भारत सरकार **Government of India**
विद्युत मंत्रालय **Ministry of Power**
केंद्रीय विद्युत प्राधिकरण **Central Electricity Authority**
क्षेत्रीय निरीक्षण संगठन (उत्तर) **Regional Inspectorial Organization(North)**
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संख्या :NRIO/CEA/Adm/2017/ 548-551 **Dated: 26.03.2018**

To,

Chief Engineer (ES), Himachal Pradesh State Electricity Board Ltd. Hamirpur -177005 (H.P.)	**Addl. Vice President, Parbati Koldam Transmission Co. Ltd., Plot No.-391/04, Bhojpur, Sundernagar, Mandi (H.P.) – 175002.**
Shri Y K Dixit General Manager, Corporate Office, Saudamini, Plot No. 2, Sector 29, Near IFFCO Chowk, Gurugram 122 001.	

Subject: Measurement of induced voltage at site due to 400kV D/C Parbati Koldam transmission line of Parbati Koldam Transmission Company Ltd.

546/ 28.3.2018

Reference is invited to minutes of the meeting to discuss the issue of induced voltage due to 400kV D/C Parbati Koldam transmission line of Parbati Koldam Transmission Company Ltd. held on 15.11.2017 in the office of Chief Engineer(CEI), CEA. In the meeting, it was decided to send a team of officers from CEA, representative from PGCIL and PKTCL for the measurement of induced voltage at site and HPSEB ltd. to coordinate with the team for the above mentioned measurement.

The proposed measurement of induced voltage at site as mentioned above shall be carried out on 05.04.2018 as proposed by PKTCL. In this regard three officers from CEA are being deputed by Chief Engineer (CEI), CEA. Shri Sunil Kumar Jain, Dy. Director (RIO-North) would be coordinating officer from CEA. Details of the officers from CEA are given below. It is requested to PGCIL and HPSEB to depute their officers for the proposed measurement on 05.04.2018 and send their contact details to coordinating officer at the earliest. Further, HPSEB is requested to coordinate with the team for the cooperation during above measurement.

Detail of CEA Officers:

1. Shri Sunil Kumar Jain, Dy. Director (Contact No. 9718784017)
2. Shri Santosh Kumar, Dy. Drector (Contact No. 08860754509)
3. Shri Mukul Kumar, Assistant Director, CEI (Div.), CEA

Yours faithfully,
P. Khichi 26/3/18
(Prakash Khichi)
Director(RIO-North), CEA

28/3/18 Sh. Mukul AD

Copy for information to:

i). Chief Engineer, Chief Electrical Inspectorate Division, CEA

Annexure-I

Investigation Report of problems being faced by villagers due to induced voltage from 400 kV D/C Parbati-Koldam Transmission line of PKTCL in Sub –Division Gohar, Distt. Mandi(H.P.)

1. Background

Special Secretary (Power) to the Govt. of Himachal Pradesh vide letter No. MPP-D(1)-3/2017 dated 19.08.2017 addressed to CEA raised the issue regarding problems being faced by villagers of Gohar Sub- Division of Mandi District in Himachal Pradesh due to induced voltage from 400kV D/C Parbati-Koldam transmission line of Parbati Koldam Transmission Co. Ltd (PKTCL). A meeting was taken by Chief Engineer (CEI), CEA with representatives from HPSEBL, PKTCL, PGCIL and RIO(North), CEA to discuss the problems being faced by villagers of Gohar Sub- Division on 15.11.2017.

In the meeting, it was decided to send a team of officers from CEA, representative from PGCIL and PKTCL for physical verification and measurement of induced voltage / electric field at the sites as mentioned in the Investigation Report submitted by the Committee headed by Chief Engineer, Electrical System, HPSEBL. Further, HPSEBL was requested to coordinate with the team for above mentioned measurements. The following three officers from CEA were nominated for the site verification and measurements:

1. Sunil Kumar Jain - Deputy Director(RIO-N),CEA
2. Santosh Kumar - Deputy Director(CEI), CEA
3. Mukul Kumar - Assistant Director(CEI),CEA

2. Electric Field due to transmission lines and its measurement

2.1 Introduction

A power transmission line during its operation emits electric and magnetic field. The strength of the electric and magnetic field depends on their operating voltage and current flowing (line loading) through the line. Equipment operating at high voltage produces comparatively stronger electric fields than the equipment operating at low voltage. Similarly, highly loaded lines produce stronger magnetic field than lightly loaded lines. The electric and magnetic field strength at any point is inversely proportional to square of the distance from the source.

