2016-17

Performance Evaluation Report

Based on Reported Data of
K-Electric (KE)
With a comparison to 2011-12 through 2015-16
As per Performance Standards (Transmission) Rules 2005

National Electric Power Regulatory Authority

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PERFORMANCE EVALUATION REPORT 2016-17

EXECUTIVE SUMMARY

0 EXECUTIVE SUMMARY

National Electric Power Regulatory Authority (NEPRA) is the sole regulator of power sector in Pakistan. Provision of safe, reliable, efficient and affordable electric power to the electricity consumers is an integral part of NEPRA's regulatory regime.

In order to encourage safe, efficient and reliable transmission service, NEPRA has framed the Performance Standards (Transmission) Rules 2005 (PSTR)[1]. Under PSTR, each transmission licensee is required to submit to NEPRA an Annual Performance Report (APR) in a manner as prescribed in the PSTR. These performance reports are analyzed by NEPRA in light of the performance parameters such as System duration of interruption, System frequency of interruption, Energy not served (ENS), Loss of supply incidents and its financial impact, System Collapses/Splitting, Voltage and Frequency variation violating limits prescribed in PSTR.

The APR for the year 2016-17, submitted by K-Electric (KE), was reviewed on the basis of these parameters. Highlights of the analysis/findings are given below:-

System duration of interruption: System duration of interruption is a reliability indicator that measures the average outage duration that an interconnection point observes in a year. The interruption was witnessed around 1.01 Hours (60.6 minutes) which shows a decrease of (31.3%) as compared to preceding year's 1.47 Hours (1 Hour & 28.2 minutes).

System frequency of interruption: System frequency of interruption is a reliability parameter that measures the average number of outages per circuit in a year. It has been observed that average number of outages per circuit for KE is 0.30, showing a decrease of (6.3%) over the previous year i.e. 0.32.

Energy not served (ENS): In order to gauge system security, the estimates of total ENS during the year as reported by the licensee has been analyzed. The total ENS as reported by KE is 2.85 million kWh. Based on the average energy sale rate[2] of KE, the financial impact amounts to around **Rs. 36.5 million.**

Loss of supply incidents: KE has reported 10 incidents of loss of supply during the year 2016-17 which translates into total duration of 7.1 hours. Based on this, incident wise average ENS, average duration along with financial impact has been assessed for KE. The detail is given below:-

▼ Description / Unit / Year ►	Unit	2014-15	2015-16	2016-17
Loss of Supply Incidents	Nos.	10	10	10
Average ENS per Incident	Million kWh	0.546	0.481	0.285
Average Duration per Incident	Hrs : Min	01 : 06	01 : 00	00: 43
Financial Impact per Incident	Rs. (Million)	8.2	6.24	3.65

[1] Under section 46 of the Regulation of Generation, Transmission and Distribution of Electric Power Act 1997 (XL of 1997), read with section 7 (2) (c) and section 34 thereof, the National Electric Power Regulatory Authority, with the approval of Federal Government, has made the Performance Standards (Transmission) Rules (PSTR) notified vide S.R.O 1138(I)/2005 dated 15th November, 2005.

[2] KE's Average energy sale rate 2016-17 = Rs. 12.82/kWh.

PERFORMANCE EVALUATION REPORT 2016-17

INTRODUCTION

1 Introduction

This Performance Evaluation Report (PER) provides information on the performance of the transmission licensee, K-Electric (KE) as per National Electric Power Regulatory Authority (NEPRA) Performance Standards (Transmission) Rules (PSTR) 2005[3], based on their reported data for the year 2016-17.

The document, moreover, takes account of system reliability, security of supply and quality of supply of the transmission network of the licensee during the reported period. Comparison over the last six years has also been provided in this regard.

1.1 Reporting Requirement

In accordance with Rule 9 of PSTR 2005, the licensee shall submit to the Authority every year, before the 31st of August of the succeeding year, an Annual Performance Report (APR). The APR shall contain all relevant information with respect to compliance with these rules during the year, including a statement of comparison with the compliance reporting achieved during the preceding year. The reporting guidelines are provided under Rule 10 of PSTR 2005.

1.2 Compliance

In pursuance of Rule 6 of PSTR 2005, the quality of supply shall be measured with reference to system voltage and system frequency.

