



भारत सरकार/Government of India
विद्युत मंत्रालय/Ministry of Power
केन्द्रीय विद्युत प्राधिकरण/Central Electricity Authority
विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग
Power System Engineering & Technology Development Division

दिनांक: 21.03.2025

सेवा में,

<as per attached list>

विषय: Report of the Standing Committee of Experts on failure of EHV transmission towers failed during the period January 2022 to December 2023-reg.

महोदया/महोदय,

A Standing Committee of Experts was constituted under Section 73, Clause (1) of the Electricity Act, 2003 to investigate the cause of failure of EHV Transmission towers and recommend remedial measures to avert failures in future. To discuss the cause of failures of the transmission line towers reported by various utilities to CEA, which had failed during the period from January 2022 to December 2023, a meeting of the Standing Committee of the Experts was held on 10/01/2024 in the Conference Room of NR-I Region Powergrid, Katwaria Sarai, New Delhi. The minutes of the meeting were issued vide CEA letter dated 08.02.2024.

In this regard, based on the deliberations during the meeting, and the recommendations of the Committee, the Report of the Standing Committee of Experts on failure of EHV transmission towers for the period January 2022 to December 2023 report has been prepared and is attached for your kind information and necessary action please.

भवदीय,


21/03/2025

(भंवर सिंह मीना /Bhanwar Singh Meena)

निदेशक/Director



**क्षतिग्रस्त ट्रांसमिशन लाइन टॉवरों पर विशेषज्ञों की स्थायी समिति की रिपोर्ट
(जनवरी 2022 - दिसंबर 2023)**

**REPORT OF THE STANDING COMMITTEE OF EXPERTS ON
FAILURE OF EHV TRANSMISSION TOWERS
(JANUARY 2022 - DECEMBER 2023)**



**भारत सरकार
केन्द्रीय विद्युत प्राधिकरण
विद्युत मंत्रालय
नई दिल्ली
Government of India
Central Electricity Authority
Ministry of Power
New Delhi**

(विद्युत अधिनियम, 2003 की धारा 73(1) के तहत के. वि.प्रा. के दायित्व का निर्वहन करते रहे)

(In fulfillment of CEA's obligation under Section 73(1) of the Electricity Act, 2003)

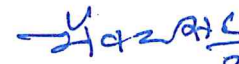
Acknowledgement

The report of the Standing Committee of Experts on Failure of EHV Transmission Line Towers has been brought out for the failures occurred in the period from January 2022 to December 2023. The prime objective of Standing Committee is to visit site of failure, investigate the cause of failure, discuss the cause of failure of various substation / switchyard equipment of Power utilities in the meeting, recommend remedial measures to prevent recurrence of such failures in future and prepare a compendium of all failures. This objective cannot be achieved without the help of the transmission utilities.

I would like to express my sincere thanks to the committee members, i.e., Additional Director, CPRI, Head of Department of Civil Engineering, DTU, Member Secretary of NRPC, ERPC, SRPC, WRPC, NERPC and also to PGCIL, IMD, Central Power Research Institute, Structural Engineering Research Center, BBMB, HVPNL, TSTRANSCO, M/s Sterlite Power, M/s Adani Transmission, M/s Indigrid, M/s UPPTCL, M/s AEGCL, , M/s RENEW for active participation and providing valuable inputs during deliberations of the Committee.

I am thankful to Shri Ghanshyam Prasad, Chairperson, CEA, for motivation and guidance from time to time. I am also thankful to Shri Ramesh Kumar, former Chief Engineer (PSE&TD), Shri NRLK Prasad, Chief Engineer I/c (PSE&TD) and Chairman of the Standing Committee for providing valuable suggestions to be adopted to avoid failures which have been incorporated in the report.

Furthermore I would also like to appreciate the efforts put in by Smt. Jyoti Singh, Deputy Directors (PSE&TD), CEA, Shri Amrendra Pratap Singh, Assistant Director (PSE&TD), CEA, in preparing this report.


21/03/2025

(Bhanwar Singh Meena)

Director (PSE&TD), CEA and
Member Secretary of the Standing Committee

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EXECUTIVE SUMMARY

1. INTRODUCTION:

- a) A Standing Committee of Experts in the field of design & operation of EHV Transmission lines was constituted by Central Electricity Authority in 1999 as per the Electricity (Supply) Act No. 54 of 1948 and re-composition of the Standing Committee was issued in 2012 (with representative from CEA, CPRI, DTU, RPCs and representative from Power Utilities), which continues to carry out investigation of failure of transmission line towers of Power utilities as per the Section 73(l) of the Electricity Act, 2003. Office order vide which Standing Committee was constituted is enclosed at **Annexure-A**. As per the requirement of the Standing Committee, all utilities / transmission licensees are supposed to report the failure of Towers of 220 kV and above voltage class transmission lines to CEA.

Further, Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2023 mandates that utilities shall inform to CEA regarding transmission system failures within forty-eight hours. Regulation 48(8) of Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2023 is given as under:

“48 (8) Failures of any 220 kV and above voltage level transformer, reactor and transmission line towers shall be reported by the owner of electrical installation, within forty eight hours of the occurrence of the failure, to the Authority and the reasons for failure and measures to be taken to avoid recurrence of failure shall be sent to the Authority within one month of the occurrence in the forms provided in Schedule VII:

Provided that in case of mines and oil-fields, the failure of 10 MVA or above transformers shall be reported to Electrical Inspector of mines.”

- b) The objective of Standing Committee is to investigate and analyze the probable causes of failure of towers of the transmission lines of power utilities in different parts of the country and recommend remedial measures to prevent repetition of such failures in future. In cases, where the visit to site of failure of tower does not

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materialize, analysis of failure is done based on the information provided by the Utilities and their participation in the Standing Committee's meeting.

- c) The failure cases of EHV transmission towers of different power utilities which are reported to CEA, are discussed during the meeting of Standing Committee of Experts and inferences are drawn in respect of causes of failure of the transmission tower based on site investigation report, information/data provided by the concerned utilities and deliberations during the meeting and various recommendations are made by the Committee to avert recurrence of such failures in future.
- d) The meeting of the Standing Committee of Experts was held on 10.01.2024 at POWERGRID, B-9, Qutub Institutional Area, Katwaria Sarai, New delhi-110016 to discuss the cause of failure of the transmission line towers of different voltage levels belonging to various power transmission utilities which had failed during the period from January 2022 to December 2023. During this period, the failure of towers of EHV transmission lines of various utilities [PGCIL, ADANI, AEGCL, INDIGRID, UPPTCL] were reported to CEA. Accordingly, the Committee discussed in detail the nature and causes of failure of towers of transmission lines of these utilities. Minutes of the meeting issued vide CEA letter dated 08.02.2024 are enclosed at **Annexure-B**.

2. BRIEF DETAILS OF FAILURE OF TOWERS OF VARIOUS TRANSMISSION LINES REPORTED TO CEA FROM JANUARY 2022 TO DECEMBER 2023:

- a) Failure of 40 Nos. of transmission towers in 22 transmission lines of 220 kV, 400 kV and 765 kV AC voltage class has been reported to CEA during the period of January 2022 to December 2023.

Si. No.	Name of the Transmission Line	Name of Utility	Date of Failure	Year of Commissioning	Wind Zone	No. of Towers Failed			Conductor
						Suspension	Tension	Total	
1.	400 kV S/C Gooty-Somanhalli Transmission line	POWER GRID	08.05.2022	1991	2	1	0	1	Twin Moose ACSR
2.	400 kV D/C Kahalgaon-Barh Transmission line	POWER GRID	19.05.2022	2007	4	4	0	4	Quad Moose ACSR
3.	765 kV D/C Aligarh-Jhatikara Transmission line	POWER GRID	23.05.2022	2016	4	1	1	2	Quad Bersimis ACSR
4.	400 kV D/C Koderma-Bokaro	POWER GRID	27.07.2022	2014	2	1	0	1	Twin Moose ACSR
5.	765 kV S/C Gwalior-Agra-I Transmission line	POWER GRID	25.08.2022	2009	4	0	1	1	ACSR Bersimis
6.	400 kV D/C Bokaro-Kodarma Transmission line	POWER GRID	30.08.2022	2014	2	1	0	1	Twin Moose ACSR
7.	400 kV D/C Silchar-Misa Transmission line Circuit-I and Circuit-II	NER-II TL/Indigri d	17.06.2022	2021	5	1	1	2	Twin Moose ACSR
8.	765 kV D/C Rajnandgaon-Bilaspur Transmission line	Adani TL	21.05.2022	2019	2	1	0	1	Hexa ZEBRA ACSR
9.	765 kV D/C Bikaner-Khetri Circui-I Transmission line	Adani TL	23.05.2022	2021	4	0	1	1	Hexa ZEBRA ACSR
10.	400 kV S/C Bikaner-Deedwana Transmission line	Adani TL	21.06.2022	2013	4	2	0	2	Twin Moose ACSR
Total (2022)						12	4	16	
11.	765 kV Bhiwani Phagi ckt 1, loc No. 476, Khetri Rajasthan	POWER GRID	07.05.2023	2015	4	1	0	1	Bersimis Conductor
12.	765 kV S/C Bina- Gwalior Ckt-3	POWER GRID	24.05.2023	2014	4	1	0	1	ACSR Bersimis

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13.	765 kV Bhiwani Phagi ckt 1, loc No. 476, Khetri Rajasthan	POWERGRID	25.05.2023	2015	4	5	2	7	Bersimis Conductor
14.	400 kV DC Mundra-Bhachau 1&2	POWERGRID	16.06.2023	2011	5	0	1	1	ACSR Snow Bird
15.	765 kV s/c Gaya Varanasi line	POWERGRID	19.06.2023	2012	4	1	0	1	ACSR Bersimis
16.	220 kV D/C Chamara III Chamba I & II	POWERGRID	09.07.2023	2011	2	0	2	2	MOOSE, Nominal Diameter: 31.77 mm
17.	220 kV D/C Anta-Bhilwara line	POWERGRID	17.08.2023	1989	4	1	0	1	Single Zebra Conductor
18.	400 kV D/C Ballabgarh-Gurgaon-CKT-I line	POWERGRID	07.09.2023	1988	4	2	2	4	Moose Conductor 31.77 mm diameter
19.	400 kV D/C Rangpo-Teesta-V TL	POWERGRID	04.10.2023	Jan 2008	4	0	2	2	MOOSE Conductor 31.77 mm diameter
20.	765 KV S/C AKOLA (2) – EKTUNI LINE – 1	Adani TL	09.04.2023 & 10.04.2023	08-04-2014	2	1	0	1	ACSR BERSIMIS CONDUCTOR
21.	220 kV D/C Rangia-Salakati line	AEGCL	21.06.2023	19/08/2019	5	0	1	1	AAAC Zebra
22.	220 KV D/C PGCIL (GORAKHPUR)-GOLA LINE	UPPTCL	23.05.2023	2021	4	0	2	2	ACSR ZEBRA
Total (2023)						12	12	24	
Total Transmission lines Tower failed:						24	16	40	

- b) The number of suspension and tension towers at various voltage levels, failed during the period of January 2022 to December 2023 and discussed in the Standing Committee meeting are indicated in Table-2 below:

Voltage Level	Utility	No. of affected Lines	No. of Towers failed					
			Suspensi on Towers	Tension Towers				Total No. of Towers failed
				A	B	C	D	
765 kV	POWERGRID	6	9	3	0	1	4	13
	ADANI	3	2	1	0	0	1	3
	TOTAL	9	11	4	0	1	5	16
400 kV	POWERGRID	7	9	1	0	4	5	14
	INDIGRID	1	1	0	0	1	1	2
	ADANI	1	2	0	0	0	0	2
	TOTAL	9	12	1	0	5	6	18
220 kV	POWERGRID	2	1	0	0	2	2	3
	AEGCL	1	0	1	0	0	1	1
	UPPTCL	1	0	0	2	0	2	2
	TOTAL	4	1	1	2	2	5	6

- c) It can be seen from the above Table that at 765 kV Voltage level Eleven (11) Numbers of Suspension Type Tower and Five (5) Numbers of Tension Type Tower have failed in Nine (9) Numbers of Transmission Lines, at 400 kV Voltage level Twelve (12) Numbers of Suspension Type Towers and Six (6) Numbers of Tension Type Towers have failed in Nine (9) Numbers of Transmission Line, and at 220 kV Voltage level One (1) Number of Suspension Type Tower and Five (5) Numbers of Tension Type Towers are failed in Four (4) Numbers of Transmission Line.

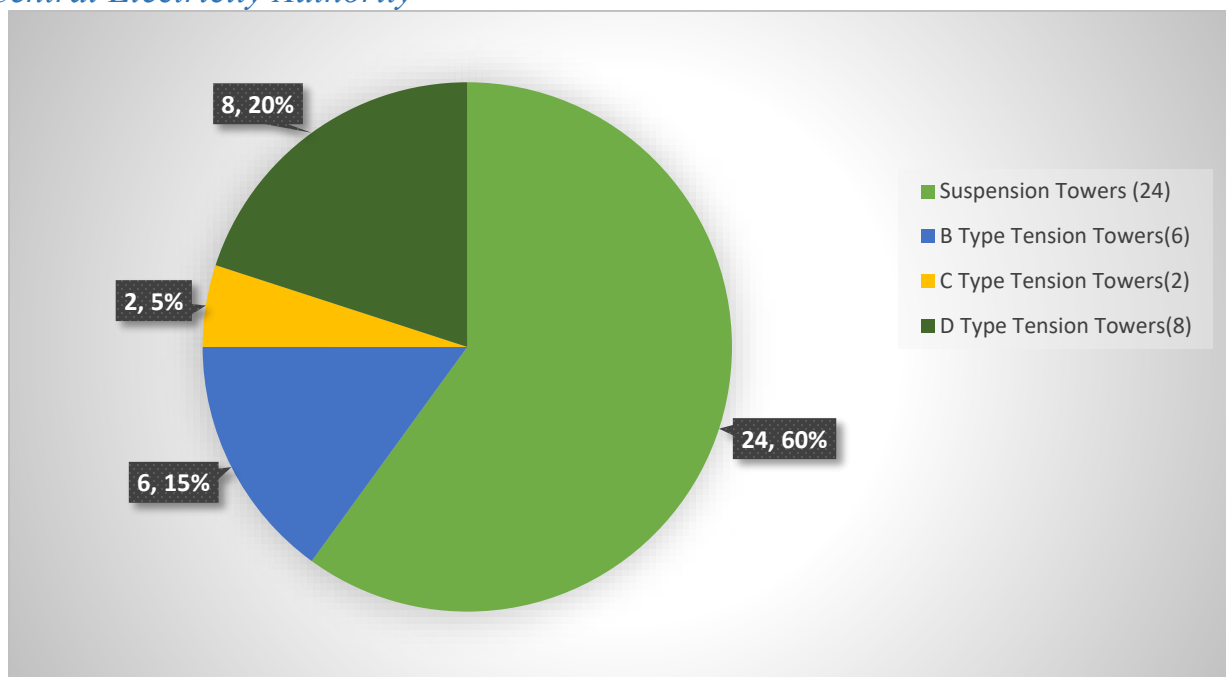


Fig. 1.

- d) It can be seen from Fig. 1 that out of total 40 numbers of Tower failure, 24 are of suspension type towers (60%) and 16 are of tension type towers (40%). Out of 16 Tension Type towers 6 are of Type B (15%), 2 are of Type C (5%) and 8 are of Type D (20%).
- e) It has been observed that the failure rate of suspension towers is much higher in comparison to tension towers. This may be because in normal terrain, generally, the No. of Suspension Type Towers in any particular line is much higher than that of Tension type towers. Further, the Suspension Type Towers are not designed to take horizontal forces in the longitudinal direction and hence the failures of one suspension type tower causes secondary failure of adjacent suspension towers due to the pulling force of conductors. In view of above, the loading criteria for the suspension type towers have been made more stringent and the longitudinal and transverse force acting on Suspension type towers under security condition has been increased in revised IS 802 (2015). However, as reported by the utilities, in some of the transmission lines the suspension towers were designed considering narrow front wind condition and with 75% wind in security condition.

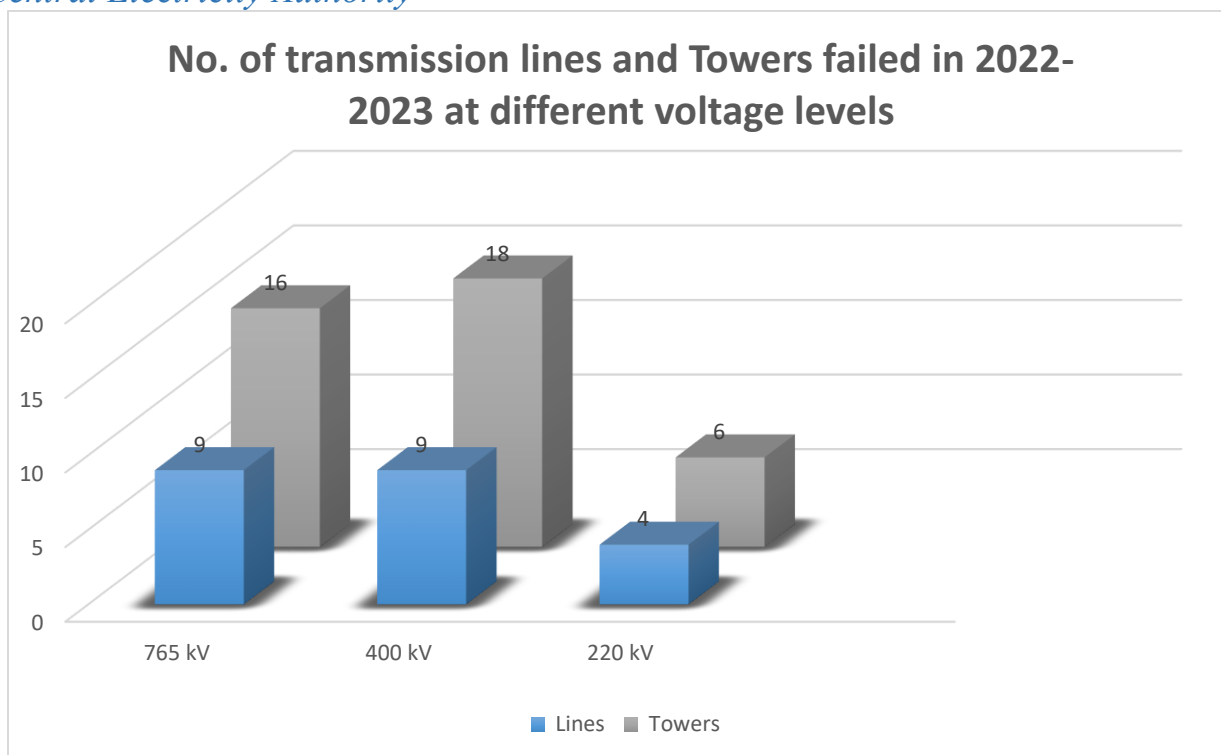


Fig. 2

- f) It can be seen from the above Fig. 2. that in 765 kV range 11 Suspension Towers and 5 Tension Towers are failed in 9 Transmission Lines, in 400 kV voltage range 12 Suspension Towers and 6 Tension Towers are failed in 9 Transmission Lines and in 220 kV voltage range 1 Suspension Towers and 5 Tension Towers are failed in 4 Transmission Lines.



Fig. 3.

- g) The total number of incidences of transmission line failures, and the no. of affected Tension type and Suspension type towers, that have been reported to CEA during the period of January 2022 to December 2023 has been indicated in the Fig. 3 shown above.

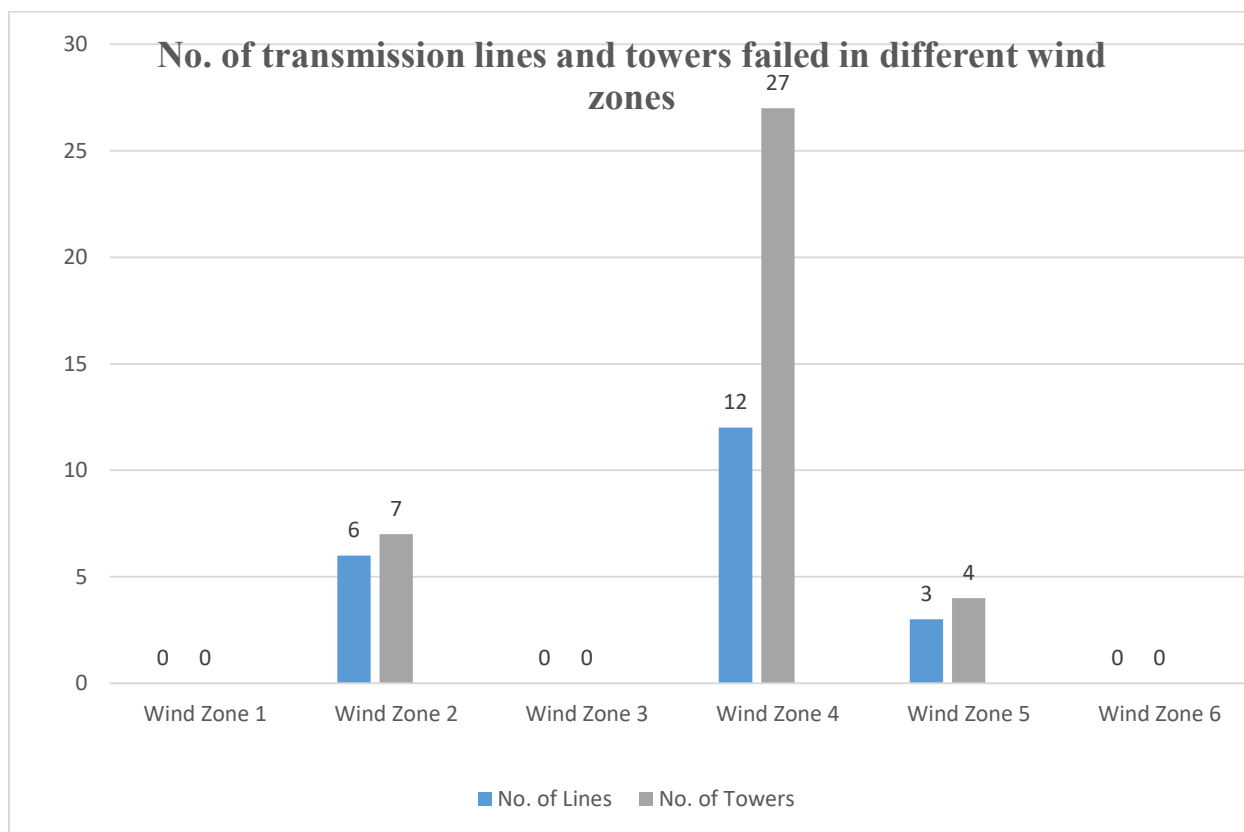


Fig. 4

- h) The wind map of India was divided into three wind pressure zones that is light, medium & heavy, before the revision of IS 802 in 1995. In the third revision of IS 802: 1995, 6 wind zones were specified dividing various regions on the basis of 3 second wind gust speed. No. of transmission lines and towers, failed during the period from January 2022 to December 2023 and designed according to various wind zones is given in Fig. 4 above. It can be seen that the maximum No. of failure of towers have occurred for transmission lines which were designed for Wind Zone 4. It may be noted that maximum area of India is covered under the wind zone 4.

3. OBSERVATIONS OF THE COMMITTEE:

- a) The type of failure of towers of lines of various voltage levels can be broadly classified as under:
- (i) Deformation in Legs of tower and cage portion of bottom cross arm level.

- (ii) Buckling of stub level leading to complete collapse of towers with/without damage to tower foundation.
 - (iii) Buckling above 1st panel (normal tower) level with/without damage to tower foundation.
 - (iv) Buckling from bottom cross arm level or top cross arm level or peak broken without any damage to lower portion of the tower and foundation.
 - (v) Damage to foundation as well as to tower structure due to increased water level and additional force due to water flow/velocity in the river/soil erosion and inadequate protection to foundation of towers.
 - (vi) Shearing of stubs of leg members of towers.
- b)** The main cause of tower failure is attributed to high intensity wind and floods by the transmission utilities, however the utilities failed to produce wind data in some of the cases which could substantiate their reasoning. The transmission utilities are unable to produce the actual wind speed data on the day of failures due to non-availability of wind speed data at the failure location. The standing committee observed that wherever reporting of tower failure is due to wind, the utility needs to get the wind data for the area which would serve as representative wind speed prevailing in that area at the time of failure. It was agreed that the high wind velocity during storm and local condition of whirl wind might have exceeded the design wind speed for which the tower is designed; however this needs to be verified. Assistance of IMD & other agencies involved in metrological field may be taken by the affected utilities in this regard and utilities may request for sharing of the wind data obtained from observatory/ Satellite/ Radar.
- c)** The structural integrity of transmission towers depends on many factors including adequacy of technical standard/ stipulated codal requirement considered for designing the transmission tower, quality of material grade used in tower body, Construction methodology, workmanship and erection practices, Operations & Maintenance practices of the transmission utilities etc.
- d)** Over the years the Indian Standards for design of transmission line tower has undergone changes. As revision of codal provisions is a continuous process, the changes are to be implemented prospectively. Strengthening of towers of existing transmission line due to change in the codal provisions could be decided on case to case basis, if repeated failures are observed in a particular line.

4. INSIGHTS INTO TOWER FAILURE INCIDENTS DURING PAST YEARS (2014-2023):

- a) The details of previous transmission line and tower failure incidents which were reported to CEA and have been discussed in the previous Standing Committee meetings from the year 2014 onwards have been analyzed by CEA.

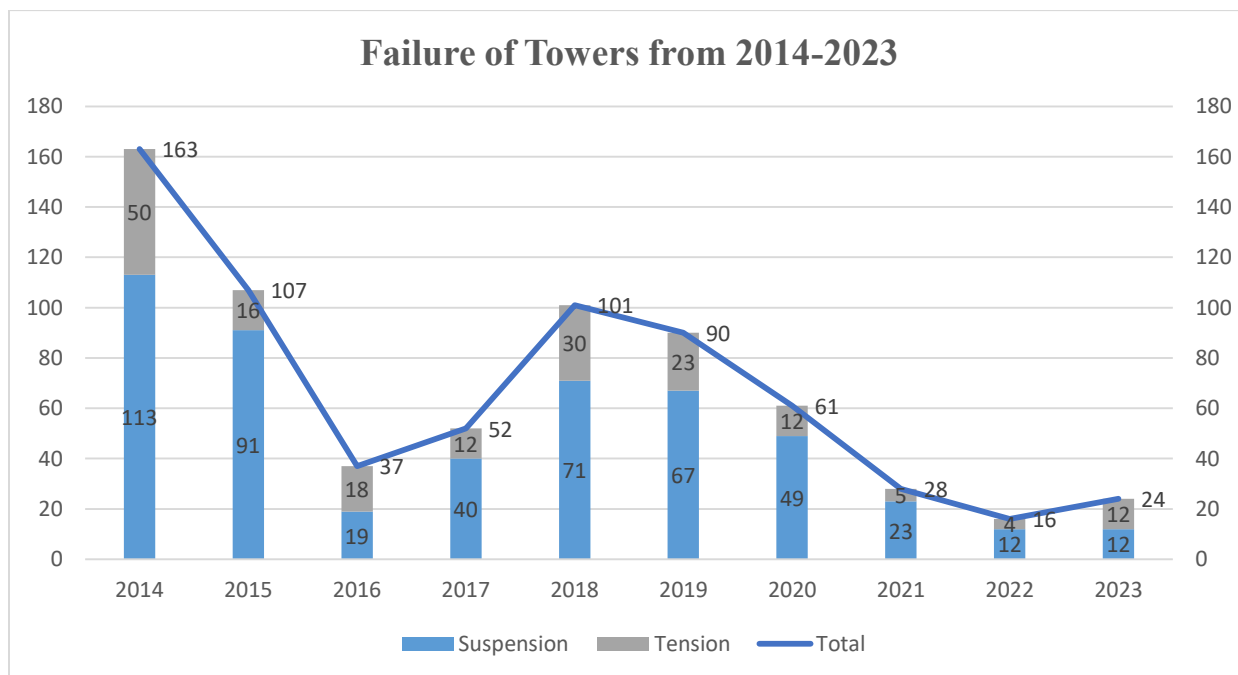


Fig. 5

- b) The graph depicting the failures of towers occurred during past years (2014-2023) that have been discussed in the previous Standing committee meetings are shown above (Fig. 5). The maximum no. of failures i.e. 163 cases of tower failures occurred during year 2014. As has been observed in the previous Standing Committee meetings, the failure rate of suspension towers is much higher in comparison to tension towers. This may be because of the cascading effect of failure of suspension type towers i.e. secondary failure of adjacent suspension towers due to the pulling force of conductors which have been developed due to failure of another tower.

