Sheikhupura with significant progress already made.

Due to these ongoing constraints, the National Power Control Center (NPCC) has been forced to rely on expensive generation from Saba Power, Halmore Power, and Sapphire Electric Power Plants since 2019. This reliance on costly thermal generation continues to put additional strain on the system and increase operational costs.

vi. 220 kV Daud Khel Grid station:

The addition of a 1x160 MVA transformer at Daud Khel was completed in February 2024**,** significantly behind the original contractual deadline of February 2023**.**

vii. 220 kV Ludewala Grid station:

The 220/132 kV Ludewala substation is currently facing transformer overloading, with the existing setup of 1x160 MVA and 2x250 MVA transformers unable to meet demand. To address this, the remedial plan includes upgrading the 1x160 MVA transformer to a 1x250 MVA transformer.

In addition, as part of the broader constraint removal strategy, the 220/132 kV Lalian new grid station has been successfully constructed and energized, further strengthening the grid stability and alleviating pressure on the Ludewala substation.

viii. 500 kV Yousufwala Grid station:

The 500 kV Yousufwala grid station has been facing overloading issues on its 220/132 kV transformers (T-3, T-4, T-5, and T-6, each 160 MVA) since 2018. To resolve this, NTDC has proposed the construction of a new 220/132 kV Arifwala grid station, with an expected completion deadline of August 2026.

Due to this ongoing constraint, expensive generation from Fauji Kabirwala and Saif Power plants continues to be relied upon, further increasing operational costs.

ix. 500 kV Guddu Grid station:

The 500 kV Guddu grid station is currently facing two key constraints:

a. faulty 220/132 kV Transformer T-4 (285 MVA) and
b. the aging Transformer T-13 (160 MVA).

To address the issue with Transformer T-4, NTDC has proposed adding a 160 MVA Auto Transformer, with a completion deadline of October 2024. For Transformer T-13, NTDC plans to upgrade the existing 2x160 MVA transformers to 2x250 MVA units. The expected completion date for this augmentation is August 2025.

x. <u>220 kV KAPCO Power House:</u>

The 220 kV KAPCO Power House is experiencing overloading issues with its 220/132 kV transformers, specifically T-1, T-2, and T-5 (3x100 MVA) as well as T-6 (200 MVA). To address these constraints and alleviate the pressure on the existing transformers, NTDC has proposed the construction of a new 220 kV Nagshah grid station.

As per the latest update, the PC-I document for the Nagshah grid station is currently under preparation. However, no specific deadline has been provided for the completion of this project at this stage.

xi. <u>Constraints at 220 kV T.M. Khan grid station ,</u>

xii. Constraints at 220 kV Hala Road grid station

&

xiii. Constraints at 220 kV Jamshoro grid station:

The 220 kV T.M. Khan substation is facing overloading issues with its existing 220/132 kV transformers, specifically T-1 and T-2 (2x160 MVA). Similarly, the 220 kV Hala Road substation is experiencing overloading on its T-1 and T-2 transformers, while T-3 and T-7 at the 220 kV Jamshoro substation are also overloaded.

To address these constraints, NTDC has outlined the following plans:

a. **Transformer Augmentation**: The existing 2x160 MVA transformers at T.M. Khan, Hala Road, and Jamshoro substations will be upgraded to 2x250 MVA units. The target completion date for this augmentation is December 2024.

b. **220 kV Mirpurkhas Grid Station**: This new grid station is being constructed to alleviate the load on the affected substations. The expected commissioning date is August 2025.

xiv. 220 kV Quetta Industrial Grid station:

To address the overloading of the 220 kV/132 kV Transformer T-2 (1x160 MVA) at the 220 kV Quetta Industrial substation, NTDC has proposed two key solutions:

a. Construction of the 220/132 kV Mastung Grid Station: This new grid station will help alleviate the load on the Quetta Industrial substation. The expected completion deadline for this project is 2025-2026.

b. Augmentation of the 3rd 250 MVA Auto Transformer (AT): The augmentation of the third AT at Quetta Industrial is aimed at enhancing the station's capacity. The project is set for completion by September 2024.

9.3 500 kV Transmission Lines Constraints (Power Evacuation Problems):

i. Overloaded 500kV Jamshoro – China Hub – HUBCO – K2K3 – Jamshoro interconnection loop, particularly on the K2K3-NKI circuit

&

ii.Overloaded 500 kV Jamshoro - Matiari cct I & I, and 500 kV Jamshoro – Dadu circuit:

The 500 kV Jamshoro grid station is facing multiple constraints that are impacting the overall power system. These include issues with the 500 kV Jamshoro - China Hub - HUBCO - K2K3 transmission lines and their interconnection loop, particularly on the 500 kV K2K3-NKI circuit. Due to these constraints, NTDC is unable to dispatch power from plants in the loop (K2K3, China HUB, and HUBCO) at full load. Additionally, the constraint is affecting power evacuation to K-Electric, limiting the flow of power to the region.

Furthermore, the 500 kV Jamshoro - Matiari Cct I & II and 500 kV Jamshoro - Dadu circuit are also overloaded. These transmission line constraints prevent NTDC from dispatching power from existing power plants in the southern region at their full capacity.

Constraint Removal Plans:

1. Completion of the 500 kV Lahore North Substation and Associated Transmission Lines:

(a) The 500 kV Lahore North Substation,
(b) The 500 kV transmission lines associated with the substation,

(c) The 220 kV transmission line,
(d) As of June 2024, the overall progress on the project is 74%.

This substation and its associated lines will help relieve the constraints at Jamshoro and improve the capacity for power dispatch.

2. Completion of the 500 kV KKI Substation:

This project, which is under the scope of K-Electric, will further strengthen the transmission network and help resolve the constraints in the region.

iii. Overloaded 500kV Jamshoro – China Hub and 500kV HUBCO – K2K3 transmission lines

The 500 kV Jamshoro grid station is facing a significant constraint due to the overloading of its 500 kV Jamshoro – China Hub and 500 kV HUBCO – K2K3 transmission lines. This overloading issue hampers NTDC's ability to dispatch power from China HUB and HUBCO power plants at full load, particularly during outages of either the 500 kV China HUB – Jamshoro or 500 kV HUBCO – K2K3 lines, which creates further operational challenges.

To address this constraint, NTDC has planned two key projects:

1. Construction of the 220 kV Dhabeji SEZ Grid Station: This new grid station will help ease the transmission bottleneck by enhancing the local network capacity. The completion deadline for this project is set for February 2025.

2. Construction of the 220 kV Mirpur Khas Grid Station: This grid station is another important component of the plan to reduce overloading and improve grid reliability in the region. The expected completion date for this project is August 2025

These projects will help mitigate the overloading on the affected transmission lines, enabling NTDC to dispatch power from the China HUB and HUBCO plants at full load, even during line outages. Additionally, the upgrades will improve the overall stability and efficiency of the regional grid.

iv. Overloaded 500kV Yousafwala – Sahiwal Coal CFPP transmission line at 500 kV Yousafwala:

The 500 kV Yousafwala grid station has been facing overloading issues on the 500 kV Yousafwala - Sahiwal Coal CFPP transmission line since June 2023. This overloading is restricting the ability to dispatch power from the Sahiwal Coal Power Plant (CFPP) at its full capacity, impacting overall power generation and grid stability.

To address this constraint, NTDC has proposed the addition of a new 500 kV circuit from the 500 kV Yousafwala grid station to the Sahiwal CFPP. This new circuit will help alleviate the overloading on the existing transmission line and ensure that power from the Sahiwal CFPP can be fully dispatched, improving grid performance and energy supply reliability.

The deadline of the project is June 2026 and currently the PC-I is under preparation.

v. Overloaded 500kV Nokhar – Karot – Neelum Jhelum interconnection loop at 500 kV Nokhar grid station:

The 500 kV Nokhar grid station is facing a constraint due to the overloading of the 500 kV Nokhar – Karot – Neelum Jhelum interconnection loop. This overloading limits NTDC's ability to dispatch power from the Karot and Neelum Jhelum power plants at full capacity, particularly during outages of any circuit connected to the Nokhar grid station.

To resolve this issue, NTDC has proposed the construction of a double-circuit transmission line between Maira and Karot to meet the N-1 reliability criteria and ensure system stability during outages. The project is scheduled for completion by December 2025.

This project will enhance the reliability and flexibility of the transmission network, enabling NTDC to dispatch power from Karot and Neelum Jhelum power plants at full capacity.

vi. Overloaded 500kV Sheikh Muhammadi – Tarbela transmission line of 500kV Sheikh Mohammadi Peshawar grid station:

The 500 kV Sheikh Mohammadi Peshawar grid station is facing a constraint due to the overloading of the 500 kV Sheikh Muhammadi – Tarbela transmission line. This overloading limits the grid station's ability to efficiently manage power flow and meet demand.

To address this issue, NTDC has proposed establishing a second source of supply to the 500 kV Sheikh Muhammadi grid station. This will enhance the station's capacity and improve overall system reliability. The project is expected to be completed by June 2026.

9.4 . Overloaded 220 kV Transmission Lines:

i. Overloaded 220kV Jamshoro – Hala Road circuits I & II of 500kV Jamshoro:

The 500 kV Jamshoro grid station is experiencing constraints on the 220 kV Jamshoro – Hala Road Circuits I & II, which is limiting the capacity and reliability of the system.

To address this, NTDC has proposed an in-out arrangement of the 220 kV Jamshoro – T.M. Khan single circuit, which will provide a second source of supply to the 220 kV Hala Road grid station, enhancing grid stability and reliability. The expected completion date for this project is 2026-27.

ii. Overloaded 220kV New Ghakkar – Ghakkar transmission line at 220kV Ghakkar grid station:

During periods of low generation from Mangla, the 220 kV New Ghakkar - Ghakkar transmission line experiences overloading, which impacts the stability and reliability of power transmission in the region.

To address this issue, NTDC has planned the construction of a new 220 kV Gujranwala-II substation, which will help alleviate the overload and strengthen the transmission network. The project is scheduled for completion by June 2026.

As of June 2024**,** the land acquisition for the substation has been successfully completed. However, financing for the project is still pending and needs to be arranged by NTDC.

iii. Overloaded 220kV Ghakkar – Sahuwala Sialkot circuit at 220kV Ghakkar grid station:

The 220 kV Ghakkar – Sahuwala Sialkot transmission line is experiencing constraints, and to resolve this, NTDC has proposed the construction of the 500 kV Sialkot substation and the 220 kV Gujranwala-II substation, with a target completion date of May 2027. As per the latest update, material procurement and civil works tenders are currently in progress. The progress of the Gujranwala-II substation has already been discussed earlier.

In addition to these projects, NTDC has identified several other transmission line constraints that are under review by the system operator:

1. **220 kV Daud Khel Grid Station**: Constraints are observed on the 220 kV Daud Khel - Sheikh Muhammadi Circuit No. 1 and 2.
2. **220 kV Mardan Grid Station**: Constraints involve the 220 kV Mardan - Tarbela Circuit No. 1 &
3. **220 kV WAPDA Town Grid Station**: Issues are being faced with the 220 kV WAPDA Town - New Lahore Circuit.
4. **220 kV Bandala Grid Station**: Constraints are affecting the 220 kV Gatti – Bandala Circuit No. I and II.

These transmission line constraints are currently under evaluation, and NTDC is working with the system operator to assess potential solutions and implement necessary upgrades to improve grid stability and ensure reliable power delivery.

9.5 Constraint of SEPCO due to damaged 220kV 285MVA Power Transformer at 500kV Guddu grid station:

The damaged 220 kV 285 MVA power transformer at NTDC's 500 kV Guddu grid station has been out of service for the past four years, resulting in increased transmission losses for SEPCO during this period. This issue has been a significant challenge for the region's power supply and has been affecting the efficiency of the transmission network.

NTDC has been directed to resolve this constraint on an urgent basis. According to the latest report submitted by NTDC, the constraint is expected to be removed by the end of August 2024, with the installation of a 160 MVA power transformer at the Guddu grid station. This replacement will help reduce transmission losses, restore grid stability, and improve the overall power supply to SEPCO.

9.6 South to North Transmission Constraints:

The South-to-North power transmission constraints within the NTDC network are critical issues that hinder Pakistan's ability to efficiently transfer power from the major generation hubs in the southern regions to the northern load centers. Pakistan's primary power generation plants, which produce cost-effective electricity from local coal**,** nuclear**,** and gas**,** are concentrated in the south. In contrast, the demand centers**,** such as Punjab and Khyber Pakhtunkhwa (KP)**,** are primarily located in the north.

These transmission limitations necessitate the operation of expensive RFO-based plants in the north, driving up electricity costs and contributing to higher tariffs for consumers, as well as exacerbating circular debt in the power sector. Additionally, new generation sources, including Thar coal-based plants and upcoming renewable energy projects are also concentrated in the south. This geographical imbalance underscores the urgent need for a high-capacity, robust transmission system to facilitate the smooth flow of power from south to north.

The constraints within the NTDC network are directly impacting the ability to evacuate cheap and economic power from southern generation plants, limiting the efficiency of the national grid and increasing the overall cost of electricity. To ensure greater energy security, affordability, and sustainability, addressing following transmission bottlenecks is essential;

a. Limited Capacity of Existing NTDC HVAC Transmission Lines:

The current transmission infrastructure, particularly the 500 kV and 220 kV transmission lines, is inadequate for efficiently transferring the required power from southern generation plants to northern load centers. These existing lines are often overloaded, leading to significant inefficiencies, power losses, and an increased dependence on costly local generation. As a result, frequent bottlenecks occur in power transfer, causing load-shedding and voltage stability issues across the grid. According to the System Operator, under normal operating conditions, the power flow is limited to 1800 MW, despite an available transfer capacity of 4500 MW (comprising 1800 MW AC and 2700 MW DC). This imbalance results in the re-dispatch/curtailment of 1,750 MW and export constraints for energy markets (EMO), further straining the system. To address this, the System Operator has recommended an incremental capacity upgrade to the AC corridor to enable the full utilization of the 4000 MW capacity of the existing HVDC link. This upgrade would significantly improve power flow efficiency, reduce the need for costly generation in the north, and help ensure a more stable, reliable, and cost-effective electricity supply across the country.

b. Full Utilization of 4000 MW of HVDC/PMLTC T/Line:

The 878 km Matiari-Lahore HVDC (High Voltage Direct Current) transmission line is a landmark project designed to alleviate the south-to-north transmission constraints by enabling the transfer of 4,000 MW of electricity. While the line achieved its Commercial Operation Date (COD) in September 2021, challenges remain in achieving its full operational capacity—specifically, the ability to evacuate the full 4,000 MW from south to north. These ongoing issues are primarily due to the delayed completion of the 500 kV Lahore North substation and its associated 500 kV and 220 kV transmission lines, which are crucial for stabilizing the system and ensuring seamless power flow. Without these key infrastructure components in place, the HVDC link cannot operate at its intended capacity, limiting the transfer of cheap and efficient power from southern generation hubs to northern load centers.

Addressing these delays is critical to fully unlocking the potential of the Matiari-Lahore HVDC transmission line, enabling it to meet its design capacity and improve the overall efficiency and reliability of the national grid. Completing the 500 kV Lahore North substation and its related transmission lines will allow the HVDC system to operate at full capacity, reducing transmission losses, minimizing bottlenecks, and supporting a more stable, cost-effective power supply across the country. The details of transmitted energy and invoices raised by PMLTC during the FY 2023-24 are provided in the table below:

Table: 30 HVDC Invoice & Actual Energy Transmissted

FY 2023-24	Invoice Amount Billed by PMLTC	Actual Energy Transmitted
Months	**PKR**	**kWh**
July	8,268,816,000	1,749,506,000
August	8,268,816,000	1,831,207,000
September	8,002,080,000	1,571,854,000
October	8,423,865,600	797,118,000
November	8,152,128,000	610,316,000
December	8,423,865,600	748,739,000
January	8,206,617,600	942,366,000
February	7,677,158,400	665,553,000
March	8,206,617,600	720,121,000

April	7,932,384,000	837,600,000
May	8,196,796,800	1,404,909,000
June	7,932,384,000	1,347,268,000
Total	**97,691,529,600**	**13,226,557,000**
Source: PMLTC and Technical Department Data		

c. Transmission & Transformations Constraints resulting in curtailment of EMO based Power Plants from South to North:

As per the data submitted by NTDC following are the key Transmission & Transformation constraints affecting its network resulting in curtailment in evacuation of economic power from South to North and full utilization of HVDC T'Line;

i. **Transmission Line Constraint at 500 kV Dadu - Shikarpur & 500 kV Moro – Rahim Yar Khan cct**: This constraint has forced NTDC to curtail generation from southern power plants under N-0 conditions (i.e., without any contingency events), as the HVDC current-carrying capacity from south to north is insufficient to handle the total generation capacity in the southern region. This limitation restricts the full utilization of the generation potential in the south, impacting the overall efficiency and stability of the transmission system.

ii. **Transmission Line Constraint at 500 kV Shikarpur – Guddu 1 & 2, 500 kV Moro – Rahim Yar Khan cct**: Due to the ongoing constraints on these key transmission lines, NTDC is unable to dispatch the full load from existing power plants in the south. This results in generation underutilization and a failure to optimally deploy available power capacity, exacerbating the challenges in balancing supply and demand, and hindering the efficient flow of electricity from the southern generation hubs to northern load centers.

9.7 Delay in execution of SCADA-III Project by NTDC:

The SCADA system has been in use by NTDC since 1992. However, due to a lack of technical hardware and software updates, several critical components of the system have become obsolete, impairing its functionality. To address these issues, NTDC initiated the SCADA-III project to modernize and expand the system nationwide. Recognizing its significance as a project of national importance, NEPRA has been closely monitoring its progress. Following continuous monitoring, the project has made substantial progress, reaching approximately 65% completion, marking a significant turnaround from the previous two years of stagnation and slow progress.

The test run of the SCADA-III system is expected to begin in December 2024. The project is being supported by the Asian Development Bank (ADB), with key objectives to enhance the visibility, operations, and monitoring capabilities of NTDC's System Operator. Additionally, the project aims to establish real-time data acquisition and control systems from all power plants and Common Delivery Points (CDPs).Although the SCADA-III project was originally scheduled to be completed and operational by June 24, 2024, it has been delayed by one year. The delays are attributed to three key factors:

1. Approval of design documents
2. Installation of Optical Ground Wire (OPGW)
3. Delays in HESCO and SEPCO Transmission Towers installation

The updated timelines for the implementation of the SCADA-III project, as communicated by NTDC, are as follows:

Table: 31 Timelines for SCADA-III project

Description	Contractual Timelines	Expected Timelines
OPGW (Backbone)	January, 2024	31st July, 2024 (already completed in May, 2024)
OPGW (Remaining)	February, 2024	30th December, 2024

SCADA Go-Live	March, 2024	30th December, 2024
Microwave	May, 2024	30th June, 2025
SCADA Completion	May, 2024	30th June, 2025
Overall (Project Completion)	**24th June, 2024**	**30th June, 2025**

9.8 Transmission Investment Plan of NTDC:

NTDC submitted its revised investment plan in July 2023, which details a series of constraint removal schemes and critical interventions aimed at improving system security and reliability. In response to the long-standing challenges of transmission and transformation constraints, NTDC has incorporated 33 constraint removal projects into the revised plan. These projects are specifically designed to eliminate key bottlenecks, enhance grid efficiency, and facilitate smoother power flow across the network.

The summary of these projects across various categories of the revised Transmission Investment Plan (TIP) is provided below. NEPRA has already approved NTDC's revised investment plan, which is now publicly available on the NEPRA website. Upon successful implementation, these projects are expected to significantly reduce transmission constraints, strengthen system stability, and support the integration of new generation capacity, ultimately ensuring a more reliable and efficient national grid.

