

**Report
of
Standing
Committee
of Experts**

**REPORT OF STANDING COMMITTEE OF EXPERTS TO
INVESTIGATE FAILURE OF TOWERS OF DELHI TRANSCO LTD,
DURING MAY 2014**

1.0 General Manager(O&M)I, Delhi Transco Ltd. Vide e-mail dated 01.06.2014 to Member (PS), CEA had informed that on 30.05.2014, a heavy storm was observed in the South West, North West and North Delhi area and there were number of trippings of 220kV transmission system of Delhi Transco Ltd.(DTL) due to failure of towers. A request was made to depute CEA team for inspection of these sites along with DTL team.

2.0 THE INCIDENT OF FAILURE OF TOWER

Details of failure of towers in Transmission Lines of Delhi Transco Ltd., on 30.05.2014 are indicated below:

<u>Sl. No.</u>	<u>Names of the Transmission Lines</u>	<u>Date of Occurrence of Failure</u>
(i)	220 kV D/C Bamnauli-Pappankalan-I Transmission line	30.05.2014
(ii)	220 kV D/C Bawana-Rohini-II Transmission line	30.05.2014
(iii)	220 kV D/C Mandola-Gopalpur Transmission line	30.05.2014

3.0 OBSERVATIONS OF THE COMMITTEE AND RECOMMENDATIONS

The team of officers from CEA (Shri P.K.Mishra, Director; Shri C.N.Devarajan, Asstt. Director and Shri R.K.Meena, Assistant Director) and DTL (Shri M. P.Singh, Manager, Shri Y.P.Verma, Manager) had visited sites of failure of towers of the transmission lines on 02/06/2014 & 13/06/2014 and preliminary report was submitted.

As per CEA Order No. 5-41/98/Secy/CEA/809, dated 30.9.1999 and subsequent amendments thereof, a Standing Committee of experts was constituted as per Chapter II Para 3 (viii) of the Electricity (Supply) Act No.54 of 1948 to investigate failure of transmission line towers of power utilities. As per the Electricity Act, 2003, CEA continues to be authorized under Section 73 (l) to carry out or cause to be carried out, any investigation for the purpose of generating or transmitting or distributing electricity.

Accordingly, the meeting of Standing Committee of Experts on failure of the above mentioned lines along with other lines failed during the period was held in CEA on 19.06.2014. Copy of the extracts of minutes of the meeting is enclosed as **Annexure – A**. The nature and reasons of failures of towers, conductors and insulators of the above mentioned transmission lines were discussed in detail and recommendations of the committee to avoid such failures in future are as under:

(i) 220 kV D/C Bamnauli-Pappankalan-I Transmission Line

The 220 kV D/C Bamnauli-Pappankalan-I Transmission Line was constructed by M/s Pioneer Construction Company and was commissioned in 2000. The towers of this line were designed for medium wind zone as per old IS 802 as informed by DTL officer.

General Observations:

- (a) Location No. 9 (A+3):** The tower bent and fell in transverse direction from 1st panel (normal tower) level. Leg member has been broken at this level. The foundation was intact. Anti Climbing Device was missing. There were holes left in the leg members. Being old line, some of the members have rusted.
- (b) Location No. 10 (A+3):** The tower bent and fell in transverse direction from 1st panel (Normal tower) level. Two stubs were also bent. The foundation was intact. Some bolts were missing at the leg joints. Extra holes were left in the leg members. Some of the members have rusted.

(c) **Location No. 11 (A+3):** The tower bent and fell from 1st panel (Normal tower) level. The foundation was intact. Extra holes were left in leg members. Some of the members have rusted.

(d) **Location No. 12 (A+3):** The tower bent and fell from 1st panel (Normal tower) level. The foundation was intact. Extra holes were left in leg members. Some of the members have rusted.

It was observed that a compound wall was running parallel to the line. The high velocity localized whirl wind, obstructed by the raised compound wall near the failed towers, might have increased the wind pressure further near the tower locations leading to damage of the towers at normal tower level. Most likely, the towers, which were subjected to such whirl wind, have suffered damages whereas the other adjoining towers in the line are found to be intact. All the four towers (A-Type) in one section of the line had fallen towards the wall in transverse direction. The foundations were intact. Other transmission line i.e. 220kV Bamnauli-Najafgarh D/c line with towers having broad base, which is passing parallel and close to this line was also intact and no damage was reported.

The line was restored on normal tower on 16-06-2014 (Ckt-I) and 23-06-2014 (Ckt-II).

(ii) **220 kV D/C Bawana-Rohini-II Transmission line**

This line was constructed in 1995 by M/s Aquarian Enterprises and commissioned in 2005. Design criteria adopted was as per old IS 802.