1.2.1 Rule 7 of PSTR 2005 (System Voltage)

1) *Under normal conditions the voltage variations of plus or minus ±5% of the nominal voltage for voltages of 132kV (where applicable) and above shall be permitted.*
2) *Under (N-1) contingency conditions voltage variations of plus or minus ±10% of the nominal voltage for voltages of the 132kV (where applicable) and above shall be permitted.*
3) *The criteria for reporting voltage variations outside the limits specified in sub-rules (2) and (3) only apply when the duration of variation exceeds a continuous period of thirty (30) minutes.*

1.2.2 Rule 8 of PSTR 2005 (System Frequency)

1) *The frequency variations of plus or minus ±1% of the nominal frequency of 50 Hertz shall be permitted, i.e. frequency to remain within the frequency limits of 49.50 to 50.50 Hertz at all times.*
2) *The criteria for reporting frequency variations outside the limits specified in sub-rule (1) only apply when the duration of the variation exceeds a continuous period of five (5) minutes.*

[3] In exercise of the powers conferred by section 46 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 (XL of 1997), read with clause (c) of sub section (2) of section 7 and section 34 thereof, the National Electric Power Regulatory Authority, with the approval of Federal Government, has made the Performance Standards (Transmission) Rules (PSTR) notified vide S.R.O. 1138(I)/ 2005 dated 15th November, 2005.

Available at: http://www.nepra.org.pk/Legislation/Rules/Performance%20Standards%20(Transmission)%20Rules%202005.pdf

1.3 Performance Overview

An overview of the performance of NTDC is given hereunder in light of the reported data;

System Reliability

Average Duration of Interruption

1. Total outages hours recorded at all interconnection points (excluding 132 kV line tripping) = **7.10 Hrs**
2. Total number of interconnection points = **7**
3. System duration of interruption = 7.10÷7 = **1.01 Hrs/point** i.e. **60.6 min.**

   Indicates a 31.3% decrease over the previous year i.e. ***1.47 Hrs/point (1 Hr & 28.2 min)***

Average Frequency of Interruption

1. Total number of outages recorded at all 132 kV outgoing circuits (excluding 132 kV line tripping) = **10**
2. Total number of 132 kV circuits = 33
3. System frequency of interruption = 10÷33 = **0.30 Nos./circuit**

   Indicates a 6.3% decrease over the previous year i.e. ***0.32 Nos./circuit***

System Security

Energy Not Served (ENS)

1. Total ENS = **2.85 Million kWh**
2. Number of incidents, where there has been a loss of supply = **10**
3. Average ENS per incident = **0.285 million kWh**
4. Average duration per incident = **43 min**
5. Financial impact of ENS = **Rs. 36.5 Million**
6. Financial impact of per incident = **Rs. 3.65 Million**

Quality of Supply

Voltage

1. Total number of violations under normal conditions = **Nil**
2. Total number of violations under N-1 conditions = **7**
3. Total number of violations under Normal & N-1 conditions = **7**
4. Lowest voltage recorded under N-1 conditions = **114 kV**
5. As reported, no highest voltage violation recorded for 220 kV & 132 kV.

Frequency

1. Number of times frequency remained outside the limits in a year = **5**
2. Time duration the frequency remained outside the limits in a year = **1 Hrs & 4 min.**
3. %age time of the year the frequency remained outside the limits = **0.012% time of the year**
4. Maximum continuous period of deviation = **38 min**
5. Highest frequency recorded = **50.60 Hz**
6. Lowest frequency recorded = **49.30 Hz**

Allowable limits: 49.5 Hz – 50.5 Hz

2 Brief about KE

K-Electric (KE) formerly known as Karachi Electric Supply Company was established on September 13, 1913 under the Indian Companies Act of 1882 as the Karachi Electric Supply Corporation (KESC). The entity was nationalized in 1952 and re-privatized on November 29, 2005. In September, 2008 it was renamed as Karachi Electric Supply Company (KESC). Thereafter, it was rebranded as K-Electric.