Table: 32 Details of NTDC's TIP

S. No.	Head	Number of Projects	CAPEX (Million Rs.)
1	Constraints Removal Projects/ System Expansion Projects	51	172,681
2	Power Evacuation Projects	30	277,434
3	Projects for Special Economic Zones	5	30,369
4	Other Development Projects (Other)	13	29,621

9.9 Transmission Investment Plan of K-Electric:

In accordance with Section 32 of the NEPRA Act and the NEPRA Guidelines for the Determination of Consumer End Tariff (Methodology and Process) 2015, K-Electric submitted its Transmission and Distribution Integrated Investment Plans for the Multi-Year Tariff (MYT) control period covering FY 2023-24 to FY 2029-30, on January 30, 2023. After a thorough procedural review, the Authority formally approved K-Electric's seven-year transmission and distribution investment plan on April 24, 2024.

The approved plan outlines the company's capital investments and associated loss reduction targets for the control period. The summarized investment plan and performance targets for K-Electric are presented below, reflecting the company's strategic initiatives to enhance its transmission and distribution infrastructure, improve system reliability, and achieve operational efficiencies over the next seven years.

Table: 33 Details of KE's TIP

Head	Total Requested (Million Rs.)	Total Allowed (Million Rs.)
Transmission Business	280,916	238,220
Distribution Business	184,650	136,764
Others Support Plans	18,514	17,306
3rd Party Audit by NEPRA	-	200
Grand Total	**Rs. 484,080/-**	**Rs. 392,490/-**

9.10 Delay in Power Evacuation & Augmentation Projects of NTDC:

A significant number of NTDC projects are facing substantial delays, with their expected completion dates extending well beyond the original contractual deadlines. Following a comprehensive review, the projects experiencing these delays, categorized by region, are outlined below:

- **North Region**:

Table: 34 Delayed project of NTDC at North Region

S. No.	Project	Original Completion Date	Revised Completion Date
1	+/-500kV Converter Station + Electrode Station at Charsada (CASA-1000 Power Project)	28-Feb-2024 & 05-Nov-2024	28-Feb-2025
2	500kV Nowshera (HVAC) G/Station	27-Feb-2024	18-Oct-2024
3	Augmentation works at 220kV WAPDA Town & 500kV Sheikhupura G/Station	30-May-2023	31-Dec-2024
4	Augmentation works at 220kV Ludewala, 220kV University, New Kot Lakpat G/Stations	09-Apr-2024	31-Dec-2024
5	Augmentation works at 500kV Nokhar G/Station	14-Nov-2024	14-Mar-2025
6	500kV Maira Switching Station	19-Nov-2021 (Commencement)	Slow Progress
7	500/220/132kV Lahore North G/Station & 500kV Nokhar G/Station Extension Works	22-Mar-2024	10-Dec-2024 & 31-Jan-2025
8	220kV Jauharabad G/Station	Not Provided	Slow Progress
9	220kV D/C Twin Bundle T/Line (500/220kV Faisalabad West to 220kV Lalian)	25-Mar-2023	31-Oct-2024
10	500kV FIEDMC/AIIC G/S with associated T/Line	10-Nov-2023	30-Jun-2025
11	220/132kV QABP G/Station with associated T/Line	31-Oct-2023	31-Dec-2024
12	220/132kV Swabi G/Station & associated T/Line	24-Jul-2023 & 26-Jul-2024	31-Mar-2025 & 28-Feb-2025
13	220/132kV Haripur G/Station with associated T/Line	30-Aug-2023 & 09-Jan-2024	30-Apr-2025 & 31-Mar-2025

❖ **South Region**

Table: 35 Delayed project of NTDC at South Region

S. No.	Project	Original Completion Date	Revised Completion Date
1	Augmentation Works at 220kV Quetta Industrial G/Station (WB-09B-2020)	30-Nov-2022	30-Sep-2024
2	Augmentation Works at 220kV Daharki & Bahawalpur, 220kV Rohri Extension Works (WB-08B-2020)	13-Feb-2023	22-Jul-2024
3	Extension Works at 220kV Sibbi & Loralai G/Stations (WB-09A)	20-Mar-2023	31-Oct-2024
4	Augmentation Works at 220kV TM Khan, Hala Road, Jamshoro G/Stations (WB-08A)	09-May-2023	31-Dec-2024
5	220kV Zhob G/Station	06-Sep-2022	03-Sep-2024
6	220kV Mirpurkhas G/Station and associated T/Lines	10-Jul-2021	29-Aug-2025 (G/S), Feb 2026 (T/Lines)
7	500kV K2/K3 Port Qasim T/Line	21-Apr-2022	31-Dec-2024
8	220kV Dhabeji G/Station and associated T/Lines	09-Oct-2022	28-May-2025 & 31-Oct-2024
9	Pilot Battery Energy System at 220kV Jhimpir-I	28-Mar-2023	27-Jul-2025

NTDC is facing significant delays across several key infrastructure projects, with many in both the North and South regions now expected to be completed well beyond their original contractual timelines. In the North Region, critical projects such as the +/-500kV Converter Station at Charsada, the 500kV Nowshera (HVAC) Grid Station, and various augmentation works at 500kV and 220kV grid stations are all experiencing setbacks. Revised completion dates for these projects have been extended into late 2024 and 2025. Notably, progress at the Maira Switching Station and Jauharabad Grid Station has been slower than expected.

In the South Region, delays are also affecting important projects like the augmentation of the 220kV Quetta Industrial Grid Station, the 220kV Zhob Grid Station, and the high-priority 500kV K2/K3 Port Qasim Transmission Line. The revised timelines for these projects now extend as far as 2026.

These repeated delays underscore persistent challenges in NTDC's project management, highlighting the need for more robust oversight, improved resource allocation, and stronger execution strategies. Failure to address these issues may further impact the stability, reliability, and security of Pakistan's national transmission system.

9.11 Delay in construction of dedicated 500 kV K2/K3 - Port Qasim Transmission Line:

The dedicated transmission line for evacuating power from the K2/K3 Nuclear Power Plants (NPPs) was originally slated for completion by April 2022, but due to delays, it was energized through an interim arrangement in March 2022. After a partial blackout in October 2022, NTDC was directed to prioritize the completion of the dedicated transmission line. In response, NTDC engaged in negotiations with the contractor, and the project is now scheduled for completion by December 2024. This revised timeline aims to address the power evacuation issues and ensure reliable transmission from the K2/K3 plants to the national grid.

9.12 Analysis of Significant Delays in K-Electric Projects:

K-Electric is facing substantial delays across multiple critical projects, with completion timelines currently unspecified. Key delayed projects include the Hub, Vinder, Uthal, Bela (HVUB) project, the 500/220/132 kV KKI Grid Station, and the 220kV Dhabeji Grid Station and its associated transmission lines. Additionally, the planned upgrade of three existing 66kV grid stations to 132kV remains incomplete. These delays highlight significant challenges in K-Electric's infrastructure development, impacting overall grid reliability and capacity enhancements across their network.

9.13 Absence of Ring Network in Transmission Network of NTDC:

To prevent the recurrence of tripping and partial or total blackouts that have historically affected the system, it is crucial to develop a ring-fenced network within the transmission infrastructure. This will ensure both system reliability and contingency capacity, providing the necessary resilience to avoid system splitting and mitigate the risk of partial blackouts or brownouts.

Additionally, to strengthen the existing 220kV & 500kV HVAC network in the southern transmission network of NTDC in its faragile network in southern region, it is important to study the construction of a ring-fenced 220kV network. This would connect key grid stations such as Shikarpur, Dadu, Jamshoro, and Hala Road, Moro, Rohri, along with their associated transmission lines, as a means to enhance system stability and improve transmission reliability in the region. These proposed mitigation measures are critical for reducing vulnerability to outages and ensuring a more secure and efficient power transmission network in the southern region.

9.14 Reconductoring, Reinforcement & Rehabilitation of old G/Stations & Associated HVAC Transmission Lines:

Re-conductoring the outdated and fragile portions of the HVAC network in the South Region—specifically the 500kV Jamshoro-Dadu and Jamshoro-Matiari-Dadu transmission lines, which are over 36 years old—is critical to addressing the frequent trippings and instability caused by their deteriorating condition. This reconductoring effort is essential to ensure that these lines can handle the required loads and to minimize the risk of power outages and transmission failures.

In addition to the re-conductoring, it is also necessary to enhance the transformation capacity across these key transmission corridors, which will help alleviate the strain on the existing infrastructure and reduce the incidence of overloading.

Furthermore, reinforcement plans for crucial older grid stations—including Rawat, Burhan, Kot Lakpat, KSK, Gatti, TPS Muzafargarh I-II, Dadu, Hala Road, T.M. Khan, Jamshoro, Guddu, and Quetta—must

be prioritized. These stations are critical nodes in the network and require upgrading to improve their operational efficiency, reliability, and ability to meet the growing demand. Together, these measures will significantly strengthen the transmission system in the transmission network, improving grid stability and reducing the risk of power disruptions.

9.15 Interim Arrangements Present Within NTDC Transmission Network:

The reliance on interim arrangements underscores the significant challenges faced by NTDC in completing critical transmission infrastructure within the set timelines. While these temporary measures help avert immediate power shortages, they highlight the urgent need for the completion of permanent systems to reduce dependency on provisional solutions. Prolonged use of interim setups not only strains the transmission network but can also lead to increased operational risks, inefficiencies, and higher costs.

Delayed completion of permanent grid enhancements has the potential to compromise system reliability, elevate transmission losses, and result in higher operational costs, particularly during peak demand periods. The continued reliance on temporary measures, while necessary in the short term, emphasizes the importance of expediting the completion of permanent infrastructure projects to ensure long-term stability and efficiency across NTDC's transmission network. The following outlines the key interim arrangements currently in place within NTDC's transmission network:

Table: 36 Detail of 500kV & 220kV Circuits on Interim Arrangement by NTDC

Detail of 500kV & 220kV Circuits on Interim Arrangement under Asset Management (North)	
Sr.	**Name of Circuit**
1	500kV Nokhar - Lahore North CCT
2	220kV Kala Shah Kaku - Lahore North CCT
3	220kV Lahore (Sheikhupura) - Ravi CCT
4	220kV Kala Shah Kaku-Ravi CCT
5	220kV Kala Shah Kaku-Ghazi CCT
6	500kV Suki Kinari-Neelum Jhelum CCT
7	500kV Suki Kinari-Karot CCT
Interim Arrangements Present in South Region of Asset Management (NTDC)	
8	500kV K2-Hub Circuit
9	500kV Jamshoro-K2K3 Circuit-II
10	132kV Jhampir-I - Tanaga Circuit (via 220kV Gharo-Jhampir-I T/L)
11	220kV Transmission Line from Pak-Iran border (Gabd) to 132kV Jiwani Gwadar interconnection point

Interim arrangements within the NTDC transmission network serve as temporary measures to bridge gaps in the permanent infrastructure across both the northern and southern regions. These provisional setups are essential in maintaining power flow while critical transmission lines and substations are under construction or facing delays.

In the northern region, key circuits such as the 500 kV Nokhar-Lahore North CCT and the 220 kV Kala Shah Kaku-Lahore North CCT are currently operating under interim arrangements. These allow power to be transmitted through newly constructed segments while the full substation and transmission line infrastructure is still being completed. These temporary solutions ensure that power supply remains uninterrupted while permanent upgrades are finalized.

In the southern region, several crucial transmission circuits also rely on interim arrangements. The 500 kV K2-Hub Circuit and the 500 kV Jamshoro-K2K3 Circuit-II are vital for evacuating power from the K2/K3 nuclear power plants. Additionally, the 132 kV Jhampir-I to Tanaga Circuit, supported by the 220 kV Gharo-Jhampir-I transmission line, is another interim solution ensuring continued power transmission. Similarly, the 220 kV transmission line from the Pak-Iran border (Gabd) to Jiwani Gwadar interconnection is operating under provisional arrangements to facilitate power supply to the region.

These interim solutions are crucial in maintaining grid stability and power availability, but they highlight the urgency of completing the permanent transmission infrastructure to ensure long-term reliability, reduce operational risks, and enhance the overall efficiency of the NTDC network.

9.16 Details of Tower Collapse of 500kV & 220kV Transmission Lines of Licensees during FY 2023-24:

Transmission towers are vulnerable to natural disasters like hurricanes, earthquakes, and sabotage, leading to power outages, economic losses, and grid instability. To mitigate these impacts, solutions include stronger tower designs, improved weather forecasting, regular maintenance, emergency response plans, and effective right-of-way management.

NEPRA has been actively monitoring tower collapse incidents within NTDC and K-Electric's transmission networks. These incidents, often exacerbated by theft of tower materials, have resulted in power supply disruptions, partial blackouts, and system overloading. In response, NTDC and K-Electric were directed to develop a comprehensive Transmission Line Security Policy to address theft and mitigate risks from natural disasters like high winds and cyclones.

K-Electric has implemented a transmission line security policy that includes regular patrolling by transmission and security teams to identify and address potential threats. NTDC has taken additional steps, such as studying & implementing High Intensity Wind (HIW) Mapping and employing local guards in high-risk areas to reduce theft and tower collapse incidents.

During FY 2023-24, NTDC reported the collapse of 27 towers, primarily due to severe weather and sabotage, with the Hyderabad and Quetta regions being most affected. K-Electric reported 9 tower collapses, while no incidents occurred in the networks of FTCL and ST&DCPL.

Table: 37 Details of Tower collapse occurred during FY 2023-24

Voltage Level	Transmission Line & Tower Nos.	Region (Division)	No. of Towers Collapsed	Reason for Collapse
500 kV	K2-Jamshoro Circuit-2, Towers 79 & 81	Hyderabad (NKI Karachi)	2	Sabotage Activity
	Guddu-Shikarpur Circuit-I, Towers 293, 294 & 295	Hyderabad (Shikarpur)	3	Heavy Wind Storm & Thunderstorm Rain
	Shikarpur-Dadu Circuit-I, Towers 744 to 747	Hyderabad (Shikarpur)	4	Heavy Wind Storm & Thunderstorm Rain
	Shikarpur-Dadu Circuit-II, Towers 37 to 41	Hyderabad (Shikarpur)	7	Heavy Wind Storm & Thunderstorm Rain
	Shikarpur-Dadu Circuit-II, Towers 100 & 101	Hyderabad (Shikarpur)	2	Heavy Wind Storm & Thunderstorm Rain
	NKI-Jamshoro T/L, Towers 313 to 317	Hyderabad (NKI Karachi)	5	Tornado
220 kV	DG Khan-Loralai T/B D/C, Tower 335	Quetta (T/L M Division Quetta)	1	Heavy Thunderstorm, Gust & Rainfall
	Jamshoro-Jhampir-II Cct, Tower 36	Hyderabad (Jamshoro)	1	Heavy Wind Gust & Sabotage Activity
	DG Khan-Loralai T/B D/C, Tower 20	Quetta (T/L M Division Quetta)	1	Heavy Thunderstorm, Gust & Rainfall
	Tarbela-Burhan-3-ISPR DC, Suspension Tower No. 73	Islamabad (TL Division Tarbela)	1	Thunderstorm & Gusty Winds
Total	-	-	**27**	-

The table above indicates that a total of 23 transmission towers collapsed on various 500 kV circuits, including the K2-Jamshoro, Guddu-Shikarpur, Shikarpur-Dadu, and NKI-Jamshoro lines. Additionally,

four (04) 220 kV towers were reported to collapse on the DG Khan-Loralai, Jamshoro-Jhampir-II, and Tarbela-Burhan-ISPR lines. The primary causes of these incidents were heavy windstorms, thunderstorms, and a tornado. The Hyderabad region, particularly the Shikarpur and NKI Karachi divisions, was the most affected, experiencing the highest number of tower collapses due to severe weather conditions.

Historical Trend of Tower Collapse of 500 & 220kV T/Lines (NTDC) for last 4 years:

Table: 38 Historical Trend of tower collapse for last 4 years

Region	No. of tower collapsed (FY 20-21)	No. of tower collapsed (FY 21-22)	No. of tower collapsed (FY 22-23)	No. of tower collapsed (FY 23-24)
South Region (Hyderbad + Quetta)	11	23	33	26
North Region (Islamabad + Lahore + Multan)	2	3	9	1
Total (South + North)	13	26	46	27

The impact of hiring local security guards through 3rd party is apparent from the fact that the number of tower collapse in NTDC network has significantly decreased as compared to the last year.

During FY 2023-24, K-Electric reported a total of 9 tower collapses across different voltage levels, primarily due to severe weather conditions and theft.

Table: 39 Details of Tower Collapse of 220kV, 132kV & 66kV T/Lines (KE) for FY (2023-24)

Voltage level	T/Line & Tower Type	K-Electric (TL Division)	No. of Tower collapsed	Reason of Tower Collapse
500kV	-	-	-	-
220kV	220kV NPQ-Dhabeji-NPP Circuit 1 & 2	AM- Qayyumabad Region	1	High Wind & theft of iron braces/ joint plates
132kV	-	-	-	-
66kV	66kV Malir- Gadap Pole Structure	AM-KDA Region	3	During maintenance due to grip slip
66kV	66kV Uthal- Bela RCC Pole Structure	AM- Qayumabad Region	5	High Wind & Heavy Rain
TOTAL			**9**	

One tower collapsed on the NPQ-Dhabeji-NPP line in the Qayyumabad region, caused by a combination of high winds and theft of iron braces/joint plates. In the Malir-Gadap region, three 66 kV pole structures collapsed during maintenance due to grip slippage. Additionally, five RCC pole structures on the Uthal-Bela line in the Qayyumabad region were brought down by high winds and heavy rain. Fortunately, no incidents were reported at the 132 kV level during this period.

Table: 40 Details of Tower Collapse of 220kV T/Lines (KE) for last 2 years

KE	No. of Tower Collapsed (FY 22-23)	No. of tower collapsed (FY 23-24)
Total	4	9

9.17 Wind Mapping of NTDC Transmission Network:

Over the past two decades, NTDC's transmission network, particularly in the southern region, has experienced recurrent tower collapses, largely attributed to High-Intensity Winds (HIWs). These incidents have predominantly occurred along the right bank of the Indus River, where wind loading—especially in

the form of 3-second gusts—has emerged as a critical factor in the structural integrity of transmission towers. However, NTDC has not yet conducted a comprehensive study on HIWs, nor are there detailed wind maps indicating 3-second gust wind speeds across Pakistan.

The frequent tower collapses underscore the urgent need for detailed wind mapping, as per ASCE (American Society of Civil Engineers) standards, to better assess wind speeds and strengthen transmission tower designs in vulnerable areas. Below are the transmission lines that have experienced tower collapse incidents due to heavy winds, gusts, and thunderstorms:

i. Guddu-Shikarpur-Dadu-Jamshoro (Single Circuit-I) - 3 Bundle/Phase
ii. Jamshoro-Matiari-Dadu-Shikarpur-Guddu (500kV Single Circuit-II) - 4 Bundle/Phase
iii. Hub-NKI-Jamshoro (500kV Single Circuit-I) - 4 Bundle/Phase
iv. Port Qasim-Matiari (500kV Double Circuit) - 4 Bundle/Phase 220kV Guddu
v. 220kV Shikarpur-II (PCC Pole)
vi. 220kV Guddu - Shikarpur I/ Guddu-Sibbi
vii. 220kV Gharo - Jhampir
viii. 220kV Guddu - Shikarpur & Shikarpur Uch
ix. 220kV Guddu - Sibbi & Guddu-Uch

Given the recurring tower collapses in NTDC's network due to heavy winds and gusts, the Authority directed NTDC to conduct a comprehensive study on wind mapping. In response, NTDC engaged NESPAK, a consultant, to carry out the wind mapping for High-Intensity Wind Zones (HIWz). However, despite the passage of more than two years, the final study and its deliverables are still pending. This delay further underscores the urgency of addressing wind-related vulnerabilities in the transmission network to prevent future infrastructure damage and ensure system reliability.