General observations :

a) **Location No. 29(B+0):** The tower was damaged from top cross arm level. The foundations were intact. Copping of chimneys was not done.

b) **Location No. 30(A+3):** The tower was bent from top of the 1st panel of normal tower and took a 'U' shape, top pointing towards ground. The foundations were intact. Copping of chimneys was not done. Some holes were left in the tower members.

c) **Location No. 31(A+3):** The tower was bent from top of the 1st panel. Foundations were intact. Copping of chimneys was not done. Some holes were left in the tower members. Stubs were bent. These needs repair/replacement.

d) **Location No. 32 (A+3):** The tower was bent from top of the 1st panel. Foundations were intact. Copping of chimneys were not done. Some holes were left in the tower members. Stubs were bent. These needs repair/

replacement. Bushes were grown around the foundation. These are to be removed.

- e) **Location No. 36 (A+3):** The tower was bent from top of the 1st panel. Foundations were intact. Stubs were bent and need repair/ replacement.
- f) **Location No. 37 (C+3):** The tower fell from the stub level. Stubs were damaged. Stubs are to be repaired/replaced.

It was observed that a canal was running parallel to the line at a higher elevation. The high velocity localized whirl wind, obstructed by the canal near the failed towers, might have increased wind pressure further near the tower locations leading to damage of the towers at normal tower level. Most likely, the towers, which were subjected to such whirl wind, have suffered damages whereas the other adjoining towers in the line are found to be intact. The towers have fallen towards the canal.

The line was restored on normal tower on 20-06-2014.

(iii) **220 kV D/C Mandola-Gopalpur Transmission line**

This line was energized in year 1975. As informed by DTL, design criteria adopted was as per old IS 802. One tower at location no. 25 (A+6) had failed on 30.05.2014.

General observations

The tower failed due to falling of a tree on the line during the high intensity storm. New tower has been erected and the line was restored on normal tower on 16-06-2014 (Ckt-I) and 17-06-2014 (Ckt-II).

Analysis of failures:

From the preliminary investigation and discussion with DTL officers, it was brought to the notice that all towers of above three lines were designed with narrow base. It was also reported that high velocity localized whirl wind have caused damage to number of trees in the locality near the failed tower locations. A part of nearby wall in agricultural field was also damaged due to the effect of wind and relevant photographs are enclosed as **Appendix A – (vi) & (vii)**.

All the four towers (A-Type) in one section of the **220 kV D/C Bamnauli-Pappankalan-I Transmission Line** had fallen towards the wall in transverse direction. The foundations were intact. The other transmission line i.e. 220kV Bamnauli-Najafgarh D/c line with towers having broad

base, which is passing parallel and close to this line was also intact and no damage was reported. Hence it is presumed that the high velocity localized whirl wind, obstructed by the raised compound wall running parallel to above line (near the location of failed towers), might have increased wind pressure further near the tower locations leading to damage of the towers at normal tower level. Most likely, the towers, which were subjected to such whirl wind, have suffered damages whereas the other adjoining towers in the line are found to be intact.

Similarly five towers of **220 kV D/C Bawana-Rohini-II Transmission line** have fallen towards the canal in transverse direction and one tower damaged from top cross arm level. The foundations were intact. Hence it is presumed that the high velocity localized whirl wind, obstructed by the canal near the failed towers, might have developed further wind pressure near the tower locations leading to damage of the towers at normal tower level. Most likely, the towers, which were subjected to such whirl wind, have suffered damages whereas the other adjoining towers in the line are found to be intact.

DTL officers have informed that the towers were designed long back by a private firm using old codes probably as per IS 802: 1977 and these towers are being used in most of their lines. No relevant design documents are available with them. It is pertinent to mention that earlier the entire country was divided into only three wind pressure zones as per IS 802:1977. Subsequently the IS 802 was revised in year 1995 and the country was divided into six wind zones based on wind velocity pattern. As per new code (IS 802:1995), Delhi comes under wind zone-IV with a higher wind speed as compared to old code (IS 802:1977) for which towers of DTL were designed. In absence of meteorological data it is difficult to assess the wind speed on 30-05-2014 at the failed tower locations. However, paper clippings provided by DTL shows that on that particular day, the wind velocity was in the range of 114 to 130 km/hr in some parts of Delhi. DTL officials were requested to collect relevant information from the Meteorological department.

The basic wind speed data provided in IS: 875 based on which the wind zones have been classified, takes into account the recorded cyclones to some extent but do not account for other localized high intensity wind condition having narrow front viz tornadoes, hurricanes, localized thunder storms/ dust-storms etc. These are short lived and cover small area but devastation caused for such high intensity winds is very severe though restricted to a smaller area only.

In view of above reason, the whirl wind could be one of the causes of failure of towers as other adjoining towers of the line as well as other

nearby lines are intact. Moreover, the towers / lines are not generally designed for such condition because of high cost involved and the probability of occurrences of such incidences are very low. The holes in some of the tower members including leg members are found to be left unfilled with bolts & nuts, which results in decrease in strength of members.

The Material test reports of samples taken from the failed towers, conducted at M/s Microtech Testing & Research Laboratory, Delhi (Building & road materials) has been examined by CEA and found to be in order. But DTL may ensure that the test laboratory in which such tests have been carried out in recognized NABL approved laboratories / Govt./ Govt. approved laboratory.

Recommendations/ Remedial measures to be taken by Delhi Transco Ltd.