When the exposure levels of electric field and magnetic field generated by HV/EHV substation equipment and transmission lines in their vicinity exceed specified limits, they are likely to have adverse effects on human beings, plants, and animals. Human beings or animals coming in direct contact with electrically isolated objects lying below the HV/EHV equipment or transmission line would experience shocks, which at times may be fatal. Therefore, it is necessary to keep these field levels in the vicinity of HV/EHV equipment & lines within limits.

2.2 Exposure limits of Electric Field

Electric field is generated by electric charges. The electric field at any point represents the force exerted on the electric charge due to one another. The strength of an electric field depends on the voltage associated with these charges. The electric field is present around the equipment/conductor due to its operating voltage. High voltage equipment & lines produce comparatively stronger electric fields than low voltage equipment & lines. The field reduces if the equipment is grounded/external conductive objects are present nearby. The magnitude of the AC electric field is expressed in terms of Volts per meter or kV per meter (kV/m).

The electric field generated by the lines is of the same frequency as that of operating voltage of line. The factors which primary influence the electric field strength beneath an overhead transmission line are given below:

a. Actual (rather than the nominal) voltage on the line
b. Height of the conductors above ground (which is influenced considerably by the ambient temperature and heating caused by the current passing through the conductor).
c. Geometric configuration of phase and ground conductor on the towers, and in the case of two circuits in proximity, the relative phase sequencing
d. Proximity of the grounded metallic structure of the tower
e. Proximity of other tall objects (trees, fences, etc.)
f. Distance of point of measurement of electric field from the conductor.
g. Height above ground at the point of measurement
h. Atmospheric conditions (Temperature, humidity, wind speed etc.

International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines are followed in India for designing of transmission line. The electric field continuous exposure limits for general public recommended by ICNIRP are 5kV/m.

2.3 Instrument used (Digital Electric Field Meter)

The Instrument used for the measurement was Digital Electric Field Meter. It is a free body type which had been designed, developed and fabricated in CPRI. The meter measures the power frequency induced charge between two hemispherical electrodes of an isolated conductive body in an Electric field. The incident field on the meter electrodes is directly proportional to kV/m. The free body probe is suitable for survey type measurements. It is portable and does not require a known ground reference. The incident charge Q across the electrodes is directly proportional to the voltage gradient. That is, Q = C V, where C is capacitance of the medium. The Electric field meter has a measurement uncertainty of ±10%.

3. Measurements and Observations

The team visited the affected sites on 05.04.2018 and took several measurements and discussed the problems being faced by the affected villagers. The measurement of electric field due to 400 kV double circuit Parbati Koldam transmission line, vertical and horizontal clearances from the structures at affected sites were carried out.

All the measurements of electric field were carried out at 1 meter height from the ground level as per IEEE standard 644-1994 guidelines and also, at 1.8 meter from the ground (i.e. at normal human height) to study the effective field intensity levels on human beings. The measurements were carried out in the clear sky weather during 1100 Hrs to 1600 Hrs. The line loading during the period is given in the Table below:

Time / Parameters	1100 Hrs	1300 hrs	1500 hrs	1600 hrs
Circuit-1 :Line voltage(kV)	416	417	416	416
Circuit-1 :Line loading(MW)	5	28	31	21
Circuit-2 :Line voltage(kV)	417	418	417	417
Circuit-2 :Line loading(MW)	16	36	28	19

All sites were on altitudes ranging between 1500m-1700m above MSL.

The site-wise details of the various measurements, observations and conclusions are given below:

(i) Site-1 (Village Saroa)

In village Saroa, it was observed that house of Shri Tulsi Ram was near to tower No. 88 (Construction location No. 82-83) of 400kV transmission line. The various observations taken are as under:-

a. Vertical and Horizontal Clearances

The minimum vertical and horizontal clearance between lowest and nearest conductor of 400kV transmission line and at the edge of the slab/roof of the house are 13.6m and 2.6m respectively. The ground clearance of the lowest conductor is 20m.

b. Electric field measurement

- Electric Field observed at 1 metre height from the roof top surface and horizontally at the nearest point on the rooftop to the nearest conductor was 6.1 kV/m.
- Electric Field observed at 1.8 metre height from the roof top surface and horizontally at the nearest point on the rooftop to the nearest conductor was 5.3 kV/m.