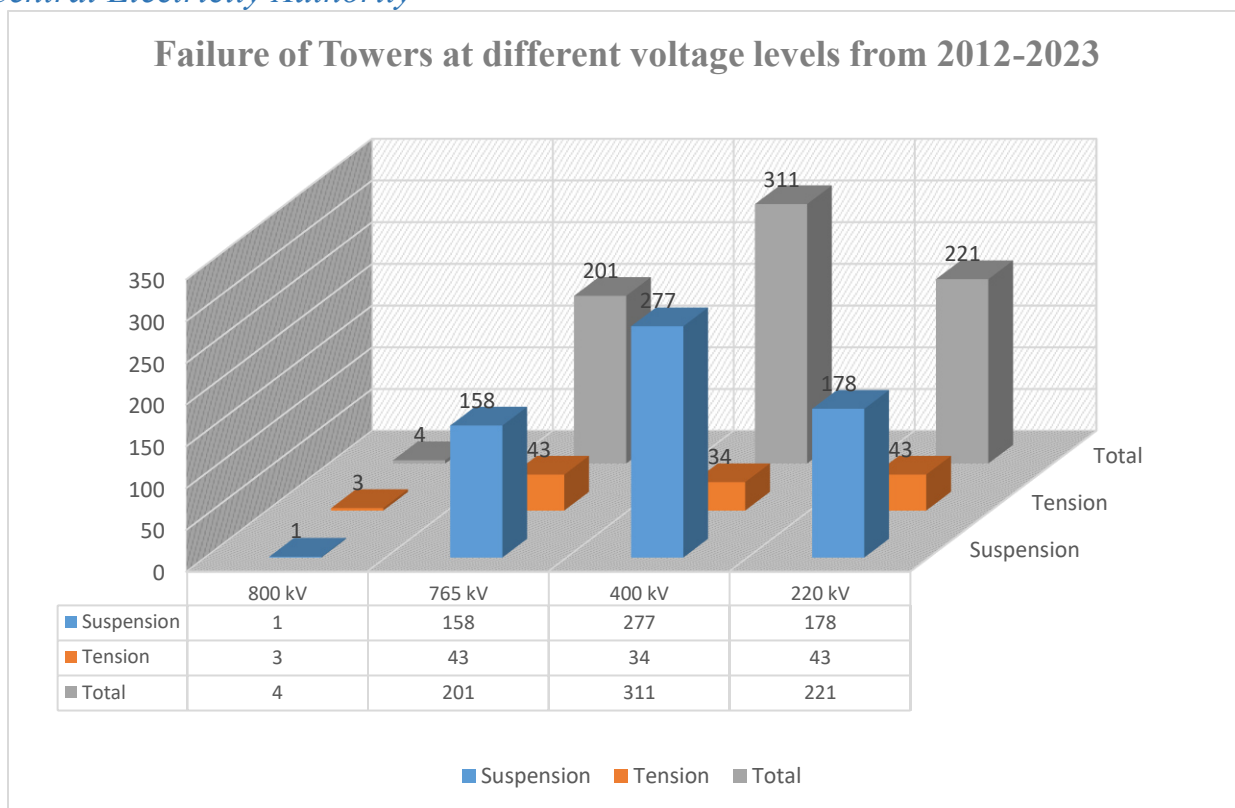


Fig. 6

- c) The graph depicting the failures of towers at various voltage levels that have occurred during past years (2012-2023) and intimated to CEA which have been discussed in the Standing committee meetings are shown in Fig. 6. It may be observed that towers of 400 kV voltage level have maximum incidents of failure. It may be noted that the mandate of the Standing Committee is to investigate failure of towers of 220 kV and above voltage class transmission line and the graph shows the details of only those transmission line failure which have been intimated to CEA and the large percentage of tower failure incidents reported to CEA pertains to POWERGRID which has maximum numbers of transmission lines of 400 kV voltage level.

5. RECOMMENDATIONS & REMEDIAL MEASURES SUGGESTED BY THE COMMITTEE:

The recommendations and remedial measures suggested by the Committee after detailed deliberations are as follows:

- a) It is observed that intensity of wind has changed in some parts of the Country due to climate change and the wind map was revised by SERC in 2016, the same has

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been incorporated in the National Building Code of BIS. However, IS 875 has not been amended to include revised wind map. Till the time IS 875 is not revised, Utilities should follow wind map given in National Building Code for designing of towers.

- b) After every failure, the concerned utility needs to submit the actual wind velocity prevailed in the affected area so that the Investigating Team of Standing Committee could get reference wind speed prevailed over that area. In this matter, the respective Utility may seek the help of IMD to estimate the wind speed in affected area based on data obtained from observatory/ Satellite/Radar.
- c) The drag coefficient considered for tower design shall be as follows –

As per IS 802:1995	
Solidity ratio	Drag Coefficient
Up to 0.05	3.6
0.1	3.4
0.2	2.9
0.3	2.5
0.4	2.2
0.5 & above	2.0

- d) Due to climatic change, incidents of high winds are increasing. Transmission Utilities need to take proactive measures such as increased line patrolling, immediate replacement of missing members/bolts. Various deficiencies such as missing members, missing bolts, bent members, incorrect attachment of cross arm, chimney covered with soil, rusted stub/members etc. has been observed during the failure site visit of various transmission towers of different utilities. These deficiencies may be attributed to poor workmanship, erection deficiency, O&M issues etc. Utilities shall take necessary precautions and carry out proper maintenance of their lines so as to avoid failure of towers due to such deficiencies.
- e) In case of towers in critical locations with regular high speed wind phenomenon, redundant members of tower should be designed with actual loads and non-linear analysis of tower should be carried out. Modern technique/methods should be adopted for erection and stringing of towers.
- f) Pile type foundation shall be used for towers located in river or creek bed or on bank of river having scourable strata or in areas where river flow or change in river course is anticipated, based on detailed soil investigation and previous years' maximum flood discharge of the river, maximum velocity of water, highest flood level, scour depth and anticipated change in courser of river based on river morphology data of at least past 20 years to ensure availability and reliability of the transmission line.

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- g)** The transmission towers erected near river banks should be frequently patrolled and assessment based on history should be made to anticipate the change in course of river and necessary protection should be provided to towers to avoid its damage during such incident.
- h)** In case of damage of foundation of towers, the foundation design is required to be examined.
- i)** The material test report of failed towers should be examined to ascertain the quality of the material.
- j)** Utilities shall ensure that casting of chimneys and placement of stubs are done as per approved drawings. Due to improper erection, residual stresses are developed in the towers which cause failure of towers.
- k)** Committee suggested to clear the encroachment in the ROW of the line. Committee advised that utilities should improve their erection and operation and maintenance practices.
- l)** Regular patrolling of the lines is required for smooth and trouble free operation of line. During patrolling any unauthorized construction/use/ storage under & around the towers should also be checked and if such activity is observed, local administrative authority should be immediately informed for assistance and necessary action. In case of failure due to theft/misconduct of miscreants, accidents of vehicles in the tower structure etc., Committee recommended to submit a FIR copy.

APPENDIX

INVESTIGATION REPORTS OF FAILURE OF TOWERS OF VARIOUS TRANSMISSION UTILITIES

DETAILED REPORTS OF FAILURE OF TOWERS**A. POWERGRID**

The following Transmission Lines Towers of POWERGRID had failed during January 2022 to December 2023:

Si. No.	Name of the Transmission Line	Name of Utility	Date of Failure	Year of Commissioning	Wind Zone	No. of Towers Failed			Conductor
						Suspension	Tension	Total	
A.1	400 kV S/C Gooty-Somanhalli Transmission line	POWER GRID	08.05.2022	1991	2	1	0	1	Twin Moose ACSR
A.2	400 kV D/C Kahalgaoon-Barh Transmission line	POWER GRID	19.05.2022	2007	4	4	0	4	Vertical Quad Moose ACSR
A.3	765 kV D/C Aligarh-Jhatikara Transmission line	POWER GRID	23.05.2022	2016	4	1	1	2	Quad Bersimis ACSR
A.4	400 kV D/C Koderma-Bokaro	POWER GRID	27.07.2022	2014	2	1	0	1	Twin Moose ACSR
A.5	765 kV S/C Gwalior-Agra-I Transmission line	POWER GRID	25.08.2022	2009	4	0	1	1	ACSR Bersimis Conductor
A.6	400 kV D/C Bokaro-Kodarma Transmission line	POWER GRID	30.08.2022	2014	2	1	0	1	Twin Moose ACSR
TOTAL (2022)						8	2	10	

A.7	765 kV Bhiwani Phagi ckt 1, loc No. 476, Khetri Rajasthan	POWE RGRID	07.05.2023	2015	4	1	0	1	Bersimis Conduct or / 35 mm diameter
A.8	765 kV S/C Bina- Gwalio r Ckt-3	POWE RGRID	24.05.2023	May, 2014	4	1	0	1	ACSR Bersimis conducto r
A.9	765 kV Bhiwani Phagi ckt 1, loc No. 476, Khetri Rajasthan	POWE RGRID	25.05.2023	2015	4	5	2	7	Bersimis Conduct or / 35 mm diameter
A.10	Tower type DD+ 23.5 at Loc. No. 248 of 400kV DC Mundra- Bhachau 1&2	POWE RGRID	16.06.2023	01.10.2011	5	0	1	1	ACSR Snow Bird
A.11	765 kV S/C Gaya Varanasi line	POWE RGRID	19.06.2023	March 2012	4	1	0	1	ACSR Bersimis , 35.04 mm overall diameter
A.12	220 kV D/C Chamera III Chamba I & II	POWE RGRID	09.07.2023	Novemb er 01, 2011	2	0	2	2	MOOSE, Nominal Diamete r: 31.77 mm
A.13	Tower no 512 of 220kV D/C Anta- Bhilwara line	POWE RGRID	17.08.2023	1989	4	1	0	1	Single Zebra Conduct or

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A.14	400 kV D/C Ballabgarh- Gurgaon- CKT-I line	POWER RGRID	07.09.202 3	1988	4	2	2	4	Moose Conductor / 31.77 mm diameter
A.15	400 kV D/C Rangpo- Teesta-V	POWER RGRID	04.10.202 3	Jan 2008	4	0	2	2	MOOSE Conductor / 31.77 mm diameter
TOTAL (2023)						11	9	20	

DETAILS IN RESPECT OF EACH TRANSMISSION LINE

A.1 400 kV S/C Gooty-Somanhalli Transmission line failed on 8.05.2022

[Tower at Location no.763 (A+0)]

Brief Background :

The 400 kV S/C Gooty- Somanhalli transmission line was designed by M/s SAE and commissioned in 1991. The total length of the line is 302 km. The tower of this line was designed for wind zone 2. The 01 Number of suspension tower got failed on 08.05.2022. The type of conductor used is Twin Moose and the type of insulator used is Porcelain and glass.

Sl. No.	Details	Remarks
1	Name of Transmission Line	400 kV S/C Gooty- Somanhalli
2	Date of Failure	08.05.2022
3	Length of Line	302 km
4	Type of Configuration	S/C
5	Designed by	M/s SAE
6	Year of Commissioning	1991
7	Executing Agency	M/s SAE
8	Number and Type of Failed Towers	01 No., Suspension Type
9	Towers Location No.	Tower No. 763
10	Name and Size of Conductor	Twin Moose
11	No. of sub-conductors per bundle and bundle spacing	2
12	Number and size of Ground wire/OPGW (if provided)	7/3.66 EW AND OPGW
13	Type and Configuration of Insulator	Porcelain and glass I (side phases) & V String (middle phase)
14	No. of insulators per string and No. of strings per phase	24
15	Weather condition on the date of failure	Heavy Cyclonic wind
16	Terrain Category	Plain
17	Wind Zone	2
18	Details of earthing of tower	Pipe Type
19	The agency who designed the line	M/s SAE.
20	Any Special consideration in design	No

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21	Details of last maintenance activity along with date	Regular Patrolling
22	Power flow in the line prior to failure	Ckt-1: 250-300 MW
23	Any missing member found before / after failure of towers	No
24	Condition of foundation after failure	Stubs Bent, Leg B Cracked
25	Brief Description of failure	01 No. of Suspension Tower got failed due to heavy cyclonic wind.
26	Probable cause of failure	Heavy Cyclonic Wind. Metal Sheets with angle hit the tower.
27	Details of previous failure of the line / tower	NIL
28	Whether line will be restored on ERS or Spare tower will be used	ERS
29	Likely date of restoration	14.05.2022
30	Present Status	Line restored.
31	Wind speed data of date & time of failure from nearby authorized observatory	Request sent to IMD
32	Location of failed towers	12.8711378, 77.4596396
33	Tower weight	5.28 MT

Observations:

a.	The affected suspension tower at location 413 was located in plain field with few trees in vicinity near village Somanahalli, Bangalore South Taluk in Bangalore district (Karnataka).				
b.	The affected tower was damaged in transverse direction of the line. The details of damaged towers is as follows:				
	Si. No	Loc. No.	Tower Type	Span (in m)	Angle of Dev.
	1	763	A+0	320	-
	• Tower collapsed completely as shown in Fig 7(a). • Foundation was intact. • All four stubs are damaged as shown in Fig 7(b). • Main leg members along with many bracing members were deformed.				
c.	Failed tower was examined for missing members, bolts & nuts. There was no any sign of any theft and tower was also found in healthy and completeness condition.				
d.	It has been observed that there was wind storm in the vicinity of failed tower. And high voltage towers of KPTCL also failed in the vicinity of failed tower location				
e.	It is observed that the roof of nearby building made of steel sheets along with C-channel and steel square pipes for holding the steel sheets has dislocated from its place (approx. 50 meters away from tower) and collided with the leg section of the tower (be-tween A-leg and D-leg) due to very heavy wind. The roofs steel sections were very heavy as is evident from pictures attached [Fig.7(c)].				
f.	There was encroachment below the line. Many residential houses and commercial building				

	were constructed below the line and in the Right of Way.
g.	Utility itself identified samples for material testing in laboratory and submitted the test results.
h.	Results of recommended test samples have been received and are in order as per IS: 2062.



Fig 7(a). Collapsed tower Loc. No. 763 (A+0)



Fig 7 (b). Damage of the Stubs



Fig 7(c). The roofs steel sections.

Committee Observations:

It was observed by the committee that 01 No. of Suspension Type Tower at Location No. 763 got collapsed. The tower was designed for Wind Zone-2 for basic wind velocity of 39 m/s. There was encroachment below the line, many residential houses and commercial buildings were constructed in the Right of Way of the line.

The committee had also observed that there was wind storm in the vicinity of failed tower and high voltage towers of KPTCL were also failed in the vicinity of failed tower location. All the four stubs of Transmission Line tower at Location No. 763 were found damaged while the foundation was found intact. Main leg members along with many bracings were found deformed. The committee had also observed that the roof of nearby building made of steel sheets along with C-channel and steel square pipes for holding the steel sheets had dislocated from its place (approx. 50 meters away from tower) and collided with the leg section of the tower (between A-leg and D-leg) due to very heavy wind. There was encroachment below the tower which needs to be avoided. The roofs steel sections were very heavy as is evident from pictures attached [Fig.7(c)].

Committee suggested to clear the encroachment in the ROW of the line. Committee advised that utilities should improve their erection and operation and maintenance practices and ensure that structural strength is not compromised due to deficiencies like unplugged holes, rusting of stubs, etc. Committee has recommended that “Task Force on Cyclone Resilient Robust Electricity Transmission & Distribution Infrastructure in coastal areas” should be followed by utilities while designing / erection of transmission lines in cyclone affected area.

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line with metal sheet hitting the tower, leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure has not been provided by the transmission utility.

A.2 400 kV D/C Kahalgaon-Barh Transmission line failed on 19.05.2022

[Tower at Location no.213 (DA+3), 214 (DA+0), 215 (DA+0), 216 (DA+0)]

Brief Background :

The 400 kV D/C Kahalgaon Barh transmission line was designed by M/s POWERGRID and commissioned in 2007. The total length of the line is 217 km. The tower of this line was designed for wind zone 4. The 4 Numbers of suspension type tower get failed on 19.05.2022. The type of conductor used is Quad Moose ACSR and the type of insulator used is Porcelain and Double I suspension.

Sr. No.	Details	Remarks
1	Name of Transmission Line	400 kV D/C Kahalgaon Barh
2	Date of Failure	19.05.2022
3	Length of Line	217 KM
4	Designed by	M/s POWERGRID
5	Year of Commissioning	2007
6	Executing Agency	M/s KEC
7	Number and Type of Failed Towers	04 (All were suspension type)
8	Towers Location No.	213,214,215,216 from Kahalgaon end.
9	Name and Size of Conductor	Quad Moose ACSR (Stranding -Al- 54/3.53mm & Steel- 7/3.53mm – Overall diameter-31.77mm dia)
10	No. of sub-conductors per bundle and bundle spacing	04; 450 mm
11	Number and size of Ground wire/OPGW (if provided)	1 no. GS Earth wire (7/3.66 mm), 1 no. OPGW/24F/12mm-dia
12	Type and Configuration of Insulator	Porcelain and Double I suspension
13	No. of insulators per string and No. of strings per phase	23/string; 02 strings/phase
14	Weather condition on the date of failure	Heavy Wind, localized high intensity wind storm/thunder storm
15	Terrain Category	Plain
16	Wind Zone	4
17	Reliability Level	1
18	Details of earthing of tower	Pipe Type
19	Adopted Standard in design	IS:802 (1995)
20	The agency who designed the line	POWERGRID in house designed tower
21	Any Special consideration in design	75 % wind in security condition and narrow front

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22	Details of last maintenance activity along with date	Last Patrolling done in December 2021. No defect observed
23	Power flow in the line prior to failure	Line was under SD since 14.05.2022 for diversion work of NHAI
24	Any missing member found before / after failure of towers	NIL
25	Condition of foundation after failure	Ok
26	Brief Description of failure	As per attached photos
27	Probable cause of failure	Heavy Wind, localized high intensity wind storm/thunder storm
28	Details of previous failure of the line / tower	NIL
29	Whether line will be restored on ERS or Spare tower will be used	Spare Tower
30	Likely date of restoration	-Not available-
31	Present Status	-Not available-
32	Details of any Tests carried out after failure	The material/samples tested are in order as per IS: 2062.
33	Wind speed data of date & time of failure from nearby authorized observatory	Not available, as no IMD observatory exists near the location.
34	Location of failed towers	86.6268327036047: 25.2214993169608
35	Tower weight	DA+0 -18.82 MT/tower ; DA+3- 19.56 MT/tower
36	Any other information	Line was under shutdown since 14.05.2022 for diversion work of NHAI.

• **Observations:**

a. All the affected suspension towers at location 213,214,215&216 were located in plain field with few trees in vicinity near village Kalyanpur, Bariyarpur Taluk in Munger district (Bihar).

b. All the affected towers were collapsed completely to the ground in transverse direction of the line. The details of damaged towers is as follows:

b. c.	SI. No.	Loc. No.	Tower Type	Span (in m)	Angle of Dev	Extent of Damage
	1	213	DA+3	399	NIL	• Tower collapsed completely as shown in Fig 1(a). • All the four stubs of the tower along with foundation and chimney were intact. • Tower failed from waist level i.e. above fifth panel from GL in transverse direction towards right hand side while looking from Kahalgaon to Barh.
	2	214	DA+0	374	NIL	• Tower collapsed completely.

						• All the four stubs of the tower along with foundation and chimney were intact. • Tower failed above first panel from GL in transverse direction towards right hand side while looking from Kahalgaon to Barh.
	3	215	DA+0	377	NIL	• Tower collapsed completely. • All the four stubs of the tower along with foundation and chimney were intact. • Tower failed above first panel from GL in transverse direction towards right hand side while looking from Kahalgaon to Barh.
	4	216	DA+0	379	NIL	• Tower collapsed completely • All the four stubs of the tower along with foundation and chimney were intact. • Tower failed above second panel from GL in transverse direction towards right hand side while looking from Kahalgaon to Barh.
	From Location No. 213 to 209, it was also observed that the top & middle conductor of circuit-I swung, detached/snapped and fell on the ground at an approx. distance of 60-70 meter away from respective towers.					
d.	Failed towers and its adjacent located towers were examined by the committee for missing members, bolts, nuts. There was no any sign of any theft and adjacent towers were also found in healthy and completeness condition.					
e.	Further, foundation dimensions i.e. back to back and diagonal distance, level differences at the stub top were measured for all the collapsed tower. No appreciable difference was observed when compared with the values mentioned in original drawings available at site.					
f.	It was observed that few trees and poles of LT lines located near tower location no. 213 along with 04 towers of 132 kV S/C Sultanganj-Tarapur and 07 towers of 132 kV D/C Sultanganj-Haveli Kharagpur transmission line of BSPTCL nearby tower location no. 208 of 400 kV D/C Kahalgaon-Barh TL were also damaged.					
g.	It was noticed that all the damaged towers were already cut down into piece and laying on the ground even before the committee reached to site for inspection and investigation of cause of failure.					
h.	Committee identified and recommended 06 numbers of samples among all the failed towers for material testing in laboratory.					
i.	Results of recommended test samples have been received and are in order as per IS: 2062.					

➤ **Photographs:**



Fig 1(a). Tower at Location No.: 213 (DA+3)



Fig 1(b). Tower at Location No.: 214 (DA+0)



Fig.1(c). Tower at Location No.: 215 (DA+0)

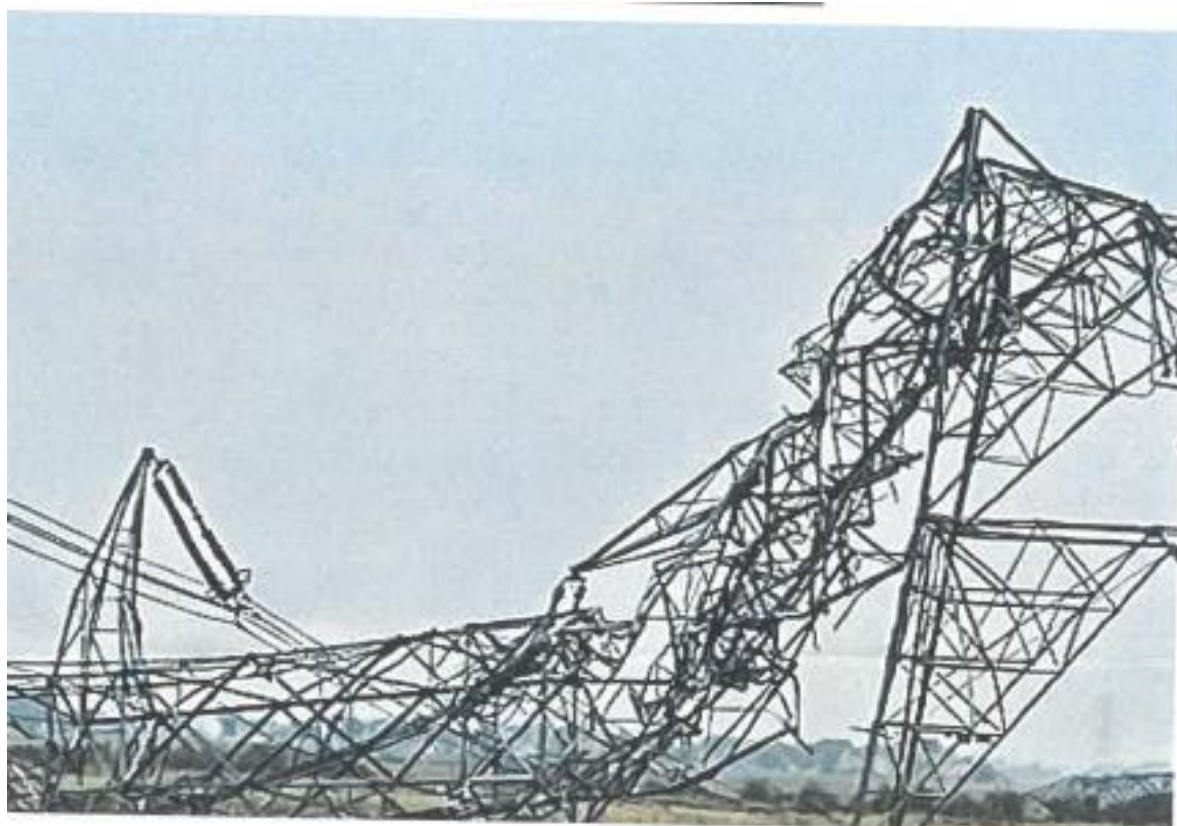


Fig 1(d). Tower at Location No.: 216 (DA+0)

Committee Observations:

It was observed by the committee that 04 Numbers of Suspension Type Towers at location Numbers 213, 214, 215 and 216 got failed. The towers was designed for wind zone-4 for basic wind velocity of 47 m/s and as per IS: 802-1995. It was also observed that few trees and poles of LT lines located near tower location no. 213 along with 04 towers of 132 kV S/C Sultanganj-Tarapur and 07 towers of 132 kV D/C Sultanganj-Haveli Kharagpur transmission line of BSPTCL nearby tower location no. 208 of 400 kV D/C Kahalgaon-Barh TL were also damaged.

Failed towers and its adjacent located towers were examined by undertaking the site visit by Committee for missing members, bolts, nuts. There was no sign of theft and adjacent towers were also found in healthy and completeness condition. Further, foundation dimensions i.e. back to back and diagonal distance, level differences at the stub top were measured for all the collapsed tower. No appreciable difference was observed when compared with the values mentioned in original drawings available at site.

The Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility because no IMD observatory have data of the failure location.

A.3 765 kV D/C Aligarh-Jhatikara Transmission line failed on 23.05.2022

[Tower at Location no.1079 (DB+6), 1080 (DA+9)]

Brief Background :

The 765 kV D/C Aligarh-Jhatikara transmission line was designed by M/s L&T Construction – PT&D and commissioned in 2016. The total length of the line is 159 Km. The tower of this line was designed for wind zone 4 and the adopted Standard in design is IS:802 (1995). The 2 Numbers of DB+6, DA+9 type tower get failed on 23.05.2022. The type of conductor used is Quad Moose ACSR and the type of insulator used is 2 nos. of 7/3.66M EARTHWIRE (10.98 mm diameter).