9.18 Fatal and Non-fatal Incidents in Pakistan's Transmission Line Network:

According to the data provided by NTDC and K-Electric for FY 2023-24, NTDC's North region, which includes the Islamabad, Peshawar, Lahore, and Multan circles, reported three fatal incidents involving NTDC employees within its transmission network. In contrast, no fatal or non-fatal incidents were reported in NTDC's South region, which covers the Hyderabad and Quetta circles.

For K-Electric, a total of three (03) fatal incidents (electrical) were reported, including one employee and two members of the general public. Additionally, six non-fatal incidents occurred, involving 1 employee and five members of the general public. No fatal or non-fatal incidents were reported within the transmission networks of FTCL and ST&DCL.

9.19 Investigations carried during FY 2023-24 against NTDC on Account of Fatal Accidents:

A fatal incident involving Mr. Zain Ul Abedeen, an electrician, occurred on October 24, 2022, while performing routine work at the 500 kV Dadu Grid Station. Subsequently, another fatal accident took place on March 15, 2023, during rehabilitation work (re-jumpering of the blue phase) on tower No. 252 at the 500 kV Guddu-Shikarpur Circuit-I, resulting in the fatality of Mr. Khair Bux, a Line Maintenance-II (LM-II) employee.

NTDC submitted the preliminary inquiry reports after an eight-month delay. These reports were reviewed in detail, and NTDC was instructed to provide the comprehensive inquiry reports along with an update on the progress of the recommendations made by the Inquiry Committee.

However, NTDC has failed to submit the detailed inquiry reports, and the lack of compliance has been noted by the Authority with serious concern. As a result, NEPRA has constituted an independent inquiry

committee under Section 27A of the NEPRA Act to investigate the incidents. The proceedings are currently underway.

9.20 Deterioration of NTDC Assets due to Environment Pollution:

The repeated trippings of transmission lines and the rapid deterioration of switchyard equipment in the NTDC network, attributed to unforeseen factors, were raised before NEPRA. Upon detailed analysis, it was determined that these issues are primarily caused by environmental pollution affecting the insulators and other switchyard equipment.

NEPRA addressed this matter with NTDC, which responded by informing that a pollution study is currently underway. This study is being conducted in collaboration with NESPAK's research platform, focusing on the impact of environmental pollution on various types of insulators, including porcelain, glass, and composite materials. The findings from this study are expected to provide insights into mitigating the adverse effects of pollution on the transmission network.

9.21 Inadequate NTDC & KE Interconnection/Transformation Capacity:

The issue of insufficient interconnection capacity, specifically the 1,100 MW link between NTDC and K-Electric (KE), was raised by NEPRA during FY 2022-23. This interconnection is facilitated through a network that links NTDC's system with KE's at the 500 kV Jamshoro and 500 kV NKI grid stations. In response to these concerns, KE has reported that a new 500 kV grid station at KKI and the augmentation of the 500 kV NKI grid station are currently in progress.

Additionally, KE highlighted its efforts to enhance interconnection capacity for the benefit of KE consumers and the broader national economy, especially considering the surplus capacity available in the national grid. In FY 2023-24, KE has made significant strides in advancing additional interconnection points at 500 kV KKI and 220 kV Dhabeji with the national grid. The progress of these interconnection projects during FY 2023-24 is outlined as follows:

a) **220/132 kV Dhabeji Grid Station and Transmission Lines:** The 220/132 kV Dhabeji interconnection project is nearing completion, with approximately 97% of the work finalized. The 220/132 kV Dhabeji Grid Station has been fully energized, including two 250 MVA Auto Transformers. The 220 kV transmission line connecting the NTDC network is in its final stages.

b) **500/220 kV Karachi-KANUPP Interconnection (KKI) Grid Station and Transmission Lines:** The 500 kV KKI Grid Station and the existing 220 kV D/C transmission lines (Baldia – Mauripur I & II) are being connected to the 220 kV KKI Grid. The project is progressing well and is expected to be commissioned soon.

It is important to note that with the addition of these two new interconnection points (500 kV KKI and 220 kV Dhabeji), KE's total transformation capacity from the national grid will increase to approximately 2,400-2,600 MW. This will be achieved through KE's four interconnection points with the national grid: 500 kV Jamshoro, 500 kV NKI, 500 kV KKI, and 220 kV Dhabeji, as indicated in the load flow study submitted to KE by PSP, NTDC.

9.22 The Annual System Reliability Assessment and Improvement Report (ASRAIR):

In accordance with the provisions of the newly approved Grid Code 2023, the Annual System Reliability Assessment and Improvement Report (ASRAIR) is required to be submitted to the Authority by the end of February each calendar year. Unfortunately, NTDC/NPCC and K-Electric have failed to submit this critical report within the stipulated timeframe. The ASRAIR is essential for identifying and evaluating congestion issues within the transmission system that could lead to operational constraints, hinder economic dispatch, necessitate load curtailment, or significantly increase service costs. Timely submission

of this report is vital to facilitate the early identification of transmission system bottlenecks and ensure their swift resolution, thereby maintaining the efficiency, reliability, and stability of the power sector.

9.23 Contractual Arrangements between CPPA-G & KE:

Contractual agreements, such as the Power Purchase Agreement (PPA), Energy Power Purchase Agreement (EPA), and Connection Agreement (CA), have been initiated between CPPA-G and K-Electric to establish a clear legal and financial framework for electricity transactions between the two entities. These agreements are designed to ensure smooth operations and avoid payment disputes in the future. The Authority has consistently emphasized the need for CPPA-G and K-Electric to formalize distinct and comprehensive contractual arrangements, underscoring their importance in fostering transparency, accountability, and financial stability within the power sector.

9.24 Separation of System Operator Functions from NTDC:

Pursuant to the amended NEPRA Act, 2018, the roles of the System Operator (SO) and the Transmission Network Company were functionally unbundled to promote a transparent, fair, and competitive wholesale power market, while maintaining the reliability and security of the national power grid. To mitigate any potential conflict of interest between system operations and transmission network functions, the Authority, in accordance with its regulatory mandate, issued a separate and distinct license for the System Operator to NTDC in January 2023, alongside the approval of the revised Grid Code 2023. This regulatory decision aims to enhance oversight, strengthen market competitiveness, and ensure compliance with system reliability standards. However, despite this significant step, the formal separation of the System Operator from NTDC has not yet been fully implemented during FY 2023-24.

9.25 Monitoring of System Constraints & Development of Online Portal:

Monitoring of NTDC's system constraints was initiated to address the impact of network limitations on the optimal utilization of power generation capacity. These constraints have resulted in the underuse of efficient power plants and the forced operation of costly, out-of-merit power plants, thus violating the Economic Merit Order (EMO). In response, NEPRA has been closely monitoring NTDC's performance and has issued specific directives to expedite the resolution of these constraints. To improve transparency and streamline reporting, an online portal has been developed, enabling NTDC to submit data on system constraints in timely manner. This portal incorporates automated features for tracking monthly, quarterly, and annual progress, ensuring timely updates and enhanced oversight.

9.26 Legal Proceeding initiated Against Transmission Licensees:

The legal proceedings against NTDC, the transmission licensee, are as follows:

(a) **Fine for Partial Blackout (September 2021)**: A fine of Rs. 10 million was imposed on NTDC following the partial blackout caused by a fault at the 500 kV Jamshoro Grid Station in September 2021.

(b) **Legal Action for Jhimpir-II Grid Station**: NEPRA initiated legal action against NTDC after a visit to the under-construction and energized 220 kV Jhimpir-II Grid Station. Based on the inspection report, the Authority issued a Show Cause Notice to NTDC. However, following NTDC’s response, the Authority decided to suspend further legal proceedings until the M&E team verifies NTDC’s claims of having completed 90% of the electrical works. NTDC has been directed to complete the remaining civil works and resolve discrepancies within six months.

(c) **Fine for Tower Collapse due to Cyclonic Winds**: A fine of Rs. 10 million was imposed on NTDC due to the collapse of transmission towers in the South region, which was caused by severe cyclonic winds.

(d) **Non-Compliance Regarding Power Dispersal Cost**: An explanation was issued to NTDC on September 21, 2023, for failing to comply with NEPRA’s directions concerning the reimbursement of power dispersal costs to the Nandipur power plant.

(e) **Explanation Regarding Nationwide Blackout (October 2022)**: Following a detailed inquiry into the total power blackout that occurred on October 13, 2022, NEPRA issued an explanation to NTDC on February 13, 2024, regarding its role in the incident.
(f) **Fine for Fatal Accident**: NEPRA imposed a fine of Rs. 10 million on NTDC in connection with a fatal accident. NTDC has challenged the Authority's order before the NEPRA Tribunal.

9.27 Approval of Policies by NTDC w.r.t Handing Over / Taking over of NTDC Assets & Compensation Policy for Right of Way and Land Acquisition:

During field visits and investigations at various NTDC grid stations and transmission lines, NEPRA identified significant delays, incomplete works, and cost escalations, leading to time overruns in both developmental and operational projects. It was observed that the lack of a standardized policy or standard operating procedures (SOP) for asset compensation and the formal process of handing over and taking over assets contributed to these challenges.

In response, NEPRA directed NTDC to develop and implement a comprehensive Handing/Taking Over and Asset Compensation Policy to streamline and formalize these processes. To comply with this directive, NTDC submitted two key policies, which were duly approved by its Board of Directors (BoD) during FY 2023-24. These are:

1. **Handing Over/Taking Over of NTDC Assets Policy**
2. **Compensation Policy for Right of Way and Land Acquisition**

The implementation of these policies is expected to address existing gaps, reduce operational inefficiencies, and enhance transparency in the construction, development, and operational management of NTDC's transmission system projects. These measures will contribute significantly to mitigating delays and cost overruns, ultimately improving the reliability and efficiency of the national grid.

9.28 Monitoring of Transient Trippings due to technical reasons i.e. tower collapse and Fire Incidents at Power Transformer, CTs, PTs etc. in Switchyards of Grid Station due to technical reasons:

NEPRA has been closely monitoring incidents of transmission line trippings, tower collapses, and fire outbreaks at grid stations caused by technical malfunctions. These disruptions not only compromise the stability and reliability of the power transmission system but also present significant safety risks and can lead to prolonged operational downtime.

To address these critical issues, NEPRA has directed NTDC and other relevant stakeholders to implement immediate corrective actions. Key focus areas include:

1. **Strengthening Preventive Maintenance**: NEPRA has emphasized the need for enhanced preventive maintenance practices to proactively address potential vulnerabilities in the transmission network.
2. **Improving Structural Integrity**: Efforts are being made to reinforce the physical infrastructure of transmission towers and grid stations, ensuring they are better equipped to withstand adverse weather conditions and technical stress.
3. **Enhancing Emergency Response Protocols**: NEPRA has directed NTDC to establish more robust and efficient emergency response plans to minimize downtime and improve the speed and effectiveness of corrective actions in the event of an incident.

9.29 Establishment of Safety Directorate within all field formations of NTDC:

All Licensees are required to establish an independent Directorate or Department of Occupational Health, Safety, and Environment. In compliance with regulatory obligations, NTDC has now established a

dedicated Safety Directorate and appointed a Deputy Director / Executive Engineer (XEN) at the circle level. This officer is responsible for overseeing safety practices and ensuring the training and instruction of both staff and officers.

9.30 Monitoring of Interconnection Issues of IPPs & other relevant stakeholders with NTDC:

NEPRA has identified significant challenges in the interconnection processes between NTDC, IPPs, and DISCOs, which are undermining the reliability and efficiency of Pakistan's power transmission and distribution system. While NTDC is legally obligated to provide non-discriminatory access to its transmission network, technical constraints—including inadequate capacity, voltage fluctuations, and synchronization issues—have led to frequent bottlenecks. These challenges have compromised the stability of the transmission system, hindered the timely evacuation of electricity, and disrupted the efficient distribution of power. Additionally, procedural delays in grid integration and the slow pace of infrastructure upgrades have further exacerbated these issues. NEPRA is closely monitoring NTDC's efforts to address these challenges and ensure compliance with regulatory requirements to improve system performance and reliability.

9.31 Cyber-Security Measures:

To strengthen network security and comply with evolving regulatory requirements, KE has proactively implemented a range of cyber security controls, including robust Access Control measures (both logical and physical), regular vulnerability assessments, and Cyber Hygiene practices such as hardening all dedicated configuration tools. These initiatives have significantly enhanced KE's defenses against potential cyber threats, safeguarding the integrity and reliability of its infrastructure.

Meanwhile, NTDC has reported progress in securing its enterprise network, including encrypted traffic management through SD-WAN/VPNs for internet and intranet access by end users. The organization has also successfully implemented IT/MIS systems and services. Furthermore, NTDC has recently obtained approval for the appointment of the Director General of IT Governance (DG ITG) from its Scrutiny Committee, with the allied team now in place. This proposal will be submitted to the Board of Directors for final approval. The DG ITG will lead the Cyber Security team, driving efforts to further enhance NTDC's cyber security posture.

9.32 Cross-Border Transmission Lines:

Currently, two key cross-border power exchange and import projects are in the pipeline in Pakistan, as detailed below:

a. 1000MW CASA-1000 Project

The CASA-1000 Project (Central Asia-South Asia Electricity Transmission and Trade Project) is a significant regional initiative aimed at facilitating the export of surplus hydroelectric power from Central Asia to South Asia. Specifically, the project is designed to transmit electricity generated in Kyrgyzstan and Tajikistan (both part of Central Asia) to Afghanistan and Pakistan (South Asia).However, the project has encountered setbacks due to various reason and facing delays.

b. Power Import from Iran to Gwadar

Since 2003, Pakistan has been importing 70-90 MW of electricity from Jackigor (Iran) to Mand (Pakistan) via a 132kV transmission line. In addition, since 2023, a new 132kV transmission link between Polan (Iran) and Gwadar (Pakistan) has been operational, with a capacity of up to 100 MW. This link is expected to be upgraded to a 220kV level by 2027-2028. This upgrade will include the completion of a 220kV transmission line and a 220kV GIS substation in Gwadar, which will significantly enhance the power supply to the region and support its growing energy needs.

9.33 Strengthening of Telecommunication network within Transmission Sector:

During recent NEPRA field visits, the poor condition of NTDC's telecom network was noted, an issue raised in PER FY 2022-23. In response, NTDC has increased coordination for tele-protection testing with WAPDA Hydel, IPPs, and others, and boosted maintenance frequency at NTDC sites. Keeping in view the importance of robust telecom network within power sector nowadays, NTDC must urgently modernize its aging telecom infrastructure to align with global standards for efficient network control and operations.

Meanwhile, K-Electric has upgraded its transmission network with Smart Hybrid Telecom (FOX) equipment and regular in-house improvements.

9.34 Critical Infrastructure Assessment of NTDC's Transmission Network:

NEPRA conducted a network analysis of NTDC, reviewing key tasks including Event & Fault Recorders, time synchronization of protection relays, commissioning of numerical relays, firewalls for sensitive equipment, transformer overloading mitigation plans, and thermo-vision camera installations across NTDC's transmission network (Islamabad, Lahore, Multan, and Hyderabad). NTDC has been directed to prioritize and complete these tasks promptly.

a) Status of Event and Fault Recorders:

Lahore Region: Out of 26 G/stations, only 4 have Event & Fault Recorders installed.
Islamabad Region: Out of 13 G/stations, 2 have functional and healthy Event & Fault Recorders, while 2 have faulty recorders.
Multan Region: Out of 11 G/stations, only 2 have functional and healthy Event & Fault Recorders.
Hyderabad Region: Out of 22 G/stations, 11 have working Event & Fault Recorders.

(b) Status of Time Sync of Protection:

Lahore Region: Out of 26 G/stations, only 4 have fully functional and automatic GPS time synchronization.
Islamabad Region: None of the 13 G/stations have functional GPS time synchronization.
Multan Region: Out of 11 G/stations, only 1 has functional GPS time synchronization.
Hyderabad Region: None of the 22 G/stations have functional GPS time synchronization, raising concerns over relay coordination during faults. Additionally, there appears to be no progress in GPS module procurement by AM South.

(c) Status of Numerical Relays:

Lahore Region: Out of 26 G/stations, 12 have fully functional numerical relays.
Islamabad Region: Out of 13 G/stations, 8 have fully functional numerical relays.
Multan Region: Out of 11 G/stations, 5 have fully functional numerical relays.
Hyderabad Region: Out of 22 G/stations, only 2 have fully functional numerical relays.

(d) Status of Construction & Commissioning of Fire Walls near Sensitive Equipment:

Lahore Region: Out of 26 G/stations, 12 have commissioned firewalls for sensitive equipment.
Islamabad Region: Out of 13 G/stations, 12 have constructed firewalls for sensitive equipment.
Multan Region: Out of 11 G/stations, 9 have constructed firewalls for sensitive equipment.
Hyderabad Region: Out of 22 G/stations, 11 have constructed firewalls for sensitive equipment.

(e) Status of Civil Defense / Firefighting Trainings:

The data from NTDC's regions (Islamabad, Lahore, Multan, and Hyderabad) was thoroughly reviewed, revealing several anomalies. G/stations are conducting training sessions bi-annually, quarterly, and monthly, but without a coordinated approach or a central SOP aligned with the NEPRA Power Safety Code 2023. Additionally, some G/stations are focusing solely on firefighting training, while only a few involve Civil Defense, Rescue 1122, or Fire Brigade teams in mock drills and training exercises.

f) Status of availability of Thermo vision Cameras:

Lahore Region: Out of 26 G/stations, 17 have their own thermo vision cameras. The rest either borrow cameras from nearby circles or G/stations or do not require them.

Islamabad Region: Out of 13 G/stations, 8 do not require thermo vision cameras.

Multan Region: Out of 11 G/stations, 7 have their own thermo vision cameras. The remaining stations either borrow cameras or do not require them.

Hyderabad Region: None of the 22 G/stations have thermo vision cameras.

(g) Status of DES and DGA test:

A review of NTDC's records reveals recurring issues, including failure of bushings and insulation, shortcomings in the procurement and commissioning of transformers (such as nitrogen gas evaporation, broken diaphragms in pressure relief devices, bent radiator valves, and overloading of transformers above 90%-95% during summer seasons). These issues have contributed to the recent incident involving the 160MVA 220kV/132kV Auto Transformer T-I (Hyundai Bulgaria) at the 220kV Bahawalpur G/S. NTDC is advised to prevent the recurrence of such issues and is directed to ensure that all field formations remain vigilant and promptly report any similar concerns to management for timely resolution.

(i) Status of Calibration of Oil and Winding Temperature Gauges:

Lahore Region: Out of 26 G/stations, 22 have reported that oil and winding temperature gauges are functioning properly.

Islamabad Region: Out of 13 G/stations, 9 have reported that all oil and winding temperature gauges are calibrated and working correctly, while 3 stations reported issues.

Multan Region: Out of 11 G/stations, 8 have reported that oil and winding temperature gauges are calibrated and working properly, with 3 stations reporting issues.

Hyderabad Region: Out of 22 G/stations, 18 have reported that calibration of oil and winding temperature gauges has been done per SOP. However, the dates of the last calibration/testing were not provided.

9.35 Loading Position in KE Transmission Network:

The operational data for the 220/132 kV grid stations, as reported by KE, shows no instances of overloading during FY 2023-24. However, at the 132/11 kV level, out of 180 power transformers, 37 were reported to be overloaded during the same period. Additionally, two power transformers at the 66/11 kV level were operated above 80% of their rated capacity. KE is advised to closely monitor transformer loads and implement proactive measures to ensure optimal performance, mitigate risks, and prevent potential issues.