2.1 Licence

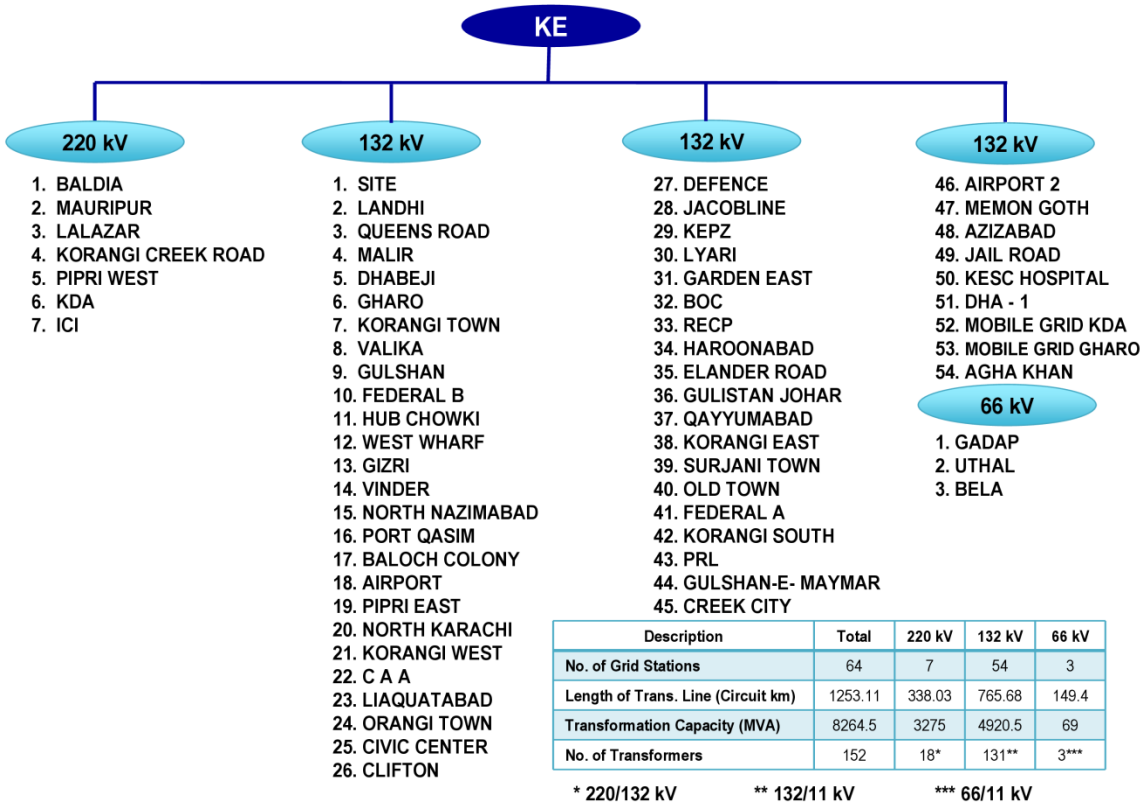
K-Electric was granted transmission licence on 11th June 2010 by National Electric Power Regulatory Authority (NEPRA) to engage in the exclusive transmission business for a term of twenty (20) years, pursuant to section 17 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

2.2 Transmission Network

K-Electric's transmission system comprises a total of 1,253 km of 220 kV, 132 kV and 66 kV transmission lines with 64 grid stations, 14 Auto Transformers and 138 power transformers, as of June 2017. K-Electric grid is interconnected with the NTDC grid system through four (04) 220 kV transmission circuits, namely;

i. KDA-NKI
ii. Baldia-NKI
iii. KDA-Jamshoro-1
iv. KDA-Jamshoro-2

Figure 2.1: KE transmission system (2016-17)



Description	Total	220 kV	132 kV	66 kV
No. of Grid Stations	64	7	54	3
Length of Trans. Line (Circuit km)	1253.11	338.03	765.68	149.4
Transformation Capacity (MVA)	8264.5	3275	4920.5	69
No. of Transformers	152	18*	131**	3***

* 220/132 kV ** 132/11 kV *** 66/11 kV

PERFORMANCE EVALUATION REPORT 2016-17

ANALYSIS OF

ANNUAL PERFROAMCE REPORT

3 Analysis of Annual Performance Report (APR)

The APR submitted by KE has been evaluated in light of the PSTR 2005. The detail of which is as under;

3.1 System Reliability

3.1.1 System Duration of Interruption

The total outages hours recorded at all interconnection points are 7.1 that amounts to 31.3% decrease in comparison to the preceding year's 10.32 hours. However, number of interconnection points has remained the same.

The average duration of interruption per interconnection point during the reported period remained 1.01 hours (60.6 minutes). This indicates a 6.3% decrease over the previous year's 1.47 hours (1 hour & 28.2 minutes).