Sr. No.	Details	Remarks
1	Name of Transmission Line	765 kV D/C Aligarh-Jhatikara
2	Date of Failure	23.05.2022
3	Length of Line	159 KM
4	Designed by	M/s L&T Construction – PT&D
5	Year of Commissioning	2016
6	Executing Agency	M/s KPTL
7	Number and Type of Failed Towers	02 (DB+6, DA+9)
8	Towers Location No.	1079, 1080
9	Name and Size of Conductor	Bersimis
10	No. of sub-conductors per bundle and bundle spacing	4 nos. of sub conductor/phase
11	Number and size of Ground wire/OPGW (if provided)	2 nos. of 7/3.66M EARTHWIRE (10.98 mm diameter)
12	Type and Configuration of Insulator	Polymer and Tension
13	No. of insulators per string and No. of strings per phase	2 no. of insulators per String 2 no. of strings per Phase
14	Weather condition on the date of failure	Sporadic heavy whirl wind followed by localized cyclonic storm and rain
15	Terrain Category	Plain with mild hills
16	Wind Zone	4
17	Reliability Level	2
18	Details of earthing of tower	Counter Poise
19	Adopted Standard in design	IS:802 (1995)
20	The agency who designed the line	Larsen & Toubro Construction – PT&D
21	Any Special consideration in design	No
22	Details of last maintenance activity along with date	24.03.2022

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23	Power flow in the line prior to failure	328MW
24	Any missing member found before / after failure of towers	05 Nos.
25	Condition of foundation after failure	Good
26	Brief Description of failure	Due to very heavy localised wind storm
27	Probable cause of failure	Due to heavy wind flow
28	Details of previous failure of the line / tower	NIL
29	Whether line will be restored on ERS or Spare tower will be used	Spare Tower will be used
30	Likely date of restoration	02.06.2022
31	Present Status	Work Completed. Line Charged
32	Details of any Tests carried out after failure	It is observed that the tower collapsed due to nature's fury. No technical deficiencies were observed in collapsed tower, hence further testing on material and quality of work was not recommended.
33	Wind speed data of date & time of failure from nearby authorized observatory	NIL
34	Location of failed towers	T.No.- 1079, 28.199433, 77.005260 T.NO-1080: 28.199925, 77.000773
35	Tower weight	Loc. No. 1080: 62018.953 Kg (A+9)/ Loc. No. 1079:114995.776 Kg (B+6)
36	Any other information	Nil

Observations:

a.	All the affected tension and suspension towers at location 1079&1080 respectively were located in plain field with few trees in vicinity near village Dhulawat, Taoru Taluk in Mewat district (Haryana).					
b.	All the affected towers were in transverse direction of the line. The details of damaged tower is as follows:					
	Sl. No.	Loc. No.	Tower Type	Span (in m)	Angle of Dev	Extent of Damage
	1	1079	DB+6	440	0° 57' 11" LT	• Tower damaged partially as shown in Figs 4(a), 4(b) and 4(c). • All the four stubs of the tower along with foundation and chimney were intact. • Peak of Earth wire got damaged • Anti-climbing device, name plate and phase sequence plate was missing. • Nut-bolt and many members of tower were missing from bottom part.

	2	1080	DA+9	265	NIL	• Tower damaged partially as shown in Figs 4(d), 4(e), 4(f), 4(g). • All the four stubs of the tower along with foundation and chimney were intact. • Tower broken above bottom cross arm. • Anti-climbing device, name plate and phase sequence plate was missing. • Nut-bolt and many members of tower were missing from bottom part.
c.	Patrolling data of both the towers were checked and it was found that earlier there were some defects observed in aforementioned towers during patrolling but all were corrected at that time itself. Defects were mainly related to grading ring, spacer, reverse GR etc.					
d.	It was also observed that few trees and poles of LT lines located near tower location no. 1079 & 1080 were also uprooted.					
e.	Failed towers and its adjacent located towers were examined by the committee for missing members, bolts, nuts. There were many signs of theft and towers were also not in completeness condition.					
f.	It was also observed that towers were constructed for double circuit. However, at present stringing is done for single circuit only.					
g.	Committee identified and recommended samples for material testing in laboratory.					

➤ **Photographs:**

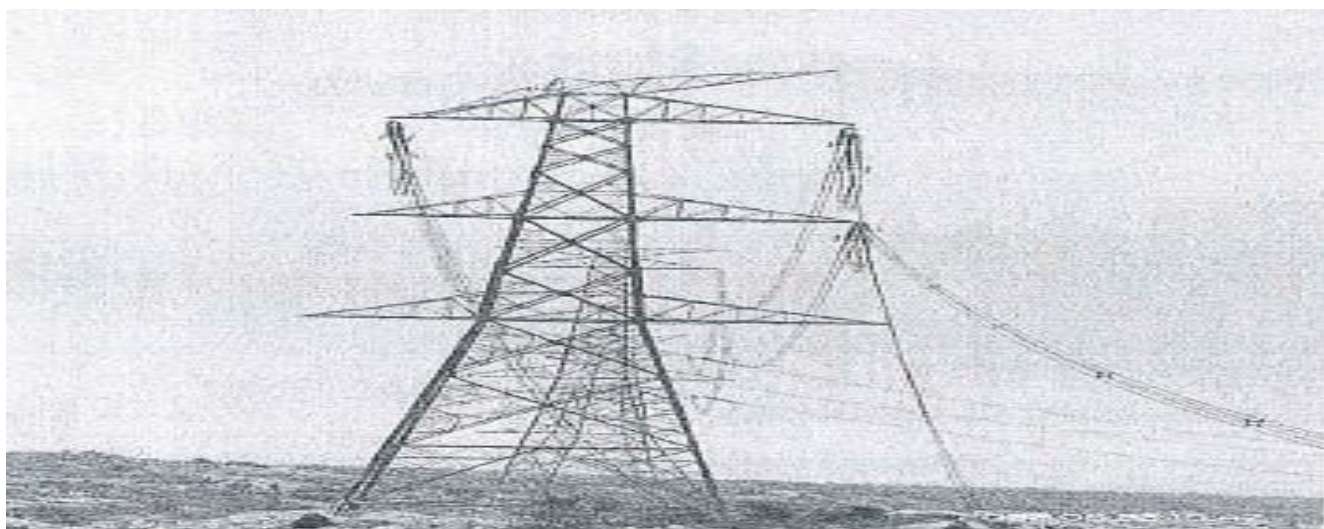


Fig 4(a). Tower at Location No.: 1079 (DB+6) - Earth wire peak damaged.

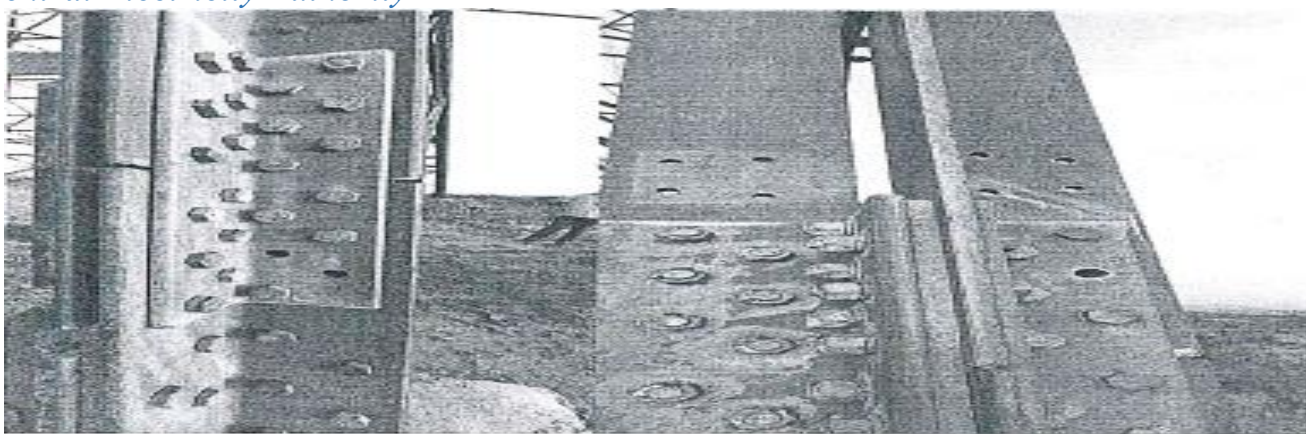


Fig 4(b). Tower at Location No.: 1079 (DB+6) – Missing Nut/Bolts.

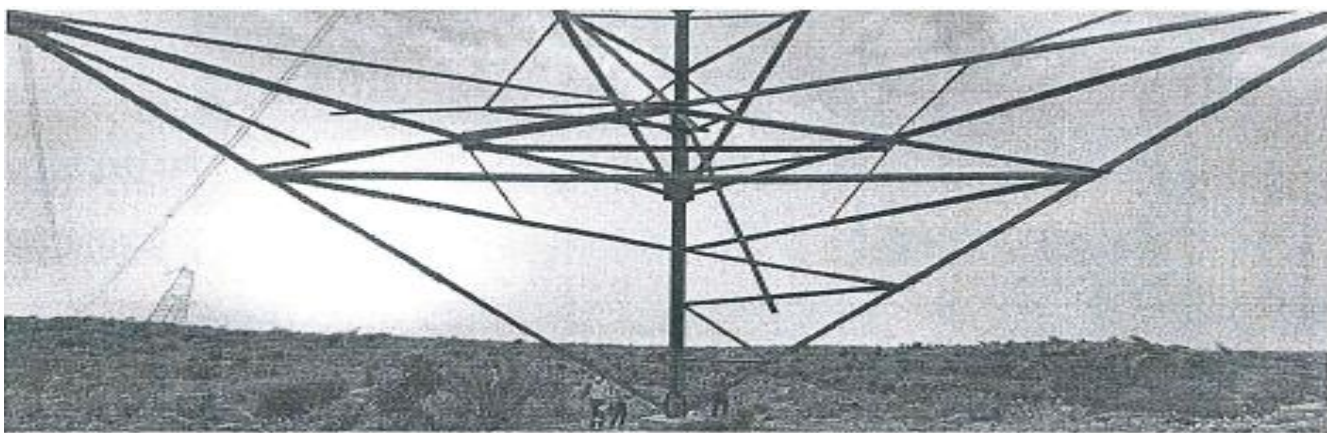


Fig 4(c). Tower at Location No.: 1079 (DB+6) – Missing Members.

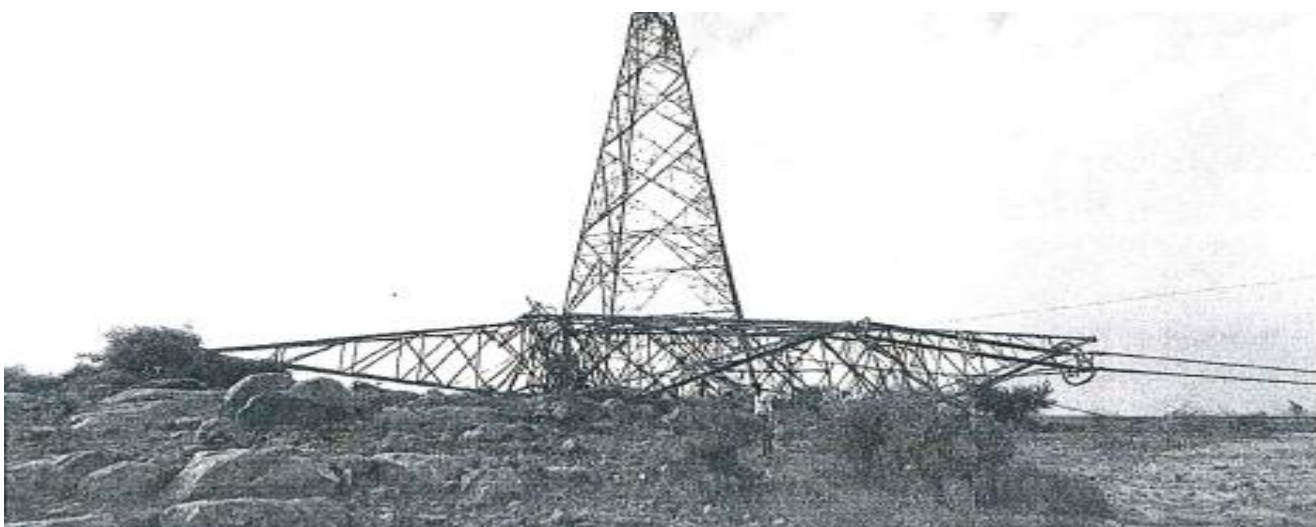


Fig (d). Tower at Location No.: 1080 (DA+9)

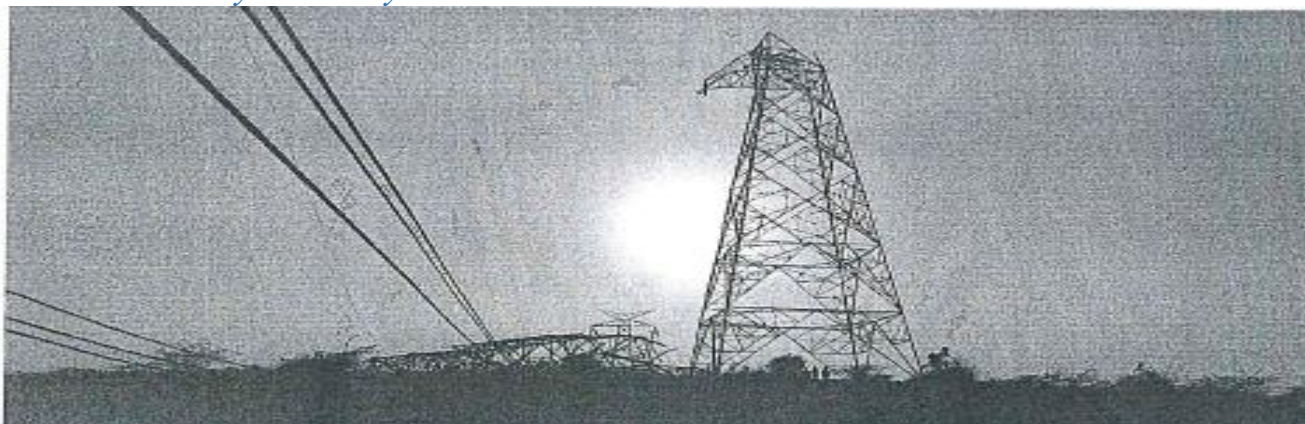


Fig 4(e). Tower at Location No.: 1080 (DA+9)

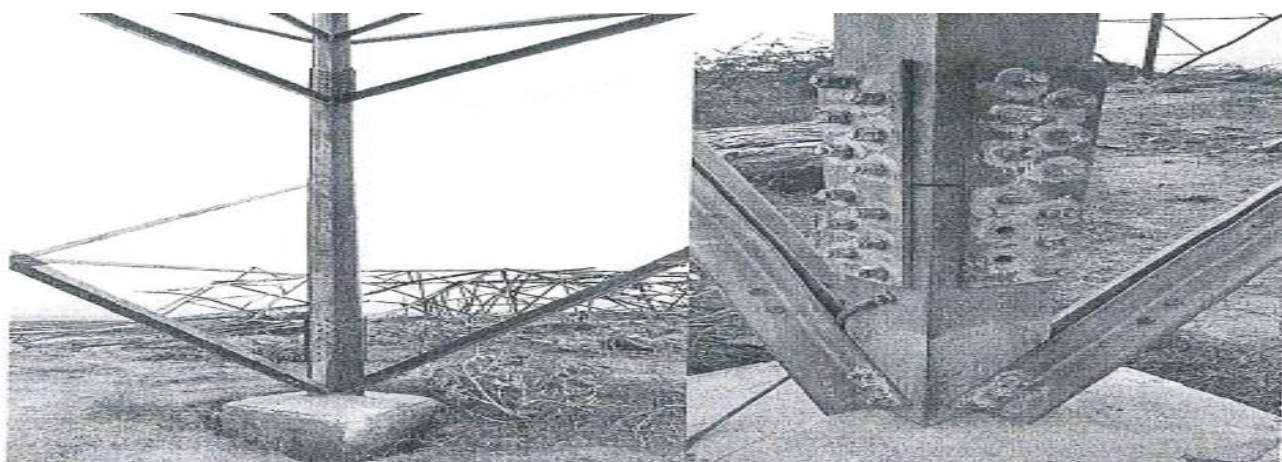


Fig 4(f). Tower at Location No.: 1080 (DA+9) – Missing Nut/Bolts.

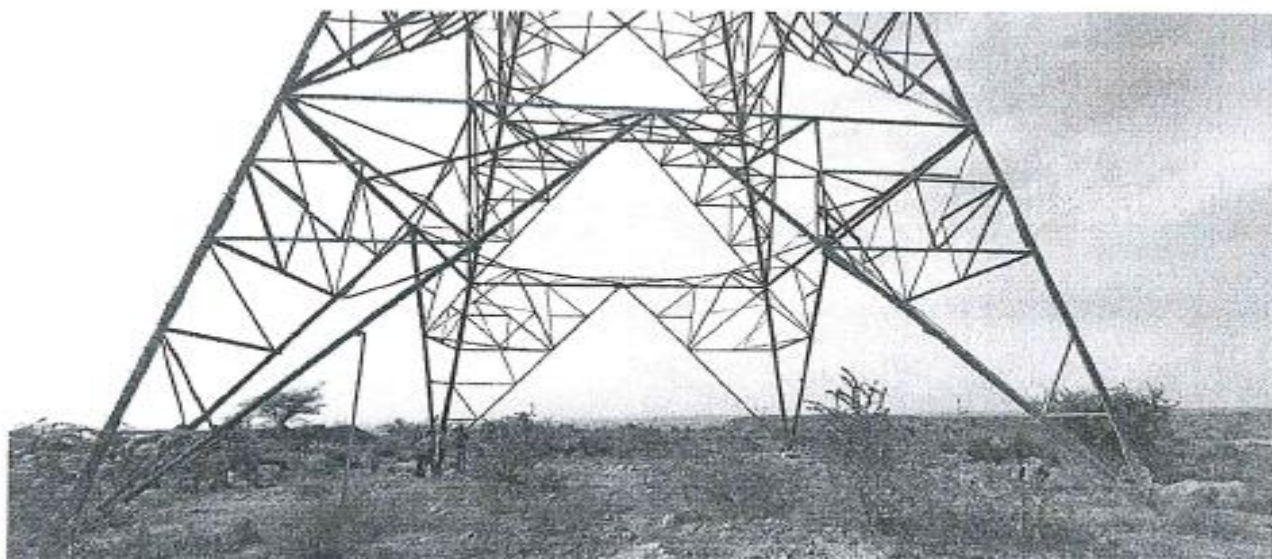


Fig 4(g). Tower at Location No.: 1080 (DA+6) – Missing Members.

Committee Observations:

It was observed by the committee that nut bolts, few members, anti-climbing device, name plate and phase sequence plate were missing in Towers at Location numbers 1079 and 1080. Patrolling data of both the towers were checked and it was found that earlier there were some defects observed in the aforementioned towers during patrolling but all were corrected at that time itself. Defects were mainly related to grading ring, spacer, reverse GR etc. It was also observed that towers were constructed for double circuit. However, at present stringing is done for single circuit only. Failed towers and its adjacent located towers were examined by the committee for missing members, bolts, nuts. There were many signs of theft and towers were also not in completeness condition.

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

Committee suggested that the patrolling frequency of the line may be increased. Committee noted that the small deficiencies in the tower structure may lead to its collapse in the event of occurrence of high speed wind. Committee advised that utilities should improve their erection and operation & maintenance practices and ensure that structural strength is not compromised due to deficiencies like, unplugged holes, rusting of stubs, missing members and nuts & bolts etc.

A.4 400 kV Koderma Bokaro D/C transmission line failed on 27.07.2022

Brief Background:

The 400 kV Koderma Bokaro D/C transmission line was commissioned in 2014. The total length of the line is 100 km. The tower of this line was designed for wind zone 2 and the adopted Standard in design is IS:802 (1995). The 01 number of suspension type- 01 DA +6 tower get failed on 27.07.2022 at 01:21 hours. The type of conductor used is Twin Moose ACSR (Stranding -Al- 54/3.53mm & Steel- 7/3.53mm – Overall diameter-31.77mm dia) and the type of insulator used is Porcelain.

S.No.	Details	Remarks
(i)	Name of Transmission line with voltage level:	400 kV Koderma Bokaro D/C
(ii)	Date and time of occurrence/discovery of failure:	27.07.2022/01:21 hours
(iii)	Length of line (km):	100 Km
(iv)	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)	D/C
(v)	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	01 nos. suspension type- 01 DA +6 Suspension
(vi)	Tower location No. with reference to nearest substation(indicate Name):	Location no 185 from Bokaro (BTPS) .
(vii)	Name and size of conductor:	Twin Moose ACSR (Stranding - Al- 54/3.53mm & Steel- 7/3.53mm – Overall diameter-31.77mm dia)
(viii)	No. of sub-conductors per bundle and bundle spacing:	02; 450 mm
(ix)	Number and size of Ground wire/OPGW (if provided):	2 no. GS Earth wire (7/3.66 mm)

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(x)	Type of insulators in use(Porcelain / Glass / Polymer):	Porcelain
(xi)	Configuration of insulators (I / V / Y tension):	I suspension
(xii)	No. of insulators per string and No. of strings per phase:	23/string; 01 strings/phase
(xiii)	Year of construction / commissioning:	2014
(xiv)	Executing Agency:	M/s Jyoti Structures Limited
(xv)	Weather condition on the date of failure:	Heavy Wind, lightening, thunder storm
(xvi)	Terrain Category:	Plain
(xvii)	Reliability Level:	1
(xviii)	Wind Zone (1/2/3/4/5/6) and velocity of wind:	2
(xix)	Details of earthing of tower (pipe type/ Counter poise):	Pipe Type
(xx)	Line designed as per IS:802 (1977/1995/2015 any other code):	IS:802 (1995)
(xxi)	The agency who designed the line:	POWERGRID in house designed tower
(xxii)	Any Special consideration in design:	75 % wind in security condition and narrow front
(xxiii)	Details of last maintenance activity along with date:	Last Patrolling done in January 04, 2022. No defect observed
(xxiv)	Power flow in the line prior to failure	27 x 2 = 54 MW
(xxv)	Any missing member found before / after failure of towers:	Nil
(xxvi)	Condition of foundation after failure:	OK
(xxvii)	Probable cause of failure:	Sabotage of member by miscreants
(xxviii)	Details of previous failure of the line / tower :	17.07.2022 at location 171 (DA+0) & 172 (DA+0)
(xxix)	Whether line will be restored on ERS or Spare tower will be used:	Restored on spare tower
(xxx)	Likely date of restoration:	Restored on 03.08.2022
(xxxi)	Present Status:	Restoration completed on 03.08.2022
(xxxii)	Details of any Tests carried out after failure(attach test reports):	NA
(xxxiii)	Wind speed data of date & time of failure from nearby authorized observatory:	NA

(xxxiv)	Tower weight:	DA+6 -13 MT/tower
(xxxv)	Any other relevant information:	No

Photographs:



Committee Observation:

Committee observed that the tower failure occurred due to sabotage of members by the miscreants.

Committee recommended that frequency of patrolling of transmission lines should be more in theft prone areas and for the vulnerable tower locations (Thunder prone, cyclonic prone area) so as to ensure safe and reliable operation. Missing members should be replaced as early as possible to avoid failure of towers.

It is recommended to develop a patrol schedule based on past theft incidents, increase the patrolling frequency in theft-prone areas, and increasing patrols during high-risk times like nights.

Assistance of local people, installation of vibration sensitive cameras in theft prone areas may help to minimize the theft and damage to towers.

A.5 765 kV S/C Gwalior-Agra-I Transmission line failed on 25.08.2022

Brief Background:

The 765 kV S/C Gwalior-Agra #2 transmission line was commissioned in 01.04.2009. The total length of the line is 128.095 KM. The tower of this line was designed for wind zone 4 and as per IS:802 (1995). The 01 number, D type Tower (D+18 extn.) get failed on 25.08.2022. The type of conductor used is ACSR Bersimis Conductor (Al-42/4.57mm & Steel-7/2.54 mm, overall dia-35.04mm and the type of insulator used is Composite Long Rod Polymer.

S.No.	Details	Remarks
(i)	Name of Transmission line with voltage level:	765 kV S/C Gwalior-Agra #2
(ii)	Date and time of occurrence/discovery of failure:	25.08.2022
(iii)	Length of line (km):	128.095 KM
(iv)	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	S/C
(v)	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	01 no, D type Tower (D+18 extn.) {River Crossing Tower of Chambal River}
(vi)	Tower location No. with reference to nearest substation (indicate Name):	Gwalior station, Tower no 248
(vii)	Name and size of conductor:	ACSR Bersimis Conductor (Al-42/4.57mm & Steel-7/2.54 mm, overall dia-35.04mm
(viii)	No. of sub-conductors per bundle and bundle spacing:	Quad Conductor (450 mm)
(ix)	Number and size of Ground wire/ OPGW (if provided):	2 No Earth-wire (7/3.66m)
(x)	Type of insulators in use (Porcelain / Glass / Polymer):	Composite Long Rod Polymer
(xi)	Configuration of insulators (I / V / Y / tension):	Quad Tension String- 210 KN

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(xii)	No. of insulators per string and No. of strings per phase:	2 Nos insulators per string & 04 strings per phase
(xiii)	Year of construction / commissioning:	01.04.2009
(xiv)	Executing Agency:	M/s KEC International Ltd.
(xv)	Weather condition on the date of failure:	Continuous heavy rain and flooding in Chambal River due to sudden opening of gates of Gandhi-Sagar Dam and Kota Beraj Dam.
(xvi)	Terrain Category:	2
(xvii)	Reliability Level:	2
(xviii)	Wind Zone (1/2/3/4/5/6) and velocity of wind:	4 (Basic wind speed-47m/sec)
(xix)	Details of earthing of Tower (Pipe type/ Counter poise):	Pipe earthing
(xx)	Line designed as per IS:802 (1977/1995/2015 any other code):	1995
(xxi)	The agency who designed the line:	POWRGRID Standard Design, Delta Configuration
(xxii)	Any Special consideration in design:	Pile foundation
(xxiii)	Details of last maintenance activity along with date:	The patrolling of above locations was carried out on 07.04.2022 in previous cycle and no missing members were reported.
(xxiv)	Power flow in the line prior to failure:	565 MW
(xxv)	Any missing member found before / after failure of towers:	no
(xxvi)	Condition of foundation after failure:	Bracing panels and main leg members got buckled considerably. The pile foundation and pedestals are found to be in good condition.
(xxvii)	Probable cause of failure:	Flash Flood in Chambal river due to opening of gates of Gandhi Sagar and Kota Beraj Dam on 24.08.2022
(xxviii)	Details of previous failure of the line / tower :	No
(xxix)	Whether line will be restored on ERS or Spare tower will be used:	Spare tower shall be used
(xxx)	Likely date of restoration:	Likely date of rectification: 15.11.2022 (Rectification shall be undertaken after permanent restoration of 765kV Gwalior Agra-1 line)
(xxxi)	Present Status:	In Service
(xxxii)	Details of any Tests carried out after failure (attach test reports):	Visual Inspection only.
(xxxiii)	Wind speed data of date & time of failure from nearby authorized observatory:	-
(xxxiv)	Location of failed tower a. Location Coordinates: b. Nearest Airport:	a. Longitude-78.124517, Latitude-26.792967 b. Gwalior

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	c. District and State:	c. Morena, MP
(xxxv)	Tower weight:	73.87 MT
xxxvi)	Any other relevant information:	-

➤ **Observations:**

- a. The affected suspension tower at location 247 was located in plain field with few trees in vicinity near village Daljit ka Pura, Ambah Taluk in Morena district (Madhya Pradesh).
- b. The affected tower was collapsed completely to the ground in transverse direction of the line. The details of damaged towers is as follows:

Sl. No.	Loc. No.	Tower Type	Span (in m)	Angle of Dev.	Extent of Damage
1	247	D+25	640	NIL	- Tower collapsed completely. - All the four stubs of the tower got detached from leg A, B and C. - Pedestal of Leg C & D damaged at a distance of 2-3 meter from top. - Pedestal of Leg A damaged at a distance of 1 meter from top. - Minor Cracks observed in Pedestal of Leg B.