9.36 Loading Position in Transmission Network of NTDC:

The ongoing overloading at various NTDC grid stations highlights an urgent need for infrastructure upgrades and network capacity expansion to prevent outages, especially during peak demand periods. The table below outlines the power transformers at NTDC's 500 kV and 220 kV grid stations that operated at 80% capacity or higher throughout FY 2023-24, underscoring the scale of the issue.

Table: 41 Loading Position of NTDC

Voltage Level	Number of Grid Stations	Number of Power Transformers	Transformers Loaded >80%
500/220 kV	19	47	32
220/132 kV	50	183	88
Total	69	230	120

Source: NTDC

Four 500/220 kV grid stations in the Hyderabad Region, along with three 500 kV grid stations in Islamabad, four in Lahore, and three in Multan, were consistently overloaded in FY 2023-24. At the 220 kV level, overloading occurred at two stations in Hyderabad, one in Quetta, five in Islamabad, ten in Lahore, and three in Multan, revealing widespread capacity constraints across the network.

9.37 Issue of Incomplete / Partially Completed Punch list in NTDC Projects:

NEPRA has identified ongoing issues with incomplete or partially completed punch lists in NTDC's power transmission development projects. These punch lists, essential for ensuring the technical and operational readiness of infrastructure, remain unresolved even as projects near closeout. This delay impacts project quality and timelines, as critical deficiencies—such as equipment malfunctions, safety non-conformities, and grid integration challenges—remain unaddressed. These issues can lead to load imbalances, increased transmission losses, and higher outage risks, ultimately compromising the grid's technical integrity.

Moreover, delays in resolving punch list items have significant financial implications, with prolonged project timelines and incomplete deliverables risking cost overruns and liquidated damages. Immediate corrective action is required to address these deficiencies through improved project management, stricter contractor oversight, and strict adherence to contractual deadlines.

9.38 Delay in construction of dedicated TSG training center:

The construction of a dedicated Technical Services Group (TSG) training center at Jamshoro, aimed at providing regular technical training to NTDC officials in the South region, has faced significant delays despite multiple directives from the Authority. The lack of a specialized training facility is hindering the continuous professional development of technical personnel, which is essential for maintaining and upgrading the skills needed to effectively manage and operate NTDC's infrastructure.

9.39 Issues resulting delay in execution of projects:

During field visits, NEPRA professionals observed a shortage of staff and resources within the EHV/GSC South, leading to inadequate monitoring and supervision of ongoing projects. It was noted that multiple projects are being managed by a single Chief Engineer in Hyderabad, supported by only two Project Directors (PDs), who are responsible for overseeing an extensive area covering the Hyderabad, Quetta, and Multan regions. This large geographical scope severely limits mobility and significantly impacts the efficiency of project supervision.

9.40 Poor Civil Works and their maintenance at NTDC Grid Stations:

Several NTDC grid stations are facing deteriorating civil infrastructure, severely impacting the reliability and safety of the transmission network. Key components such as transformer foundations, control room buildings, cable trenches, and drainage systems exhibit structural deficiencies, including cracks, water seepage, and poor material quality. These issues have led to frequent water ingress in switchyards and control rooms, increasing the risk of short circuits, equipment failures, and outages.

Improper grading and drainage have caused waterlogging, further damaging electrical infrastructure and resulting in significant financial losses. The lack of regular maintenance and timely repairs has accelerated the degradation of these structures, posing serious risks to grid stability, especially during extreme weather conditions.

NTDC must implement stricter quality control measures in civil works, improve maintenance schedules, and ensure adherence to industry best practices in both new and existing grid stations to mitigate long-term operational and safety risks.

9.41 Implementation Status of NTDC w.r.t the Recommendations of Performance Evaluation Report (PER) 2022-23:

Sr. No.	Recommendations	NTDC Reply	Status
1.	Assess seasonal variations in demand and external factors like weather events and develop specific strategies and maintenance schedules to address these seasonal challenges effectively.	The Grid Code mandates System Operator to carry out operational planning based on inputs from users (CDGU & DISCOs). Accordingly, all maintenance schedules are carefully planned during non-peak seasons after thorough studies and due deliberation to minimize disruptions to the power grid. Further in order to enhance existing forecasting capabilities, System Operator (SO) is actively developing an in-house load forecasting tool that aligns with global standards.	Implemented
2.	Perform risk analysis to determine the most likely causes of system interruptions, such as equipment failures, extreme weather events and external threats. After identification, prioritize the most critical components of the grid, such as substations, transformers and key transmission lines, based on their impact on system reliability.	The SO is mandated to submit the Annual System Reliability Assessment and Improvement Report (ASRAIR) on 15th of February of each year as per clause PC 2.1(h) of the Grid Code 2023. The ASRAIR effectively serves the purpose of identifying and evaluating the Transmission System Congestion problems that cause or may potentially cause restrictions in the economic dispatch and/or may cause load curtailment. All the factors highlighted in the above points are comprehensively covered within the ASRAIR report.	Not Implemented NTDC failed to submit the (ASRAIR) to NEPRA as per deadline given in Grid Code 2023.
3.	Install Wind Measuring devices that can predict severe weather events, such as storms, heavy winds and ice accumulation which pose a risk to tower stability.	NTDC has initiated the process of procurement of anemometers for installing on towers of different transmission lines of NTDC in south region of Pakistan, through tender No. ADB-301D(R).	Under Implementation
4.	Increase interconnection capacity between KE and NTDC system to facilitate unconstrained power flow, supply of cheap / economic power to KE and bolster system stability.	NTDC has an Interconnection Agreement (ICA) with K-Electric. Additionally, KE is constructing the 500KV KKI Grid Station which is likely, to be completed by end of August 2024. After successful commissioning of 500KV KKI Grid Station, the interconnection capacity will substantially increase to 2100MW. Also, 220 kV link between Jhimpir-II and Dhabeji are presently under construction by KE. The exact timelines of these projects may be obtained from KE.	Under Implementation
5.	Draft & implement transmission line security policy and ensure regular	Asset Management teams are carrying out welding of nuts and bolts on Transmission Line Towers in areas	Partially Implemented

Sr. No.	Recommendations	NTDC Reply	Status
	patrolling to prevent theft of braces to ensure the reliability and safety of the transmission network.	prone to theft. Further, regular patrolling of Transmission Lines is being ensured as per TSG SOP. Moreover, the matter of theft has been taken up with the concerned Law Enforcement Agencies for safety of NTDC Assets. Moreover, formal TL security SOP is under active deliberation with higher management to reach an optimum solution in this regard.	
6.	Upgrade grid infrastructure, especially in the area where frequent incidents are occurring repeatedly and prioritize replacement of ageing equipment in the grid infrastructure.	Replacement & up gradation of aged & under-rated equipment is already being carried out at various NTDC Grid Stations as per SOP. Further, replacement of aged equipment is also being deliberated with other NTDC formations. Upon conclusion, the aged equipment will be replaced.	Under Implementation
7.	To ensure the installation of modern technologies devices such as Wide Area Management (WAM) including pharos Management Units (PMU) to detect oscillations instability which can be mitigated by Remedial Action Scheme (RAS).	NTDC has prepared the Tender documents for Wide Area Management (WAM) System. However, NTDC requires a No objection Letter (NOL) from the World Bank as the latter is the funding organization for the aforementioned project. Furthermore, the Remedial Action Scheme (RAS) can be developed once the WAM system is fully developed and is in operational condition.	Under Implementation
8.	Prioritize the completion of all pending projects to alleviate constraints and reduce the reliance on expensive power generation methods.	In order to alleviate constraints and reduce reliance on expensive power generation, NTDC is working on completion of the ongoing project 500 kV Lahore North grid station on war footing basis. Moreover, after commissioning of 500 kV KKI grid station and 220 kV link between Jhimpir-II and Dhabeji in South, the utilization of the economical generation in South in K-electric network will increase by 900-1000 MW.	Partially Implemented
9.	Accelerate the implementation of Constraints Removal Schemes to address issues without further delay.	Same as Sr.No.8	Not Implemented
10.	Conduct a comprehensive reassessment of each delayed project to identify the primary causes of delays and work with project managers and stakeholders to revise project schedule that is both realistic and aggressive.	The major reasons of delay in execution of the projects is late arrangement of financing, acquisition of Land, Right of Way, arrangement of budget / cash foreign exchange allocation, security issues etc. The major reasons of delay are beyond the control of NTDC. In order to mitigate the delays, NTDC has devised the SoP to gauge the	Under Implementation

Sr. No.	Recommendations	NTDC Reply	Status
		performance of the contractors and also established the Project Management Office (PMO) to enhance coordination between different stakeholders. However, legislation would be required at the Government level to address the issues pertaining to land acquisition and Right of Way.	
11.	Promote active engagement and collaboration with Provincial Grid Companies to strengthen the power network.	During preparation of Transmission System Expansion Plan (TSEP) 2024, NTDC contacted with Provincial Grid Companies for provision of their data and plans.	Implemented
12.	Expand the number of Regional Control Centers to bolster system control and operation.	As per terms of its license the SO, NPCC, NTDC is currently in the transition phase of separation from NTDC to become an independent System Operator. Consequently, the process of establishing a new Board of Directors (BOD), modifying the organizational structure, and allocating resources and assets is ongoing. Once the separation process is finalized, the work on establishing new Regional Center will be initiated under the new regime.	Under Implementation
13.	The existing interim arrangement may immediately be reinforced with standard hardware. Aging factor of the conductor and quality of material before and proper workmanship during the execution of interim arrangement must be ensured.	The interim interconnection arrangement has been modified to a permanent interconnection scheme through contract No. TLC-21-2022. Additionally, complete old material of approximately 24 km of T/Line, including the conductor, shield wire, hardware, and insulators of the old 500kV single-circuit HUB-NKI transmission line, which has been interconnected with the K2/K3 transmission line, has been replaced with new material through the mentioned contract.	Partially Implemented
14.	Periodic maintenance / monitoring activities, especially the interim arrangement designed for K2/K3 Circuits, must be ensured as per SOP.	As apprised in Sr. No. 1, the interim interconnection arrangement has been modified to a permanent interconnection scheme through contract No. TLC-21-2022. Periodic Maintenance of all Transmission Lines and Grid Stations is being ensured as per TSG O&M SOP.	Implemented
15.	VAR compensations study shall be carried out and required measures in the light of the study shall be taken to avoid Power Swing.	NTDC has engaged M/s. CESI as Consultant to carry out System Studies for Review of the Gird System Performance and Proposals for System Stability Improvement. As per TORs of the study, the consultant shall Prepare Reactive Power Management Plan for both high and low reactive demand	Under Implementation

Sr. No.	Recommendations	NTDC Reply	Status
		scenarios to control low and high voltages under different operating conditions. Provide optimum locational solutions in terms of installing Reactive Power Compensation Devices (SVC, TCR, STATCOM or any other FACTS controller) at appropriate sites with appropriate ratings/sizes. M/S CESI has submitted its draft report 14th June 2024, that includes locational VAR compensation study. In the report, installation of ±400MVAR STATCOM in NTDC Network has been proposed at the following grid stations: a. 500 kV Lahore (Sheikhupura) b. 500 kV Muzaffargarh c. 500 kV R.Y.Khan d. 500 kV Dadu e. 500 kV Guddu Comments on draft report from NTDC have been shared for incorporation in final report. NTDC will implement VAR Compensation solutions as per the recommendations of final study. In addition to above, the installation of 250 MVAR SVS at 220 kV Quetta Industrial and 200 MVAR SVS at 220 kV Khuzdar Grid Station, proposed in TSEP 2022, are also included in TSEP 2024. Also, additional switched shunt capacitors for reactive power compensation at many other grid stations has also been proposed in TSEP 2024.	
16.	Availability of required professionals and staff as per approved yardstick, along with required T&P including thermo vision camera, especially in southern region must be arranged on an urgent basis to ensure timely maintenance of existing network for system stability, reliability and security.	A total of about 1800 positions have been advertised since July 2023 to date. The recruitment process was temporarily suspended from August 2023 to February 2024 due to the Election Commission of Pakistan's ban during the Caretaker Government leading up to General Elections. Necessary T&P is available with field teams for timely maintenance of existing network. Moreover, thermo vision cameras have been procured under NOR-93 and will be handed over to field formations upon delivery.	Not Implemented
17.	NTDC Telecom department's deficiencies must be addressed to ensure proper communication of inter grid signals and avoid transmission and false signals.	NTDC Telecom has taken up following measures in order to improve system reliability and to ensure proper communication of inter grid signals. The measures are as follows: NTDC Telecom has increased coordination for tele-protection testing	Implemented

Sr. No.	Recommendations	NTDC Reply	Status
		with WAPDA Hydel, IPPs, etc. Scheduled maintenance frequency at NTDC sites has also been increased. It is however requested that NEPRA may please instruct IPPs, WAPDA Hydel, GENCOs, and 132kV DISCOs to depute their Telecom Engineers and develop SOPs for periodic tele-protection testing. The requirement for informing NTDC Telecom before taking a shutdown is communicated to the appropriate NTDC formations and is being effectively followed. It is however requested that NEPRA may please issue a standing instruction for IPPs, WAPDA Hydel, GENCOs, and 132kV DISCOs to inform NTDC Telecom before availing shutdown. Other relevant NTDC formations have already been advised to conduct tele-protection testing using injection method with equipment like OMICRON. Testing via jumpers is discouraged. NTDC Telecom is improving the Telecom system by replacing the obsolete Telecom equipment with the latest state-of-the-art equipment. It is however requested that NEPRA may advise IPPs, WAPDA Hydel, GENCOs and 132kV DISCOs to replace the corresponding old equipment with the new latest state-of-art equipment at their own end and cost.	
18.	Execution work of dedicated transmission lines shall be completed before the energization of transformation equipment (or) COD of Power Plants to avoid the LDs resultantly reducing the basket price for the consumer.	NTDC is already vigorously implementing project schemes and shall execute dedicated transmission lines before CoD of Power Plants, where LDs are involved and to reduce basket price for the consumer.	Under Implementation
19.	A study shall be carried out to install additional Shunt Reactors at appropriate locations i.e., on the Grid Station Busbar.	The study mentioned in point no. 6 also encompasses the requirement of shunt reactors in the Power System Network. In TSEP 2024, additional shunt reactors have been proposed at the following grid stations in order to control over-voltage especially during winter off-peak season when system demand is minimum: a. 500 kV Sheikh Muhammadi b. 500 kV Rawat c. 500 kV Faisalabad West d. 500 kV D.G. Khan e. 500 kV Shikarpur	Implemented

Sr. No.	Recommendations	NTDC Reply	Status
		f. 220 kV Loralai g. 220 kV D.M.Jamali h. 220 kV Zhob i. 220 kV Mirpur Khas	
20.	NTDC shall ensure the healthiness and operation of recently installed Out of Step devices, as the same did not operate during the event.	Out of step devices installed under Asset Management North & South NTDC are healthy and operational.	Implemented

9.42 Implementation Status of K-Electric w.r.t the Recommendations of Performance Evaluation Report (PER) 2022-23:

Sr. No.	Recommendations	KE Reply	Status
1.	Assess seasonal variations in demand and external factors like weather events and develop specific strategies and maintenance schedules to address these seasonal challenges effectively.	It is humbly stated that KE diligently develops strategies to manage fluctuations in demand arising from seasonal variations and/or festive occasions. It may please be noted that KE prepares a demand-supply outlook by assessing the demand pattern considering the weather forecasts and festive days. Additionally, a comprehensive annual maintenance schedule is prepared and duly implemented to enhance the reliability and performance of the system.	Implemented
2.	Perform risk analysis to determine the most likely causes of system interruptions, such as equipment failures, extreme weather events and external threats. After identification, prioritize the most critical components of the grid, such as substations, transformers and key transmission lines, based on their impact on system reliability.	KE performs proactive risk analysis, through health assessment of all critical equipment installed in KE's transmission network, Based on these health assessments, recommendations are provided to regional teams for implementation of corrective actions on prompt basis. Additionally, KE performs risk analysis to determine its critical assets and establishes measures to avoid any impact on the reliability of its system due to external threats and/or extreme weather conditions.	Partially Implemented (results/study not shared)
3.	Install Wind Measuring devices that can predict severe weather events, such as storms, heavy winds and ice accumulation which pose a risk to tower stability.	The wind measuring devices are already installed at various locations within KE's transmission network to gauge wind speed across the city. Furthermore, KE also maintains close liaison with Pakistan Meteorological Department (PMD) for periodic updates on weather's predictive outlook.	Implemented (locations and no of wind measuring devices not shared)
4.	Increase interconnection capacity between KE and NTDC system to facilitate unconstrained power flow, supply of cheap / economic power to KE and bolster system stability.	As per the signed Interconnection Agreement (ICA) between KE and NTDC, the firm capacity allocated to KE is 1,000 MW and supply over and above the firm capacity and upto interconnection Transmission capacity will be on pro-rata basis. However, to off-take additional	Under Implementation

Sr. No.	Recommendations	KE Reply	Status
		power from National grid, the construction of 500kV KKI interconnection is in full swing with a cumulative progress of around 82% for both 500/220kV grid and 220kV transmission line. This interconnection is expected to be energized in the 3rd Quarter of 2024. Additionally, the 220kV Dhabeji interconnection project is also approaching final stages and has an overall progress status of approximately 96%. The complete works for the 220kV Dhabeji-NTDC Interconnections are in progress, with energization expected in September 2024.	
5.	Draft & implement transmission line security policy and ensure regular patrolling to prevent theft of braces to ensure the reliability and safety of the transmission network.	The transmission line security policy is already in place, based on which patrolling of the transmission lines is performed by respective transmission teams. For added security, KE's security team also performs regular patrols to promptly identify and address any potential threats to the assets.	Implemented However, KE did not share the said policy with NEPRA
6.	Upgrade grid infrastructure, especially in the area where frequent incidents are occurring repeatedly and prioritize replacement of ageing equipment in the grid infrastructure.	KE has submitted a detailed investment plan which takes into account all the mentioned considerations for improving system reliability. Moreover, upgrades in the transmission network are periodically planned, which includes replacement of deteriorated system equipment to improve the system reliability and efficiency. The improvements in transmission reliability resulting from these infrastructure upgrades are reflected in the performance indices submitted each year to the Honorable NEPRA Authority as part of KE's Annual Transmission Performance Reports.	Under Implementation
7.	To ensure the installation of modern technologies devices such as Wide Area Management (WAM) including pharos Management Units (PMU) to detect oscillations instability which can be mitigated by Remedial Action Scheme (RAS).	It is humbly stated that to install the mentioned devices, a detailed network study is required to analyze the dynamics and impact on the power system. Such a study is already being planned by KE and its Terms of Reference (ToR) is under development.	Under Implementation
8.	Being responsible for providing reliable power to its customers, especially Karachi, the economic hub of the country, it is essential that KE takes measures/steps to operate in island mode in the event of external major incidents to avoid unnecessary power cuts.	It is stated that a detailed study is planned, as explained in response to recommendation # 7, for implementation of an islanding scheme in KE's transmission network. However, for a well-coordinated study and for system stability at large, KE humbly requests the Honorable NEPRA Authority to direct NTDC to participate in a joint and coordinated study so that this issue can be deliberated in a holistic manner. KE shall reach out to the Honorable NEPRA Authority with the scope and approval of associated costs of the study.	Not Implemented

Sr. No.	Recommendations	KE Reply	Status
		In addition to the above, KE would like to humbly reiterate its request to allow out of Economic Merit Order (EMO) operation of generators in KE and NTDC network, during winters, for network stability and to alleviate the chances of exigencies in the network.	

10. Conclusion:

10.1 System Reliability:

In FY 2023-24, NTDC achieved notable improvements in system reliability, with a reduction in both the **System Duration of Interruption** (0.03 hrs/point) and **System Frequency of Interruptions** (0.09 no./circuit), marking the lowest values in the past five years. Additionally, the tie line system showed no interruption in duration (0 hrs/point), with a frequency of 0.25 interruptions per circuit.