All these system parameters are shown in figures 3.1, 3.2 and 3.3 respectively.

Figure 3.1
A. Total outages hours recorded at all interconnection points (excluding 132 kV line tripping)
B. Total number of interconnection points

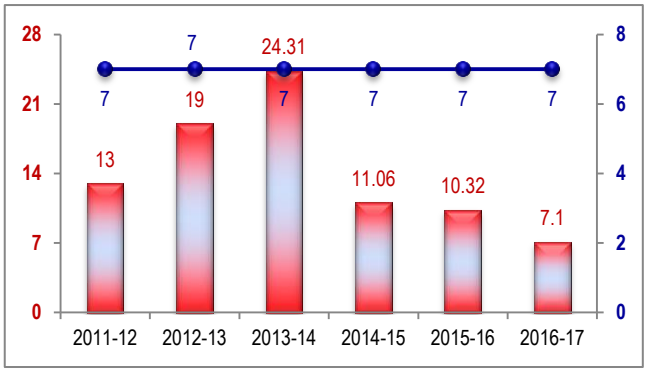
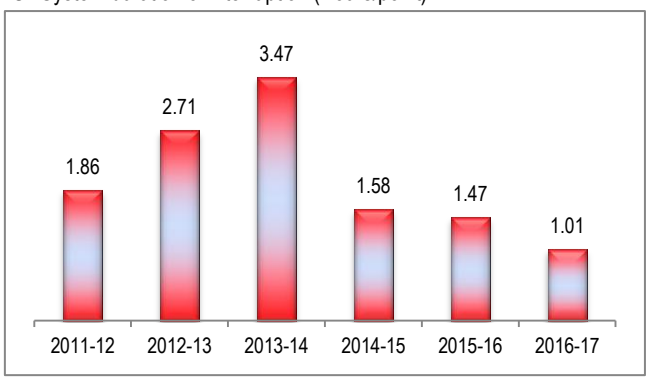


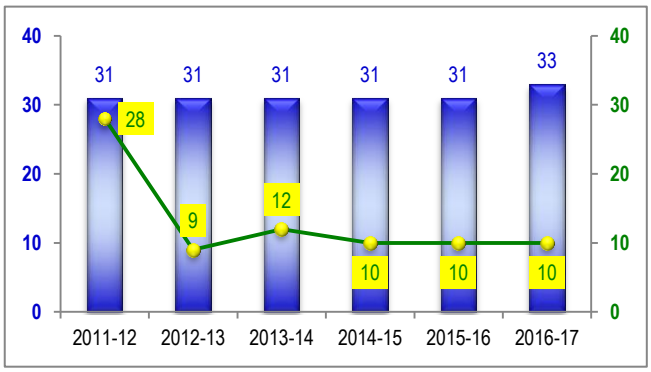
Figure 3.2
C. System duration of interruption (Hours/point) = A÷ B



3.1.2 System Frequency of Interruption

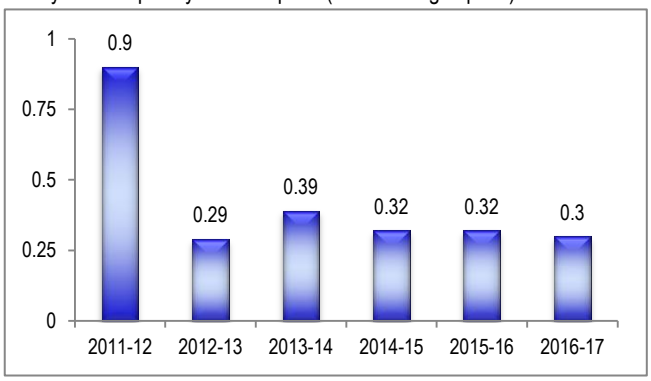
The total number of outages remained the same as compared to previous year i.e. 10, as shown in figure 3.3. However, 2 numbers 132 kV outgoing circuits have been added to the system.

Figure 3.3
D. Total number of outages recorded at all 132 kV outgoing circuits (excluding 132 kV line tripping)
E. Total number of 132 kV circuits



The average number of interruptions per circuit during the reported period is 0.30 that indicates 6.3 % reduction in comparison to the preceding year's 0.32 as shown in figure 3.4.