- c. Patrolling data of tower was checked and no defects in the reports found.
- d. During the committee visit, visible evidence of water logging/bend grass in direction of water flow along with accumulated debris up to 7.5 meter height in tower at location no. 246 was also observed.
- e. Committee identified and recommended samples for material testing in laboratory.
- f. Results of recommended test samples have yet to be received.

➤ **Photographs:**

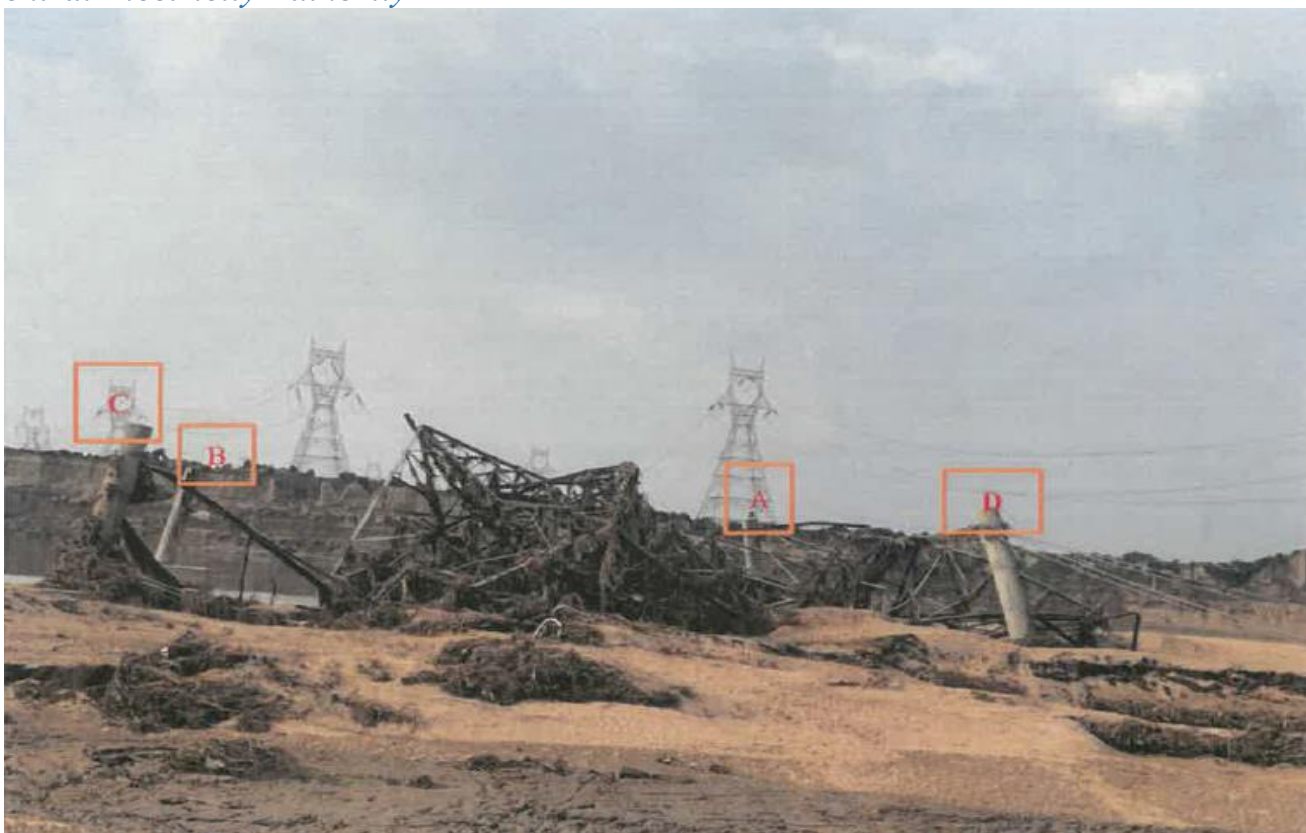


Fig 5(a). Tower at Location No.: 247 (D+25)

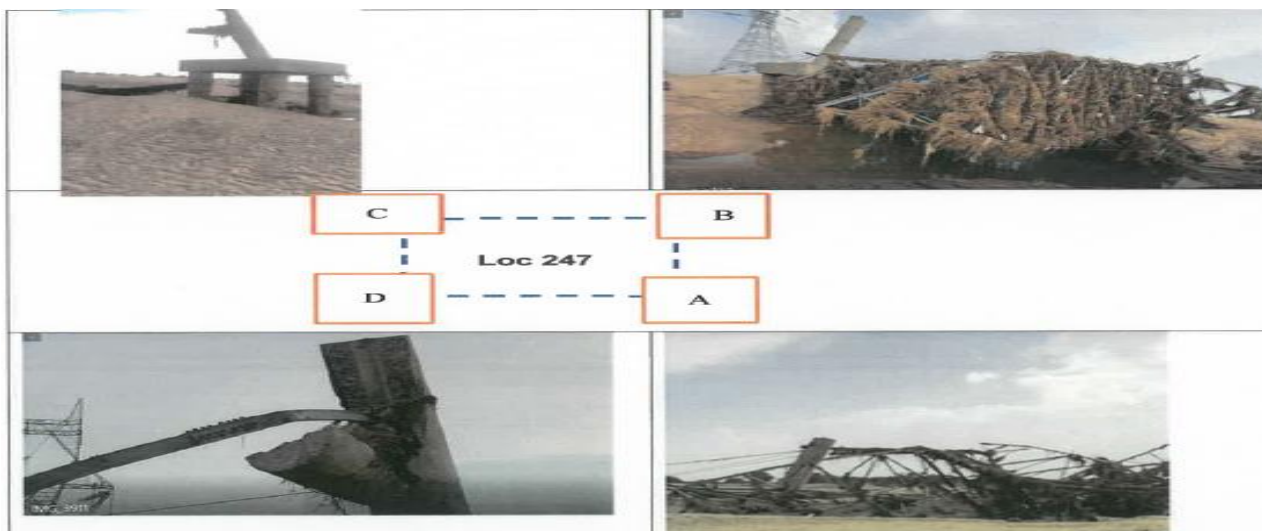


Fig 5(b). Tower at Location No.: 247 (D+25)-Leg Positions



Fig 5(c). Tower at Location No.: 246 (D+0)-Debris Observed



Fig (d). Bend Grass in the direction of Water Flow.

Committee Observations:

During site visit by the committee, visible evidence of water logging/bend grass in direction of water flow along with accumulated debris up to 7.5 meter height in tower at location no. 246 was observed. Patrolling data of tower was checked and it was found to be in order.

Committee observed that the failure of tower was due to increased flow of water caused by the flash floods in the Chambal River due to opening of gates of Gandhi Sagar and Kota Beraj Dam on 24.08.2022.

The committee recommends that transmission lines should be routed a few kilometers away from river banks or anticipated future river courses. This measure aims to minimize the risk of damage to transmission towers due to changes in the river's course. The committee suggests the use of pile foundations or additional

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piles based on thorough soil investigation reports and the latest high flood data because such foundations offer better stability and resistance to erosion.

To further enhance the structural integrity of transmission towers, the Committee suggests implementing additional protection measures like Installing retaining walls, gabion walls, or other protective structures as needed, implementing proper revetment to prevent erosion around the tower foundations, incorporating geosynthetic material in foundation construction to improve stability and prevent soil erosion, encasing the tower foundations in concrete and painting the stubs in water logging areas to prevent corrosion and extend the lifespan of the towers.

A.6 400 kV D/C Koderma Bokaro Line failed on 30.08.2022**Brief Background:**

The 400 kV Koderma Bokaro D/C transmission line was commissioned in 2014. The total length of the line is 100 km. The tower of this line was designed for wind zone 2 and the adopted Standard in design is IS:802 (1995). The 01 nos. suspension type- 01 DA +0 tower get failed on 30.08.2022. The type of conductor used is Twin Moose ACSR (Stranding -Al- 54/3.53mm & Steel- 7/3.53mm – Overall diameter- 31.77mm dia) and the type of insulator used is Porcelain.

S.N o.	Details	Remarks
(i)	Name of Transmission line with voltage level:	400 kV D/C Koderma Bokaro Line
(ii)	Date and time of occurrence/discovery of failure:	30.08.2022/21:13 hours
(iii)	Length of line (km):	100 kM
(iv)	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	D/C
(v)	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	01 No. suspension type- 01 DA +0 Suspension
(vi)	Tower location No. with reference to nearest substation(indicate Name):	Location no 6 from Koderma (BTPS)
vii)	Name and size of conductor:	Twin Moose ACSR (Stranding - Al- 54/3.53mm & Steel- 7/3.53mm – Overall diameter-31.77mm dia)
viii)	No. of sub-conductors per bundle and bundle spacing:	02; 450 mm
(ix)	Number and size of Ground wire/OPGW (if provided):	2 no. GS Earth wire (7/3.66 mm)

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(x)	Type of insulators in use(Porcelain / Glass / Polymer):	Porcelain
(xi)	Configuration of insulators (I / V / Y / tension):	I suspension
(xii)	No. of insulators per string and No. of strings per phase:	23/string; 01 strings/phase
(xiii)	Year of construction / commissioning:	2014
(xiv)	Executing Agency:	M/s Jyoti Structures Limited
(xv)	Weather condition on the date of failure:	Heavy Wind, lightening, thunder storm
(xvi)	Terrain Category:	Plain
(xvii)	Reliability Level:	1
(xviii)	Wind Zone (1/2/3/4/5/6) and velocity of wind:	2
(xix)	Details of earthing of tower (pipe type/ Counter poise):	Pipe Type
(xx)	Line designed as per IS:802 (1977/1995/2015 any other code):	IS:802 (1995)
(xxi)	The agency who designed the line:	POWERGRID in house designed tower
(xxii)	Any Special consideration in design:	75 % wind in security condition and narrow front
(xxiii)	Details of last maintenance activity along with date:	Last Patrolling done in August 22, 2022. No defect observed
(xxiv)	Power flow in the line prior to failure:	23 x 2 = 46 MW
(xxv)	Any missing member found before / after failure of towers:	Nil
(xxvi)	Condition of foundation after failure:	OK
(xxvii)	Probable cause of failure:	Sabotage of member by miscreants
(xxviii)	Details of previous failure of the line / tower :	27.07.2022 at location 184 (DA+0)
(xxix)	Whether line will be restored on ERS or Spare tower will be used:	Restored on spare tower
(xxx)	Likely date of restoration:	Restored on 07.09.2022
(xxxi)	Present Status:	Restoration completed on 07.09.2022
(xxxii)	Details of any Tests carried out after failure(attach test reports):	NA

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iii)	Wind speed data of date & time of failure from nearby authorized observatory:	NA
iv)	Tower weight:	DA+6 -11 MT/tower
xv)	Any other relevant information:	No

Photographs :



Committee Observations:

Committee observed that the tower failure occurred due to sabotage of members by the miscreants.

Frequency of patrolling of transmission lines should be more in theft prone areas and for the vulnerable tower locations (Thunder prone, cyclonic prone area) so as to ensure safe and reliable operation. Missing members should be replaced as early as possible to avoid failure of towers.

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It is recommended to increase the patrolling frequency in theft-prone areas, developing a patrol schedule based on past theft incidents and increasing patrols during high-risk times like nights.

Assistance of local people should be taken in theft prone areas to minimize the theft and damage to towers.

A.7 765 kV S/C PHAGI(JAIPUR)-BHIWANI-CKT-I line

Brief Background:

The 765 kV S/C PHAGI(JAIPUR)-BHIWANI-CKT-I line transmission line was commissioned in 2015. The total length of the line is 270.8 km. The tower of this line was designed for wind zone 4 and the adopted Standard in design is IS:802 (1995). The 01 Suspension (+0 m) type tower get failed on 07.05.2023 at 18:23 PM. The type of conductor used is Bersimis Conductor / 35 mm diameter and the type of insulator used is Bersimis Conductor / 35 mm diameter).

S.No.	Details	Remarks
1.	Name of Transmission line with voltage level:	765 kV S/C PHAGI(JAIPUR)-BHIWANI-CKT-I line
2.	Date and time of occurrence/discovery of failure:	07.05.2023 / 18:23 PM
3.	Length of line (km):	270.8KM
4.	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)	Single Circuit
5.	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	01 Suspension (+0 m)
6.	Tower location No. with reference to nearest substation(indicate Name):	With reference to nearest substation(indicate Name): Loc. No. 476, SIKAR
7.	Name and size of conductor:	Bersimis Conductor / 35 mm diameter
8.	No. of sub-conductors per bundle and bundle spacing:	Quad Sub-Conductors
9.	Number and size of Ground wire/OPGW (if provided):	Ground Wire both peak / Size-3.66mm
10.	Type of insulators in use(Porcelain / Glass / Polymer):	Glass Insulator
11.	Configuration of insulators (I / V / Y / tension):	I and V
12.	No. of insulators per string and No. of strings per phase:	38 and 2
13.	Year of construction / commissioning:	2015

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14.	Executing Agency:	NCC
15.	Weather condition on the date of failure:	WIND STORM
16.	Terrain Category:	PLAIN
17.	Reliability Level:	2
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind:	4 (Wind Zone - IV)
19.	Details of earthing of tower (pipe type/ Counter poise):	Pipe type
20.	Line designed as per IS:802 (1977/1995/2015 any other code):	IS: 802 1995
21.	The agency who designed the line:	KEC
22.	Any Special consideration in design:	NA
23.	Details of last maintenance activity along with date:	26.12.2022 to 27.12.2022
24.	Power flow in the line prior to failure:	389 MW
25.	Any missing member found before / after failure of towers:	NIL
26.	Condition of foundation after failure:	OK
27.	Brief Description of failure: [Along with photographs (if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	WIND STORM CAUSE FAILURE ABOVE WAIST LEVEL
28.	Probable cause of failure:	WIND STORM
29.	Details of previous failure of the line / tower	Eight number towers collapsed on 23.05.2016 due to severe localized wind. In addition, cross arm of one tower was also damaged.
30.	Whether line will be restored on ERS or Spare tower will be used:	Line restored through spare tower
31.	Likely date of restoration:	Line restored and charged on 14.05.2023
32.	Present Status:	: Line charged
33.	Details of any Tests carried out after failure(attach test reports):	Three tower members have been identified and shall be sent for testing: (i) B31SA1X (ii) B31SA106LH (iii) B31SA106RH
34.	Wind speed data of date & time of failure from nearby authorized observatory:	Requested to provide these data from concerned authority.
35.	Location of failed tower	a. 28.01160278N, 75.673523E

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	a. Location Coordinates: b. Nearest Airport: c. District and State:	b. JAIPUR c. JHUNJHUNU , Rajasthan
36.	Tower weight:	15,397 Kg
37.	Tower schedule of affected section:	Attached as Annexure-I
38.	Sag tension calculation considered for design of tower:	$WL^2 / 8T$

Photographs:





Committee Observations:

It was observed that the tower at location No. 476 buckled above waist height in transverse direction. The damage was limited to the cross arm and the tower below waist height was found to be in good condition with healthy members, stubs, tower legs and foundation. However, the beam and members above the K frame joint were found damaged. Committee observed that the failure has initially started at the side section (facing west side) of beam resulting fault into Y- Phase and further evolve to Middle Section, i.e., B-Phase (Phase position at Tower No. 476, R-Phase in East with respect to middle Phase B and Y Phase in west) and finally due to heavy wind pressure the tower was tilted in East direction above the K-Section of the tower.

It was also observed that it was the second instance of tower failure of this line. Earlier on 23.05.2016, 08 Nos. of Towers at Location No. 65/4 (SA+0), 66/0 (SE+0), 66/1 (SA+0), 66/2 (SA+0), 67/0 (SD+0), 67/1 (SA+0), 67/2 (SA+0) and 67A/0 (SB+0) collapsed which was 30 km from Bhiwani Substation.

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. Photographs of uprooted trees and damaged roofs / walls of the houses due to high speed wind is submitted. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

Committee suggested that the patrolling frequency of the line may be increased. Committee noted that the small deficiencies in the tower structure may lead to its collapse in the event of occurrence of high speed wind. Committee advised that utilities should improve their erection and operation & maintenance practices and ensure that structural strength is not compromised due to deficiencies like, unplugged holes, rusting of stubs, etc.

A.8 765 kV S/C Bina- Gwalior ckt. 3 :

Brief Background:

The 765 kV S/C Bina- Gwalior ckt. 3 transmission line was commissioned in 2014. The total length of the line is 231.30 km. The tower of this line was designed for wind zone 4 and the adopted Standard in design is IS:802 (1995). The 1 Number of A+0 type tower get failed on. 24.05.2023 at 15:53 hrs. The type of conductor used ACSR Bersimis conductor, (Al-42/4.57mm & steel- 7/2.54 mm, overall dia- 35.04 mm) and the type of insulator used is glass.

1.	Name of Transmission line with voltage level	765 kV S/C Bina- Gwalior ckt. 3
2.	Date and time of occurrence/discovery of failure	24.05.2023 at 15:53 hrs
3.	Length of line (km)	231.30 km
4.	Type of configuration [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	S/C
5.	Number of Towers and Type of Towers failed [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type length of extension)]	01 Loc. No. 560 (A+0)-
6.	Tower location No. with reference to nearest substation (indicate Name)	560 (A+0) Gwalior Substation
7.	Name and size of conductor	ACSR Bersimis conductor, (Al-42/4.57mm & steel- 7/2.54 mm, overall dia- 35.04 mm)
8.	No. of sub-conductors per bundle and bundle spacing	Quad Conductor (450mm)
9.	Number and size of Ground wire/OPGW (if provided)	2 no Earth wire (7/3.63mm)
10.	Type of insulators in use(Porcelain / Glass /	Glass
11.	Configuration of insulators (I / V / Y / tension)	I & V
12.	No. of insulators per string and No. of strings per phase	2nos 'I'- 40nos x 2 & 1no 'V'- 35nos- 2
13.	Year of construction / commissioning	May, 2014
14.	Executing Agency	M/s Lanco
15.	Weather condition on the date of failure	Heavy wind and scattered rain

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16.	Terrain Category	2
17.	Reliability Level	2
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind: Zone	4 (Basic wind speed – 47m/sec)
19.	Details of earthing of tower (pipe type/ Counter poise):	Pipe earthing
20.	Line designed as per IS:802 (1977/1995/2015 any other code	1995
21.	The agency who designed the line	POWERGRID Std design., Horizontal
22.	Any Special consideration in design	PS
23.	Details of last maintenance activity along with date	The patrolling of above loc was carried out on dt. 03.02.2023.
24.	Power flow in the line prior to failure	198 MW
25.	Any missing member found before / after failure of towers	1.5 Ton members reported missing after failure of tower
26.	Condition of foundation after failure	All 3 stubs damaged completely (A, C & D) C leg stub remain intact.

27.	Probable cause of failure	Severe theft of tower members from 1 st section of tower loc. No. 560
28.	Details of previous failure of the line / tower	Loc. 611 of Bina# 3
29.	Whether line will be restored on ERS or Spare tower will be used	Spare tower will be used
30.	Likely date of restoration	05.06.2023
31.	Present Status	Out of service
32.	Details of any Tests carried out after failure (attach test reports)	Visual inspection. Sample is being collected for testing.
33.	Wind speed data of date & time of failure from nearby authorized observatory	NA
34.	Tower weight	15.397MT

Photographs:





Committee Observations:

It was observed that 01 No. of Suspension Type tower at location No. 560 got collapsed. Committee observed that the tower failure occurred due to theft of tower members.

Committee suggested that the frequency of patrolling of transmission lines should be more in theft prone areas and for the vulnerable tower locations (Thunder prone, cyclonic prone area) so as to ensure safe and reliable operation. Missing members should be replaced as early as possible to avoid failure of towers. Assistance of local people should be taken in theft prone areas to minimize the theft and damage to towers.

A.9 765 kV S/C PHAGI(JAIPUR)-BHIWANI-CKT-I line:**Brief Background:**

The 765 kV S/C PHAGI(JAIPUR)-BHIWANI-CKT-I transmission line was commissioned in 2015. The total length of the line is 270.8 km. The tower of this line was designed for wind zone 4 and the adopted Standard in design is IS:802 (1995). The 07 Nos. Suspension Towers (05 A+0 and 02 B+0) get failed on 25.05.2023 at 20:09 PM. The type of conductor used is Bersimis Conductor / 35 mm diameter and the type of insulator used is Glass Insulator.

S. No.	Details	Remarks
1.	Name of Transmission line with voltage level:	765 kV S/C PHAGI(JAIPUR)-BHIWANI-CKT-I line
2.	Date and time of occurrence/discovery of failure:	25.05.2023 / 20:09 PM
3.	Length of line (km):	270.8KM
4.	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	Single Circuit
5.	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	07 Suspension Towers (05 A+0 and 02 B+0)
6.	Tower location No. with reference to nearest substation(indicate Name):	Loc. No. 556 to 562, SIKAR
7.	Name and size of conductor:	Bersimis Conductor / 35 mm diameter
8.	No. of sub-conductors per bundle and bundle spacing:	Quad Sub-Conductors
9.	Number and size of Ground wire/OPGW (if provided):	Ground Wire both peak / Size- 3.66mm
10.	Type of insulators in use(Porcelain / Glass / Polymer):	Glass Insulator
11.	Configuration of insulators (I / V / Y / tension):	I and V

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12.	No. of insulators per string and No. of strings per phase:	38 and 2
13.	Year of construction / commissioning:	2015
14.	Executing Agency:	NCC
15.	Weather condition on the date of failure:	WIND STORM
16.	Terrain Category:	PLAIN
17.	Reliability Level:	N-1
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind:	4 (Wind Zone - IV)
19.	Details of earthing of tower (pipe type/ Counter poise):	Pipe type
20.	Line designed as per IS:802 (1977/1995/2015 any other code):	IS: 802 1995
21.	The agency who designed the line:	KEC
22.	Any Special consideration in design	
23.	Details of last maintenance activity along with date:	26.12.2022 to 27.12.2022
24.	Power flow in the line prior to failure:	389 MW
25.	Any missing member found before / after failure of towers:	NIL
26.	Condition of foundation after failure:	OK
27.	Brief Description of failure: [Along with photographs (if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	WIND STORM CAUSE FAILURE UPTO STUB LEVEL (3 towers) and UPTO WAIST LEVEL (4 towers)
28.	Probable cause of failure:	WIND STORM
29.	Details of previous failure of the line / tower :	i) One number tower damaged from cross arm level on 07.05.2023 due to severe localized wind ii) Eight number towers collapsed on 23.05.2016 due to severe localized wind. In addition, cross arm of one tower was also damaged.
30.	Whether line will be restored on ERS or Spare tower will be used:	Line to be restored through spare tower
31.	Likely date of restoration:	Line restored and charged on 08.06.2023
32.	Present Status:	Line restoration work going on.
33.	Details of any Tests carried out after failure(attach test reports):	Three tower members have been identified and shall be sent for testing: (i) B31SA1X (ii) B31SA106LH (iii) B31SA106RH

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34.	Wind speed data of date & time of failure from nearby authorized observatory:	-
35.	Location of failed tower a. Location Coordinates: b. Nearest Airport: c. District and State:	a. Location Coordinates: 28.211477778N, 75.86125E b. Nearest Airport: JAIPUR c. District and State: JHUNJHUNU
36.	Tower weight:	15,397 kG
37.	Tower schedule of affected section:	Attached as Annexure-I
38.	Sag tension calculation considered for design of tower:	$WL^2 / 8T$

Photographs:





Committee Observations:

It was observed by the committee that the 07 Nos. of Transmission Line Towers at Location No. 556 (SA+0), 557 (SA+0), 558 (SB+6), 559 (SA+0), 560 (SB+6), 561 (SA+0) and 562 (SA+0) got collapsed. The towers was designed for basic wind speed of 47 m/s corresponding to wind zone-4 and as per IS: 802-1995. It was also observed that this is the third instance of tower failure of the line. Earlier on 23.05.2016, 08 Nos. of Towers at Location No. 65/4 (SA+0), 66/0 (SE+0), 66/1 (SA+0), 66/2 (SA+0), 67/0 (SD+0), 67/1 (SA+0), 67/2 (SA+0) and 67A/0 (SB+0) collapsed which was 30 km from Bhiwani Substation. Also, on 07.05.2023, 01 No. of tower got bent from upper portion of K-frame.

Committee observed that 05 Numbers of towers have buckled up approximately 10 m above the ground level in the transverse direction and tower at 02 locations have collapsed completely on ground whose stubs were bent but foundations were found intact.

Committee observed that tower at location No. 562 (SA+0) was completely collapsed to ground. All the four stubs were found bent with foundation at all the legs were found broken and rusting was found on the stubs. Tower at Location No. 561 (SA+0) was completely collapsed to ground with all four stubs of the tower was found bent with foundation at all the legs were found broken and rusting was found on the stubs. Tower at Location No. 560 (SB+6) was buckled from +6 extension level and leg B stub was found damaged. Tower at Location No. 559 (SA+0) was buckled above waist level. Snapping of conductor was observed between tower No 559 and 560. Tower at Location No. 557 (SA+0) was buckled above basic body level with one stub of the tower was found damaged. Tower at Location No. 556 (SA+0) and 558 (SB+6) was buckled above basic body level.

Committee observed that since a number of trees were uprooted in the vicinity, high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

A.10 400 kV D/C Mundra-Bhachau 1&2 transmission line

Brief Background:

The 400 kV D/C Mundra-Bhachau 1&2 transmission line was commissioned in 01.10.2011. The total length of the line is 99.468 km. The tower of this line was designed for wind zone 5 and the adopted Standard in design is IS:802 (1995). The 01 no, Tension Tower (DD+23.5 Extn. 1.5RC) get failed on 16.06.2023 at 09:11 Hrs. The type of conductor used is ACSR Snow Bird and the type of insulator used is Composite Long Rod polymer insulator.