KE's 220 kV transmission network also demonstrated high reliability, with a **System Duration of Interruption** of 0.01 hrs/point and a **System Frequency of Interruptions** of 0.02 no./circuit. However, at the 132 kV and 66 kV levels, the **System Duration** was 3.42 hrs/point and the **System Frequency** was 1.93 interruptions per circuit. For tie lines, the **System Duration** was 2.91 hrs/point, with a frequency of 1.25 interruptions per circuit.

FTCL reported a slight reduction in **System Duration** (7.21 hrs/point) compared to last year's 8.5 hrs/point, but a rise in **System Frequency** (3 no./circuit) from 2.5 no./circuit.

For ST&DCPL, the **System Duration** of interruptions increased sharply to 67.13 hrs/point, a 292.6% rise from the previous year's 17.71 hrs/point.

10.2 System Security:

In FY 2023-24, NTDC's **Energy Not Served (ENS)** decreased significantly to 4.48 GWh, a sharp reduction from the previous year's 137.7 GWh. Notably, no blackouts or major breakdowns occurred during the reporting period.

KE reported an ENS of 0.046 GWh on its 220 kV network, with no ENS on its 132 kV and 66 kV networks. KE's tie lines also reported zero ENS. However, three outages with a total duration of 8.4 hours were recorded, while NTDC-maintained tie lines experienced two outages, totaling 3.25 hours and 74.8 MWh of ENS.

FTCL reported a slight decrease in ENS, with a total of 0.886 GWh in FY 2023-24 compared to 0.918 GWh the previous year. In contrast, STDC saw a significant increase in ENS, rising to 13.57 GWh from 3.58 GWh the previous year.

10.3 Quality of Supply:

Frequency:

During FY 2023-24, NTDC's system frequency exceeded permissible limits seven times on the higher side, with no instances of low-frequency violations.

KE recorded one instance of high-frequency violation but no low-frequency violations during the same period.

FTCL experienced 96 instances of frequency violations, both high and low, totaling 489 minutes.

STDC reported no frequency violations during FY 2023-24.

Voltage:
During FY 2023-24, NTDC reported 157,692 voltage violations, an increase from the previous year, with 156,534 violations under normal conditions and 1,158 under N-1 conditions.

KE recorded 35 high voltage violations under normal conditions, with no high voltage violations under N-1 conditions. KE also reported 3 low voltage instances under normal conditions, with no low voltage violations under N-1.

FTCL's highest voltage violation was 144.40 kV under normal conditions, with no violations under N-1. No low voltage violations were recorded for either condition.

STDC reported no voltage violations under both normal and N-1 conditions.

11. Recommendations:
Based on the above, following are the recommendations to improve the system conditions at NTDC, KE and rest of the transmission network:

1. Grid Capacity Enhancement: NTDC must increase grid transformation capacity by installing additional transformers and reactive power compensation equipment at critical grid stations, including 500 kV Jamshoro, 500 kV Dadu, 500 kV Rawat, 220 kV Sarfaraz Nagar, 500 kV Yousafwala, 500 kV Sheikhupura, 220 kV Quetta Industrial, and 500 kV Sheikh Mohammadi Peshawar.

2. Adoption of Modern Switchgear: NTDC & KE should adopt higher-capacity, modern switchgear to improve load management and prevent overloading during peak demand. Grid reinforcement plans must address both short-term (transformer upgrades) and long-term (new substations and transmission lines) needs.

3. Real-Time Transformer Load Monitoring: NTDC & KE should implement real-time transformer load monitoring systems to better manage loads and prevent outages.

4. Project Management & Accountability: Transmission licensees must enforce strict project completion timelines, improved project management practices, and contractor accountability. Penalties for delays and incentives for timely completions should be introduced. Additionally, real-time project tracking systems must be adopted to ensure transparency and accurate forecasting.

5. Modular Grid Station Designs: Transmission licensees should adopt modular grid station designs for faster construction and commissioning. Regular progress reports, covering financial and technical milestones, must be submitted to NEPRA on a monthly, quarterly, and annual basis.

6. Load Flow Analyses: NTDC & KE must submit monthly load flow analyses to NEPRA to ensure compliance with grid reliability standards.

7. Address Southern Transmission Constraints: NTDC must prioritize resolving transmission capacity issues between southern generation plants and northern load centers. Key constraints,

including Shikarpur–Guddu, Jamshoro–Muzaffargarh, and Matiari–Lahore, must be addressed for capacity expansion and upgrades.

8. Permanent Transmission Infrastructure: NTDC must reduce reliance on interim solutions and fast-track the completion of permanent transmission infrastructure, particularly for circuits like 500 kV Nokhar-Lahore North and 500 kV K2-Hub.

9. Full Operationalization of HVDC Matiari-Lahore: The full operationalization of the HVDC Matiari-Lahore transmission line must be prioritized to alleviate south-to-north transmission constraints and enhance the power transfer capacity of the grid.

10. Substation & Transmission Line Completion: NTDC & KE should accelerate the completion of 500 kV substations (Lahore North, KKI Grid) and associated transmission lines. A transparent timeline for these priority projects must be submitted to NEPRA.

11. Grid Code Compliance: All Transmission Licensees and System Operator (SO) must ensure full compliance with the new Grid Code (2023), including submission of detailed Annual Reliability Assessments and Improvement Reports (ASRAIR).

12. Shunt Reactors & Voltage Stability: NTDC must expedite the installation of shunt reactors at key network points (e.g., Faisalabad, D.G. Khan, Shikarpur) to manage over-voltage issues, especially during low-demand periods. The use of Static VAR Compensators (SVCs) for better voltage stability should be considered.

13. Strengthen Contractor Oversight: Transmission licensees must implement performance-based contracts, with penalties for delays caused by poor contractor performance. Regular contractor performance reports should be submitted to the M&E department, and contractors should provide guarantees for project quality and timeliness.

14. Environmental Control Measures: Transmission licensees must adopt rigorous environmental control measures to prevent asset deterioration from pollution. Anti-pollution insulators and regular cleaning of equipment in high-pollution areas should be mandated. Periodic maintenance standards must be enforced.

15. Cyber security Compliance: With increasing cyber threats, transmission licensees must comply with NEPRA's cybersecurity regulations and implement a robust cybersecurity framework. Regular vulnerability assessments, compliance with ISO/IEC 27001 standards, and regular audits must be conducted.

16. Fast-Tracking SCADA-III Project: The SCADA-III project, essential for real-time data monitoring, must be fast-tracked to avoid further delays. NTDC should ensure the original SCADA-III team remains involved, with a dedicated Chief Engineer/Project Director responsible for its implementation.

17. IPP Integration & Grid Stability: NTDC must address integration challenges faced by Independent Power Producers (IPPs), improving grid synchronization and minimizing procedural delays in interconnection agreements. Compliance with interconnection timelines and evacuation capacity should be enforced.

18. Expedited ROW Acquisition: NTDC's Legal Department must collaborate with federal and provincial governments to expedite Right of Way (RoW) acquisition. A dedicated task force

should be formed to resolve disputes, and NTDC should pursue faster resolutions through legal avenues.

19. Punch List Completion Framework: Transmission licensees must adopt a Punch List Completion Framework to ensure that all outstanding issues are addressed before commissioning. Contractors should face penalties for incomplete punch list items, and final audit reports must be submitted prior to project commissioning.

20. Routine Maintenance & Fault Detection: Transmission licensees should implement strict maintenance schedules for critical transmission lines and substations. Advanced fault-detection systems such as Wide Area Monitoring (WAM) and Phasor Measurement Units (PMUs) should be used for real-time issue resolution, supported by a centralized maintenance system.

21. Renewable Energy Integration: Transmission licensees should develop a Renewable Energy Integration Plan that outlines infrastructure upgrades, grid flexibility measures, and energy storage solutions to accommodate renewable sources. Real-time data monitoring and dynamic line rating systems should be implemented for better integration.

22. Optimize Operating Expenses: NTDC must review and optimize operating expenses, renegotiate debt, and explore opportunities for private investment in transmission infrastructure.

23. Involve Provincial Grid Companies: NTDC & KE should consider involving Provincial Grid Companies (PGCs) in grid expansion projects for better coordination and regional development.

24. Departmental Overhaul & Transparency: NTDC should reorganize its Civil & EHV departments to improve efficiency, transparency, and project delivery in field formations.

25. Technical Services Group (TSG) Training Center: NTDC must expedite the construction of the dedicated TSG Training Center at Jamshoro to provide essential technical training for professionals in the southern regions (Sindh and Balochistan).

Voltage violations data - detailed circuit wise analysis

NTDC Islamabad Region

1. 500 kV Rawat
2. 500 kV Peshawar
3. 220 kV Bannu
4. 220 kV Burhan
5. 220 kV Daudkhel
6. 220 kV ISPR (Sangjani)
7. 220 kV Mardan
8. 220 kV Nowshera
9. 220 kV Shahibagh
10. 220 kV University
11. 220 kV Mansehra
12. 220 kV Chakdara
13. 220 kV D. I. Khan

NTDC Islamabad Region

1. 500kV Grid Station Rawat

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Rawat - Barotha Ckt I & II	223	195	60	Nil	Nil	537	150	539	120	542	120	Nil	Nil	Nil	Nil	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	-	Nil	–	–	–	–	–	–	-	-	Nil	Nil	-	-	-	-	-	-	-	-	-	-
Normal	500 kV Rawat - Tarbela	223	195	-	Nil	Nil	537	150	539	120	542	120	Nil	Nil	Nil	Nil	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	-	Nil	–	–	–	–	–	–	-	-	Nil	Nil	-	-	-	-	-	-	-	-	-	-
Normal	500 kV Rawat - Neelum Jehlum	223	195	60	NIl	Nil	537	150	539	120	–	–	Nil	Nil	Nil	Nil	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	NIl	Nil	–	–	–	–	–	–	Nil	Nil	Nil	Nil	-	-	-	-	-	-	-	-	-	-
Normal	500 kV Rawat - Nokhar	223	195	60	Nil	Nil	537	150	539	120	542	120	Nil	Nil	Nil	Nil	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	-	Nil	–	–	–	–	–	–	-	-	Nil	Nil	-	-	-	-	-	-	-	-	-	-
Normal	220 kV Rawat - ISPR Ckt I & II	1,469	879	821	512	539	245	180	245	240	248	120	246	60	248	60	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	-	Nil	–	–	–	–	–	–	–	–	Nil	Nil	-	-	-	-	-	-	-	-	-	-
Normal	220 kV Rawat - Mangla Ckt I & II	1,469	879	821	512	539	245	180	245	240	248	90	246	60	248	60	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	-	-	-	-	-	-	-	-	-	-
Normal	220 kV Rawat - Bahria Town Ckt I & II	1,469	881	821	512	539	245	180	245	240	248	120	246	60	248	60	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	-	-	-	-	-	-	-	-	-	-
Normal	220 kV Rawat - University Ckt I & II	1,469	879	821	512	539	245	180	245	240	248	120	246	60	248	60	-	-	-	-	-	-	-	-	-	-
N-1		–	–	–	-	Nil	–	–	–	–	–	–	–	–	Nil	Nil	-	-	-	-	-	-	-	-	-	-

Total No. of Variations (Normal)	6,768	4,298	3,464	2,048	2,156
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	6,768	4,298	3,464	2,048	2,156

Highest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

2. 500kV Grid Station SHEIKH MUHAMMADI PESHAWAR

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Tarbela - Peshawar	432	172	632	1,407	612	541	60	536	60	553	60	545	60	543	180	468	60	473	60	469	60	473	60	473	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Peshawar - Daudkhel Ckt I & 2	587	415	1,244	1,042	437	238	60	234	60	239	60	238	60	236	300	185	60	199	60	192	60	202	60	203	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Peshawar - Nowshera	635	415	1,240	521	221	238	60	234	60	239	239	238	60	236	300	186	60	199	60	192	60	202	60	203	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Peshawar - Shahibagh	621	415	1,241	521	224	238	60	234	60	-	-	238	60	236	300	185	60	199	60	-	-	204	60	203	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	2,275	1,417	4,357	3,491	1,494
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	2,275	1,417	4,357	3,491	1,494

Highest Voltage Under Normal Condition @220kV/500kV level

Lowest Voltage Under Normal Condition @220kV/ 500kV level

NTDC Islamabad Region

3. 220 kV Grid Station Bannu

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Daudkhel - Bannu Ckt I & II	358	332	1,238	1,893	983	240	60	241	60	240	60	242	60	243	1,440	-	-	-	-	-	-	-	-	200	60
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220 kV Chashma - Bannu Ckt I & II	358	332	677	1,894	983	240	60	241	60	240	60	242	60	243	1,440	-	-	-	-	-	-	-	-	200	60
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Total No. of Variations (Normal)	716	664	1,915	3,787	1,966
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	716	664	1,915	3,787	1,966

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

4. 220 kV Grid Station Burhan

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Burhan - ISPR Ckt I & II	516	322	234	36	8	235	120	238	180	242	60	241	60	240	60	194	60	204	60	201	60	–	–	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Burhan - Tarbela Ckt I, II & III	516	322	234	36	8	235	120	238	180	242	60	241	60	240	60	194	60	204	60	201	60	–	–	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	1,032	644	468	72	16
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	1,032	644	468	72	16

Highest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

5. 220 kV Grid Station Daudkhel

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Daudkhel - Peshawar Ckt I & 2	228	81	4	137	62	242	240	238	540	234	240	243	120	238	60	204	60	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Daudkhel - Chashma Ckt I & II	228	81	4	130	62	242	240	238	540	234	240	243	120	238	60	204	60	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Daudkhel - Bannu Ckt I & II	228	81	4	132	62	242	240	238	540	234	240	243	120	238	60	204	60	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Total No. of Variations (Normal)	684	243	12	399	186
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	684	243	12	399	186

Highest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

6. 220kV Grid Station ISPR (SANGJANI)

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV ISPR - Burhan	259	102	306	124	89	232	30	–	–	236	60	–	–	Nil	Nil	190	60	196	60	195	180	200	120	202	240
N-1		–	–	–	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220 kV ISPR - Tarbela	322	168	284	22	24	238	90	240	240	242	60	239	120	238	180	195	60	196	60	196	60	206	180	204	60
N-1		–	–	–	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220 kV ISPR - Bahria Town	269	84	266	178	59	235	90	234	120	234	60	–	–	240	240	190	60	195	60	192	180	202	120	202	60
N-1		–	–	–	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220 kV ISPR - Rawat	268	84	266	177	59	235	90	232	120	–	–	–	–	240	240	190	60	195	60	192	180	202	120	202	60
N-1		–	–	–	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220 kV ISPR - Mansehra Ckt I	124	72	150	16	23	235	60	236	180	240	60	–	–	240	60	196	60	198	60	195	180	205	60	204	60
N-1		–	–	–	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220 kV ISPR - Mansehra Ckt II	122	72	150	16	23	235	60	236	180	240	60	–	–	240	60	196	60	198	60	195	180	205	60	204	60
N-1		–	–	–	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Total No. of Variations (Normal)	1,364	582	1,422	533	277
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	1,364	582	1,422	533	277

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

7. 220kV Grid Station Mardan

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Tarbela - Mardan Ckt I & II	1,820	1,333	2,093	1,953	958	–	–	–	–	–	–	235	60	236	300	181	60	185	60	185	60	194	60	194	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Mardan - Nowshera Ckt I & II	1,820	1,333	2,093	977	479	–	–	–	–	–	–	235	60	236	300	181	60	185	60	185	60	194	60	194	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Mardan - Chakdara Ckt	1,820	1,333	2,093	977	479	–	–	–	–	–	–	235	60	236	300	181	60	185	60	185	60	194	60	194	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	5,460	3,999	6,279	3,907	1,916
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	5,460	3,999	6,279	3,907	1,916

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

8. 220kV Grid Station Nowshera

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Nowshera - Mardan	338	215	767	316	113	240	60	238	60	238	60	238	60	237	60	199	30	200	60	195	60	201	60	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Nowshera - Barotha 1 & 2	689	215	767	632	113	240	60	238	60	238	60	238	60	237	60	199	30	200	60	195	60	201	60	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Nowshera - S. M Peshawar	330	198	767	316	113	240	60	238	60	238	60	238	60	237	60	199	30	200	60	195	60	201	60	133	180
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	1,357	628	2,301	1,264	339
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	1,357	628	2,301	1,264	339

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

9. 220kV Grid Station NEW SHAHIBAGH PESHAWAR

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Shahibagh - Peshawar Ckt II	2,103	2,954	3,067	1,347	607	–	–	–	–	–	–	–	–	Nil	Nil	182	60	184	120	182	60	190	120	193	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Shahibagh - Chakdara	1,517	1,396	1,703	367	479	–	–	–	–	–	–	–	–	Nil	Nil	182	60	185	60	187	60	190	90	190	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	3,620	4,350	4,770	1,714	1,086
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	3,620	4,350	4,770	1,714	1,086

Lowest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

10. 220kV Grid Station UNIVERSITY

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV University - Rawat Ckt I & II	2,812	2,363	1,469	618	257	246	240	249	120	249	60	244	120	245	300	202	120	–	–	203	120	–	–	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	2,812	2,363	1,469	618	257
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	2,812	2,363	1,469	618	257

Highest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

11. 220kV Grid Station MANSEHRA

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit						Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
								Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Mansehra - Allai Khwar 1 &2	62	28	156	92	27	77	235	120	238	180	242	60	242	60	241	120	194	60	198	50	200	60	205	60	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Mansehra - ISPR 1 & 2	62	28	156	86	27	77	235	120	238	180	242	60	242	60	241	120	194	60	198	50	–	–	205	60	Nil	Nil
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	124	56	312	178	54	154
Total No. of Variations (N-1)	-	-	-	-	-	-
Total (Normal & N-1)	124	56	312	178	54	154

Highest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

11. 220kV Grid Station CHAKDARA

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Chakdara - Shahibagh	289	169	183	85	41	–	–	–	–	235	90	233	90	237	90	190	90	190	90	180	60	193	60	200	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Chakdara - Mardan	289	199	183	85	41	–	–	–	–	235	90	233	90	237	90	190	90	190	90	180	60	193	60	200	60
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	578	368	366	170	82
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	578	368	366	170	175

Highest Voltage Under Normal Condition @220kV level

NTDC Islamabad Region

13. 220kV Grid Station D. I. KHAN

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV D. I. Khan - Chashma 1 &2	3,126	1,842	1,146	44	138	242	120	240	180	242	120	244	60	241	60	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Total No. of Variations (Normal)	3,126	1,842	1,146	44	138
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	3,126	1,842	1,146	44	138

Highest Voltage Under Normal Condition @220kV level

Voltage violations data - detailed circuit wise analysis

NTDC Lahore Region

1. 500 kV Gatti
2. 500 kV West Faisalaabad
3. 500 kV Sheikhupura
4. 220 kV Bandala
5. 220 kV Ludewala
6. 220 kV Lalian
7. 220 kV Toba Tek Singh
8. 220 kV Nishatabad
9. 220 kV Samundri Road
10. 220 kV Jaranwala
11. 220 kV Bund Road Lahore
12. 220 kV Kala Shah Kaku
13. 220 kV Ghazi Road
14. 220 kV Gakkhar
15. 220 kV Gujrat
16. 500 kV New Lahore
17. 220 kV New Kot Lakhpat
18. 500 kV Nokhar
19. 220 kV Ravi
20. 220 kV Sialkot
21. 220 kV Shalamar
22. 220 kV Sarfraz Nagar
23. 220 kV WAPDA Town
24. 500 kV Yousafwala
25. 220 kV Okara
26. 220 kV Kassowal