Figure 3.4
F. System frequency of interruption (No. of outages/point) = D÷ E



3.2 System Security

In order to gauge system security, the estimates of total energy not served (ENS) during the reported period has been analyzed. The total ENS as reported by KE is 2.85 million kWh. Based on the average energy sale rate[4] of KE, the financial impact of 2.85 million kWh, amounts to approximately Rs. 36.5 million. Reported ENS is given hereunder;

Table 3.1: Reported ENS

Unit / Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Million kWh	7.393	7.081	6.765	5.459	4.808	2.85

Number of incidents, where there has been a loss of supply, average ENS per incident, average duration per incident and financial impact per incident assessed is given in table 3.2 below.

Table 3.2: Loss of supply incidents, average ENS, duration & financial impact per incident

Description / Unit / Year	Unit	2014-15	2015-16	2016-17
Loss of Supply Incidents	Nos.	10	10	10
Average ENS per Incident	Million kWh	0.546	0.481	0.285
Average Duration per Incident	Hrs : Min	01 : 06	01 : 00	00: 43
Financial Impact per Incident	Rs. (Million)	8.2	6.24	3.65

The ENS trend and average ENS per incident & average duration per incident are shown in the following figures.

Figure 3.5: ENS trend (million kWh)

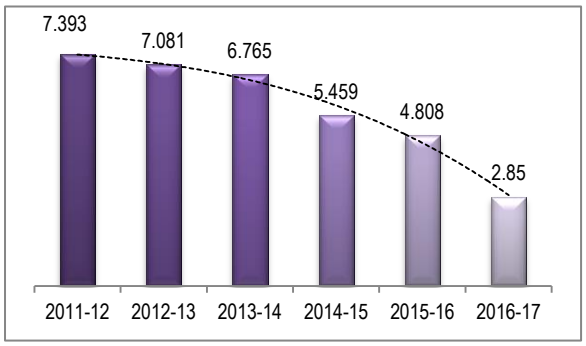
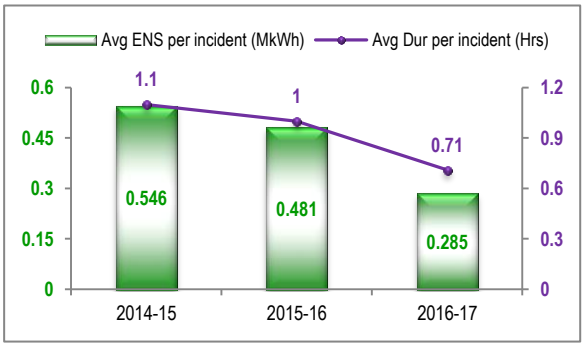


Figure 3.6: Average ENS & duration per incident



[4] NTDC tariff determination 2015-16 & 2016-17

3.3 Quality of Supply

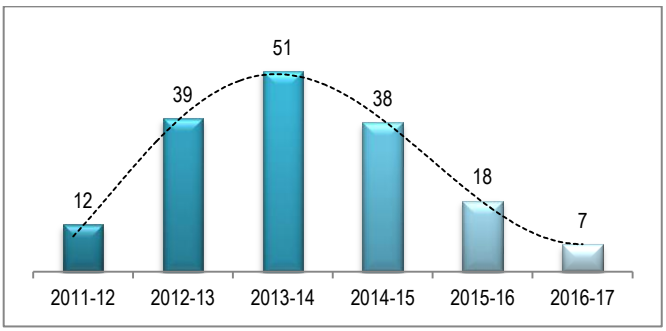
Quality of supply (QoS) is measured with reference to system voltage and system frequency (see section 1.2.1). The analysis of QoS data as reported by KE is given hereunder:

3.3.1 System Voltage

The data pertaining to number of voltage violations as submitted by KE was analyzed and it was observed that no violation has been occurred at 220 kV level both under normal and N-1 conditions. Also at 132 kV level, limits have been violated under N-1 condition only.

Figure 3.7 shows the historical trend over the six years period. From year 2011-12 to year 2013-14, the number of voltage violations is increasing with respect to preceding years. However, 2013-14 onwards it is reducing accordingly. Circuit wise detail is given at appendix 1.

Figure 3.7: Number of voltage violations (KE)



3.3.2 System Frequency

The data as submitted by KE was analyzed and revealed that a total of 5 times the frequency limits were violated for a total duration of 64 minutes in the year 2016-17 that comes out to be approximately 0.012% of the reported period. The following table shows statistics of system frequency over the reported period.