- (i) Towers of the line were designed as per old code IS:802 (1977) and the wind zone for Delhi area has been changed as per revised code IS: 802 (1995). In view of the above, DTL may review design of towers in line with latest IS codes and strengthening of members of tower, if required, may be carried out accordingly to avoid reoccurrence of such failures in future and thereby increase the availability of the line. PGCIL/CPRI/SERC / any other organization may be consulted for review of the design.
- (ii) In future, the use of tower designed as per old IS:802(1977), should be avoided as a replacement to failed towers in any existing lines or in new lines until the design review is complete.
- (iii) The regular patrolling of lines should be carried out by DTL to check for missing of tower members. Regular maintenance activities such as chopping of nearby trees to maintain adequate safety clearances, considering MOE & F guidelines, removing the bushes near the foundation area, and coping of chimneys etc. should be carried out by DTL from time to time, as and when required.
- (iv) For old lines, rusting in members of all the towers (due to exposure to atmosphere over a long period of time) may be checked and painting of the rusted members with Zinc rich paints may be done as remedial measures.
- (v) The holes in the tower members including leg members are to be filled with bolts & nuts to increase the strength of members.
- (vi) Chimneys of all the towers should be provided with coping to avoid accumulation of rain water near stub. If required, the height of the chimneys may be raised where the tower is located in agricultural

field to avoid deposit of soil on the chimneys due to agricultural activities.

- (vii) Quality of steel material may be ensured while replacing these missing members.
- (viii) Material test of the failed tower members should be carried out from recognized NABL approved laboratories / Govt. approved laboratories to assess the quality of steel material used in the tower.

(C.N.Devarajan)
Asstt. Director (Transmission)
SETD Division

(P.K.Mishra)
Director (Transmission)
SETD And
Member Secretary,
Standing Committee of
Experts to investigate
Failures of towers

New Delhi
Date :

ANNEXURE -A

**Extracts of
Minutes
of the
Meeting
Of Standing
Committee of
Experts**

Extracts of minutes of meeting of the Standing Committee of Experts held on 19-06-2014 at CEA Headquarters regarding failure of Towers of Delhi Transco Ltd.

The list of participants is at Annexure-I.

Based on field visit reports, detailed discussion was held to investigate the probable causes of failure of towers.

1. 220 kV D/C Bamnauli-Pappankalan-1 line

Location no. 9(A+3), 10(A+3), 11(A+3) & 12(A+3) failed on 30.05.2014

This line was constructed by M/s Pioneer construction company during 1993-1994 and was commissioned in year 2000. All the four towers failed were of (A+3) type and have fallen from the normal tower ('0' meter) level. A compound wall of about 1/2 meter height exist close to the line. From the preliminary investigations, it was observed that the high velocity wind on 30/05/2014 was obstructed by the compound wall, developed pressure and damaged the towers at normal tower level. The foundations were in tact. DTL officials have informed that these towers were erected and line restored.

The committee agreed to the preliminary observations of the field visits.

2. 220 kV D/C Bawana-Rohini II Transmission line

Location no. 29(B+0), 30(A+3), 31(A+3), 32(A+3), 36(A+3) & 37(C+3) failed on 30/05/2014

This line was constructed in 1995 by M/s Aquarian Enterprises and commissioned in 2005. Tower at location no. 29(B+0) was damaged at top cross arm level. Towers at location no. 30(A+3), 31(A+3), 32(A+3), 36(A+3) were failed at top of 1st panel level. Tower no. 37(C+3) was fallen from stub level. From the preliminary investigation, it was noticed that the high velocity wind, due to the presence of a high level canal running parallel to the line developed high pressure on the towers and damaged them. Some holes were left in the members of the towers. Bushes were grown at the base of the tower. DTL officials were directed to fill the holes in the members with bolt & nut and to clean the bushes. Coping of chimneys to be done.

DTL officials have informed that new towers were erected in place of failed towers.

The committee agreed to the preliminary observations of the field visits.

**3. 220kV D/C Mandola-Gopalpur Transmission Line
Location no. 25(A+6) failed on 30/05/2014**

The line was energized in the year 1975. The tower at location no. 25(A+6) fallen from the stub level. DTL officials have informed that tower failed due to falling of a tree on line due to heavy wind storm on 30/05/2014. New tower has been erected and the line was restored.

The committee agreed to the preliminary observations of the field visits.

List of Participants

Central Electricity Authority

1. Shri P.K.Mishra, Director(Transmission)
2. Shri C.N.Devarajan, Assistant Director
3. Shri Faraz, Assistant Director

Powergrid Corporation of India Ltd.

1. Shri Anish Anand, AGM(Engg.TL)
2. Shri Abhishek, CDE(Engg.TL)

Delhi Transco Ltd.

1. Shri Prem Prakash, General Manager(O&M) 1
2. Shri Loveleen Singh, DGM(T) OS&L

Rajasthan Rajya Vidyut Prasaran Nigam Ltd.

1. Shri M.K.Soni, Executive Engineer

WAPCOS Ltd.

1. Shri Vijay Pal, Top Level Expert