NTDC Lahore Region

1. 500kV Grid Station GATTI FAISALABAD

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500KV Gatti - Barotha CCT-I	–	–	–	–	1	–	–	–	–	–	–	–	–	528	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	500KV Gatti - Barotha CCT-II	–	–	1	1	1	–	–	–	–	530	60	530	90	528	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	500kV Gatti-Rousch	26	30	12	213	226	540	330	540	360	540	270	540	240	545	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	500KV Gatti - H.B Shah 1	23	7	12	–	Nil	543	390	535	90	540	240	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	500KV Gatti - H.B Shah 2	232	18	39	–	Nil	540	690	540	390	540	570	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	500KV Gatti - Bhikhi Line	1	1	38	97	64	533	100	530	150	540	330	540	60	535	360	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	500kV Gatti-West FSD	–	–	78	307	231	–	–	–	–	540	240	550	60	540	300	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–

Normal	220KV Gatti-Nishatabad CCT-I & II	84	18	64	15	7	234	120	236	240	236	70	234	210	233	270	203	330	207	60	204	120	205	180	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	220KV Gatti - Jaranwala Road CCT I & II	90	56	194	21	Nil	232	120	235	240	236	270	232	210	Nil	Nil	200	240	204	60	201	180	205	120	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	220KV Gatti-Yousafwala CCT-I & II	134	NP	454	21	Nil	231	90	NP	NP	235	270	–	–	Nil	Nil	200	60	NP	NP	195	390	204	540	–	–
N-1		–	NP	–	–	Nil	–	–	NP	NP	–	–	–	–	Nil	Nil	–	–	NP	NP	–	–	–	–	–	–
Normal	220KV Gatti-Ludewala CCT-I & II	182	82	316	61	Nil	–	–	–	–	–	–	–	–	NP	NP	201	330	203	120	200	180	202	540	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	NP	NP	–	–	–	–	–	–	–	–	–	–
Normal	220KV Gatti - Bandala CCT-I & II	76	42	156	19	39	236	240	232	300	240	120	234	240	235	90	206	90	204	120	202	180	205	180	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	220KV Gatti-Lalian CCT	–	–	39	79	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	204	180	202	540	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	848	254	1,402	833	567
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	848	254	1,402	833	567

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Lahore Region

2. 500kV Grid West FAISALABAD

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500KV WFSD-Gatti	–	–	738	2,314	928	–	–	–	–	542	60	548	120	546	540	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	500KV WFSD-HBS	–	–	738	2,313	952	–	–	–	–	542	60	548	120	546	540	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	220KV WFSD-TTS	–	–	10	3,355	644	–	–	–	–	235	180	249	60	249	600	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	25	–	–	–	–	–	–	–	–	244	60	–	–	–	–	–	–	–	–	–	–
Normal	220KV WFSD-Trimmu	–	–	10	NP	406	–	–	–	–	235	180	NP	NP	249	600	–	–	–	–	–	–	NP	NP	NP	NP
N-1		–	–	–	NP	22	–	–	–	–	–	–	NP	NP	Nil	Nil	–	–	–	–	–	–	NP	NP	NP	NP

Total No. of Variations (Normal)	–	–	1,496	7,982	2,930
Total No. of Variations (N-1)	–	–	–	–	47
Total (Normal & N-1)	–	–	1,496	7,982	2,977

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Lahore Region

3. 500kV Grid Station Sheikhupura

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500KV SKP - Nokhar	8	7	NA	1	3	528	90	528	90	NA	NA	528	120	529	60	–	–	–	–	NA	NA	–	–	Nil	Nil
N-1		–	–	NA	–	Nil	–	–	–	–	NA	NA	–	–	Nil	Nil	–	–	–	–	NA	NA	–	–	Nil	Nil
Normal	500KV SKP - Bhiki	26	5	NA	1	13	540	60	526	120	NA	NA	527	60	531	60	–	–	–	–	NA	NA	–	–	Nil	Nil
N-1		–	–	NA	–	Nil	–	–	–	–	NA	NA	–	–	Nil	Nil	–	–	–	–	NA	NA	–	–	Nil	Nil
Normal	500KV SKP - New Lahore	5	NP	NP	NP	Nil	528	60	NP	NP	NP	NP	NP	NP	Nil	Nil	–	–	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	Nil	–	–	NP	NP	NP	NP	NP	NP	Nil	Nil	–	–	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500KV SKP - HVDC		7	2	4	23	–	–	526	90	525	60	529	60	532	60	–	–	–	–	–	–	–	–	Nil	Nil
N-1			–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV SKP - WAPDA TOWN	283	17	52	7	2	–	–	–	–	230	60	232	120	232	60	197	90	202	60	197	60	203	120	207	180
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV SKP - NKLP	686	6	91	31	3	–	–	–	–	–	–	234	180	233	60	194	60	202	60	193	120	190	60	205	60
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV SKP: - Bund Road CCT-I, II, III & IV	582	57	156	38	98	–	–	–	–	232	60	238	150	240	90	197	60	202	90	200	90	199	60	201	90
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV SKP - RAVI ROAD.	436	42	31	1	3	–	–	–	–	–	–	232	90	232	60	197	60	204	90	196	150	–	–	205	90
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV SKP - ATLAS P/H.	986	27	24	17	32	–	–	237	120	–	–	240	180	239	180	184	60	204	120	196	150	201	270	200	90
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	3,012	168	356	100	177
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	3,012	168	356	100	177

Highest Voltage Under Normal Condition @220kV/500kV level

Lowest Voltage Under Normal Condition @220kV/500kV level

Highest Voltage Under N-1 Condition @220kV/500kV level

NTDC Lahore Region

4. 220kV Grid Station Bandala

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220kV T/L Bandala-KSK I & II	900	520	228	67	245	241	90	240	120	–	–	237	120	238	60	202	60	201	180	190	60	203	90	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220kV T/L Bandala-Gatti I & II	900	136	228	67	245	241	90	–	–	–	–	237	120	238	60	202	60	201	180	190	60	203	90	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	1,800	656	456	134	490
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	1,192	1,800	656	456	134

Highest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

5. 220kV Grid Station Ludewala

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220KV Ludewala-Gatti	210	75	402	2	Nil	240	120	240	240	239	60	Nil	Nil	Nil	Nil	198	60	204	120	200	60	203	120	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 KV CHASHMA-LUDEWALA CCT-1&2	201	82	354	144	100	238	120	240	210	238	120	240	90	241	90	198	90	202	60	199	60	204	90	203	90
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV Ludewala-Lalian	–	–	1	139	78	–	–	–	–	–	–	241	90	240	90	–	–	–	–	208	60	205	90	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	411	157	757	285	178
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	411	157	757	285	178

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Highest Voltage Under N-1 Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Lahore Region

6. 220kV Grid Station Lalian

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220KV Lalian-Gatti	–	–	–	5	10	–	–	–	–	–	–	Nil	Nil	236	60	–	–	–	–	–	–	203	180	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV Lalian-Ludewala	–	–	–	5	71	–	–	–	–	–	–	239	120	240	90	–	–	–	–	–	–	203	180	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	–	–	–	10	81
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	-	-	-	10	81

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Highest Voltage Under N-1 Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Lahore Region

7. 220kV Grid Station Toba tek singh

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220KV Multan - Toba Tek Singh Circuit # 1&2	468	224	906	490	793	245	660	247	1,110	251	570	247	330	250	1,410	171	1,410	182	540	176	1,260	206	60	Nil	Nil
N-1		2	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	172	1,410	–	–	–	–	–	–	Nil	Nil
Normal	220KV Toba Tek Singh-Samundri Road Circuit #1&2	468	224	906	490	793	245	660	247	1,110	251	570	247	330	250	1,410	171	1,410	182	540	176	1,260	206	60	Nil	Nil
N-1		2	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	172	1,410	–	–	–	–	–	–	Nil	Nil
Normal	220KV Toba Tek Singh-PTPL Circuit #1,2,3&4.	–	–	–	490	1,077	–	–	–	–	–	–	247	330	250	1,410	–	–	–	–	–	–	206	60	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	936	448	1,812	1,470	2,663
Total No. of Variations (N-1)	4	–	–	–	–
Total (Normal & N-1)	940	448	1,812	1,470	2,663

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Highest Voltage Under N-1 Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Lahore Region

8. 220kV Grid Station Nishatabad

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220KV Gatti-Nishatabad Circuit # I , II	134	28	6	3	Nil	–	–	235	90	235	60	234	60	Nil	Nil	–	–	203	60	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–
Normal	220KV Samundri Road-Nishatabad Circuit # I & II	134	–	6	3	Nil	–	–	–	–	235	60	234	60	Nil	Nil	–	–	203	60	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	268	28	12	6	0
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	268	28	12	6	6

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Highest Voltage Under N-1 Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Lahore Region

9. 220kV Grid Station Samundri

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220KV SAMUNDRI ROAD - NISHATABAD CCT. NO. I&II	402	200	576	175	40	239	90	241	210	242	180	238	60	235	180	205	210	204	90	204	210	–	–	Nil	Nil
N-1		2	–	–	–	NP	–	–	–	–	–	–	–	–	NP	NP	179	90	–	–	–	–	–	–	Nil	Nil
Normal	220KV T.T.SINGH - SAMUNDRI ROAD CCT. NO. I&II	201	24	976	175	43	239	90	238	120	242	180	238	60	235	300	205	210	204	90	204	210	–	–	Nil	Nil
N-1		1	–	–	–	NP	–	–	–	–	–	–	–	–	NP	NP	179	90	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	603	224	1,552	350	83
Total No. of Variations (N-1)	3	-	-	-	–
Total (Normal & N-1)	606	224	1,552	350	83

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Highest Voltage Under N-1 Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Lahore Region

10. 220kV Grid Station Jaranwala

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220KV Gatti - JWR CCT-I & II.	661	52	268	3	Nil	242	62	234	35	–	–	233	57	Nil	Nil	–	–	206	159	202	70	208	206	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	661	52	268	3	Nil
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	661	52	268	3	Nil

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Highest Voltage Under N-1 Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Lahore Region

11. 220kV Grid Station BUND ROAD LAHORE

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Bund Road - NKLP I & II	875	841	2,070	562	381	–	–	–	–	–	–	–	–	–	–	188	90	198	90	184	90	194	150	194	150
N-1		10	–	22	–	Nil	–	–	–	–	–	–	–	–	–	–	190	150	–	–	191	90	–	–	Nil	Nil
Normal	220 kV Bund Road - KSK I & II	1,052	904	2,114	562	381	–	–	–	–	–	–	–	–	–	–	190	210	197	90	184	90	194	150	194	150
N-1		9	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	190	210	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Bund Road - SKP I & II	852	833	2,114	562	441	–	–	–	–	–	–	–	–	–	–	188	90	198	90	184	90	194	150	194	150
N-1		11	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	192	150	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Bund Road - SKP III & IV	874	842	2,114	562	321	–	–	–	–	–	–	–	–	–	–	188	90	198	90	184	90	194	150	194	150
N-1		11	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	192	150	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	3,653	3,420	8,412	2,248	1,524
Total No. of Variations (N-1)	41	–	22	–	–
Total (Normal & N-1)	3,694	3,420	8,434	2,248	1,524

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

13. 220kV Grid Station GHAZI ROAD LAHORE

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Ghazi - Shalamar	1,745	3,225	3,037	2,211	1,726	–	–	–	–	–	–	–	–	–	–	195	60	180	120	176	60	188	60	188	60
N-1		1,765	–	–	3	Nil	–	–	–	–	–	–	–	–	–	–	168	60	–	–	–	–	196	60	Nil	Nil
Normal	220 kV Ghazi - KSK	1,745	3,225	3,037	2,196	1,684	–	–	–	–	–	–	–	–	–	–	195	180	180	120	176	60	188	60	188	60
N-1		1,765	–	–	2	Nil	–	–	–	–	–	–	–	–	–	–	168	60	–	–	–	–	197	120	Nil	Nil
Normal	220 kV Ghazi Road - New Lahore	771	3,201	3,035	2,211	1,539	–	–	–	–	–	–	–	–	–	–	198	180	180	120	176	60	188	60	188	60
N-1		185	–	–	3	Nil	–	–	–	–	–	–	–	–	–	–	184	60	–	–	–	–	196	60	Nil	Nil
Normal	220 kV Ghazi - Sarfaraznagar	–	3,211	2,976	2,179	1,725	–	–	–	–	–	–	–	–	–	–			180	120	176	60	188	60	188	60
N-1		–	–	–	1	Nil	–	–	–	–	–	–	–	–	–	–			–	–	–	–	196	60	Nil	Nil

Total No. of Variations (Normal)	4,261	12,862	12,085	8,797	6,674
Total No. of Variations (N-1)	3,715	–	–	9	–
Total (Normal & N-1)	7,976	12,862	12,085	8,806	6,674

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

14. 220kV Grid Station GAKKHAR

Condition	Name of Transmission Circuit(s) violating the voltage criteri	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Gakkhar - Mangla Ckt	990	756	60	60	6	–	–	–	–	–	–	–	–	–	–	189	60	191	120	200	60	200	60	206	180
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	188	60	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Gakkhar - Sialkot	1,016	770	60	60	24	–	–	–	–	–	–	–	–	–	–	189	60	191	120	200	60	200	60	204	60
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	186	60	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Old Gakkhar - New Gakkhar (Nokhar)	1,299	1,000	NP	NP	Nil	–	–	–	–	–	–	–	–	–	–	188	60	189	120	NP	NP	NP	NP	NP	NP
N-1		–	–	NP	NP	Nil	–	–	–	–	–	–	–	–	–	–	184	60	–	–	NP	NP	NP	NP	NP	NP
Normal	220 kV Gakkhar - Gujrat	1,299	1,000	NP	NP	Nil	–	–	–	–	–	–	–	–	–	–	188	60	189	120	NP	NP	NP	NP	NP	NP
N-1		–	–	NP	NP	Nil	–	–	–	–	–	–	–	–	–	–	184	60	–	–	NP	NP	NP	NP	NP	NP
Normal	220KV Bus Bar - I & II	–	–	116	116	59	–	–	–	–	–	–	–	–	–	–					198	60	198	60	202	60
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–					–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	4,604	3,526	236	236	89
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	4,604	3,526	236	236	89

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

15. 220kV Grid Station GUJRAT

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Gujrat - Old Gakkhar	876	1,087	924	617	317	241	60	239	60	239	60	241	30	242	360	193	60	191	150	187	30	200	60	204	60
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Gujrat - New Gakkhar	880	1,084	924	617	317	241	60	239	60	239	60	241	30	242	360	193	60	191	150	187	30	200	60	204	60
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Gujrat - Mangla 1 & 2	876	1,123	1,848	617	317	241	60	239	60	239	60	241	30	242	360	193	60	189	60	187	30	200	60	204	60
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	2,632	3,294	3,696	1,851	951
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	2,632	3,294	3,696	1,851	951

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

16. 500kV Grid Station NEW LAHORE

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV New Lahore - Balloki	110	94	226	416	185	534	60	534	120	540	120	540	60	538	180	464	60	473	60	–	–	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV New Lahore - GAKKHAR	106	94	113	416	179	534	60	534	120	540	120	540	60	538	180	464	60	472	60	–	–	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV New Lahore - CFPP Sahiwal	111	93	113	416	185	534	60	534	120	540	120	540	60	538	180	464	60	473	60	–	–	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV New Lahore - HVDC Conv 1 & 2		93	226	416	185	–	–	534	120	540	120	540	60	538	180	–	–	473	60	–	–	–	–	Nil	Nil
N-1			–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV New Lahore - Ghazi Road	11	202	222	294	122	234	150	235	60	237	60	237	60	236	270	207	20	202	60	200	60	206	60	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV New Lahore - New Kot Lakhpat- I&II	83	201	444	294	122	235	180	235	60	237	60	236	60	236	270	203	60	202	60	200	60	206	60	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV New Lahore - SNR	71	NP	NP	NP	NP	235	180	NP	NP	NP	NP	NP	NP	Nil	Nil	203	60	NP	NP	NP	NP	NP	NP	Nil	Nil
N-1		–				NP	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV New Lahore - Wapda Town	90	202	222	293	121	235	180	235	60	237	60	237	60	236	270	203	60	202	60	200	60	206	60	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	582	979	1,566	2,545	1,099
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	582	979	1,566	2,545	1,099

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Lahore Region

17. 220kV Grid Station NEW KOT LAKHPAT

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV NKLP - BDR - 1 & 2	2,084	2,294	1,778	562	415	–	–	–	–	–	–	–	–	232	90	185	90	185	90	180	150	193	210	195	150
N-1		–	–	–	–	1	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	197	90
Normal	220 kV NKLP - SKP Ckt	479	1,059	975	609	502	235	90	–	–	–	–	–	–	Nil	Nil	190	90	186	90	182	90	190	90	196	90
N-1		–	–	–	–	1	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	197	90
Normal	220 kV NKLP - SNR Ckt	474	691	582	281	186	–	–	–	–	–	–	232	90	Nil	Nil	195	150	187	150	185	90	198	210	198	90
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV NKLP - New Lahore Ckt I & II	785	691	1,302	335	285	–	–	–	–	–	–	233	90	238	90	191	90	188	90	181	90	196	270	196	690
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	3,822	4,735	4,637	1,787	1,388
Total No. of Variations (N-1)	–	–	–	–	2
Total (Normal & N-1)	3,822	4,735	4,637	1,787	1,390

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Highest Voltage Under N-1 Condition @220kV level

NTDC Lahore Region

18. 500 kV Grid Station Nokhar

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV New Gakkhar - Rawat I & II	64	56	42	45	103	537	90	536	120	534	180	531	120	538	240	472	180	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV New Gakkhar - Lahore (SKP)	32	28	21	136	103	537	90	536	120	534	180	538	120	538	240	472	180	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV New Gakkhar - New Lahore	32	28	21	136	103	537	90	536	120	534	180	538	120	538	240	472	180	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV New Gakkhar - Neelum Jhelum	–	–	42	136	103	–	–	–	–	534	180	538	120	538	240	–	–	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV New Gakkhar - Karot P P	–	–	–	6	91	–	–	–	–	–	–	538	120	538	240	–	–	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	-	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV New Gakkhar - Old Gakkhar	449	245	161	533	513	241	150	240	120	238	180	240	120	242	360	197	90	202	270	201	120	–	–	195	150
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV New Gakkhar - Gujrat	–	–	161	533	512	–	–	–	–	238	120	240	120	242	360	–	–	–	–	201	120	–	–	195	150
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	577	357	448	1,525	1,528
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	577	357	448	1,525	1,528

Highest Voltage Under Normal Condition @220kV/500kV level

Lowest Voltage Under Normal Condition @220kV/500kV level

NTDC Lahore Region

19. 220kV Grid Station Ravi

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Ravi - Atlas Power House	558	492	743	97	59	–	–	–	–	–	–	–	–	232	90	188	90	194	90	191	150	199	210	200	90
N-1		4	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	190	90	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Ravi - Kala Shah Kaku	1,258	697	994	205	172	–	–	–	–	–	–	–	–	Nil	Nil	180	90	193	90	190	210	195	90	200	210
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Ravi - Sheikhupura	500	406	710	59	29	–	–	–	–	–	–	–	–	233	90	190	90	192	210	188	150	200	330	201	60
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Ravi - Shalamar	1,161	620	1,046	177	85	–	–	–	–	–	–	–	–	Nil	Nil	180	60	195	90	186	90	198	270	200	150
N-1		7	–	–	–	Nil	–	–	–	–	–	–	–	–	Nil	Nil	190	60	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	3,477	2,215	3,493	538	345
Total No. of Variations (N-1)	11	–	–	–	–
Total (Normal & N-1)	3,488	2,215	3,493	538	345