Table 3.3: KE System frequency statistics (2016-17)

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	Minutes	Hours	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
July	31	744	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Aug	31	744	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Sep	30	720	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
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	50.60	Nil	6	0.1	0.2	Nil	Nil	1
Feb	28	672	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Mar	31	744	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Apr	30	720	Nil	49.30	38	0.63	Nil	-0.4		1
May	31	744	50.60	Nil	7*	0.12	0.2	Nil	Nil	3
June	30	720	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Year	**365**	**8760**	**50.60**	**49.30**	**64**	**1.07**	**0.2**	**-0.4**	**0.012**	**5**

Note: Shaded figures show highest & lowest frequency recorded and %age variation
*Duration of variation over complete month = 20 minutes

The figures below show KE's month wise reported highest & lowest frequency for the year 2016-17. The dotted red line shows the prescribed limits (upper 50.5 Hz & lower 49.5 Hz) as per PSTR 2005. Break in the plot indicates 'no violation'. Historical data as reported by KE is given at appendix 2.

Figure 3.8: Highest frequency recorded (Hz)

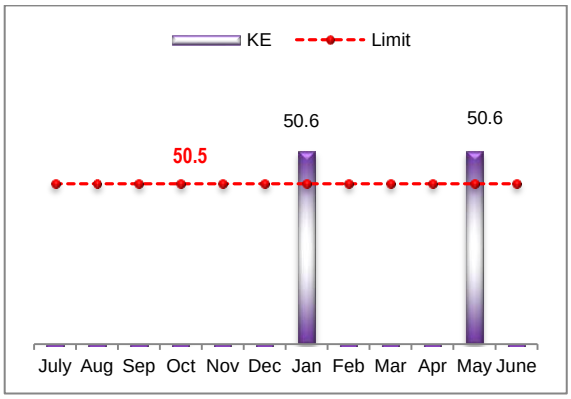
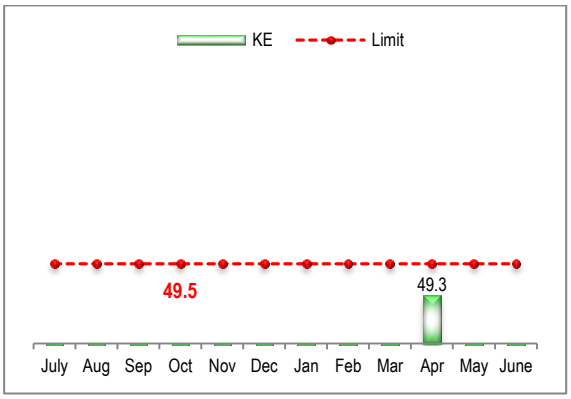


Figure 3.9: Lowest frequency recorded (Hz)



PERFORMANCE EVALUATION REPORT 2016-17

APPENDICES

Appendix 1

QoS data – KE's detailed circuit wise analysis

K-Electric System

Circuit Wise Number of Voltage Variations Violating Criteria

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)											
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2011-12		2012-13		2013-14		2014-15		2015-16		2016-17	
								Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	220 kV Baldia - Mauripur	–	–	–	Nil			–	–	–	–	–	–	Nil						–	–	–	–	–	–	Nil					
N-1		–	–	–				–	–	–	–	–	–							–	–	–	–	–	–						
Normal	132 kV Surjani - Maymar	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	122	NP	117	NP	116	NP	–	–	–	–	–	–
N-1		–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114		–	–	–	–	–	–
Normal	132 kV Surjani - Valika	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	122	NP	117	NP	114	NP	–	–	–	–	–	–
N-1		–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		112		–	–	–	–	–	–
Normal	132 kV SITE - SGT 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV SITE - SGT 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV KDA - Federal B	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119	NP	119	NP	116	NP	115	NP	–	–	–	–
N-1		–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		113		114		117.4	147	–	–
Normal	132 kV Valika - N. Karachi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Gulshan - Civic	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119	NP	113	NP	–	–	–	–	–	–
N-1		–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	113		–	–	–	–	–	–
Normal	132 kV West Wharf - Lyari	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119	NP	–	–	–	–	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Qayyumabad - K. East	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118	NP	116	NP	122	NP	112	NP	–	–	–	–
N-1		–	–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114		116		117.1	280	114	48
Normal	132 kV Memon Goth - Malir	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	120	NP	114	NP	114	NP	–	–	–	–	–	–
N-1		1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		118		116		–	–	–	–	–	–
Normal	132 kV Malir - CAA	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	120	NP	114	NP	114	NP	–	–	–	–	–	–
N-1		1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		115		115		–	–	–	–	–	–
Normal	132 kV Gulshan - Hospital	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	122	NP	116	NP	113	NP	–	–	–	–	–	–
N-1		1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		–	–	113		–	–	–	–	–	–
Normal	132 kV Gharo - RECP	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	123	NP	120	NP	118	NP	121	NP	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV BOC - Dhabeji	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	122	NP	118	NP	121	NP	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