1.	Name of Transmission line with voltage level	400 kV D/C Mundra-Bhachau 1&2
2.	Date and time of occurrence/discovery of failure	16.06.2023, 09:11 Hrs
3.	Length of line (km)	99.468 KM
4.	Type of configuration [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	D/C
5.	Number of Towers and Type of Towers failed [Suspension/tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	01 no, Tension Tower (DD+23.5 Extn. 1.5RC) Powerline crossing of 400kv APL-Charanka line
6.	Tower location No. with reference to nearest substation (indicate Name)	Bhachau SS, Tower no 248
7.	Name and size of conductor	ACSR Snow Bird
8.	No. of sub-conductors per bundle and bundle spacing	Triple Conductor
9.	Number and size of Ground wire/OPGW (if provided)	2 Nos Earthwire (7/3.66 mm)
10.	Type of insulators in use (Porcelain / Glass / Polymer)	Composite Long Rod polymer insulator
11.	Configuration of insulators (I / V / Y / tension)	Double Tension String

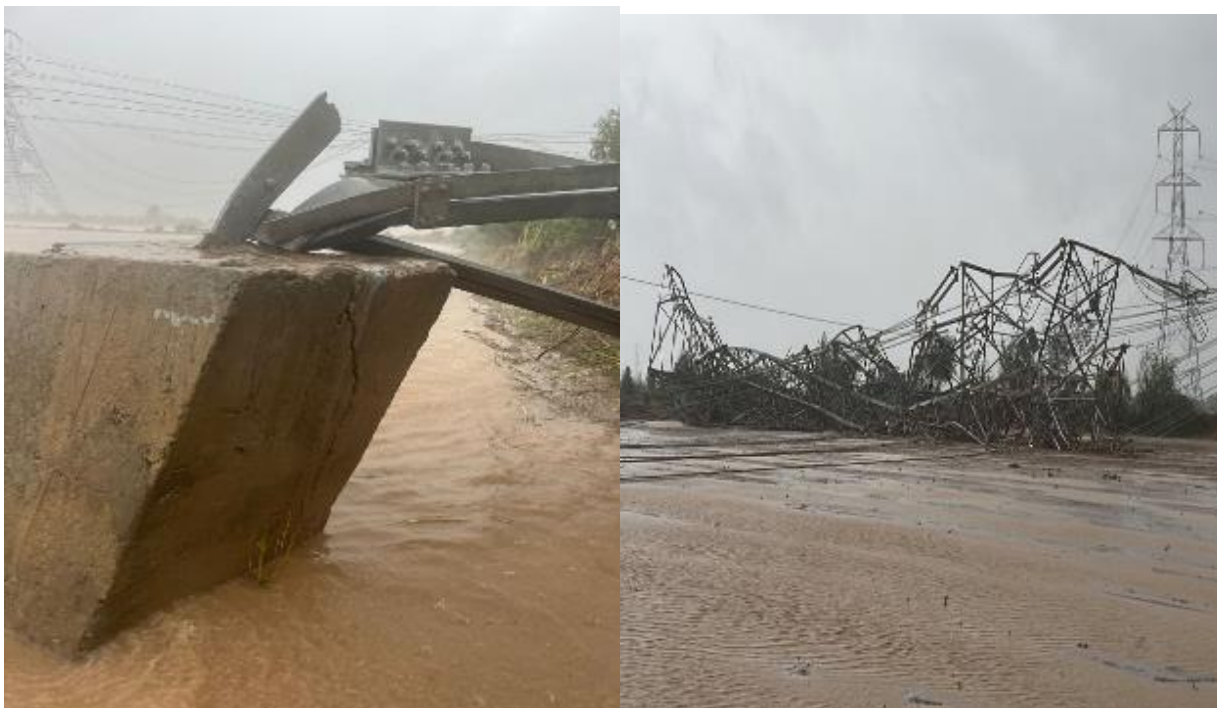
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12.	No. of insulators per string and No. of strings per phase	02 & 04 (Total 04 nos. 210KN CLR Polyme insulators)
13.	Year of construction / commissioning	01.10.2011
14.	Executing Agency	M/s Tata Projects Agency
15.	Weather condition on the date of failure	Landfall of very severe Cyclone “Biparjoy”
16.	Terrain Category	Vulnerable, Tower having powerline crossing
17.	Reliability Level	-----
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind: Zone	5
19.	Details of earthing of tower (pipe type/ Counter poise):	Pipe
20.	Line designed as per IS:802 (1977/1995/2015 any other code	1995
21.	The agency who designed the line	POWRGRID Standard Design
22.	Any Special consideration in design	Pile foundation
23.	Details of last maintenance activity along with date	Patrolling of above locations was carried out on 16.06.23 in heavy wind and rain during landfall of Biparjoy cyclone
24.	Power flow in the line prior to failure	280 MW
25.	Any missing member found before / after failure of towers	no
26.	Condition of foundation after failure	All stubs of leg A,B,C,D got bent and raised Chimney of leg B got completely broken and remaining legs have crack in it.
27.	Brief Description of failure [Along with photographs (if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	01 no, Tension Tower collapsed due to Landfalling of Very severe cyclone Biparjoy.
28.	Probable cause of failure	Landfalling of Very severe cyclone Biparjoy
29.	Details of previous failure of the line / tower	No
30.	Whether line will be restored on ERS or Spare tower will be used	Spare tower shall be used
31.	Likely date of restoration	26.06.2023
32.	Present Status	Out of Service
33.	Details of any Tests carried out after failure (attach test reports)	Visual Inspection
34.	Wind speed data of date & time of failure from nearby authorized observatory	IMD report dated 16.06.2023
35.	Location of failed tower	

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	a. Location Coordinates	Longitude-70.07523611, Latitude- 23.19841389
	b. Nearest Airport	Bhuj Airport
	c. District and State	Lakhapar Village, Kutchh District, Gujarat
36.	Tower weight	73.12MT

Photographs:







Committee Observations:

It was observed that 01 No. of Tension Tower (DD+23.5 Extn. 1.5 RC) at location no 248, designed as per IS: 802-1995. Committee concluded that the tower failure was due to heavy wind and rain due to Biparjoy Cyclone in that area. All stubs of leg A, B, C, D got bent and raised Chimney of leg B got completely broken and remaining legs have crack in it.

Committee observed that the failure of tower was due to the impact of cyclone Biparjoy. The recommendations of “Task Force on Cyclone Resilient Robust Electricity Transmission & Distribution Infrastructure in coastal areas” should be followed by utilities while designing/erection of transmission lines in cyclone affected area.

Committee suggested that frequency of patrolling of transmission lines should be more for the vulnerable tower locations particularly in thunder & cyclone prone areas.

A.11 765 kV S/C Gaya Varanasi line failed on 19.06.2023**• Brief Background :**

The 765 kV s/c Gaya Varanasi line transmission line was commissioned in March 2012. The total length of the line is 264 KM. The tower of this line was designed for wind zone 4 and the adopted Standard in design is IS:802 (1995). The 01 Number suspension tower at location number 318 (A+0) s/c get failed on 19.06.2023 at 18:11 Hrs. The type of conductor used is ACSR Bersimis, 35.04 mm overall diameter and the type of insulator used is Glass.

S.No.	Details	Remarks
1.	Name of Transmission line with voltage level:	765 kV s/c Gaya Varanasi line
2.	Date and time of occurrence/discovery of failure:	19.06.2023 at 18:11 Hrs
3.	Length of line (km):	264 KM
4.	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	S/C Delta Configuration
5.	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	01 No. tower location number 318 (A+0) s/c wz 4
6.	Tower location No. with reference to nearest substation(indicate Name):	318 (A+0) s/c wz 4 from Gaya side
7.	Name and size of conductor:	ACSR Bersimis, 35.04 mm overall diameter
8.	No. of sub-conductors per bundle and bundle spacing:	4 conductors, 457 mm
9.	Number and size of Ground wire/OPGW (if provided):	2 side E/W (7/3.66M, Diameter 10.98 mm)
10.	Type of insulators in use(Porcelain / Glass / Polymer):	Glass
11.	Configuration of insulators (I / V / Y / tension):	Suspension (2 X Double I, 1XV)

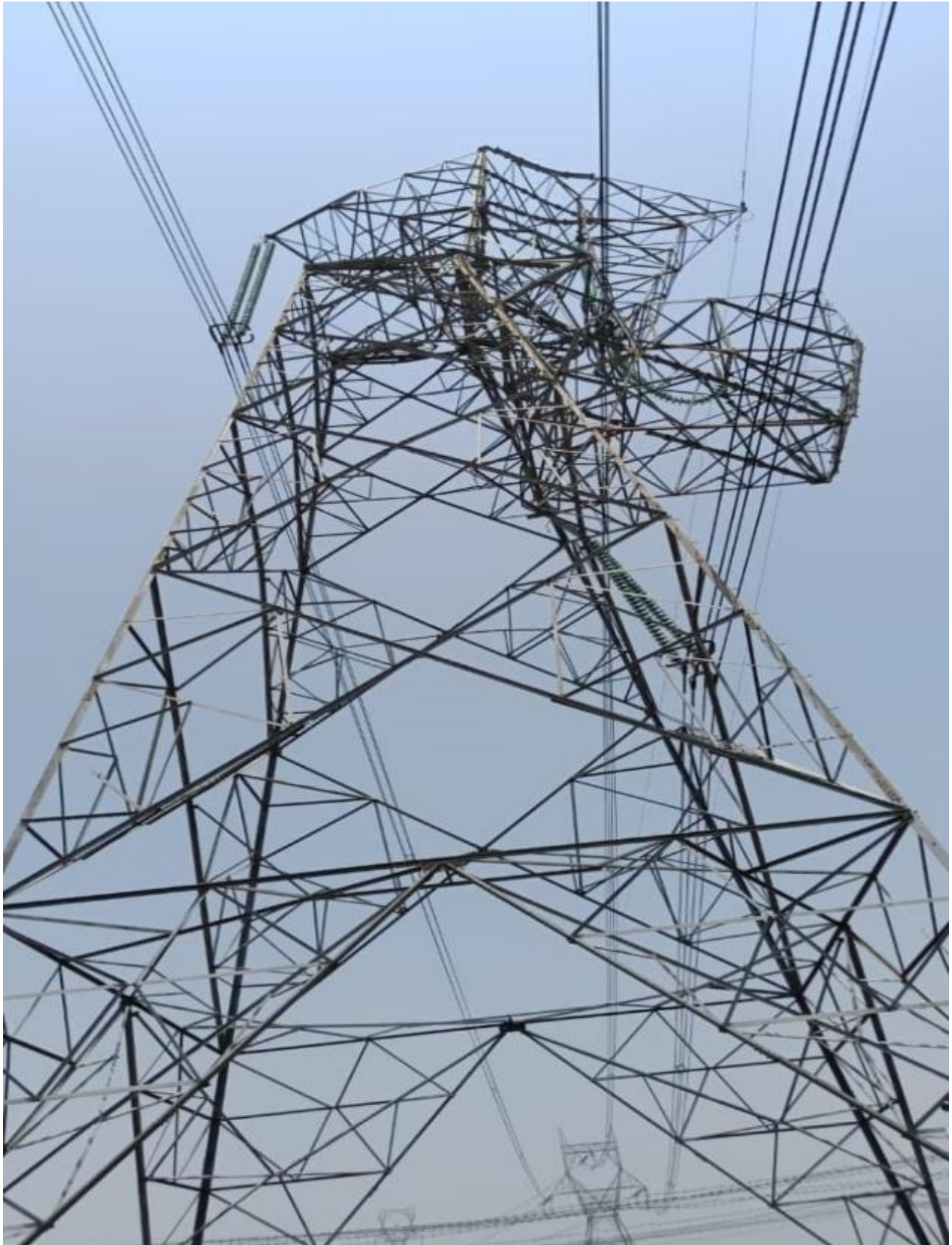
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12.	No. of insulators per string and No. of strings per phase:	02 No. Double I type insulator per phase ; 01 V type insulator string per phase ; 40 insulators per string in I type and 35 insulators in V type.
13.	Year of construction / commissioning:	March 2012
14.	Executing Agency:	M/s KPTL
15.	Weather condition on the date of failure:	Heavy Wind Storm with Thunder and Rain/ 19.06.2023
16.	Terrain Category:	2
17.	Reliability Level:	2
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind:	4, Basic wind speed – 47 m/s
19.	Details of earthing of tower (pipe type/ Counter poise):	Pipe
20.	Line designed as per IS:802 (1977/1995/2015 any other code):	Yes- IS 802:1995
21.	The agency who designed the line:	Powergrid Inhouse designed towers
22.	Any Special consideration in design:	Nil
23.	Details of last maintenance activity along with date:	LOC 318
24.	Power flow in the line prior to failure:	63 MW
25.	Any missing member found before / after failure of towers:	NIL
26.	Condition of foundation after failure:	GOOD
27.	Brief Description of failure: [Along with photographs (if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	Due to very heavy localized windstorm.(newspaper cutting attached)
28.	Probable cause of failure:	Due to heavy localized cyclonic winds
29.	Details of previous failure of the line / tower :	Details- 2014 - 14 towers 2017 – 03 towers 2018 – 02 towers

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30.	Whether line will be restored on ERS or Spare tower will be used:	Spare tower will be used
31.	Likely date of restoration:	Line expected to be restored on date 27.06.2023
32.	Present Status:	Restoration under progress
33.	Details of any Tests carried out after failure(attach test reports):	Shall be submitted after receipt of test reports. The test reports suggested that there is no failure due to the Ultimate tensile strength and chemical reaction test. The result of chemical reaction and ultimate tensile strength is within the limit.
34.	Wind speed data of date & time of failure from nearby authorized observatory:	Request letter sent on 20.06.2023
35.	Location of failed tower a. Location Coordinates: b. Nearest Airport: c. District and State:	Village Mominpur; Block + Thana Kargahar; Panchayat Kalyanpur; Dist. Rohtas. a. T.No.-318, 25.0585241, 83.916601, 77.005260 b. Varanasi Airport, UP c. Rohtas, Bihar
36.	Tower weight:	Loc 318- 21 MT

Photographs:











Committee Observations:

It was observed by the committee that the failed tower (A+0 Delta) at Location No. 318 is located in a plain agricultural field and was designed for wind zone-4 for basic wind speed of 47 m/s as per IS:802-1995. It was observed that the foundation, main legs and stubs of the tower were intact. The tower was collapsed from above K-frame waist level leading to damage of cross arms and peaks. There was no damage to adjacent tower locations, i.e. at 317 and 319.

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. Newspaper cutting indicating the high speed wind has been submitted. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

A.12 220 kV D/C Chamera III Chamba I & II failed on 09.07.2023

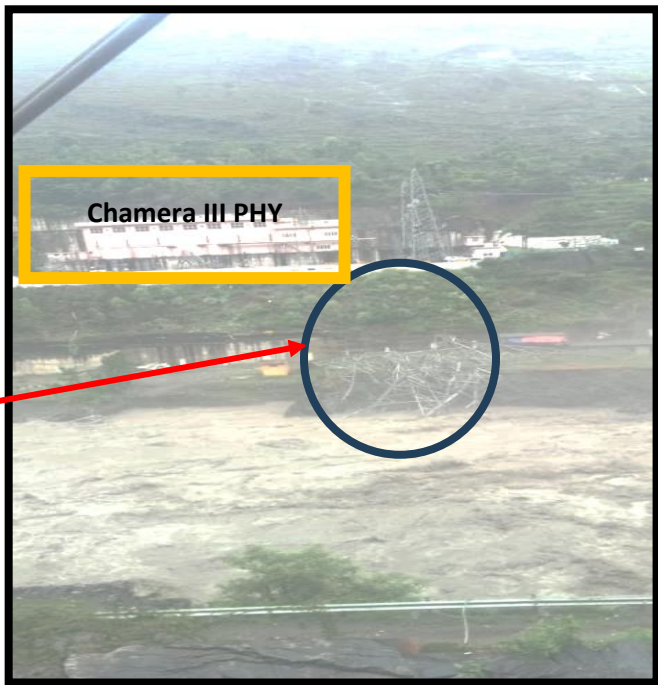
• Brief Background :

The 220 kV D/C Chamera III Chamba I & II transmission line was commissioned in March 2011. The total length of the line is 14.226 KM. The tower of this line was designed for wind zone 2. The **Tower No: 01:** Tension Type, DD+9 (Dead end tower at Chamera III PHY) **Tower No: 02:** Tension Type, DD+3 (Top and Middle Crossarms damaged get failed on 09.07.2023 at 10:28 Hrs. The type of conductor used is MOOSE, Nominal Diameter: 31.77 mm and the type of insulator used is Porcelain discs.

1)	Name of Transmission line with voltage level:	220 kV D/C Chamera III Chamba I & II (Charged using 400 kV D/C Twin Moose Design)
2)	Date and time of occurrence/discovery of failure:	1028 hrs/09.07.2023 and discovery of failure immediately by NHPC Chamera III Officials
3)	Length of line (km):	14.226 kms
4)	Type of configuration: (S/C, D/C, S/C strung on D/C towers, narrow base etc.)	D/C
5)	Number of Towers and Type of Towers failed: [suspension / tension/dead end /special tower /river crossing tower/ Powerline crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	Tower No: 01: Tension Type, DD+9 (Dead end tower at Chamera III PHY) Tower No: 02: Tension Type, DD+3 (Top and Middle Crossarms damaged)
6)	Tower location No. with reference to nearest substation(indicate Name):	Tower No. 01 (Sequence from Chamera III end and nearest to Chamba Sub-station/TL group of POWERGRID)
7)	Name and size of conductor:	MOOSE, Nominal Diameter: 31.77 mm
8)	No. of sub-conductors per bundle and bundle spacing:	Twin with bundle spacing of 45.7 cm
9)	Number and size of Ground wire/OPGW (if provided):	Earth-wire is 3.66 mm strand dia and 10.98 mm nominal dia in Circuit II OPGW is 24 strand/12mm nominal dia I Circuit I
10)	Type of insulators in use(Porcelain / Glass / Polymer):	Porcelain discs
11)	Configuration of insulators (I / V / Y / tension)	Vertical configuration D/C Tension tower with each insulator string using “DT” string

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12)	No. of insulators per string and No. of strings per phase:	“Double Tension” string having two pairs of 25 nos. of 160 kN porcelain discs
13)	Year of construction / commissioning:	Charging on Commissioning: November 01, 2011
14)	Executing Agency:	M/s KEC Ltd.
15)	Weather condition on the date of failure:	Torrential rainfall with heavy flash flooding River Ravi
16)	Wind speed and duration at the time of failure	NA
17)	Terrain Category:	Tough hilly terrain with tower lying on the banks of River Ravi at Chamera III PHY
18)	Reliability Level	-
19)	Wind Zone (1/2/3/4/5/6) and velocity of wind for which tower was designed:	Wind Zone-2, 39 m/sec (LMSZ-15 mm)
20)	Line designed as per IS: 802 (1977/1995/2015/any other code):	-
21)	Type of steel	Galvanized steel
22)	The agency who designed the line:	-
23)	Any Special consideration in design:	Line is designed at 400 kV Level D/C Tower but charged at 220 kV
24)	Agency where tower prototype was tested and year of testing	-
25)	Power flow in the line prior to failure:	145 MW
26)	Any missing member found before / after failure of towers:	No
27)	Condition of foundation after failure:	Foundation base of two legs have washed away with River Ravi
28)	Details of previous failure of the line / tower	No previous tower failure of any tower in this line
29)	Details of last maintenance activity along with date	Last patrolling date was 02.06.2023 with no defects found
30)	Brief Description of failure: [along with photographs(if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	Tower No: 01: • Tension Type, DD+9 (Dead end tower at Chamera III HEP) Collapsed completely also damaging the gantry of Chamera III • Tower collapsed completely owing to flashfloods in Ravi River which took away the base of the foundation along with the protection walls. Flash floods exacerbated due to extensive water released from Chamera III added on by flash floods. Tower No: 02: • Tension Type, DD+3 • Due to collapse of tower no 01, top and middle cross arms of right circuit (looking from Chamera III Towards Chamba) buckled due to sudden jerk during failure of tower no. 1.

		Photographs in below link: 
31)	Probable cause of failure:	Prima facie, it seems that the damage has been caused due to extensive floods in River Ravi on account of sudden inrush of water owing to torrential rainfall over night in whole state of HP which has also led to extensive damage in other infrastructure leading to cutoff in connectivity at several places
32)	Whether line will be restored on ERS or Spare tower will be used:	The possibility for restoration of line on ERS is being explored.
33)	Likely date of restoration:	Could be ascertained only after reaching the site
34)	Present Status:	Both circuits are out
35)	Details of any Tests carried out after failure:	-
36)	Single line diagram / clearance diagram of the failed tower(s) with all dimensions (Horizontal and vertical dimensions including the base width of tower)	SLD using Google maps Attached
37)	Tower spotting data	TSD attached
38)	Tower Schedule for the failed section	

			Tower No.	Type of Tower	Forward Span (mtrs.)
			0	GANTRY	54
			1	DD+9	166
			2	DD+3	86
			3	DD+3	86

Photographs:











Committee Observations:

Committee observed that the failure of tower was due to increased flow of water caused due to extensive floods in River Ravi on account of sudden inrush of water owing to torrential rainfall over night in whole state of Himachal Pradesh (H.P.).

It was observed that Tower at Location Number 01, i.e., Tension Type, DD+9 (Dead end tower at Chamera III HEP) Collapsed completely also damaging the gantry of Chamera III. Tower was completely collapsed due to flashfloods in Ravi River which took away the base of the foundation along with the protection walls. Flash floods exacerbated due to extensive water released from Chamera III added on by flash floods.

It was also observed that due to collapse of tower no 01, top and middle cross arms of right circuit of Tower No. 02, i.e. Tension Type, DD+3 (looking from Chamera III Towards Chamba) buckled due to sudden jerk during failure of tower at Location No. 1.

Committee also recommended that Pile type foundation may be considered for all towers in flood prone area based on soil investigation report and latest high flood data, to avoid this type of failure. Providing proper Protection (retaining wall, Gabion wall etc.), proper revetment and use of geo-synthetic material in foundation, concrete encasing & painting of stub in water logging areas etc. may also be considered, wherever required.

A.13 220 kV D/C Anta – Bhilwara transmission line failed on 18.08.2023

Brief Description:

The 220 kV Anta – Bhilwara D/C transmission line was commissioned in 1989. The total length of the line is 186.67 Km. The 01 Number of Suspension Tower (Tower Location No. 512(DA+0)), get collapsed on 17.08.2023 due to a passenger bus bumped into Tower no 512 of 220 KV Anta - Bhilwara D/C line leading to collapse of tower. The type of conductor used is Single Zebra conductor.

Photographs:





Probable Cause of Failure:

A passenger bus bumped into Tower no 512 of 220 kV Anta - Bhilwara D/C line leading to collapse of tower.

Committee observations:

Committee observed that a passenger bus bumped into Tower no 512 of 220 kV Anta - Bhilwara D/C line leading to collapse of tower.

Committee recommended to submit a FIR copy in case of such type of failures.

A.14 400kV D/C Ballabgarh-Gurgaon-CKT-I line failed on 07.09.2023

• **Brief Description:**

The 400 kV D/C Ballabgarh-Gurgaon-CKT-I transmission line was commissioned in March 1988. The total length of the line is 42.7 km. The tower of this line was designed for wind zone 4 as per IS:802(1995). The 02 Numbers of Suspension Tower (Tower no. 4: DA – Complete tower failure, Tower no. 2: DA – EW peak Bend) and 02 Number of Tension tower (Tower no. 3: DB – Bend from Top Cross Arm, Tower no. 5: DD - EW peak Bend) get failed on 07.09.2023 at 23:56 PM. The type of conductor used is Moose Conductor / 31.77 mm diameter and the type of insulator used is Polymer Insulator.

S.No.	Details	Remarks
1.	Name of Transmission line with voltage level:	400 kV D/C Ballabgarh-Gurgaon-CKT-I line
2.	Date and time of occurrence/discovery of failure:	07.09.2023 / 23:56 PM
3.	Length of line (km):	42.7KM
4.	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)	Double Circuit (Tower 1 to 5), S/C – Single Circuit (6 onwards)
5.	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	02 Suspension Tower(Tower no. 4: DA – Complete tower failure, Tower no. 2: DA – EW peak Bend) and 02 Tension tower (Tower no. 3: DB – Bend from Top Cross Arm, Tower no. 5: DD - EW peak Bend)
6.	Tower location No. with reference to nearest substation(indicate Name):	Loc. No. 2-5, Ballabgarh
7.	Name and size of conductor:	Moose Conductor / 31.77 mm diameter
8.	No. of sub-conductors per bundle and bundle spacing:	Twin Sub-Conductors
9.	Number and size of Ground wire/OPGW (if provided):	OPGW both peak / Dia. – 12 mm
10.	Type of insulators in use(Porcelain / Glass / Polymer):	Polymer Insulator
11.	Configuration of insulators (I / V / Y / tension):	Suspension: I type , Tension

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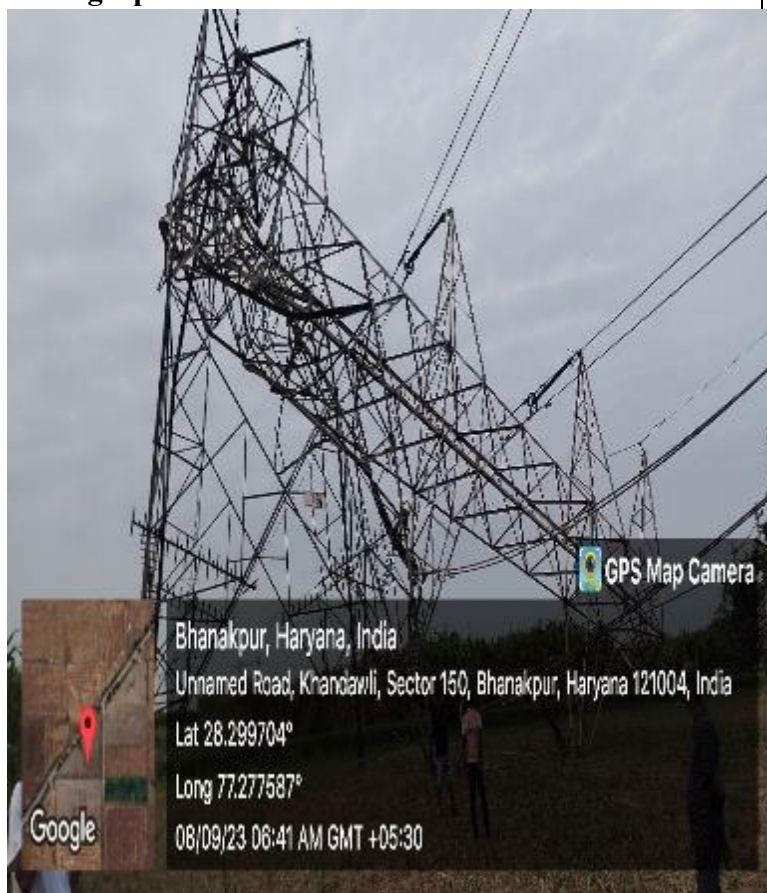
12.	No. of insulators per string and No. of strings per phase:	Suspension: 23 and 1, Tension: 24 and 2
13.	Year of construction / commissioning:	1988
14.	Executing Agency:	KPTL
15.	Weather condition on the date of failure:	Normal
16.	Terrain Category:	PLAIN
17.	Reliability Level:	N-1
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind:	4 (Wind Zone - IV)
19.	Details of earthing of tower (pipe type/ Counter poise):	Pipe type
20.	Line designed as per IS:802 (1977/1995/2015 any other code):	IS: 802 1995
21.	The agency who designed the line:	KPTL
22.	Any Special consideration in design:	-
23.	Details of last maintenance activity along with date:	08.05.2023
24.	Power flow in the line prior to failure:	115 MW
25.	Any missing member found before / after failure of towers:	NIL
26.	Condition of foundation after failure:	OK
27.	Brief Description of failure: [Along with photographs (if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	Bend from Waist Level (1 tower), Bend from Top Cros arm level (1 tower) and Earthwire peak bend (2 towers)
28.	Probable cause of failure:	The cause of tower failure is due to cutting of idle conductor (middle and bottom) by some miscreants
29.	Details of previous failure of the line / tower :	Nil
30.	Whether line will be restored on ERS or Spare tower will be used:	Line restored on ERS
31.	Likely date of restoration:	11.09.2023
32.	Present Status:	Line restoration work nearing completion
33.	Details of any Tests carried out after failure(attach test reports):	NA
34.	Wind speed data of date & time of failure from nearby authorized observatory:	NA
35.	Location of failed tower a. Location Coordinates: b. Nearest Airport: c. District and State:	a. 28.299704N, 77.277587E b. IGI airport, Delhi c. Ballabhgarh, Haryana

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36.	Single line diagram/clearance diagram of failed tower(s) with all dimensions (horizontal & vertical dimensions including base width of tower)	Provided
37.	Tower weight:	12312 kG
38.	Tower spotting data:	NA
39.	Sag tension calculation considered for design of tower:	$WL^2/8T$ (W: Weight per unit length of Conductor, L: Length of Span, T: Tension in Conductor)

Photographs:

Photographs:



ERS erected:





Tower No 5



Tower No 4



Tower No 3



Tower No 2

Committee Observations:

It was observed that the conductor of two idle phases (middle and bottom) have been cut down by the miscreants at Tower No. 5 and due to the impact of sudden jerk tower no. 4 collapsed, and subsequently peak of Tower Nos. 2 and 5 bent and top cross arm of Tower No. 3 also bent. The committee concluded that the cause of failure is due to the snapping of the idle conductor (middle and bottom) between span of Tower Nos 4 and 5. The copy of F.I.R. was submitted.