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

20. 220kV Grid Station Sialkot

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Sailkot - Gakkhar	1,224	1,174	1,410	721	429	–	–	–	–	–	–	–	–	–	–	180	90	180	330	180	330	190	210	198	210
N-1		–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	190	150	–	–	Nil	Nil
Normal	220 kV Sailkot - Kala Shah Kaku	1,195	1,176	1,409	733	415	–	–	–	–	–	–	–	–	–	–	180	150	180	210	180	330	190	210	198	210
N-1		1	–	10	–	–	–	–	–	–	–	–	–	–	–	–	190	90	–	–	190	540	–	–	Nil	Nil

Total No. of Variations (Normal)	2,419	2,350	2,819	1,454	844
Total No. of Variations (N-1)	1	–	14	–	–
Total (Normal & N-1)	2,420	2,350	2,833	1,454	844

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

21. 220kV Grid Station Shalamar

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Shalamar - Ravi	718	949	996	614	454	–	–	–	–	–	–	–	–	–	–	186	90	182	120	178	90	190	90	192	90
N-1		278	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	183	90	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Shalamar - Ghazi Road	563	953	901	618	458	–	–	–	–	–	–	–	–	–	–	186	90	182	120	180	60	190	90	192	90
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	1,281	1,902	1,897	1,232	912
Total No. of Variations (N-1)	278	–	–	–	–
Total (Normal & N-1)	1,559	1,902	1,897	1,232	912

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

22. 220kV Grid Station Sarfraznagar

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Sarfraz Nagar - New Kot Lakhpat	814	1,556	1,853	1,445	1067	–	–	–	–	–	–	–	–	–	–	178	270	176	210	172	120	185	60	189	60
N-1		–	–	–	5	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	190	420	Nil	Nil
Normal	220 kV Sarfraz Nagar - Okara-I&II	818	1,518	1,877	1,498	1065	–	–	–	–	–	–	–	–	–	–	178	270	176	210	172	120	185	60	191	60
N-1		–	–	–	17	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	184	30	Nil	Nil
Normal	Sarfarz Nagar-Ghazi Road	345	1,532	1,853	1,464	1051	–	–	–	–	–	–	–	–	–	–	178	270	176	210	172	120	185	60	189	60
N-1		–	–	–	12	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	184	30	Nil	Nil

Total No. of Variations (Normal)	1,977	4,606	5,583	4,407	3,183
Total No. of Variations (N-1)	–	–	–	34	–
Total (Normal & N-1)	1,977	4,606	5,583	4,441	3,183

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

23. 220kV Grid Station WAPDA TOWN LAHORE

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Wapda Town - Sheikhupura	518	639	485	210	65	–	–	–	–	–	–	–	–	–	–	193	90	190	90	187	90	196	150	202	30
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Wapda Town - New Lahore	441	599	452	202	71			–	–	–	–	–	–	–	–	193	90	190	90	188	90	196	150	202	90
N-1		1	–	–	–	Nil			–	–	–	–	–	–	–	–	207	90	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	959	1,238	937	412	136
Total No. of Variations (N-1)	1	–	–	–	–
Total (Normal & N-1)	960	1,238	937	412	136

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

24. 500kV Grid Station Yousafwala

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Yousafwala - Lahore	–	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP
Normal	500 kV Yousafwala - Multan	693	NP	441	826	344	541	180	552	120	NP	NP	539	60	544	90	–	–	–	–	NP	NP	–	–	Nil	Nil
N-1		–	NP	–	–	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil
Normal	500 kV Yousafwala - CFPP	184	NP	671	1,117	436	542	180	–	–	NP	NP	542	60	546	90	–	–	–	–	NP	NP	–	–	Nil	Nil
N-1		–	NP	–	–	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil
Normal	500 kV Yousafwala - SNR	–	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP
Normal	220 kV Yousafwala-Gatti - I & II	167	NP	1,680	329	211	239	120	238	120	NP	NP	239	60	240	240	–	–	200	120	NP	NP	196	120	202	120
N-1		–	NP	–	–	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil
Normal	220 kV Yousafwala-Kassowal - I & II	158	NP	1,726	398	217	237	120	236	120	NP	NP	237	60	238	240	198	120	198	120	NP	NP	194	120	199	120
N-1		–	NP	–	–	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil
Normal	220 kV Yousafwala - CFPP	–	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP
Normal	220 kV Yousafwala-Okara - I & II	118	NP	1,606	323	209	236	180	237	120	NP	NP	238	60	239	300	198	120	199	120	NP	NP	195	120	200	120
N-1		–	NP	–	–	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil	–	–	–	–	NP	NP	–	–	Nil	Nil

NP: Not Provided

Total No. of Variations (Normal)	1,320	–	–	2,993	1,417
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	1,320	–	–	2,993	1,417

Highest Voltage Under Normal Condition @220kV/500kV level

Lowest Voltage Under N-1 Condition @220kV/500kV level

NTDC Lahore Region

25. 220kV Grid Station OKARA

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Okara - Sarfaraznagar Ckt I & II	204	100	300	303	321	241	390	–	–	237	240	239	30	239	390	195	1440	195	1,440	186	1440	191	1,200	194	600
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Okara - Yousafwala Ckt I & II	204	104	306	303	288	241	390	–	–	237	240	239	30	239	300	195	1440	195	1,440	186	1440	191	1,200	194	600
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	408	204	606	606	609
Total No. of Variations (N-1)	-	-	-	-	-
Total (Normal & N-1)	408	204	606	606	609

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Lahore Region

26. 220kV Grid Station KASSOWAL

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Kassowal-Vehari Circuits I & II	636	546	72	600	239	242	60	239	60	244	60	241	60	242	120	197	60	197	60	188	60	182	60	195	60
N-1		24	4	–	–	–	–	–	–	–	–	–	–	–	–	–	193	60	–	–	–	–	–	–	–	–
Normal	220 kV Kassowal-Yousafwala - I & II	598	546	72	600	238	242	60	239	60	244	60	241	60	242	120	197	60	197	60	188	60	182	60	195	60
N-1		16	4	–	–	–	–	–	–	–	–	–	–	–	–	–	193	60	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	1,234	1,092	144	1,200	477
Total No. of Variations (N-1)	40	8	–	–	–
Total (Normal & N-1)	1,274	1,100	144	1,200	477

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Voltage violations data - detailed circuit wise analysis

NTDC Multan Region

1. 500 kV D. G. Khan
2. 500 kV Multan
3. 500 kV Muzaffargarh
4. 220 kV Muzaffargarh
5. 500 kV Rahim Yar Khan
6. 220 kV Bahawalpur
7. 220 kV Chishtian
8. 220 kV Lal Sohanra
9. 220 kV Vehari

NTDC Multan Region

1. 500kV Grid Station D.G. KHAN

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV D.G. Khan - Guddu	39	21	18	15	307	565	60	560	60	564	60	566	60	558	1,260	494	60	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	NIL	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV D.G. Khan - Loralai cct I & II	148	156	200	117	428	252	60	250	60	252	60	247	180	250	600	–	–	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	NIL	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	500 kV D.G. Khan - Muzaffargarh	Added in 2021-22		5	1	317	Added in 2021-22				559	60	553	60	559	1,260	Added in 2021-22				–	–	–	–	Nil	Nil
N-1				–	–	NIL					–	–	–	–	Nil	Nil					–	–	–	–	Nil	Nil

Added in 2021-22

Total No. of Variations (Normal)	187	177	223	133	1,052
Total No. of Variations (N-1)	–	–	–	–	0
Total (Normal & N-1)	187	177	223	133	1,052

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Multan Region

2. 500kV Grid Station MULTAN

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Multan - Muzaffargarh	NIL	NA	NIL	NIL	654	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	545	1,260	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
N-1		NIL	NA	NIL	NIL	NIL	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
Normal	500 kV Multan - Yousafwala	–	NP	NP	826	NIL	–	–	NP	NP	NP	NP	545	60	NP	NP	–	–	NP	NP	NP	NP	–	–	NP	NP
N-1		–	NP	NP	_	NIL	–	–	NP	NP	NP	NP	–	–	NP	NP	–	–	NP	NP	NP	NP	–	–	NP	NP
Normal	500 kV Multan - Rousch	–	NP	NP	Nil	394	–	–	NP	NP	NP	NP	Nil	Nil	580	180	–	–	NP	NP	NP	NP	Nil	Nil	Nil	Nil
N-1		–	NP	NP	Nil	NIL	–	–	NP	NP	NP	NP	Nil	Nil	Nil	Nil	–	–	NP	NP	NP	NP	Nil	Nil	Nil	Nil
Normal	500 kV Multan - R Y Khan	NIL	NA	NIL	NIL	411	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	547	1,080	NA	NA	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
N-1		NIL	NA	NIL	NIL	NIL	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil	NA	NA	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
Normal	500 kV Multan - HBS	–	NP	NP	Nil	128	–	–	NP	NP	NP	NP	Nil	Nil	540	180	–	–	NP	NP	NP	NP	Nil	Nil	Nil	Nil
N-1		–	NP	NP	Nil	NIL	–	–	NP	NP	NP	NP	Nil	Nil	Nil	Nil	–	–	NP	NP	NP	NP	Nil	Nil	Nil	Nil
Normal	220 kV Multan - Muzaffargarh 1	2	NA	NIL	NIL	201	–	–	NA	NA	NIL	NIL	NIL	NIL	240	690	207	570	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
N-1		–	NA	NIL	NIL	NIL	–	–	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil	–	–	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
Normal	220 kV Multan - Muzaffargarh 2	–	6	6	19	263	–	–	252	180	249	240	249	60	246	1,380	–	–	–	–	–	–	–	–	Nil	Nil
N-1		–	–	–	–	NIL	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Multan - Muzaffargarh 3	1	3	4	1	271	–	–	NA	NA	–	–	246	120	244	1380	207	240	NA	NA	208	450	–	–	Nil	Nil
N-1		–	–	–	–	NIL	–	–	NA	NA	–	–	–	–	Nil	Nil	–	–	NA	NA	–	–	–	–	Nil	Nil
Normal	220 kV Multan - Muzaffargarh 4	2	NA	NIL	NIL	86	–	–	NA	NA	NIL	NIL	NIL	NIL	240	150	207	570	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
N-1		–	NA	NIL	NIL	NIL	–	–	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil	–	–	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
Normal	220 kV Multan - Kapco 3 & 4	6	28	NIL	5	293	251	90	252	150	NIL	NIL	246	60	248	1440	–	–	–	–	NIL	NIL	–	–	Nil	Nil
N-1		–	–	NIL	–	NIL	–	–	–	–	NIL	NIL	–	–	Nil	Nil	–	–	–	–	NIL	NIL	–	–	Nil	Nil
Normal	220 kV Multan - Kapco 5 & 6	NIL	NA	2	NIL	280	NIL	NIL	NA	NA	247	270	NIL	NIL			NIL	NIL	NA	NA	–	–	NIL	NIL	Nil	Nil
N-1		NIL	NA	–	NIL	NIL	NIL	NIL	NA	NA	–	–	NIL	NIL			NIL	NIL	NA	NA	–	–	NIL	NIL	Nil	Nil
Normal	220 kV Multan - NGPS 1 & 2	1	2	NIL	NIL	523	–	–	246	90	NIL	NIL	NIL	NIL	244	1,440	208	120	–	–	NIL	NIL	NIL	NIL	Nil	Nil
N-1		–	–	NIL	NIL	NIL	–	–	–	–	NIL	NIL	NIL	NIL	Nil	Nil	–	–	–	–	NIL	NIL	NIL	NIL	Nil	Nil
Normal		9	12	6	NIL	583	250	210	250	290	250	240	NIL	NIL	246	240	208	60	–	–	–	–	NIL	NIL	Nil	Nil

N-1	220 kV Multan - Vehari 1 & 2	–	–	–	NIL	NIL	–	–	–	–	–	–	NIL	NIL	Nil	Nil	–	–	–	–	–	–	NIL	NIL	Nil	Nil
Normal	220 kV Multan - T.T. Singh 1 & 2	1	4	6	NIL	566	–	–	246	90	245	300	NIL	NIL	245	450	208	60	–	–	–	–	NIL	NIL	Nil	Nil
N-1		–	–	–	NIL	NIL	–	–	–	–	–	–	NIL	NIL	Nil	Nil	–	–	–	–	–	–	NIL	NIL	Nil	Nil

NP: Not Provided

Total No. of Variations (Normal)	22	55	24	851	4,653
Total No. of Variations (N-1)	–	–	–	–	0
Total (Normal & N-1)	22	55	24	851	4,653

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Multan Region

3. 500kV Grid Station MUZAFFARGARH

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Muzaffargarh - Gatti	NA	NA	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NP	NP	NP	NP	NA	NA	NA	NA	NIL	NIL	NP	NP	NP	NP
N-1		NA	NA	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NP	NP	NP	NP	NA	NA	NA	NA	NIL	NIL	NP	NP	NP	NP
Normal	500 kV Muzaffargarh - Guddu	Nil	Nil	Nil	Nil	NP	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NP	NP	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NP	NP
N-1		Nil	Nil	Nil	Nil	NP	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NP	NP	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NP	NP
Normal	500 kV Muzaffargarh - Multan	NA	NA	NIL	NIL	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP
N-1		NA	NA	NIL	NIL	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP
Normal	500 kV Muzaffargarh - Guddu 747	NA	NA	NIL	NIL	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP
N-1		NA	NA	NIL	NIL	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP
Normal	220 kV Muzaffargarh-D.G Khan	NA	NA	NIL	NIL	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP
N-1		NA	NA	NIL	NIL	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NP	NP

NP: Not Provided NA: Not Applicable

Total No. of Variations (Normal)	–	–	–	–	–
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	–	–	–	–	–

NTDC Multan Region

4. 220kV Grid Station MUZAFFARGARH

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220KV Muzaffargarh - TPS Phase	179	165	162	166	126	245	60	248	60	247	540	249	600	248	180	–	–	–	–	–	–	–	–	Nil	Nil
N-1		29	–	69	9	10	247	120	–	–	250	300	248	180	249	90	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV Muzaffargarh – Multan	179	164	150	188	55	242	210	248	60	241	540	241	720	241	420	–	–	–	–	–	–	–	–	NP	NP
N-1		29	–	81	8	NIL	247	120	–	–	250	300	250	420	–	–	–	–	–	–	–	–	–	–	NP	NP

Total No. of Variations (Normal)	358	329	312	354	181
Total No. of Variations (N-1)	58	–	150	17	10
Total (Normal & N-1)	416	329	462	371	191

Highest Voltage Under Normal Condition @220kV level

NTDC Multan Region

5. 500kV Grid Station RAHIM YAR KHAN

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Guddu 747 - RY Khan	NIL	NA	NIL	NIL	132	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	549	570	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	NIL	NIL
N-1		NIL	NA	NIL	NIL	NIL	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	NIL	NIL
Normal	500 kV Multan - RY Khan	NIL	NA	NIL	NIL	300	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	549	1,350	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
N-1		NIL	NA	NIL	NIL	NIL	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NA	NA	NIL	NIL	NIL	NIL	Nil	Nil
Normal	500 kV RY Khan - Moro	Added in 2022-23			NIL	134	Added in 2022-23						NIL	NIL	552	1,350	Added in 2022-23						NIL	NIL	Nil	Nil
N-1					NIL	1							NIL	NIL	NIL	NIL							NIL	NIL	Nil	Nil

Added in 2022-23 NA: Not applicable

Total No. of Variations (Normal)	–	–	–	–	566
Total No. of Variations (N-1)	–	–	–	–	1
Total (Normal & N-1)	–	–	–	–	567

Highest Voltage Under Normal Condition @500kV level

NTDC Multan Region

6. 220kV Grid Station BAHAWALPUR

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Bahawalpur - TPS Muzaffargarh Ckt I & II	806	660	948	473	166	242	180	252	30	242	120	243	60	242	30	197	30	–	–	195	30	199	30	199	30
N-1		226	108	200	3	NIL	252	90	247	60	250	120	244	30	NIL	NIL	190	30	192	30	196	60	–	–	NIL	NIL
Normal	220 kV Bahawalpur - Lal Sohanra Ckt I & II	505	59	306	161	12	242	30	240	60	241	90	242	30	238	90	197	30	201	60	195	30	–	–	NIL	NIL
N-1		136	6	48	4	NIL	250	90	245	30	–	–	244	30	NIL	NIL	190	30	195	30	196	60	–	–	NIL	NIL

Total No. of Variations (Normal)	1,311	719	1,254	634	178
Total No. of Variations (N-1)	362	114	248	7	0
Total (Normal & N-1)	1,673	833	1,502	641	178

Highest Voltage Under Normal Condition @220kV level

NTDC Multan Region

8. 220kV Grid Station CHISHTIAN

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Chishtian - Vehari Ckt I & II	3,923	2,389	4,192	2,898	1,496	242	90	249	150	246	120	244	30	242	540	197	30	194	120	182	30	199	120	199	120
N-1		944	83	862	312	171	250	30	247	30	245	30	247	30	243	180	190	60	–	–	179	60	164	30	176	30

Total No. of Variations (Normal)	3,923	2,389	4,192	2,898	1,496
Total No. of Variations (N-1)	944	83	862	312	171
Total (Normal & N-1)	4,867	2,472	5,054	3,210	1,667

Highest Voltage Under Normal Condition @220kV level

NTDC Multan Region

9. 220kV Grid Station LAL SOHANRA

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Lal Sohanra - BWP Ckt I & II	631	167	188	93	54	242	90	250	60	248	30	241	60	242	90	197	30	–	–	202	60	205	60	Nil	Nil
N-1		100	41	14	6	1	250	30	250	30	245	60	248	60	247	60	190	60	194	60	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	631	167	188	93	54
Total No. of Variations (N-1)	100	41	14	6	1
Total (Normal & N-1)	731	208	202	99	55

Highest Voltage Under Normal Condition @220kV level

NTDC Multan Region

10. 220kV Grid Station VEHARI

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Vehari - Multan Ckt I & II	900	639	616	689	569	243	210	249	270	241	270	241	150	246	90	195	60	–	–	190	210	200	90	200	90
N-1		99	3	257	64	2	245	270	241	270	247	150	246	270	244	90	190	90	–	–	190	210	185	60	Nil	Nil
Normal	220 kV Vehari - Kassowal Ckt I & II	900	633	668	726	468	243	210	249	270	242	270	241	150	244	60	195	60	–	–	190	210	200	330	200	90
N-1		101	5	213	86	1	245	270	241	270	247	150	246	270	244	90	190	90	–	–	–	–	180	90	Nil	Nil
Normal	220 kV Vehari - Chishtian Ckt I & II	772	377	464	427	292	–	–	249	270	241	270	241	150	241	600	–	–	–	–	190	210	200	330	200	90
N-1		98	2	61	56	Nil	–	–	241	41	247	150	246	270	Nil	Nil	–	–	–	–	–	–	180	90	Nil	Nil

Total No. of Variations (Normal)	2,572	1,649	1,748	1,842	1,329
Total No. of Variations (N-1)	298	10	531	206	3
Total (Normal & N-1)	2,870	1,659	2,279	2,048	1,332

Highest Voltage Under Normal Condition @220kV level

APPENDIX 4

Voltage violations data - detailed circuit wise analysis

NTDC Hyderabad Region

1. 500 kV Dadu
2. 500 kV Guddu
3. 500 kV 747 MW Guddu
4. 500 kV Jamshoro
5. 220 kV NKI
6. 500 kV Shikarpur
7. 220 kV Dharki
8. 220 kV Hala Road
9. 220 kV Quetta Industrial-II
10. 220 kV Rohri
11. 220 kV T. M. Khan Road
12. 220 kV Jhimpir-I
13. 220 kV Jhimpir-II
14. 220 kV kV Switchyard Guddu