NP: Not Provided

K-Electric System

Circuit Wise Number of Voltage Variations Violating Criteria

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)											
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2011-12		2012-13		2013-14		2014-15		2015-16		2016-17	
								Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	132 kV Dhabeji - Gharo	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	120	NP	118	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV KDA - Memon Goth	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119	NP	116	NP	115	NP	–	–	–	–
N-1		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114		–	–	–	–
Normal	132 kV KDA - Johar	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	113	NP	116	NP	115	NP	–	–	–	–
N-1		–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		113		114		117.4	147	–	–
Normal	132 kV Johar - Hospital	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	113	NP	111	NP	–	–	–	–	–	–
N-1		–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		111		–	–	–	–	–	–
Normal	132 kV KDA - Gulshan	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	116	NP	115	NP	–	–	–	–
N-1		–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		113		114		117.4	147	–	–
Normal	132 kV KDA - Maymar	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	117	NP	116	NA	115	NP	–	–	–	–
N-1		–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		113		114		117.4	147	–	–
Normal	132 kV Federal B - Valika	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119	NP	122	NA	–	–	–	–	–	–
N-1		–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	112		–	–	–	–	–	–
Normal	132 kV Haroonabad - Liaquatabad	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Valika - Nazimabad	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	111	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Gulshan - Jalil Road	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	117	NP	113	NP	–	–	–	–	–	–
N-1		–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		113		–	–	–	–	–	–
Normal	132 kV Gulshan - Azizabad	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	113	NP	–	–	–	–	–	–
N-1		–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	117		113		–	–	–	–	–	–
Normal	132 kV Mauripur - Haroonabad	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	117	NP	112	NP	–	–	–	–
N-1		–	1	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		116		118		117.4	331	116.8	56
Normal	132 kV Haroonabad - Nazimabad	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	114	NP	–	–	–	–	–	–
N-1		–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114		–	–	–	–	–	–	–	–
Normal	132 kV Korangi West - Defence	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118	NP	122	NP	115	NP	–	–	–	–
N-1		–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	115		117.1	280	114	48
Normal	132 kV Pipri West - Port Qasim	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	121	NP	–	–	116.9	78	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

NP: Not Provided

K-Electric System

Circuit Wise Number of Voltage Variations Violating Criteria

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)											
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2011-12		2012-13		2013-14		2014-15		2015-16		2016-17	
								Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	132 kV Pipri West - KEPZ	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	121	NP	–	–	116.9	78	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV KEPZ - Landhi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	120	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Gul Ahmed - Airport 1 & 2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	122	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV KTPS - PRL	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	120	NP	121	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV K. East - K. South	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114	NP	121	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Valika - North Nazimabad	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	–	–	–	–	–	–	–	–
N-1		–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	112	NP	–	–	–	–	–	–
Normal	132 kV Orangi - Valika	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	119	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Liaquatabad - Azizabad	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114	NP	115	NP	–	–	–	–	–	–
N-1		–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		117		–	–	–	–	–	–
Normal	132 kV Port Qasim - Landhi	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	120	NP	–	–	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Baldia - Orangi	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	124	NP	–	–	–	–
N-1		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		–	–	–	–
Normal	132 kV Baldia - Valika	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	124	NP	–	–	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Baldia - Hub	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	124	NP	–	–	–	–
N-1		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		–	–	–	–
Normal	132 kV Baldia - SGT - SITE	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	124	NP	–	–	–	–
N-1		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	118		–	–	–	–
Normal	132 kV K. West - Gizri - Baloch	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	115	NP	–	–	–	–
N-1		–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	114	48
Normal	132 kV Pipri - Korangi Town	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	121	NP	116.9	78	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