It was observed that one peak earth wire of the Tower No. 02 was bent, the top cross arm, two earth wire peaks of tower at Location No. 3 were bent, tower at location no. 4 was bent completely and one earth wire peak of the Tower no. 05 was bent with Two strings of tension type insulators of two bottom phases (idle) toward Ballabhgarh substation were found snapped. The conductors of bottom two phase (idle) of ckt (idle) between Tower no. 4 and Tower no. 5 was laid on ground.

Committee recommended that the frequency of patrolling of transmission lines should be more in theft prone areas so as to ensure safe and reliable operation. Missing members should be replaced as early as possible to avoid failure of towers.

It is recommended to increase the patrolling frequency in theft-prone areas, developing a patrol schedule based on past theft incidents and increasing patrols during high-risk times like nights. Assistance of local people should be taken in theft prone areas to minimize the theft and damage to towers.

A.15 400kV D/C Rangpo-Teesta-V Transmission Line failed on 04.10.2023

• **Brief Background :**

The 400kV D/C Rangpo-Teesta-V transmission line was commissioned in January 2008. The total length of the line is 12 KM. The tower of this line was designed for wind zone 4 as per IS:802(1995). The 02 Nos. Tension Tower (1 No. DD+9 & 1 No. DD+6) failed on 04.10.2023 at 02:55 Hours. The type of conductor used is MOOSE Conductor / 31.77 mm diameter and the type of insulator used is Porcelain Insulator.

S.N o.	Details	Remarks
1.	Name of Transmission line with voltage level:	400kV D/C Rangpo-Teesta-V TL
2.	Date and time of occurrence/discovery of failure:	04.10.2023 at 02:55 Hours
3.	Length of line (km):	12 KM
4.	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	Double Circuit
5.	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	02 Nos. Tension Tower (1 No. DD+9 & 1 No. DD+6)
6.	Tower location No. with reference to nearest substation(indicate Name):	Loc. No.-1,2 & 3, RANGPO
7.	Name and size of conductor:	MOOSE Conductor / 31.77 mm diameter
8.	No. of sub-conductors per bundle and bundle spacing:	Twin Sub-Conductors
9.	Number and size of Ground wire/OPGW (if provided):	Ground Wire one peak & OPGW other peak / Size- 3.66mm
10.	Type of insulators in use(Porcelain / Glass / Polymer):	Porcelain Insulator
11.	Configuration of insulators (I / V / Y / tension):	I
12.	No. of insulators per string and No. of strings per phase:	25 discs and 2
13.	Year of construction / commissioning:	Jan 2008

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14.	Executing Agency:	KEC
15.	Weather condition on the date of failure:	Cloud Burst with extreme heavy rain
16.	Terrain Category:	HILLY
17.	Reliability Level:	N-1
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind:	4 (Wind Zone - IV)
19.	Details of earthing of tower (pipe type/ Counter poise):	Counter-poise
20.	Line designed as per IS:802 (1977/1995/2015 any other code):	IS: 802 1995
21.	The agency who designed the line:	KEC
22.	Any Special consideration in design:	-
23.	Details of last maintenance activity along with date:	07.07.2023
24.	Power flow in the line prior to failure:	504 MW
25.	Any missing member found before / after failure of towers:	NIL
26.	Condition of foundation after failure:	Loc No.-01 (washed away), Loc No.-02 (Foundation OK) & Loc No.-03 (Foundation OK)
27.	Brief Description of failure: [Along with photographs (if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	Due to cloud burst 1 No. Tower got washed away (Loc No.-01), 1 No. Tower damaged upto stub level (Loc No.-02) and 1 No. tower Loc No.-03 partially damaged (1 No. X-arm & 2 No. Earth peaks)
28.	Probable cause of failure:	CLOUD BURST with extreme heavy rain
29.	Details of previous failure of the line / tower :	NIL
30.	Whether line will be restored on ERS or Spare tower will be used:	Under assessment
31.	Likely date of restoration:	Under planning stage.
32.	Present Status:	Extent of damage is being assessed
33.	Details of any Tests carried out after failure(attach test reports):	N/A
34.	Wind speed data of date & time of failure from nearby authorized observatory:	N/A
35.	Location of failed tower a. Location Coordinates: b. Nearest Airport: c. District and State:	a. 88.4589487 27.2513184, 88.455152 27.252714, 88.4537225 27.2516406 b. Bagdogra c. Sikkim
37.	Tower weight:	Approx. 42 MT

38.	Sag tension calculation considered for design of tower:	$WL^2 / 8T$
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Photograph:

		
Loc No.-01	Loc No.-02	Loc No.-03

Committee Observations:

Committee observed that the failure of tower was due to cloud burst with extremely heavy rain. It was informed that due to cloud burst in and around Mangan area, extremely heavy rain has occurred resulting in damage to Teesta-III & Dikhchu Dam located in the upper hills. Due to damage in the Dam, extremely heavy flow has been reported in the Teesta River which resulted in washing away of tower at location No. 01 of 400 kV D/C Rangpo-Teesta-V Transmission Line. As a result of this, tower at Location No. 02 was fully collapsed and cross arm & peak of tower at location No. 03 was also get damaged.

Committee recommended that routing of transmission lines few kilometers away from the river bank / anticipated future river course, use of pile foundation/additional piles etc. should be adopted by utilities especially for the river crossing tower locations. Committee also recommended that Pile type foundation may be considered for all towers in flood prone area based on soil investigation report and latest high flood data, to avoid this type of failure. Providing proper Protection (retaining wall, Gabion wall etc.), proper revetment and use of geo-synthetic material in foundation, concrete encasing & painting of stub in water logging areas etc. may also be considered, wherever required.

B. ADANI

Si. No.	Name of the Transmission Line	Name of Utility	Date of Failure	Year of Commissioning	Wind Zone	No. of Towers Failed			Conductor
						Suspension	Tension	Total	
B.1	765kV D/C Rajnandgaon-Bilaspur Transmission line	Adani TL	21.05.2022	2019	2	1	0	1	Vertical/ Hexa ZEBRA ACSR
B.2	765kV D/C Bikaner-Khetri Circui-I Transmission line	Adani TL	23.05.2022	2021	4	0	1	1	Vertical/ Hexa ZEBRA ACSR
B.3	400kV S/C Bikaner-Deedwana Transmission line	Adani TL	21.06.2022	2013	4	2	0	2	Horizontal/ Twin Moose ACSR
B.4	765 KV S/C AKOLA (2) – EKTUNI LINE – 1	Adani TL	09.04.2023 & 10.04.2023	08-04-2014	2	1	0	1	ACSR BERSIMIS CONDUCTOR

B.1 765 kV D/C Rajnandgaon-Bilaspur Transmission line Circuit-I failed on 21.05.2022

[Tower at Location no.413 (DHA+3)]

• **Brief Background:**

The 765 kV D/C Rajnandgaon-Bilaspur Ckt-I transmission line was commissioned in 2019. The total length of the line is 162 Km. The tower of this line was designed for wind zone 2 and the adopted Standard in design is IS:802 (1995). The 1 no., Suspension Type tower get failed on 21.05.2022. The type of conductor used is ACSR ZEBRA CONDUCTOR, 28.62 mm Overall diameter 54/3.18 mm Al + 7/3.18 mm steel and the type of insulator used is 160kN Suspension Polymer Insulator & Double I-Type Configuration of Insulator.

Sr. No.	Details	Remarks
1	Name of Transmission Line	765 kV D/C Rajnandgaon-Bilaspur Ckt-I
2	Date of Failure	21.05.2022
3	Length of Line	162 km
4	Type of Configuration	D/C strung on D/C towers
5	Designed by	M/s Gammon India Ltd.
6	Year of Commissioning	2019
7	Executing Agency	M/s KPTL
8	Number and Type of Failed Towers	01 No., Suspension Type
9	Towers Location No.	Tower No. 413 (Loc. No. 38/3),
10	Name and Size of Conductor	ACSR ZEBRA CONDUCTOR, 28.62 mm Overall diameter 54/3.18 mm Al + 7/3.18 mm steel
11	No. of sub-conductors per bundle and bundle spacing	6 nos. of sub conductor/phase (Hexa Bundle), Bundle spacing – 457 ± 5 mm
12	Number and size of Ground wire/OPGW (if provided)	1 no. of 7/3.66 G.S EARTH WIRE (10.98 mm diameter) & 1 no, of 24-F OPGW.
13	Type and Configuration of Insulator	160kN Suspension Polymer Insulator & Double I-Type Configuration of Insulator
14	No. of insulators per string and No. of strings per phase	2 nos. per String 4 nos. per Phase
15	Weather condition on the date of failure	Sporadic heavy whirl wind followed by localized cyclonic storm and rain
16	Terrain Category	2
17	Wind Zone	2

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18	Reliability Level	2
19	Details of earthing of tower	Pipe Type
20	Adopted Standard in design	IS:802 (1995)
21	The agency who designed the line	M/s Gammon India Ltd.
22	Any Special consideration in design	No
23	Details of last maintenance activity along with date	12.05.2022
24	Power flow in the line prior to failure	Ckt-1: 40.09 MW Ckt-2: 36.00 MW
25	Any missing member found before / after failure of towers	No
26	Condition of foundation after failure	Foundation is Intact. Coping is damaged.
27	Brief Description of failure	-
28	Probable cause of failure	Due to heavy gusty wind
29	Details of previous failure of the line / tower	NIL
30	Whether line will be restored on ERS or Spare tower will be used	Spare Tower will be used
31	Likely date of restoration	07.06.2022
32	Present Status	Line restored.
33	Details of any Tests carried out after failure	NIL
34	Wind speed data of date & time of failure from nearby authorized observatory	IMD Observatories are generally far away from the site of collapse of towers. –NIL-
35	Location of failed towers	28°11'58.91", 75°0'2.97"
36	Tower weight	98.793 MT (LCT+3) MS-3.818MT, HT-91.631MT, B&N-3.344MT
37	Any other information	Nil

Observations:

a.	The affected suspension tower at location 413 was located in plain field with few trees in vicinity near village Bahera Bhata, Dondilohara Taluk in Durg district (Chhattisgarh).					
b.	The affected tower was damaged in transverse direction of the line. The details of damaged towers is as follows:					
	Sl. No.	Loc. No.	Tower Type	Span (in m)	Angle of Dev.	Extent of Damage
	1	413	DHA+3			• Tower collapsed completely as shown in Fig 9(a) and 9(b). • Foundation was intact as shown in Fig 9(c). • Coping was damaged. • Main leg members along with many bracing members were deformed.

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c.	Failed tower was examined for missing members, bolts & nuts. There was no any sign of any theft and tower was also found in healthy and completeness condition.
d.	It was also observed that few trees and poles of LT lines located in near vicinity of tower were also uprooted.
e.	Intimation about failure of towers was not given on time to visit site and investigate the root cause of failure and declared as Force Majeure by utility itself.
f.	Utility itself identified samples for material testing in laboratory and submitted the test results.
g.	Results of recommended test samples have been received and are in order as per IS: 2062.
h.	Further, it is understood that the failed transmission line has been commissioned in year 2019. However, it has been informed that the transmission towers have been designed as per IS 802:1995. The reason and clarification for adopting old IS code (i.e. IS 802:1995) instead of latest code (IS 802:2015) for designing of the transmission towers was not submitted.

- **Photographs:**



Fig 9(a). Tower at Location No.: 413 (DHA+3)



Fig 9(b). Tower at Location No.: 413 (DHA+3)



Fig 9(c). Tower at Location No.: 413 (DHA+3)- Legs and Foundation.

Committee Observations:

During site visit by the Committee, it was observed that Copping of Tower at Location No. 413 was damaged. Main leg members along with many bracing members were deformed. It was also observed that the failed transmission line has been commissioned in the year 2019 but the transmission tower have been designed as per IS 802:1995. The reason and clarification for adopting old IS code

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(i.e. IS 802:1995) instead of latest code (IS 802:2015) for designing of the transmission towers was not submitted.

Failed tower was examined for missing members, bolts & nuts. There was no sign of theft and tower was also found in healthy and completeness condition. It was also observed that few trees and poles of LT lines located in near vicinity of tower were also uprooted.

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

B.2 765 kV D/C Bikaner-Khetri Transmission line Circuit-I failed on 23.05.2022

[Tower at Location no.405-43/9 (LCT+3)]

- Brief Background:**

The 765 kV D/C Bikaner-Khetri Ckt-I transmission line was commissioned in 2021. The total length of the line is 240 Km. The tower of this line was designed for wind zone 4 and the adopted Standard in design is IS:802 (1995). The 1 no., Tension Type tower get failed on 23.05.2022. The type of conductor used is ACSR ZEBRA CONDUCTOR, 28.62 mm Overall diameter 54/3.18 mm Al + 7/3.18 mm steel and the type of insulator used is Quadruple I-Type Configuration of Insulator (Tension) & Single I-Type Configuration (Pilot) of Insulator.

Sr. No.	Details	Remarks
1	Name of Transmission Line	765 kV D/C Bikaner-Khetri Ckt-I
2	Date of Failure	23.05.2022
3	Length of Line	240 KM
4	Type of Configuration	D/C strung on D/C towers
5	Designed by	M/s L&T Construction – PT&D
6	Year of Commissioning	2021
7	Executing Agency	M/s KPTL
8	Number and Type of Failed Towers	, Tension Type
9	Towers Location No.	Tower No. 405 (Loc. No. 43/9)
10	Name and Size of Conductor	ACSR ZEBRA CONDUCTOR, 28.62 mm Overall diameter 54/3.18 mm Al + 7/3.18 mm steel
11	No. of sub-conductors per bundle and bundle spacing	6 nos. of sub conductor/phase (Hexa Bundle), Bundle spacing – 457 ± 5 mm
12	Number and size of Ground wire/OPGW (if provided)	A. 1 no. of 7/3.66 G.S EARTHWIRE (10.98 mm diameter) B. 1 no. of 24-F OPGW.
13	Type and Configuration of Insulator	Quadruple I-Type Configuration of Insulator (Tension) & Single I-Type Configuration (Pilot) of Insulator
14	No. of insulators per string and No. of strings per phase	2 nos. per String 16 nos. per Phase (210kN) & 4 nos. per phase (160kN)
15	Weather condition on the date of failure	Sporadic heavy whirl wind followed by localized cyclonic storm and rain
16	Terrain Category	2

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17	Wind Zone	4
18	Reliability Level	2
19	Details of earthing of tower	Pipe Type
20	Adopted Standard in design	IS:802 (1995)
21	The agency who designed the line	M/s KPTL
22	Any Special consideration in design	No
23	Details of last maintenance activity along with date	12.05.2022
24	Power flow in the line prior to failure	Ckt-1: 40.09 MW Ckt-2: 36.00 MW
25	Any missing member found before / after failure of towers	No
26	Condition of foundation after failure	Good
27	Brief Description of failure	-
28	Probable cause of failure	Due to heavy gusty wind
29	Details of previous failure of the line / tower	NIL
30	Whether line will be restored on ERS or Spare tower will be used	Spare Tower will be used
31	Likely date of restoration	15.06.2022
32	Present Status	-
33	Details of any Tests carried out after failure	NIL
34	Wind speed data of date & time of failure from nearby authorized observatory	IMD Observatories are generally far away from the site of collapse of towers. –NIL-
35	Location of failed towers	28°11'58.91", 75°0'2.97"
36	Tower weight	98.793 MT (LCT+3) MS-3.818MT, HT-91.631MT, B&N-3.344MT

Observations:

a.	The affected tension tower at location 405 was located in plain field with few trees in vicinity near village Neema ki Dhani, Fatehpur Taluk in Khetri district (Rajasthan).					
b.	The affected tower was damaged in transverse direction of the line. The details of damaged towers is as follows:					
	Sl. No.	Loc. No.	Tower Type	Span (in m)	Angle of Dev.	Extent of Damage
	1	405	LCT+3			• Tower collapsed partially as shown in Fig 6. • Top Cross Arm of Tower damaged. • All the four stubs of the tower along with foundation and chimney were intact.
c.	Failed tower was examined for missing members, bolts, nuts. There was no any sign of any					

	theft and tower was also found in healthy and completeness condition.
d.	It was also observed that few trees and poles of LT lines located in near vicinity of tower were also uprooted.
e.	Intimation about failure of towers was not given on time to visit site and investigate the root cause of failure and declared as Force Majeure by utility itself.
f.	Utility itself identified samples for material testing in laboratory and submitted the test results.
g.	Results of recommended test samples have been received and are in order as per IS: 2062
h.	Further, it is understood that the failed transmission line has been commissioned in year 2021. However, it has been informed that the transmission towers have been designed as per IS 802:1995. The reason and clarification for adopting old IS code (i.e. IS 802:1995) instead of latest code (IS 802:2015) for designing of the transmission towers was not submitted.

Photographs:

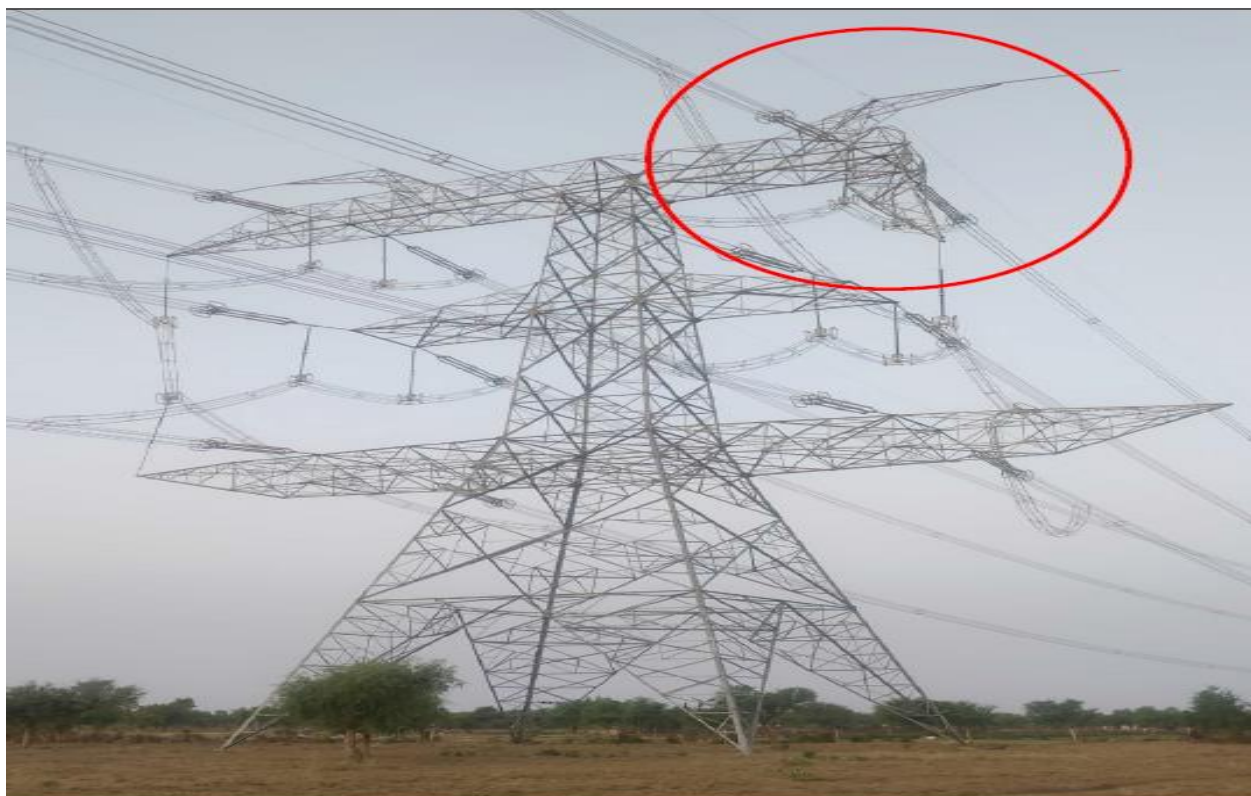


Fig 6. Tower at Location No.: 405 (LCT+3)

Committee Observations:

Committee observed that the Intimation about failure of towers was not given on time to visit site and investigate the root cause of failure and declared as Force Majeure by the Utility itself. Utility itself identified samples for material testing in laboratory and submitted the test results which is found in order as per IS: 2062. The affected tension tower at location 405 was located in plain field with few trees in vicinity near village Neema ki Dhani, Fatehpur Taluk in Khetri district

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(Rajasthan). Top cross arm of the tower was found damaged, foundation and the chimney were found intact. Further, it was also observed that the failed transmission line has been commissioned in year 2021, but the transmission towers have been designed as per IS 802:1995. The reason and clarification for adopting old IS code (i.e. IS 802:1995) instead of latest code (IS 802:2015) for designing of the transmission towers was not submitted.

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

B.3 400 kV S/C Bikaner-Deedwana Transmission line failed on 21.06.2022

[Tower at Location no.91-21/8 (A+3), 92-21/9 (A+0)]

- Brief Background:**

The 400 kV S/C Bikaner-Deedwana transmission line was commissioned in 2023. The total length of the line is 129 Km. The tower of this line was designed for wind zone 4 and the adopted Standard in design is IS:802 (1995). The 2 Numbers of Suspension Type tower get failed on 21.06.2022. The type of conductor used is Twin Moose ACSR and the type of insulator used is 120kN Suspension Polymer Insulator, Single I-Type.

Sr. No.	Details	Remarks
1	Name of Transmission Line	400 kV S/C Bikaner-Deedwana
2	Date of Failure	21.06.2022
3	Length of Line	129 KM
4	Designed by	M/s L&T Construction – PT&D
5	Year of Commissioning	2013
6	Executing Agency	M/s L&T Construction – PT&D
7	Number and Type of Failed Towers	02 (All were suspension type)
8	Towers Location No.	Tower No. 91 (Loc. No. 21/8) & Tower No 92 (Loc. No. 21/9)
9	Name and Size of Conductor	Twin Moose ACSR
10	No. of sub-conductors per bundle and bundle spacing	2 nos. of sub conductor/phase (Twin Bundle), Bundle spacing – 450 ± 5 mm
11	Number and size of Ground wire/OPGW (if provided)	2 nos. of 7/3.66 G.S EARTHWIRE (10.98 mm diameter)
12	Type and Configuration of Insulator	120kN Suspension Polymer Insulator, Single I-Type
13	No. of insulators per string and No. of strings per phase	1 no. per String 1 no. per Phase
14	Weather condition on the date of failure	Sporadic heavy whirl wind followed by localized cyclonic storm and rain
15	Terrain Category	2 as per IS:802 (Plain)
16	Wind Zone	4
17	Reliability Level	-
18	Details of earthing of tower	Pipe Type
19	Adopted Standard in design	IS:802 (1995)
20	The agency who designed the line	Larsen & Toubro Construction – PT&D
21	Any Special consideration in design	No

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22	Details of last maintenance activity along with date	24.03.2022
23	Power flow in the line prior to failure	~195 MW
24	Any missing member found before / after failure of towers	No
25	Condition of foundation after failure	Foundation damaged in both towers
26	Brief Description of failure	Complete tower failure
27	Probable cause of failure	Due to heavy gusty wind
28	Details of previous failure of the line / tower	NIL
29	Whether line will be restored on ERS or Spare tower will be used	ERS will be used for emergency restoration. Spare towers are being used for permanent restoration.
30	Likely date of restoration	01.07.2022
31	Present Status	-Not available-
32	Details of any Tests carried out after failure	It is observed that the tower collapsed due to nature's fury. No technical deficiencies were observed in collapsed tower, hence further testing on material and quality of work was not recommended.
33	Wind speed data of date & time of failure from nearby authorized observatory	Not available, as no IMD observatory exists near the location.
34	Location of failed towers	TN-91: 73°43 '02.38" E 27°52 '05.31"N TN-92: 73°43 '13.44"E 27°51 '59.59"N
35	Tower weight	6.65 MT (A+0) MS-2.63MT, HT-3.72MT, B&N-0.30MT 7.67 MT (A+3) MS-3.02MT, HT-4.31MT, B&N-0.34MT

Observations:

a.	All the affected suspension towers at location 91&92 were located in plain field with few trees in vicinity near village Kuchor Aguni, Nokha Taluk in Bikaner district (Rajasthan).					
b.	All the affected towers were collapsed completely to the ground in transverse direction of the line. The details of damaged towers is as follows:					
	Sl. No.	Loc. No.	Tower Type	Span (in m)	Angle of Dev.	Extent of Damage
	1	91	A+3			• Tower collapsed completely as shown in Fig 3(a) and Fig 3(b). • Foundation was damaged.
	2	92	A+0			• Tower collapsed completely as shown Fig 3(c) and Fig (d). • Foundation was damaged.
c.	Failed towers were examined for missing members, bolts, nuts. There was no any sign of any theft and towers were also found in healthy and completeness condition.					

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d.	Initially, Line was charged on ERS as an emergency restoration and later on outage was taken for permanent restoration.
e.	Intimation about failure of towers was not given on time to visit site and investigate the root cause of failure and declared as Force Majeure by utility itself.
f.	Material testing of the failed towers also not carried out by utility.

➤ **Photographs:**



Fig 3(a). Tower at Location No.: 91 (A+3)



Fig 3(b). Tower at Location No.: 91 (A+3)



Fig 3(c). Tower at Location No.: 92 (A+0)



Fig 3(d). Tower at Location No.: 92 (A+0)

Committee Observations:

Committee observed that the Intimation about failure of towers was not given on time to visit site and investigate the root cause of failure and declared as Force Majeure by the utility itself.