NTDC Hyderabad Region

1. 500kV Grid Station DADU

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Dadu - Jamshoro	6	3	1	6	330	535	60	535	60	530	60	535	120	545	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Dadu - Guddu I	–	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500 kV Dadu - Guddu II	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
N-1		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500 kV Dadu - Shikarpur I	6	3	1	6	338	535	60	535	60	530	60	535	120	545	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Dadu - Shikarpur II	6	3	1	6	334	535	60	535	60	530	60	535	120	545	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Dadu - Port Qasim	6	2	NP	NP	NP	535	60	530	60	NP	NP	NP	NP	NP	NP	–	–	–	–	NP	NP	NP	NP	NP	NP
N-1		–	–	NP	NP	NP	–	–	–	–	NP	NP	NP	NP	NP	NP	–	–	–	–	NP	NP	NP	NP	NP	NP
Normal	500 kV Dadu - Moro	6	3	1	6	339	535	60	535	60	530	60	535	120	545	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Dadu - Khuzdar I	50	19	3	7	154	240	60	240	240	240	60	240	60	240	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Dadu - Khuzdar II	33	19	3	7	87	240	60	240	240	240	60	240	60	240	90	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Dadu - Matiari		1	NP	6	333	–	–	535	60	NP	NP	535	120	545	60	–	–	–	–	NP	NP	–	–	–	–
N-1			–	NP	–	–	–	–	–	–	NP	NP	–	–	–	–	–	–	–	–	NP	NP	–	–	–	–

NP: Not provided

Total No. of Variations (Normal)	113	53	10	44	1,915
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	113	53	10	44	1,915

Highest Voltage Under Normal Condition @220kV/500kV level

Lowest Voltage Under Normal Condition @220kV/500kV level

NTDC Hyderabad Region

2. 500kV Grid Station GUDDU

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Guddu - Dadu I	–	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500 kV Guddu - Dadu II	–	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500 kV Guddu - D.G. Khan (Old Multan)	48	33	41	333	1,041	538	420	538	360	540	60	540	960	543	300	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Guddu - 747 MW CCPP Guddu	20	9	30	341	3,203	538	360	538	180	539	120	540	960	549	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Guddu - Muzaffargarh	101	23	29	320	1,030	540	240	538	360	538	360	540	240	544	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Guddu - Shikarpur I	29	20	18	306	1,018	539	60	538	120	538	120	540	540	544	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Guddu - Shikarpur II	62	29	47	346	1,146	538	420	538	120	539	120	540	960	542	300	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Guddu - Sibbi (D/Ckt)	–	NP	NP	375	NP	–	–	NP	NP	NP	NP	241	120	NP	NP	–	–	NP	NP	NP	NP	–	–	NP	NP
N-1		–	NP	NP	–	NP	–	–	NP	NP	NP	NP	–	–	NP	NP	–	–	NP	NP	NP	NP	–	–	NP	NP
Normal	220 kV Guddu - Uch (P/H)	–	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP

NP: Not provided

Total No. of Variations (Normal)	260	114	165	2,021	7,438
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	260	114	165	2,021	7,438

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Hyderabad Region

3. 500kV Grid Station 747 MW GUDDU

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)											
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500KV 747MW Guddu-OLD Guddu	Added in 2023			4,181	5,882	Added in 2023						547	60	549	60	Added in 2023						Nil	Nil	-	-
N-1					–								–	–									Nil	Nil	-	-
Normal	500KV 747MW Guddu - Muzaffargarh				2,960	4924							546	60	551	60							Nil	Nil	-	-
N-1					–								–	–									Nil	Nil	-	-
Normal	500KV 747MW Guddu-Rahim yar Khan				2,988	7444							546	60	551	60							Nil	Nil	-	-
N-1					–								–	–									Nil	Nil	-	-

Added in 2023

Total No. of Variations (Normal)	–	–	–	10,129	18,250
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	–	–	–	10,129	18,250

Highest Voltage Under Normal Condition @500kV level

NTDC Hyderabad Region

4. 500kV Grid Station JAMSHORO

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Jamshoro - Dadu I	69	8	12	NP		535	60	530	60	539	30	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
N-1		–	–	–	NP		–	–	–	–	–	–	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
Normal	500 kV Jamshoro - Dadu II	69	NP	NP	NP		535	60	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP		–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500 kV Jamshoro - Dadu New	–	–	–	143	1222	–	–	–	–	–	–	537	90	543	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 KV Jamshoro- NKI	–	3	7	49	671	–	–	531	60	540	30	533	90	541	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Jamshoro - Hub (D/Ckt)	69	3	11	NP		535	60	525	60	528	30	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
N-1		–	–	–	NP		–	–	–	–	–	–	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
Normal	500 kV Jamshoro - Port Qasim	69	6	NP	NP		535	60	534	60	NP	NP	NP	NP	NP	NP	–	–	–	–	NP	NP	NP	NP	NP	NP
N-1		–	–	NP	NP		–	–	–	–	NP	NP	NP	NP	NP	NP	–	–	–	–	NP	NP	NP	NP	NP	NP
Normal	500 kV Jamshoro - Thar Engro	1	NP	NP	NP		528	30	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP		–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500kV K2/K3 - Jamshoro	–	1	6	206	2200	–	–	529	60	530	60	538	30	543	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500kV CPHGC - Jamshoro	–	3	4	167	1541	–	–	530	60	530	60	538	30	545	30	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Jamshoro - KDA33 - I	702	928	2,049	NP		244	60	242	60	242	60	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
N-1		–	–	–	NP		–	–	–	–		–	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
Normal	220 kV Jamshoro - KDA33 - II	702	928	2,049	NP		244	60	242	60	242	60	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
N-1		–	–	–	NP		–	–	–	–	–	–	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	NP	NP
Normal	220kV Jamshoro- Hala Road- I & II	1,494	2,268	5,093	1,493	2017	244	60	244	60	250	30	254	60	253	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Normal	220 kV Jamshoro - T.M.Khan Road I & II	1,408	1,926	5,972	1,740	2298	241	60	244	60	245	60	243	180	245	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Jamshoro - Jhampir 2 Ckt- I & II	–	–	986	1,531	2309	–	–	–	–	240	60	244	60	245	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Jamshoro - Matiari - I	–	3	15	206	1481	–	–	528	60	540	30	537	30	543	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Jamshoro - Matiari - II	–	9	16	247	1685	–	–	532	60	540	30	535	90	544	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

NP: Not Provided

Total No. of Variations (Normal)	4,583	6,086	16,220	5,782	15,424
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	4,583	6,086	16,220	5,782	15,424

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Hyderabad Region

5. 500kV Grid Station NKI KARACHI

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV NKI - Hub	1	NP	NP	NP	NP	528	30	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
N-1		–	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP	–	–	NP	NP	NP	NP	NP	NP	NP	NP
Normal	500 kV NKI - Port Qasim	–	NA	NP	NP	NP	–	–	NA	NA	NP	NP	NP	NP	NP	NP	–	–	NA	NA	NP	NP	NP	NP	NP	NP
N-1		–	NA	NP	NP	NP	–	–	NA	NA	NP	NP	NP	NP	NP	NP	–	–	NA	NA	NP	NP	NP	NP	NP	NP
Normal	500 kV NKI - Jamshoro	NA	NA	NA	46	2,028	NA	NA	NA	NA	NA	NA	539	60	543	30	NA	NA	NA	NA	NA	NA	–	–	Nil	Nil
N-1		NA	NA	NA	–	NP	NA	NA	NA	NA	NA	NA	–	–	–	–	NA	NA	NA	NA	NA	NA	–	–	Nil	Nil
Normal	220 kV NKI - Baldia	21	NA	NA	18	1,051	234	150	NA	NA	NA	NA	238	300	238	30	208	30	NA	NA	NA	NA	–	–	Nil	Nil
N-1		–	NA	NA	–	NP	–	–	NA	NA	NA	NA	–	–	–	–	–	–	NA	NA	NA	NA	–	–	Nil	Nil
Normal	220 kV NKI - KDA33	21	NA	NA	18	1,051	234	150	NA	NA	NA	NA	238	300	238	30	208	30	NA	NA	NA	NA	–	–	Nil	Nil
N-1			NA	NA	–	NP	–	–	NA	NA	NA	NA	–	–	–	–	–	–	NA	NA	NA	NA	–	–	Nil	Nil
Normal	500 kV NKI - K2/K3	31	NA	NA	41	2,019	535	30	NA	NA	NA	NA	539	60	543	30	–	–	NA	NA	NA	NA	–	–	Nil	Nil
N-1		–	NA	NA	–	NP	–	–	NA	NA	NA	NA	–	–	–	–	–	–	NA	NA	NA	NA	–	–	Nil	Nil

NP: Not Provided

Total No. of Variations (Normal)	74	0	0	123	6,149
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	73	0	0	123	6,149

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Hyderabad Region

6. 500kV Grid Station SHIKARPUR

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	500 kV Shikarpur - Guddu Ckt I	970	827	1,051	822	737	545	120	550	180	543	120	543	180	549	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Shikarpur - Guddu Ckt II	973	828	1,035	845	843	545	120	550	180	543	120	543	180	549	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Shikarpur - Dadu Ckt I	965	832	1,043	849	723	548	120	550	180	543	120	543	180	549	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	500 kV Shikarpur - Dadu Ckt II	905	829	1,034	819	741	548	120	550	180	543	120	543	180	549	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Shikarpur - Guddu Ckt I	869	1,249	1,486	1,472	1853	242	120	245	180	242	150	242	180	247	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Shikarpur - Guddu Ckt II	1,031	1,099	1,439	125	1603	245	120	248	120	242	180	241	120	248	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Shikarpur - Uch Ckt I	831	1,278	1,529	1,544	1591	242	120	245	180	242	150	242	240	248	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Shikarpur - Uch Ckt II	1,029	1,131	1,595	1,602	1612	241	240	248	120	242	150	243	120	248	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Shikarpur - Rohri I	1,016	1,107	1,644	1,595	1594	242	120	247	120	242	180	243	120	248	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV Shikarpur - Rohri II	1,013	1,131	1,638	1,601	1591	242	330	248	120	242	180	243	120	248	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	9,602	10,311	13,494	11,274	12,888
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	9,602	10,311	13,494	11,274	12,888

Highest Voltage Under Normal Condition @220kV/500kV level

NTDC Hyderabad Region

7. 220kV Grid Station DAHARKI

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Dharki - Engro	582	589	620	620	1057	250	120	251	60	247	60	254	60	246	180	NA	NA	NA	NA	200	120	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	NA	NA	NA	NA	–	–	–	–	–	–
Normal	220 kV Ddharki - FPCDL	583	589	625	625	1059	250	120	252	120	247	60	254	60	246	180	NA	NA	NA	NA	200	120	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	NA	NA	NA	NA	–	–	–	–	–	–

Total No. of Variations (Normal)	1,165	1,178	1,245	1,245	2,116
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	1,165	1,178	1,245	1,245	2,116

Highest Voltage Under Normal Condition @220kV level

NTDC Hyderabad Region

8. 220kV Grid Station HALA ROAD

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Jamshoro - Hala Road Ckt I &II	10	2	NA	1	230	238	270	240	30	NA	NA	245	90	245	180	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	NA	NA	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	10	2	NA	1	230
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	10	2	NA	1	230

Highest Voltage Under Normal Condition @220kV level

NTDC Hyderabad Region

9. 220kV Grid Station ROHRI

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Rohri - Shikarpur I&II	920	1088	2,552	1,541	1,880	246	60	247	60	244	120	248	120	246	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–			–	–	–	–	–	–	–	–	–	–
Normal	220 kV Rohri - Engro I & II	48	412	2,552	1,525	1,896	244	60	247	120	244	120	248	120	246	120	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–		–	–	–	–	–	–	–	–			–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	968	1,500	5,104	3,066	3,776
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	968	1,500	5,104	3,066	3,776

Highest Voltage Under Normal Condition @220kV level

NTDC Hyderabad Region

10. 220kV Grid Station T.M. KHAN ROAD

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV T.M.Khan - Jamshoro I & II	2568	912	1,186	707	1008	243	60	245	60	242	60	243	60	243	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	220 kV T.M.Khan - Jhimpir I & II	2640	912	1,186	722	937	243	60	245	60	242	60	243	60	242	60	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Total No. of Variations (Normal)	5,208	1,824	2,372	1,429	1,945
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	5,208	1,824	2,372	1,429	1,945

Highest Voltage Under Normal Condition @220kV level

NTDC Hyderabad Region

11. 220kV Grid Station JHIMPIR-I

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Jhimpir - T.M.Khan I& II	830	202	410	202	4505	245	120	249	60	246	60	246	60	245	60	–	–	–	–	–	–	202	60	137	60
N-1		Nil	Nil	Nil	Nil	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV JMP I - JMP-II	-	-	-	101	3676	–	–	–	–	–	–	246	60	245	60	–	–	–	–	–	–	202	60	137	60
N-1		-	-	-	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil

Total No. of Variations (Normal)	830	202	410	303	8,181
Total No. of Variations (N-1)	-	–	–	–	–
Total (Normal & N-1)	830	202	410	303	8,181

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Hyderabad Region

12. 220kV Grid Station JHIMPIR-II

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Jhimpir II - Jamshoro 1 & 2	-	-	-	137	336	-	-	-	-	-	-	248	60	244	60	-	-	-	-	-	-	203	60	-	-
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220KV Jhimpir 2 - KDA-I & 2	-	-	-	137	328	-	-	-	-	-	-	248	60	244	60	-	-	-	-	-	-	203	60	-	-
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220 kV Jhimpir 2 - Jhimpir I	-	-	-	122	157	-	-	-	-	-	-	248	60	244	60	-	-	-	-	-	-	203	60	-	-
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Total No. of Variations (Normal)	–	–	–	396	821
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	–	–	–	396	821

Highest Voltage Under Normal Condition @220kV level

NTDC Hyderabad Region

13. 220kV Grid Station Switchyard Guddu

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220kV Guddu-Shikarpur-I	-	-	-	1474	1530	-	-	-	-	-	-	242	240	246	120	-	-	-	-	-	-	-	-	-	-
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220kV Guddu-Shikarpur-II	-	-	-	125	1378	-	-	-	-	-	-	241	120	247	210	-	-	-	-	-	-	-	-	-	-
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Normal	220kV Guddu-Sibbi D/Circuit	-	-	-	1541	1448	-	-	-	-	-	-	242	240	246	120	-	-	-	-	-	-	-	-	-	-
N-1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Total No. of Variations (Normal)	–	–	–	3140	4356
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	–	–	–	3140	4,356

Highest Voltage Under Normal Condition @220kV level

Voltage violations data - detailed circuit wise analysis

NTDC Quetta Region

1. 220 kV Dera Murad jamali
2. 220 kV Khuzdar
3. 220 kV Loralai
4. 220 kV Quetta
5. 220 kV Sibbi

NTDC Quetta Region

1. 220kV Grid Station Dera Murad Jamali

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV D. M. Jamali - Uch	2205	Nil	1,671	750	2846	241	120	Nil	Nil	241	60	243	60	256	60	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
N-1		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Normal	220 kV D. M. Jamali - Sibbi	2625	Nil	1,604	747	2846	241	120	Nil	Nil	241	60	243	60	256	60	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
N-1		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Total No. of Variations (Normal)	4830	–	3275	1,497	5692
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	4830	–	3275	1497	5,692

Highest Voltage Under Normal Condition @220kV level

NTDC Quetta Region

2. 220kV Grid Station KHUZDAR

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
							2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
		2019-20	2020-21	2021-22	2022-23	2023-24	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Dadu - Khuzdar I & II	1966	2772	3,520	1,100	755	248	60	250	60	245	60	248	60	248	60	180	60	–	–	178	60	175	60	180	35
N-1		–	–	–	–	2	–	–	–	–	–	–	–	–	Nil	Nil	–	–	–	–	–	–	–	–	195	30

Total No. of Variations (Normal)	1,966	2,772	3,520	1,100	755
Total No. of Variations (N-1)	–	–	–	–	2
Total (Normal & N-1)	246	2,772	3,520	1,100	757

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Quetta Region

3. 220kV Grid Station LORALAI

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Loralai - D.G. Khan I & II	2188	1930	3,138	1,324	1737	250	120	245	60	256	120	247	120	270	60	195	60	–	–	198	60	198	180	137	60
N-1		252	134	128	880	172	255	60	250	60	255	60	260	60	258	180	190	180	–	–	190	120	189	60	188	60

Total No. of Variations (Normal)	2,188	1,930	3,138	1,324	1,737
Total No. of Variations (N-1)	252	134	128	880	172
Total (Normal & N-1)	2,440	2,064	3,266	2,204	1,909

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

NTDC Quetta Region

4. 220kV Grid Station QUETTA

Condition	Name of Transmission Circuit(s) violating the voltage criteria	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Sibbi - Quetta Ckt I & II	5702	12011	1,948	1,948	2474	–	–	239	60	242	60	248	60	254	60	176	60	180	60	170	60	180	60	175	60
N-1		4,848	3,023	–	–	749	–	–	245	60	–	–	–	–	Nil	Nil	–	–	170	60	168	60	–	–	175	60

Total No. of Variations (Normal)	5,702	12,011	1,948	1,948	2,474
Total No. of Variations (N-1)	4,848	3,023	–	–	749
Total (Normal & N-1)	####	15,034	1,948	1,948	3,223

Highest Voltage Under Normal Condition @220kV level

Lowest Voltage Under Normal Condition @220kV level

Lowest Voltage Under N-1 Condition @220kV level

NTDC Quetta Region

5. 220kV Grid Station SIBBI

Condition	Name of Transmission cuit(s) violatin Voltage criter	Total Number / Times violating the limit					Highest Voltage Recorded (kV) / Time (Min)										Lowest Voltage Recorded (kV) / Time (Min)									
		2019-20	2020-21	2021-22	2022-23	2023-24	2019-20		2020-21		2021-22		2022-23		2023-24		2019-20		2020-21		2021-22		2022-23		2023-24	
							Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Sibbi - Quetta Ckt I&II	1554	1400	1,622	1,600	3042	241	60	243	60	244	60	245	60	245	60	205	60	–	–	200	120	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV Uch-Sibbi-I	1554	1160	1,557	1,355	3095	250	60	245	60	246	60	247	60	247	60	207	60	–	–	200	120	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Sibbi - Uch Ckt II	1554	1160	1,557	NP	Nil	250	60	245	60	246	60	NP	NP	NP	NP	207	60	–	–	200	120	NP	NP	Nil	Nil
N-1		–	–	–	NP	Nil	–	–	–	–	–	–	NP	NP	NP	NP	–	–	–	–	–	–	NP	NP	Nil	Nil
Normal	220KV Guddu-Sibbi	1514	1160	1,557	1,355	2727	250	60	245	60	246	60	247	60	247	60	207	60	–	–	200	120	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220 kV Sibbi - Uch DC Ckt	1505	1160	1,557	–	Nil	250	60	245	60	246	60	–	–	–	–	206	60	–	–	200	120	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV D.M.Jamali-Sibbi	1505	1160	1,557	1,355	2946	250	60	245	60	246	60	247	60	247	60	207	60	–	–	200	120	–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Nil	Nil
Normal	220KV Uch-II Ckt-I	–	–	–	1,355	2,068	–	–	–	–	–	–	247	60	247	60							–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–							–	–	Nil	Nil
Normal	220KV Uch-II Ckt-II	–	–	–	1,355	1,907	–	–	–	–	–	–	247	60	247	60							–	–	Nil	Nil
N-1		–	–	–	–	Nil	–	–	–	–	–	–	–	–	–	–							–	–	Nil	Nil

Total No. of Variations (Normal)	9,186	7,200	9,407	8,375	15,785
Total No. of Variations (N-1)	–	–	–	–	–
Total (Normal & N-1)	9,186	7,200	9,407	8,375	15,785

Highest Voltage Under Normal Condition @220kV level