NP: Not Provided

K-Electric System

Circuit Wise Number of Voltage Variations Violating Criteria

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)											
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2011-12		2012-13		2013-14		2014-15		2015-16		2016-17	
								Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time	Voltage	Time
Normal	132 kV Pipri - Landhi	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	121	NP	116.9	78	–	–
N-1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Normal	132 kV Qayyumabad - DHA 1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	112	NP	–	–	–	–
N-1		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		–	–	–	–
Normal	132 kV Queen's Road - Clifton	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	–	–	–	–
N-1		–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		117.1	280	114	48
Normal	132 kV Queen's Road - Gizri	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	–	–	–	–
N-1		–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		117.1	280	114	48
Normal	132 kV Queen's Road - Elander Road	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	–	–	–	–
N-1		–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		–	–	–	–
Normal	132 kV Queen's Road - Old Town	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116	NP	–	–	–	–
N-1		–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116		117.1	280	114	48
Normal	132 kV Pipri / RECP / Gharo	Nil				1	–	Nil								–	–	–	–	Nil								116.9	78	–	–
N-1						–	–									–	–	–	–									–	–	–	–
Normal	132 kV Pipri / BOC / Dhabeji	Nil				1	–	Nil								–	–	–	–	Nil								116.9	78	–	–
N-1						–	–									–	–	–	–									–	–	–	–
Normal	132 kV KDA / Memon Goth /Malir	Nil				–	–	Nil								–	–	–	–	Nil								–	–	–	–
N-1						1	–									–	–	–	–									117.4	280	–	–
Normal	132 kV Korangi West / Baloch / Gizri	Nil				–	–	Nil								–	–	–	–	Nil								–	–	–	–
N-1						1	–									–	–	–	–									117.1	280	–	–

NP: Not Provided

Total No. of Variations (Normal)	9	27	32	22	6	Nil
Total No. of Variations (N-1)	3	13	18	16	12	7
Total of Normal & N-1	12	40	50	38	18	7

Lowest Voltage Under N-1 Condition

Appendix 2

System Frequency - Historical Data as Reported by KE

Historical System Frequency Data as Reported by KE

Month	Highest System Frequency Recorded Violating the prescribed Upper Limit[1] (Hz)					
	2011-12	2012-13	2013-14	2014-15	2015-16	206-17
July	50.61	50.60	51.15	50.58	50.60	Nil
Aug	50.96	51.05	51.70	50.64	Nil	Nil
Sep	50.90	50.65	51.70	50.51	Nil	Nil
Oct	50.46	50.65	51.69	50.53	Nil	Nil
Nov	50.55	50.57	51.93	50.55	Nil	Nil
Dec	50.57	50.76	51.68	50.82	50.60	Nil
Jan	50.61	50.80	51.15	50.54	50.70	50.60
Feb	50.56	50.59	51.10	50.51	Nil	Nil
Mar	50.90	50.72	51.91	50.58	Nil	Nil
Apr	50.28	51.08	51.28	50.51	Nil	Nil
May	51.25	51.49	51.06	50.57	50.60	50.60
June	50.78	51.55	51.72	50.52	Nil	Nil

Month	Lowest System Frequency Recorded Violating the prescribed Lower Limit[2] (Hz)					
	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
July	48.51	48.56	48.61	48.97	49.40	Nil
Aug	48.60	48.60	48.68	49.1	49.40	Nil
Sep	48.60	48.59	48.73	49.13	49.40	Nil
Oct	48.51	48.60	48.80	49.18	49.40	Nil
Nov	48.67	48.60	48.74	48.94	Nil	Nil
Dec	48.60	48.59	48.76	49.15	Nil	Nil
Jan	48.60	48.50	48.61	49.07	49.40	Nil
Feb	48.52	47.12	48.80	49.39	Nil	Nil
Mar	48.60	48.80	48.59	49.26	Nil	Nil
Apr	48.60	48.74	48.63	49.26	Nil	49.30
May	48.54	48.63	48.66	49.29	Nil	Nil
June	48.59	48.62	48.80	49.32	49.40	Nil

[1] Upper Limit: 50.50 Hz, Rule 8(1) of PSTR 2005
[2] Lower Limit: 49.50 Hz, Rule 8(1) of PSTR 2005