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

Committee suggested that the patrolling frequency of the line may be increased. Committee noted that the small deficiencies in the tower structure may lead to its collapse in the event of occurrence of high speed wind. Committee advised the utilities to intimate the tower failure within 48 hours so that a site visit of committee members may be planned. Committee advised that utilities should improve their erection and operation & maintenance practices and ensure that structural strength is not compromised due to deficiencies like, unplugged holes, rusting of stubs, etc.

B.4 765 KV AKOLA (2) – EKTUNI LINE – 1 TRANSMISSION LINE failed on 09.04.2023 and 10.04.2023

• **Brief Background:**

The 765 KV S/C AKOLA (2) – EKTUNI transmission line was commissioned in 08.04.2014. The total length of the line is 220 Km. The tower of this line was designed for wind zone 2 and the adopted Standard in design is IS:802 (1995). The 1 no., Suspension Type tower, A+3 get failed on 09.04.2023. The type of conductor used is ACSR BERSIMIS CONDUCTOR, 35.05 mm Overall diameter 42/4.57 mm Al + 7/2.54 mm steel and the type of insulator used is 120kN Suspension Porcelain Insulator in I Strings, 210kN Suspension Porcelain insulator in V String.

S.No.	Details	Remarks
1.	Name of Transmission line with voltage level:	765 kV S/C AKOLA (2) – EKTUNI LINE – 1
2.	Date and time of occurrence/discovery of failure:	09.04.2023, 22:22 hrs. 10.04.2023, 04:00 hrs.
3.	Length of line (km):	220 km
4.	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)	S/C
5.	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	One Suspension Tower (1 no.) collapsed A+3 Single circuit configuration
6.	Tower location No. with reference to nearest substation(indicate Name):	Tower No. 154, 70 kms from Akola-2 Substation
7.	Name and size of conductor:	ACSR BERSIMIS CONDUCTOR, 35.05 mm Overall diameter 42/4.57 mm Al + 7/2.54 mm steel
8.	No. of sub-conductors per bundle and bundle spacing:	4 nos. of sub conductor/phase (Quad Bundle), Bundle spacing – 457 ± 5 mm
9.	Number and size of Ground wire/OPGW (if provided):	01 no. of 7/3.66 G.S EARTHWIRE B. 1 no, of 8-Fiber OPGW.
10.	Type of insulators in use(Porcelain / Glass / Polymer):	120 kN Suspension Porcelain Insulator in I Strings, 210kN Suspension Porcelain insulator in V String.

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11.	Configuration of insulators (I / V / Y / tension):	Double I-Type Configuration of Insulator (Suspension) & V -Type Configuration of Insulator (I-V-I Type Configuration)
12.	No. of insulators per string and No. of strings per phase:	Double I : 80 nos. of insulators per string & 2 Strings per phase Single V : 70 nos. of insulators per string & 1 Strings per phase
13.	Year of construction / commissioning:	08-04-2014
14.	Executing Agency:	KALPATARU POWER TRANSMISSION LIMITED (M/s KPTL)
15.	Weather condition on the date of failure:	Sporadic heavy whirl wind followed by localized cyclonic storm with rainfall
16.	Terrain Category:	Category-2
17.	Reliability Level:	Reliability Level - 2
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind:	Wind Zone-2, Basic wind speed – 39 m/s
19.	Details of earthing of tower (pipe type/ Counter poise):	Counter Poise Earthing
20.	Line designed as per IS:802 (1977/1995/2015 any other code):	IS 802:1995
21.	The agency who designed the line:	Powergrid Corporation of India Limited (PGCIL)
22.	Any Special consideration in design:	No
23.	Details of last maintenance activity along with date:	21.03.2023
24.	Power flow in the line prior to failure:	Ckt-1: 904 MW
25.	Any missing member found before / after failure of towers:	No
26.	Condition of foundation after failure:	The foundation is in good condition. No damage found.
27.	Brief Description of failure: [Along with photographs (if available), other related information like tower schedule, newspaper clipping for cyclone / wind storm etc.]	One Suspension Tower (1 no.) collapsed of Single circuit configuration was collapsed due to heavy gusty wind followed by localized whirl wind.
28.	Probable cause of failure:	Due to heavy gusty wind followed by localized whirl wind.
29.	Details of previous failure of the line / tower :	No previous failure since commissioning
30.	Whether line will be restored on ERS or Spare tower will be used:	Spare tower materials shall be used for permanent restoration.
31.	Likely date of restoration:	26.04.2023
32.	Present Status:	Permanent restoration work in progress
33.	Details of any Tests carried out after failure(attach test reports):	It is observed that the tower collapsed due to nature's fury. No

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		technical deficiencies were observed in the collapsed tower. Sample collection of damaged tower is in progress and shall be sent to NABL certified laboratory
34.	Wind speed data of date & time of failure from nearby authorized observatory:	We have requested Indian Meteorological Department (IMD) to provide relevant weather data at incident location from their nearest observatory. However as per local sources and newspaper details weather condition were heavy thunderstorm along with sporadic whirl wind condition at that time.
35.	Location of failed tower a. Location Coordinates: b. Nearest Airport: c. District and State:	a. 20°31'57.97"N", 76°39'31.02"E b. Akola (Maharashtra) Airport, 70 km from Tower & Nagpur Airport, 350 Km from Tower c. District: Buldhana, State: Maharashtra
36.	Tower weight:	21.54 MT MS-13.85 MT, HT- 6.90 MT, B&N- 0.79 MT
37.	Design document of failed towers:	Not available as tower drawings were purchased from PGCIL.

Photographs:





Committee Observations:

765 kV S/C AKOLA (2) – EKTUNI LINE 1 is owned by MEGPTCL and was constructed by M/s Kalpatru Power Transmission Limited. It was commissioned in April, 2014. The total length of the line is 220 km. The towers of this line were designed for Wind Zone-2 (wind speed of 39 m/s) as per IS: 802:1995. Tower is designed as per IS: 802:1995. Wind speed data is not provided.

Committee observed that the failure of tower has taken place due to the impact of heavy gusty wind followed by localized whirl wind. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility.

Committee suggested that the patrolling frequency of the line may be increased. Committee noted that the small deficiencies in the tower structure may lead to its collapse in the event of occurrence of high speed wind. Committee advised that utilities should improve their erection and operation & maintenance practices and ensure that structural strength is not compromised due to deficiencies like, unplugged holes, rusting of stubs, etc.

C. Indigrid

C.1 400 kV D/C Silchar-Misa Transmission line Circuit-I & II failed on 17.06.2022

[Tower at Location no.228/1 (DA+0), 229/0 (DD+0)]

- **Brief Background:**

The 400 kV D/C Silchar-Misa Circuit-I&II transmission line was commissioned in 2021. The total length of the line is 178 Km. The tower of this line was designed for wind zone 5 and the adopted Standard in design is IS:802 (2015). The 02 (228/1: Suspension, 229/0: Tension) get failed on 17.06.2022. The type of conductor used is Twin Moose ACSR and the type of insulator used is 120 KN & 160 KN long rod polymer insulator Double I suspension for suspension type tower Quad tension for Insulator & Single I for jumper in tension tower.

Sr. No.	Details	Remarks
1	Name of Transmission Line	400 kV D/C Silchar-Misa Circuit-I&II
2	Date of Failure	17.06.2022
3	Length of Line	178 KM
4	Designed by	M/s Sterlite Power Transmission Limited
5	Year of Commissioning	2021
6	Executing Agency	M/s Tata Projects Limited
7	Number and Type of Failed Towers	02 (228/1: Suspension, 229/0: Tension)
8	Towers Location No.	228/1, 229/0
9	Name and Size of Conductor	Twin Moose ACSR
10	No. of sub-conductors per bundle and bundle spacing	04; 457 mm
11	Number and size of Ground wire/OPGW (if provided)	1 no. Ground wire (7/3.66 mm) dia-10.98mm, 1 no. OPGW/48F/12.20mm-dia
12	Type and Configuration of Insulator	120 KN & 160 KN long rod polymer insulator Double I suspension for suspension type tower Quad tension for Insulator & Single I for jumper in tension tower
13	No. of insulators per string and No. of strings per phase	2/string; 01 strings/phase – suspension 4/strings; 02 strings/phase
14	Weather condition on the date of failure	Heavy flooding in KOPLI river.
15	Terrain Category	2 as per IS:802 (Plain)
16	Wind Zone	5

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17	Reliability Level	1
18	Details of earthing of tower	Pipe Type
19	Adopted Standard in design	IS:802 (2015)
20	The agency who designed the line	Sterlite Power Transmission Ltd.
21	Any Special consideration in design	NIL
22	Details of last maintenance activity along with date	NIL. No major maintenance activity carried out.
23	Power flow in the line prior to failure	60 MW
24	Any missing member found before after failure of towers	NIL
25	Condition of foundation after failure	-
26	Brief Description of failure	One tower 229/0 completely collapsed & one adjacent tower 228/1 partially damaged due to heavy floods in Kopli river with high water current.
27	Probable cause of failure	Heavy Rainfall induced floods with high water currents.
28	Details of previous failure of the line / tower	NIL
29	Whether line will be restored on ERS or Spare tower will be used	-
30	Likely date of restoration	-Not available-
31	Present Status	-Not available-
32	Details of any Tests carried out after failure	-Not available-
33	Wind speed data of date & time of failure from nearby authorized observatory	-
34	Location of failed towers	86.6268327036047: 25.2214993169608
35	Tower weight	Loc. 228/1 DA+0 =17.553 MT/tower ; DD+0-40.177 MT/tower
36	Any other information	The rainfall is incessant in the region.

Observations:

a.	The affected suspension and tension towers at location 228/1 & 229/0 respectively were located in plain field with few trees in vicinity near village Hemari Phura, Dongkamukam Taluk in West Karbi Anglong district (Assam).					
b.	All the affected towers were collapsed in transverse direction of the line. The details of damaged towers is as follows:					
	Sl. No.	Loc. No.	Tower Type	Span (in m)	Angle of Dev.	Extent of Damage
	1	228/1	DA+0	387	0° 0' 0"	Tower collapsed partially as shown in Fig 2(b) and Fig 2(c).

						• All the four stubs of the tower and chimney were intact. • One of the leg along with tower Foundation was exposed to atmosphere completely. • Tower Peak was damaged and bent. • Span conductor was also damaged.
	2	229/0	DD+0	397	31° 56' 17"	• Tower collapsed completely as shown in Fig 2(d). • Foundation had been swept off completely.
c.	Analysis of Google map for the change in river course during the last five years at location no. 229/0 was also done by M/s Indigrid and from the analysis, it is clear that the river bank shifting towards the tower was sudden and is due to natural catastrophe.					
d.	Emergency restoration of one circuit was done through ERS without OPGW connectivity. It was also emphasized to use different anchoring arrangement to encounter loose soil strata in the region because of flooding. The anchoring arrangement being used was of permanent type with concreting and required additional time for settlement when compared to the conventional anchoring mechanism.					
e.	For protection of ERS, following additional measures were taken: Bamboo palisading around ERS tower. Anchor point bamboo palisading. Bamboo screening on river bank to prevent further soil erosion.					
f.	Committed recommended to do the soil testing and investigation before erection of new towers on pile foundation.					
g.	Committee asked to share revised tower schedule along with complete plan for permanent restoration with CEA after completion of soil testing and investigation.					

➤ **Photographs:**



Fig 2(a). Surrounding Area to Damaged Towers

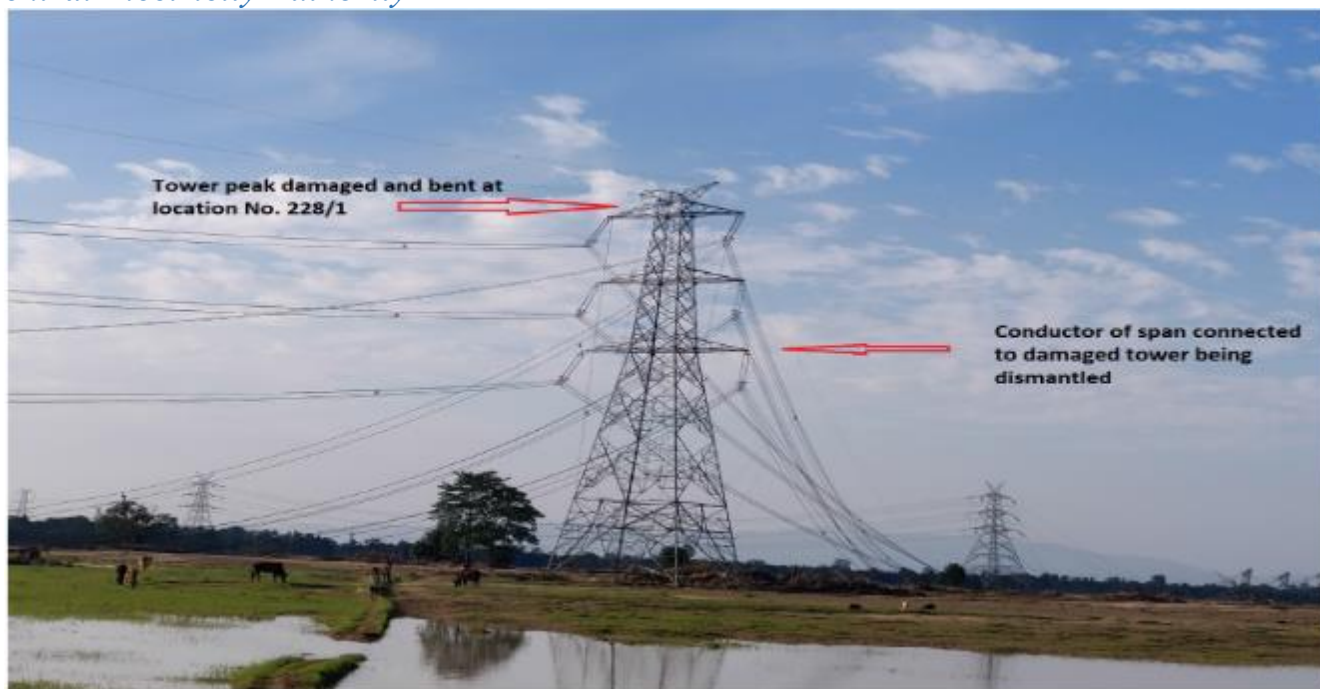


Fig 2(b). Tower at Location No.: 228/1 (DA+0)



Fig 2(c). Tower at Location No.: 228/1 (DA+0)



Fig 2(d). Tower at Location No.: 229/0 (DD+0)

Committee Observations:

It was observed by the committee that the affected suspension and tension towers at location 228/1 & 229/0 respectively were located in plain field with few trees in vicinity near village Hemari Phura, Dongkamukam Taluk in West Karbi Anglong district (Assam). Tower at Location Numbers 228/1 was collapsed partially. All the four stubs of the tower and chimney were intact and one of the leg along with tower Foundation was exposed to atmosphere completely. Tower Peak was damaged and bent. Tower at Location Number 229/0 was collapsed completely and the foundation had been swept off completely.

It was observed by the committee that Analysis of Google map for the change in river course during the last five years at location no. 229/0 was also done by M/s Indigrid and from the analysis, it is clear that the river bank shifting towards the tower was sudden and is due to natural catastrophe.

The committee recommends that transmission lines should be routed a few kilometers away from river banks or anticipated future river courses. This measure aims to minimize the risk of damage to transmission towers due to changes in the river's course. The committee suggests the use of pile foundations based on thorough soil investigation reports and the latest high flood data because such foundations offer better stability and resistance to erosion.

D. UPPTCL

D.1 220 KV PGCIL (GORAKHPUR)-GOLA D/C LINE failed on 23.05.2023

- **Brief Background:**

The 220 KV PGCIL (GORAKHPUR)-GOLA D/C transmission line was commissioned in 2021. The total length of the line is 41.172 Km. The 2 Tension Type towers 59 (C+10) and 60 (C+15) get failed on 23.05.2022 at 03.40 hrs. The type of conductor used is ACSR ZEBRA CONDUCTOR and the type of insulator used is Porcelain.

1. Name of Transmission line with voltage level	220 KV PGCIL (GORAKHPUR)-GOLA D/C LINE
2. Date and time of occurrence/discovery of failure	23.05.2023 AT 03.40 HRS
3. Length of line (km):	41.172
4. Type of configuration:	D/C
[(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)	D/C
5. Number of Towers and Type of Towers failed:	59 (C+10) & 60 (C+15)
[Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	TENSION
6. Tower location No. with reference to nearest substation(indicate Name):	59,60(PGCIL END)
7. Name and size of conductor:	ACSR ZEBRA
8. No. of sub-conductors per bundle and bundle spacing:	SINGLE
9. Number and size of Ground wire/OPGW (if provided):	24 FIBRE OPGW
10. Type of insulators in use(Porcelain / Glass / Polymer):	PORCELAIN
11. Configuration of insulators (I / V / Y / tension):	TENSION

Central Electricity Authority

12. No. of insulators per string and No. of strings per phase:	16 NOS INSULATOR SINGLE STRING
13. Year of construction / commissioning:	2021
14. Executing Agency:	M/S SHIV SHANKER ENTERPRISES
15. Weather condition on the date of failure:	CYCLONIC WIND FLOW AND RAINY WEATHER
16. Terrain Category:	TARAI
17. Reliability Level:	-
18. Wind Zone (1/2/3/4/5/6) and velocity of wind:	VELOCITY NOT AVAILABLE
19. Details of earthing of tower (pipe type/ Counter poise):	PIPE TYPE
20. Line designed as per IS:802 (1977/1995/2015 any other code):	-
21. The agency who designed the line:	M/S SKIPPER LTD
22. Any Special consideration in design:	-
23. Details of last maintenance activity along with date:	05.05.2023
24. Power flow in the line prior to failure:	106 MW (IN BOTH CIRCUIT)
25. Any missing member found before / after failure of towers:	NIL
26. Condition of foundation after failure:	FOUNDATION REMAIN INTACT
27. Brief Description of failure:	DUE TO HEAVY WIND STORM & CYCLONIC EFFECT IN THE AREA
28. Probable cause of failure:	DUE TO CYCLONIC WIND
29. Details of previous failure of the line / tower :	NIL
30. Whether line will be restored on ERS or Spare tower will be used:	SPARE TOWER
31. Likely date of restoration:	23.06.2023
32. Present Status:	LINE ENERSIED ON LOAD
33. Details of any Tests carried out after failure(attach test reports):	ATTACHED
34. Wind speed data of date & time of failure from nearby authorized observatory:	SPEEDOMETER IS NOT ESTABLISHED IN GORAKHPUR METEROLOGICAL DEPARTMENT SO WIND SPEED IS NOT AVAILABLE
35. Location of failed tower	NEAR KHAJNI
a. Location Coordinates:	tower no 59 (26.65549 83.26844) tower no 60 (26.65219 83.26981)
b. Nearest Airport:	Gorakhpur
c. District and State:	Gorakhpur Uttar Pradesh
36. Tower weight:	C+10-14.3655 MT , C+15-18.123 MT

Photographs:

Tower no.60



Tower no. 60 stub:



Tower no. 60



Tower no 59 stub:



Tower no. 59



Committee Observations:

Committee concluded that the high wind velocity might have prevailed in the vicinity of transmission line leading to failure of towers. However, wind speed data received from any authenticated observatory indicating speed of wind prevailing at the failure location at the time of the failure is not provided by the transmission utility. The committee requested to submit the wind speed data from the nearest observatory to ascertain the cause of failure. The recommendations of “Task Force on Cyclone Resilient Robust Electricity Transmission & Distribution Infrastructure in coastal areas” should be followed by utilities while designing/erection of transmission lines in cyclone affected area.

Committee suggested that the patrolling frequency of the line may be increased. Committee noted that the small deficiencies in the tower structure may lead to its collapse in the event of occurrence of high speed wind. Committee advised that utilities should improve their erection and operation & maintenance practices and ensure that structural strength is not compromised due to deficiencies like, unplugged holes, rusting of stubs, etc.

E. AEGCL**E.1 220 kV Rangia Salakati D/C line failed on 21.06.2023:****Brief details:**

The 220 kV Rangia Salakati D/C transmission line was commissioned in 2019. The total length of the line is 164 Km. The tower of this line was designed for wind zone 5 and the adopted Standard in design is IS:802 (1995). The 01 Number (B+9) Tension Tower get failed on 21.06.2023. The type of conductor used is AAAC Zebra , 37 No. Strands with diameter 4mm and the type of insulator used is Porcelain.

S. No.	Details	Remarks
1.	Name of Transmission line with voltage level:	220 kV Rangia Salakati D/C line
2.	Date and time of occurrence/discovery of failure:	a. Rangia Salakati Ckt 1 : on 21.06.2023 at 4:59 hrs b. Rangia Salakati Ckt 2 : on 21.06.2023 at 01:26 Hrs
3.	Length of line (km):	164 KM
4.	Type of configuration: [(S/C, D/C, M/C, S/C strung on D/C towers, narrow base etc.)]	D/C
5.	Number of Towers and Type of Towers failed: [Suspension/ tension/dead end/special tower /river crossing tower/ Power line crossing/Railway Crossing etc., with / without extension (indicate the type & length of extension)]	01 No. Tower failed B+9 Tension Tower with 9 m extension River crossing Tower (Pagladiya River)
6.	Tower location No. with reference to nearest substation(indicate Name):	Loc. No. 452 (From Salakati GSS) as per tower schedule and Loc. No. 56 from Rangia GSS
7.	Name and size of conductor:	AAAC Zebra , 37 No. Strands with diameter 4mm
8.	No. of sub-conductors per bundle and bundle spacing:	NA
9.	Number and size of Ground wire/OPGW (if provided):	One Ground wire
10.	Type of insulators in use(Porcelain / Glass / Polymer):	Porcelain
11.	Configuration of insulators (I / V / Y / tension):	Tension

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12.	No. of insulators per string and No. of strings per phase:	15 No. of insulator with single string
13.	Year of construction / commissioning:	19/08/2019
14.	Executing Agency:	M/s Jyoti Structures Ltd.
15.	Weather condition on the date of failure:	Strong thunderstorm with heavy downpour
16.	Terrain Category:	Near Pagladiya River
17.	Reliability Level:	1
18.	Wind Zone (1/2/3/4/5/6) and velocity of wind:	Wind Zone 5
19.	Details of earthing of tower (pipe type/ Counter poise):	Counter Poise
20.	Line designed as per IS:802 (1977/1995/2015 any other code):	1995
21.	The agency who designed the line:	Work was executed by Jyoti Structures Ltd. And design was also in their scope.
22.	Any Special consideration in design:	No
23.	Details of last maintenance activity along with date:	01/06/2023
24.	Power flow in the line prior to failure:	Rangia – Salakati ckt-1 : 52 MW at 04 hrs. on 21/06/2023 (Import) Rangia – Salakati ckt-2 : 53.9 MW at 24 hrs. on 20/06/2023 (Import)
25.	Any missing member found before / after failure of towers:	No. as complete tower is still submerged in Pagladiya river
26.	Condition of foundation after failure:	As complete tower is still submerged in Pagaladiya river, the condition of foundation can not be ascertained.
27.	Probable cause of failure:	a. Increase in water level of Pagladiya river due to release of dam water by Bhutan b. High current of Pagladiya River. c. Change in the route of Pagladiya River near Village North Borsiyal, District Nalbari Assam
28.	Details of previous failure of the line / tower :	None
29.	Whether line will be restored on ERS or Spare tower will be used:	- Restored on ERS and Rangia-Salakati Ckt-1 : Loaded at 06:53 hrs. on 29/06/2023 - Restored on ERS and Rangia-Salakati Ckt-2 : Loaded at 14:57 hrs. on 05/07/2023
30.	Likely date of restoration:	Already restored with the help of ERS
31.	Present Status:	Discussion of new tower designing at Loc. 452 (B+9) is going on

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32.	Details of any Tests carried out after failure(attach test reports):	Not Done
33.	Wind speed data of date & time of failure from nearby authorized observatory:	Not Available
34.	Location of failed tower a. Location Coordinates: b. Nearest Airport: c. District and State:	Near Village North Borsiyal, District Nalbari Assam a. 26.5474841, 91.5255082 b. Lokpriya Gopinath Bardoloi International Airport, Guwahati c. Nalbari, Assam
35.	Single line diagram/clearance diagram of failed tower(s) with all dimensions (horizontal & vertical dimensions including base width of tower)	NA
36.	Tower weight:	10.56 MT(approximately)

Photographs:





Committee Observations:

Committee observed that the failure of tower was due to increase in water level and high current in Pagladiya River. It was submitted that the water level of Pagladiya River was attained as 53.64 m against the danger level of 52.75 m on 21.06.2023. The water level of Pagladiya River is as under:

Date	Water Level (m)
19.06.2023	51.97
20.06.2023	52.20
21.06.2023	53.64
23.06.2024	52.72
24.06.2024	51.85

The above water level data shows that the water level of Pagladiya River is above the danger level on the date of tower failure

The committee recommends that transmission lines should be routed a few kilometers away from river banks or anticipated future river courses. This measure aims to minimize the risk of damage to transmission towers due to changes in the river's course. The committee suggests the use of pile foundations based on

Central Electricity Authority

thorough soil investigation reports and the latest high flood data because such foundations offer better stability and resistance to erosion.

To further enhance the structural integrity of transmission towers, the committee suggests implementing additional protection measures like Installing retaining walls, gabion walls, or other protective structures as needed, implementing proper revetment to prevent erosion around the tower foundations, incorporating geosynthetic material in foundation construction to improve stability and prevent soil erosion, encasing the tower foundations in concrete and painting the stubs in water logging areas to prevent corrosion and extend the lifespan of the towers.

ANNEXURE A

COMPOSITION OF STANDING COMMITTEE OF EXPERTS

Central Electricity Authority
Office of the Secretary

Date 24/9/99

No.5-41/98/Secy/CEA

/ 809

30

(Technical Committee No. 16)

Office Memorandum

Subject:

Constitution of Standing Committee of Experts to investigate the Failure of Towers.

Because of transmission line tower failures taking place in the country, resulting in disruption of power on large scale for long periods, it has been decided as per chapter-II, para 3 (viii) of the Electricity (Supply) Act, No 54 of 1948 to constitute a Standing Committee, consisting of experts in the field of EHV Transmission lines from CEA, Power Grid, CPRI, IIT Delhi, & SEB (of the State, where tower failure has taken place). In the event of any failure of towers for transmission lines of 220kV and higher voltages of power utilities, members of the committee should immediately visit the site to have first hand information and ascertain the causes of failure and give recommendations to prevent such recurrences in future.

2. The scope and terms of reference of the committee shall be as follows:

(i) To investigate the causes of failure of towers.

(ii) Recommendations to avert recurrences, of such failures in future.

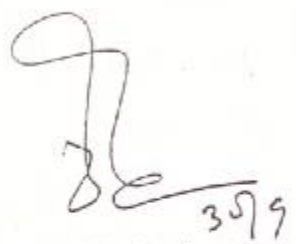
3. Committee will submit its report within three months, from the date of failure.

4. Concerned power utility will provide all assistance, required by the committee in carrying out the meetings, make arrangements for immediate site visit after failure of towers by providing transport and travel facilities and preparation of the report.