The above observations are summarized below:

Clearances (m) observed from the nearest and lowest conductor of the transmission line and at the edge of the slab/roof of the house *		Minimum clearances (m) requirement as per Reg. 61 of CEA Safety Regulations		Electric Field at 1m height from the roof top surface and horizontally at the nearest point on rooftop to the nearest conductor. (kV/m)	Electric Field at 1.8m height from the roof top surface and horizontally at the nearest point on rooftop to the nearest conductor. (kV/m)
Vertical	Horizontal	Vertical	Horizontal		
13.6	2.6	7.3	5.6	6.1	5.3

* without considering maximum deflection due to sag/wind, etc.

c. Observations

The minimum vertical and horizontal clearances stipulated for 400kV transmission line from any part of the building required as per Central

Electricity Authority (Measure related to Safety and Electric Supply) Regulation 2010(as amended), is 7.3m and 5.6m respectively. In this case minimum vertical clearance as specified in the regulation is being met but horizontal clearance from the nearest conductor is not being met. The Right of Way (RoW) requirement for 400kV transmission line which is 46m (23 m on each side from centre of tower) has not been maintained.

The level of electric field values measured at 1m and 1.8m from rooftop surface and horizontally nearest point on rooftop to the conductor are 6.1kV/m and 5.3 kV/m respectively. The electric field values are higher as compare to ICNIRP values of 5kV/m, due to which static charge accumulation is high on the metallic body, which could conceivably deliver a perceptible shock to a person.

(ii) <u>Site-2 (Village – Sainji)</u>

In village Sainji, it was observed that house of Shri Khindu Ram was near to tower No. 97 (Construction location No. 90-91) of 400kV transmission line. The roof top of the house was covered with CGI sheets in the half portion underneath the line conductors. The earthing of the CGI Sheet rooftop was found to be done at multiple points. The various observations taken at the site are as under:-

a. Vertical and Horizontal Clearances

The minimum vertical clearance between lowest conductor of 400kV transmission line and the rooftop of the house are 7.9m and the house is beneath the transmission line conductor. The ground clearance of the lowest conductor is 11.6m.

b. Electric field measurement

- Electric Field observed at 1 metre height from the roof top surface and horizontally at the nearest point on the rooftop to the nearest conductor was 1.4 kV/m.
- Electric Field observed at 1.8 metre height from the roof top surface and horizontally at the nearest point on the rooftop to the nearest conductor was 2.2 kV/m.

The above observations are summarized below:

Clearances (m) observed from the nearest and lowest conductor of the transmission line and at the edge of the slab/roof of the house *		Minimum clearances (m) requirement as per Reg. 61 of CEA Safety Regulations		Electric Field at 1m height from the roof top surface and horizontally at the nearest point on rooftop to the nearest conductor. (kV/m)	Electric Field at 1.8m height from the roof top surface and horizontally at the nearest point on rooftop to the nearest conductor. (kV/m)
Vertical	Horizontal @	Vertical	Horizontal		
7.9	---	7.3	5.6	1.4	2.2

* Without considering maximum deflection due to sag/wind, etc.
@ Transmission line conductor passes over the house.

c. Observations

The minimum vertical and horizontal clearances stipulated for 400kV transmission line from any part of the building required as per Central Electricity Authority (Measure related to Safety and Electric Supply) Regulation 2010(as amended), is 7.3m and 5.6m respectively. In this case minimum vertical clearance as specified in the regulation is being met but horizontal clearance is not being met as conductor passes over the house. The Right of Way (RoW) requirement for 400kV transmission line which is 46m (23 m on each side from centre of tower) has not been maintained.

The level of electric field values measured at 1m and 1.8m from rooftop surface and horizontally nearest point on rooftop to the conductor are 1.4kV/m and 2.2 kV/m respectively. The electric field values are lower as compare to ICNIRP values of 5kV/m since earthing of the CGI sheet rooftop has been done. However, in the static charge accumulation may be high on the metallic body in absence of earthing, which could conceivably deliver a perceptible shock to a person.

(iii) Site-3 (Village – Bahari)

In village Bahari, it was observed that house of Shri Beli Ram was near to tower No. 129 (Construction location No. 107) of 400kV transmission line. The roof top of the house was covered with CGI sheets in the half portion underneath the line conductors. The earthing of the CGI Sheet rooftop was found to be done at multiple points. The various observations taken at the site are as under:-

a. Vertical and Horizontal Clearances

The minimum vertical clearance between lowest conductor of 400kV transmission line and at the edge of the slab of the house is 8.6m. The house is in close proximity of the transmission line conductor.

b. Electric field measurement

- Electric Field observed at 1 metre height from the roof top surface and horizontally at the nearest point on the rooftop to the nearest conductor was 6.3 kV/m.
- Electric Field observed at 1.8 metre height from the roof top surface and horizontally at the nearest point on the rooftop to the nearest conductor was 3.9 kV/m.