5. All the Organisations/Power Utilities are requested to nominate their officers/alternate as their representative, and intimate to Chief Engineer STC, C.

Every incident of Tower failure must be immediately reported to Chairman, CEA and Members of the Standing Committee.

8. This issues with the approval of Chairman, CEA.


(VIJOY KUMAR)
Secretary (CEA)

✓ CMD Power Grid, New Delhi.

✓ DG CPRI, Bangalore.

✓ Head of Civil Engg. Deptt., IIT Delhi

Chairman of SEBs/Transmission Corporation/Grid Companies

PS to Chairman, CEA

PS to Member (PS), CEA

As per list
Enclosed

✓ Copy to: Chief Engineer (GM), CEA

PS to Secy, CEA

ssm
11/10/99

केविप्र
CEA

भारत सरकार
केन्द्रीय विद्युत प्राधिकरण
सचिव का कार्यालय
सेवा भवन, आरओ केओ पुरम्,
नई दिल्ली - 110 066



(अ.प्र.सं. ३००१/२००५)

o.CEA/5-41(18)/Secy-2012 / 166

Dated: 06.08.2012

OFFICE ORDER

Subject: Re-composition of the Standing Committee of Experts to investigate failure of towers-Amendment - Reg.

Standing Committee of Experts was constituted vide this Office Memorandum Technical Committee No. 16) of even no. dated 30.09.1999 to investigate the causes of failure of towers. After the enactment of Electricity Act, 2003, it is felt necessary to re-compose the above said Committee. The revised Composition of the Standing Committee of Experts to investigate failure of towers is given below:

- | | | |
|---|---|------------------|
| 1. Chief Engineer, SETD, CEA | - | Chairperson |
| 2. Additional Director, (CPRI) | - | Member |
| 3. Head, Deptt. of Civil Engg, Delhi Technological University- | - | Member |
| 4. Representative from Power Utility
where Power failure occurred | - | Member |
| 5. Member Secretary, Regional Power Committee
where Power failure occurred | - | Member |
| 6. Director (Transmission), SETD, CEA | - | Member Secretary |

The other terms of reference shall remain the same as indicated in the above referred Office Memorandum.

(M.S. Puri)

Secretary, CEA

Tel. No.26108476

To:

- ✓ 1. Chief Engineer, SETD, CEA
2. Director (Transmission), SETD, CEA
3. Additional Director, Mechanical Engineering Division, Central Power Research Institute (CPRI), C.V. Raman Road, Bangalore
4. Head, Deptt. of Civil Engineering, Delhi Technological University, Shahbad Daulatpur, Bawana Road, Delhi

Sh. Falguni

21/8/12

5. Representative from Power Utility (as per list enclosed)
6. Member Secretary, Regional Power Committee
(NRPC, WRPC, SRPC, ERPC & NERPC)

Copy for information to:

1. SA to Chairperson, CEA
2. SA to Member (PS), CEA

Copy for kind information to:

1. Secretary, Ministry of Power, Sharam Shakti Bhawan, Rafi Marg, New Delhi
2. Chairman and Managing Director, Powergrid Corporation of India Ltd., Saudamini, Plot No.2, Sector-29, Gurgaon



(M.S. Puri)
Secretary, CEA
Tel. No.26108476

ANNEXURE B

Minutes of the Meeting



भारत सरकार/ Government of India
विद्युत मंत्रालय/ Ministry of Power
केन्द्रीय विद्युत प्राधिकरण/ Central Electricity Authority
विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग
Power System Engineering & Technology Development Division

Date: 08.02.2024

सेवा में,

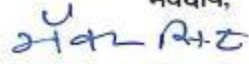
<as per attached list>

विषय: Minutes of the Meeting of Standing Committee of Experts on Failure of Transmission Line Towers during the period of January 2022 to December 2023.

महोदया/ महोदय,

A meeting of Standing Committee of Experts on Failure of Transmission Line Towers held physically on 10.01.2024 at the conference room of NR-I region Powergrid, Katwaria Sarai to discuss failure of towers in EHV transmission Lines during the period of January 2022 to December 2023 was convened under the chairmanship of Chief Engineer (PSE&TD), CEA. However, link of the online meeting through video conferencing mode was provided to the participants who could not join physically.

In this respect, please find the enclosed Minutes of the meeting for your information and necessary action.

भवदीय,

(भंवर सिंह मीना /Bhanwar Singh Meena)
निदेशक/Director

Central Electricity Authority

Copy to:

1. SA to Chairperson, CEA
2. SA to Member (PS), CEA
3. Chief Engineer, PSE&TD,CEA

To:

Director General, Central Power Research Institute, P B No.8066, Sadashivnagar PO, Prof. Sir C V Raman Road, Bangalore - 560 080 dgcpri@cpri.in , mchandra@cpri.in	Member-Secretary Southern Regional Power Committee No. 29, Race Course Cross Road, Bengaluru- 560009 mssrpc-ka@nic.in
Member-Secretary Western Regional Power Committee F-3, MIDC Area, Marol, Opposite SEEPZ, Central Road, Andheri (East), Mumbai-400093 ms-wrpc@nic.in ,	Member-Secretary Eastern Regional Power Committee 14, Golf Club Rd, Golf Gardens, Tollygunge, Kolkata, West Bengal- 700033 mserpc-power@nic.in ,
Member-Secretary Northern Regional Power Committee, 18-A, Qutab Institutional Area, Shaheed Jeet Singh Marg, Katwaria Sarai, New Delhi 110016 ms-nrpc@nic.in ,	Member Secretary, North Eastern Regional Power Committee, NERPC Complex, Dong Parmaw, Lapalang, Shillong – 793006 (Meghalaya). email: nerpc@ymail.com
Director, TCD, CEA, Sewa Bhawan, R.K. Puram, New Delhi tcdcea@nic.in	Head of the Department, Civil Engg., Delhi Technological University, Shahbad Daulatpur, Bawana Road, Delhi- 110 042 (Fax No.011-27852188) sksinghdce@gmail.com
Director, Structural Engineering Research Centre, CSIR Campus, Taramani, Post Box No.8287, Chennai–600 113 (Fax No.044-22641734) director@serc.res.in	Director General, India Meteorological Department, Mausam Bhawan, Lodhi Road, New Delhi- 110 003 (Ph.011-24616051) directorgeneral.imd@imd.gov.in / dgmmt@gmail.com / m.mohapatra@imd.gov.in
Chairman & Managing Director, POWERGRID, Saudamini, Plot No.2, Sector 29, Near IFFCO Chowk, Gurgaon – 122 001 cmd@powergrid.in	Shri E.V. Rao, KEC International Limited, RPG House, 463, Dr. Annie Besant Road, Worli, Mumbai-4000 03 raoev@kecrpg.com
Chairman Sterlite Power The Mira Corporate, Suit, Plot No. 1&2, C Block, 2nd Floor, Ishwar Nagar, Mathura Road, New Delhi – 110065 rohit.gera@sterlite.com tan.reddy@sterlite.com	Shri Kaushal Thakkar, Manager, Kalpataru Power Transmission Ltd., Plot No. 101, Part III, GIDC Estate, Sector 28, Gandhinagar-382028, Gujarat kaushal.thakkar@kalpatarupower.com

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Shri P.G. Suresh Kumar, Director, L&T IDPL, Kudgi Transmission Ltd., 1 st Floor, TCTC Building, Mount Poonamallee Road, Manapakkam, Chennai-600 089	Dr. Deepak Lakhpati, Chief Design Officer, Sterlite Power F-1, Sterlite Power, The Mira Corporate Suits, 1 & 2, Ishwar Nagar, Mathura Road, New
pgsk@Lntidpl.com	Delhi-110 065 18. deepak.lakshpati@sptlpower.in
Mr. Bipin B. Shah, Vice President–Transmission, Torrent Power Limited, 3rd Floor, Jubilee 2. House, Shahpur, Ahmedabad-380001 bipinbshah@torrentpower.com	Managing Director, Karnataka Power Transmission Corporation Limited No. 82, Shakti Bhawan, Race Course Road, Bengaluru – 560001 md@kptcl.com
Chairman & Managing Director, Madhya Pradesh Power Transmission Co. Ltd. Block No.2, Shakti Bhawan, Rampur, Jabalpur (M.P.) – 482008.	Chief Engineer (EHT-M&I), Madhya Pradesh Power Transmission Co. Ltd., 3 rd Floor, Block No.2, Shakti Bhawan, Rampur, Jabalpur (M.P.) – 482008. (0761-2702270, 2660757)
Chairman & Managing Director, Rajasthan Rajya Vidyut Prasaran Nigam Ltd. Vidyut Bhawan, Janpath, Jyoti Nagar, Jaipur (Rajasthan) – 302005(0172-2560815) cmd.rvpn@gmail.com	Chairman & Managing Director, Uttar Pradesh Power Transmission Corporation Ltd. Shakti Bhawan, 14-A, Ashok Marg, Lucknow – 226001 cmd@upptcl.org
Director, Darbhanga – Motihari Transmission Co. Ltd. 6 th Floor, Plot No. 19 & 20, Film City, Sector 16 –A, Noida, Uttar Pradesh – 201301	Chairman & Managing Director, Raichur Sholapur Transmission Company Private Limited, Plot No 6. Sy No. 20/A Above VKG TATA Show Room Gunj Area, Hyderabad Road, YADGIR 585-201 Karnatak
Sri Balabanta Basumatary, CGM (PP&D), AEGCL 94357-37222, cgm.ppd@aegcl.co.in	Sr. Vice President, M/s Adani Power Limited, 7th Floor, Sambhav Building, Judges Bungalow Road, Bodakdev, Ahmedabad, Gujarat-380015 praveen.tamak@adani.com sameer.ganju@adani.com

Central Electricity Authority

Chairman & Managing Director, Damodar Valley Corp. Head Quarter DVC Towers, VIP Road Kolkata – 700054 chairman@dvc.gov.in	Director & CEO, Indian Transmission Business Sterlite Power Transmission Ltd., F-1, The Mira Corporate, Suit, Plot No. 1 & 2, C-Block, 2nd Floor, Ishwar Nagar, Mathura Road, New Delhi – 110 065 balaji.sivan@sterlite.com fahim.alam@sterlitepower.in Sterlite.bd@sterlitepower.com chandan.dutt@sterlite.com
Chairman & Managing Director, Powergrid Corporation of India Ltd., Saudamini, Plot No. 2, Sector-29, Gurgaon-122001 (Haryana) Ph.: 0124-2571800 cmd@powergrid.in ksreekant@powergrid.in	Director General, Electric Power Transmission Association, First Floor, 6 Basant Lok, Vasant Vihar, New Delhi - 110070 Dg.epta@epta.in epta.dg@gmail.com
Chairman Bhakra Beas Management Road, Sector -19B, Madhya Marg, Chandigarh – 160019	Managing Director Karnataka Power Transmission Corporation Ltd., 1st floor, Kaveri Bhawan, K. G. Road,
cman@bbmb.nic.in	Bangalore-560009 Ph.:080-22214342 md@kptcl.com
Managing Director, Himachal Pradesh Power Development Corporation Ltd. Barowalia House, Khalini Shimla - 171004 md@hppcl.in	Chairman & Managing Director Transmission Corporation of Andhra Pradesh Limited Vidyut Soudha, Gunadala, Eluru Rd, Vijayawada, Andhra Pradesh 520004 ce.trans@aptransco.gov.in , surendrababu.karreddula@aptransco.co.in
Director (Operations) Maharashtra State Electricity Transmission Company Ltd., C-19, E-Block Prakashganga, Bandra-Kurla Complex Bandra(E), Mumbai 400 051. Ph.: 022- 26476909 dirop@mahatransco.in	Managing Director Gujarat Energy Transmission Corporation Ltd. Sardar Patel Vidyut Bhawan, Race Course, Vadodara- 390 007 Ph.: 0265-2353085 md.getco@gebmail.com

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Chairman & Managing Director Orissa Power Transmission Corporation Ltd. Janpath, Bhubaneswar- 751 022. cmd@optcl.co.in dir.operation@optcl.co.in ele.bpmohapatra@optcl.co.in ele.ssahu@optcl.co.in	Director (Operations) Rajasthan Rajya Vidyut Prasaran Nigam Ltd. Vidyut Bhawan, Jyoti Nagar Jaipur (Rajasthan) Ph.: 0141-2740814 dir.oper@rvpn.co.in cmd.rvpn@gmail.com,
Chairman & Managing Director Uttar Pradesh Power Transmission Corporation Ltd. Shakti Bhawan, 14-A, Ashok Marg, Lucknow- 226001 cmd@upptcl.org	Managing Director Assam Electricity Grid Corporation Ltd. Bijulee Bhawan, Paltan Bazar Guwahati- 781 001 managing.director@aegcl.co.in, md_aegcl@yahoo.co.in
Chairman & Managing Director, Delhi Transco. Ltd. Shakti Sadan, Kotla Marg, New Delhi – 110002 md@dtl.gov.in gmom1.dtl@gmail.com dgmtoperation1.dtl@gmail.com	Managing Director TANTRANSCO 10th Floor/NPKRR Malikai, No. 144 Anna Salai, Chennai-600002 Ph.: 044-28521057 mdtantransco@tnebn.net.org
Managing Director Madhya Pradesh Power Transmission Company Ltd. Shakti Bhawan, Rampur, Jabalpur(MP) - 482 008 Ph.: 0761-2661234 md@mptransco.nic.in gargava.pk@mptransco.nic.in; sanjeev.shrivastava65@gmail.com;	Chief Engineer (Transmission) Jharkhand Urja Sancharan Nigam Ltd. (JUSNL) Engineering Buliding, HEC, Dhurwa, Ranchi – 834004 mdjusnl@gmail.com
West Bengal State Electricity Transmission	Chairman & Managing Director
Company Ltd (WBSETCL) Vidyut Bhawan, Block-DJ, Sector-II, Bidhan Nagar Kolkata- 700 091. md@wbsetcl.in	Chhattisgarh State Power Holding Company Ltd., Vidyut Seva Bhawan P.O. Sunder Nagar, Danganiya, Raipur- 492 013 (Chhattisgarh) mddiscom@gmail.com , mddiscom@cspc.co.in

Central Electricity Authority

Chairman Haryana Vidyut Prasaran Nigam Ltd. Shakti Bhawan, Sector No. 6 Panchkula – 134109, Haryana chairman@hvpn.org.in	Chairman Kerala State Electricity Board Board Secretariat Vidyuthi Bhavanam Pattom Thiruvananthapuram – 695004 cmdkse@kse.in
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Managing Director, Power Transmission Corporation of Uttarakhand Ltd. Vidyut Bhawan, Saharnpur Road, Near I.S.B.T. Crossing, Dehradun Uttarakhand – 248002 md@ptcul.org	Chairman & Managing Director, Punjab State Transmission Corporation Ltd. The Mall, Mall Road, Patiala – 147001, Punjab cmd@pstcl.org
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Minutes of the Meeting of Standing Committee of Experts on Failure of Transmission Line Towers held on 10.01.2024 to discuss failure of towers in EHV transmission Lines during the period of January 2022 to December 2023.

A meeting of the Standing Committee of experts to investigate the failure of Transmission Line Towers held on 10.01.2024 to discuss failure of towers in EHV transmission Lines during the period of January 2022 to December 2023 was held on 10.01.2024 through physical mode, under the chairmanship of Chief Engineer (PSE&TD, CEA) and Chairman of the committee. However link of the online meeting through video conferencing mode was provided to the participants who could not join physically.

The list of the participants is at Annexure.

Chief Engineer (PSE&TD) & Chairman of the Standing Committee welcomed the participants and informed that during the period of January 2022 to December 2023, failure of 46 Nos. of transmission towers in 23 transmission lines of 220kV, 400 kV and 765 kV AC voltage class has been reported to CEA. He stated that the number of towers collapsed have gradually decreased in the past few years. He requested all the utilities to intimate the tower failure incidents in a prompt manner so that a visit of team to tower failure site can be planned. He further requested utilities to provide all the relevant details/documents including images, duly filled CEA Proforma, wind speed data, coordinates of failed towers, material test reports, etc., so that a proper investigation of cause of failure may be carried out. He requested Indian Meteorological Department (IMD) to provide the wind speed data of the tower failure location(s) so that detailed analysis of the failure of the transmission tower with respect to wind as a cause of failure can be carried out. He further requested Director (PSE&TD) to take up the agenda of the meeting.

Director (PSE&TD) and Member Secretary of the Committee welcomed all the participants and highlighted that transmission towers are important asset for the transmission systems and failure of transmission tower can cause havoc in the grid. Therefore, it is important to analyze and find out the causes which led to the failure of transmission towers and requested participants to actively participate in the deliberation to arrive at a conclusive cause of failure of transmission towers and suggest remedial measures to avoid the recurrence of such incidents in future. He requested all the utilities to intimate the failures of transmission lines timely so that a proper investigation may be carried out. He also informed that there is a tower failure intimation format available on the CEA website through which utilities can intimate tower failure incidents with all the relevant documents mentioned in the format. He requested all the utilities to provide detailed colored photographs/videos for detail analysis of tower failure. He requested that all the utilities may coordinate with IMD for Wind speed data of the time and location of failure, as wind has been highlighted as the major cause of collapsing of the tower. In such cases, it is important to have wind data from authentic observatory to collaborate that whether the speed of wind around the collapsed tower exceeded the wind speed for which the towers are designed. The availability of data indicating change in wind speed in a particular area may help to take necessary modifications in design parameters so that the failure of towers may be avoided. He further requested members from utilities to present their respective failure incidents before the Committee for deliberation.

Tower Failures of POWERGRID

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- Representative from POWERGRID presented their failures of 37 Nos. of transmission towers in 16 transmission lines, important highlights of which are summarized hereunder-
- The POWERGRID informed that major cause of tower failure was attributed to –
- **Heavy localized cyclonic storm** due to which 7 numbers of tower failure incidents had occurred and 17 numbers of towers get affected.
- **Theft** due to which 4 number of tower failure incidents took place and 8 numbers of towers get affected.
- **Floods / Landslides** due to which 4 numbers of tower failure incidents took place and 11 numbers of towers get affected.
- Co-ordination issues between various construction agencies of highways / roads and utilities was also discussed in which representative from Indigrd told that during road expansion activity in hilly areas by BRO the soil get loosened and led to collapse of towers, he also added that construction authorities does not inform timely. CE (PSE&TD) and Chairman of the Standing Committee suggested the utilities for regular patrolling and to co-ordinate with construction agencies to avert such failures in future. Utilities suggested that regulatory provisions must be strengthened and construction agencies must take NOC before constructing any roads / highways which is affecting the transmission lines.
- Powergrid representative highlighted that due to non-availability of observatory of IMD at multiple tower failure locations, it is not possible to collect the authentic information of wind speed prevailing at the tower failure location. Representative from IMD responded that that due to limited no. of observatories of IMD it will not be possible to find out the exact speed of the wind around the tower on the date of failure of transmission tower. Further, if observatory is not available at the location, the only way to conclude the wind speed at the failure site location is through indirect calculation or estimation by considering the damages observed in the area or collecting the data from the nearest located airport. However, utilities can approach National Data Centre of IMD, Pune for details of maximum wind speed recorded at observatories. Committee noted the above and directed that for all the transmission line failures in which High wind speed is claimed as the major cause of failure, utilities shall approach IMD with the details of failed towers of all the transmission lines (including coordinates and date & time of failure incident) to obtain the actual wind speed observed in the area. Committee also directed the utilities that the details of failure shall be submitted to CEA as soon as the failure incident occurs and wind speed details obtained from IMD shall also be submitted along with the duly filled tower failure intimation format available on CEA website. Director (PSE&TD) suggested Powergrid to take initiative and discuss with IMD regarding installation of wind speed observer on towers. SERC requested for the data in order to analyze and give their comments. Chief Engineer (PSE&TD) & Chairman of the Standing Committee suggested the utilities to send the proposal to IMD for cost effective wind speed measuring devices to be installed on the tower.

Tower Failures of INDIGRID

- Indigrd representative presented their 400kV D/C Silchar-Misa Transmission line Circuit-I and Circuit-II failure and informed that two numbers of tension type tower got damaged due to heavy flood with high water current in Kopli River. Director (PSETD) requested Indigrd to share the soil test report at the time of commissioning of line , HFL and water discharge rate at the time of failure.

Tower Failures of ADANI POWER

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□ Adani representative presented their failure report of five transmission towers in four transmission lines in which 4 numbers are of suspension tower type and 1 number is of tension tower type. Director (PSE&TD) told the representative of Adani that no data has been provided for analysis. The same may be provided so that exact cause of failure may be predicted. Also, requested to timely inform about the failure of towers.

Tower Failures of AEGCL

- AEGCL representative presented their failure report of 220 kV Rangia-Salakati D/C line in which one number of tension tower got failed due to-
- Increase in water level,
- High current,
- Change in the course of Pagladiya River
- AEGCL representative further added that their tower is still on ERS and due to the change in the river courses they are facing failure cases in towers. AEGCL representative informed that they have no information on change in course of river and the information should be shared among NER states. Chief Engineer (PSE&TD) & Chairman of the Standing Committee said to take the view of NERPC in such cases.

Tower Failures of UPPTCL

□ UPPTCL representative presented their failure report of 220 KV PGCIL (GORAKHPUR)-GOLA D/C LINE in which two numbers of tension towers got failed due to cyclonic winds. He further added that the wind speed data is not available from IMD at the tower failure location. Chief Engineer (PSE&TD) & Chairman of the Standing Committee said that the modality for sharing wind speed data has been discussed earlier.

Following technical issues were also discussed

(a) Drag coefficient and solidity ratio:

- Powergrid representative highlighted that to use IS 802:2015 drag coefficient values for different solidity ratios a factor approximately equals to 2 must be multiplied with drag coefficient value to get the correct drag coefficient value for tower members. He also added that the values of drag coefficient for different solidity ratio as present in IS 802:1995 is correct.
- Representative from DTU said that the effect of drag coefficient for different solidity ratio is more as compared to the effect of shielding factor on the towers and shielding factor is more effective for buildings. He also added that the site and topography difference had effects on the parameters as winds shows approximately 4000 fluctuating datas in just a second.
- DTU representative also highlighted the importance of lift coefficient but on discussion it was concluded that lift coefficient was not of much importance in designing of towers.
- Sterlite representative highlighted the point that drag coefficient value for different solidity ratio in IS 802:2015 is not as per Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022. Chief Engineer (PSE&TD) & Chairman of the Standing Committee informed that in regulation, solidity ratio is taken as per IS 802:1995 to which Sterlite was satisfied.

(b) K₃ factor :

- Director (PSE&TD) and Member Secretary of the Committee asked the participants that K₃ factor should be considered for tower designing or not, in reply of which Powergrid

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representative told that presently K_3 factor is not considered for tower design and introduction of K_3 factor will increase the designing cost significantly.

- Representative from CPRI highlighted that introduction of K_3 factor should be location specific. SERC representative also supported the view point of CPRI representative and said that K_3 factor should be included because zones maybe same but topographies are different. SERC representative also added that K_2 factor which is considered is for hilly terrain whereas K_3 factor is for topography or change in topography and it should be included.
- Chief Engineer (PSE&TD) & Chairman of the Standing Committee added that though at present K_3 factor is not taken into design consideration and no tower failure cases have been reported in such terrain. He also added that introduction of K_3 factor is not required presently, however if need arises it, may be discussed in future.

(c) K_4 factor:

- Director (PSE&TD) and Member Secretary of the Committee said that as per the Task Force report on cyclone resilient robust electricity transmission and distribution (T&D) infrastructure in coastal area, the wind speed during the cyclones often exceeds the basic wind speed of the coastal area as per the wind map of the country. The effect of cyclonic storms is largely felt in a belt of approximately 60 km from the coast line. In order to ensure safety of structures in coastal areas, IS 875 (Part 3) 2015 recommends use of importance factor for cyclonic region that is K_4 which is 1.3 for structures of post-cyclone importance (such as cyclone shelters, hospitals, school and community buildings, communication towers, power-plant structures, and water tanks) and 1.15 for industrial structures, in reply of which SERC and CPRI representative told that in a Task Force report and in CEA's regulation it was already discussed that K_4 value of 1.3 should be considered for tower designing.

(d) Steel Grade:

- Director (PSE&TD) and Member Secretary of the Committee said that as per IS 2062, grade 250 and 350 are specified for tower structure. In hilly terrains grade C of steel is being adopted and in pole structures higher grade steel is allowed. He also added that in previous standing committee meetings on tower failure it was inquired that whether the higher grade steels (such as E410) may also be allowed for transmission lines or not, in that it was discussed that as carbon content of the steel increases, the strength of steel increases but the steel becomes brittle and elongation properties reduces which led to multiple failure of towers. Powergrid representative told that nowadays higher grade steel can be produced without increasing the carbon content significantly. He also added that they had deigned pole structures with Fe 450 and it reduces the weight of the tower.
- DTU representative told that as grade of the steel increases its tensile strength increases and hence the failure time also increases. Chief Engineer (PSE&TD) & Chairman of the Standing Committee suggested the participants from different utilities to forward their observation on grade of the steel and it will be taken in separate meeting.

Committee noted that all the utilities should intimate the failures of transmission line timely and should provide all the relevant details/documents including images, duly filled CEA Proforma, wind speed data, coordinates of failed towers, material test reports, etc. so that a proper investigation of cause of failure may be carried out. IMD and other agencies involved in metrological field may be requested to assist the affected utilities for obtaining the wind speed data of the failed tower locations.

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Director (PSE&TD) and Member Secretary of the Committee noted that there are failure cases due to change in the river courses and said to utilities to submit the velocity discharge and highest water level observed data and Material Test Report data on time with IMD wind speed data wherever applicable. He further added that the discussion on high graded steel will be done separately. After detailed deliberations / discussions among all participants, the Committee observed the various causes which attributed to failure of EHV towers and various suggestions emerged which shall be adopted to avert failure of towers in future. These will be incorporated appropriately in the Report of the Committee which shall be circulated to all the Committee members and Stake holders.

Chief Engineer (PSE&TD) & Chairman of the Standing Committee thanked all the participants who had joined physically and through online video conferencing mode. He further added that by sharing experiences on failure cases all gets benefitted and suggested all the utilities to intimate and send failure reports on time with all the relevant datas and test reports.

The meeting ended with thanks to the Chair.

List of Participants:

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- Shri Bhanwar Singh Meena, Director, PSE&TD & Member Secretary of the Committee
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- Shri Pankaj Kumar Verma, Deputy Director, PSE&TD
- Shri Saurabh Kumar, Dy. Director(CD), CEA
- Shri Nishant Chohla, Assistant Director, PSE&TD
- Shri Bhavesh Mahawar, Assistant Director, PSE&TD
- Shri Amrendra Pratap Singh, Assistant Director, PSE&TD

TSTRANSCO:

- Shri B. Krishna Mohan Singh, Divisional Engineer, TSTRANSCO
- Shri P. Damodar, Superintending Engineer, TSTRANSCO

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- Shri Anil Malik, XEN, HVPNL
- Shri B. S. Dahiya, SE/TS, HVPNL

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- Shri Vivek Kartihikeyan, AGM, INDIGRID

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- Shri D.K. Meena, SE(O), NRPC

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- Shri S. Kennedy, O.M, MSPCL

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- Shri Ashutosh Bhattacharji, GM, AEGCL

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- Shri Aman, Sr. Exen, BBMB

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