The above observations are summarized below:

Clearances (m) observed from the nearest and lowest conductor of the transmission line and at the edge of the slab/roof of the house *		Minimum clearances (m) requirement as per Reg. 61 of CEA Safety Regulations		Electric Field at 1m height from the roof top surface and horizontally at the nearest point on rooftop to the nearest conductor. (kV/m)	Electric Field at 1.8m height from the roof top surface and horizontally at the nearest point on rooftop to the nearest conductor. (kV/m)
Vertical	Horizontal @	Vertical	Horizontal		
8.6	---	7.3	5.6	6.3	3.9

* Without considering maximum deflection due to sag/wind, etc.
@ House is in close proximity from the transmission line conductor.

c. Observations

The minimum vertical and horizontal clearances stipulated for 400kV transmission line from any part of the building required as per Central

Electricity Authority (Measure related to Safety and Electric Supply) Regulation 2010(as amended), is 7.3m and 5.6m respectively. In this case minimum vertical clearance as specified in the regulation is being met but horizontal clearance is not being met as conductor passes in close proximity from the house. The Right of Way (RoW) requirement for 400kV transmission line which is 46m (23 m on each side from centre of tower) has not been maintained as specified by Ministry of Power , Government of India notification No. 3/7/2015-Trans dated 15.10.2015.

The level of electric field values measured at 1m and 1.8m from rooftop surface and horizontally nearest point on rooftop to the conductor are 6.3kV/m and 3.9 kV/m respectively. The electric field values are higher as compare to ICNIRP values of 5kV/m. These values are influenced due to presence of exposed metallic rods at the roof top slab.

4. Remedial Measures against Induced voltages /currents due to induced electric field

1. Electromagnetic & Electrostatic fields are always present near the transmission lines. In the present case, the proximity of the structure result in the danger of shock by providing conductive path to the charge accumulated due to electric field. A perfect shield cannot be provided against the problem of electric shock, however, it can be reduced to some extent by providing and maintaining adequate, effective, and multiple and distinct earthings at all the affected structures /houses.
2. The horizontal clearance as per CEA (Measure relating to Safety and Electric Supply),2010 (as amended), between the nearest conductor and any part of such building i.e. 5.33 m for 400kV Transmission line shall be maintained.
3. As per CEA (Measure relating to Safety and Electric Supply)2010, an overhead line shall not cross over an existing building as far as possible and no building shall be constructed under an existing overhead line. Where an overhead line passes above or adjacent to any building or part of a building it shall have on the basis of maximum sag a vertical clearance above the highest part of the building immediately under such line, not less than 7.3m for 400kV line which need to be maintained.
4. Any Structure (whether permanent or temporary) such as buildings , storage sheds, fence parallel to the transmission line are not

permitted in the Right of Way Corridor as per Ministry of Power, Government of India Notification No. 3/7/2015-Trans dated 15.10.2015.

5. Further, it is to mention that any dispute arising may be dealt under the provisions of Section 67 & 68 of ELECTRICITY ACT, 2003 which are reproduced at Annex.

(Sunil Kumar Jain)	(Santosh Kumar)	(Mukul Kumar)
Dy. Director , CEA	Dy. Director , CEA	Assistant Director , CEA

Annex

***Section* 67 (sub section 3-5) of Electricity Act,2003**

(3) A licensee shall, in exercise of any of the powers conferred by or under this section and the rules made thereunder, cause as little damage, detriment and inconvenience as may be, and shall make full compensation for any damage, detriment or inconvenience caused by him or by anyone employed by him.

(4) Where any difference or dispute [including amount of compensation under sub-section (3)) arises under this section, the matter shall be determined by theAppropriate Commission.

(5) The Appropriate Commission, while determining any difference or disputearising under this section in addition to any compensation under sub-section (3),may impose a penalty not exceeding the amount of compensation payableunder that sub-section.

***Section* 68 (sub section 5 & 6) of Electricity Act,2003**

(5) Where any tree standing or lying near an overhead line or where any structure orother object which has been placed or has fallen near an overhead line subsequentto the placing of such line, interrupts or interferes with, or is likely to interrupt orinterfere with, the conveyance or transmission of electricity or the accessibility ofany works, an Executive Magistrate or authority specified by the AppropriateGovernment may, on the application of the licensee, cause the tree, structureor object to be removed or otherwise dealt with as he or it thinks fit.

(6) When disposing of an application under sub-section (5), an Executive Magistrateor authority specified under that sub-section shall, in the case of any tree inexistence before the placing of the overhead line, award to the person interested inthe tree such compensation as he thinks reasonable, and such person mayrecover the same from the licensee.