

# TNEBEA SUGGESTIONS ON IMPROVEMENT OF HOT LINES WING

## **HISTORY :**

The first techniques for live-line working were developed in the early years of the 20th century, and both equipment and work methods were later refined to deal with increasingly higher voltages. In the 1960s, methods were developed in the laboratory to enable field workers to come into direct contact with high voltage lines. Such methods can be applied to enable safe work at the highest transmission voltages.

## **NECESSITY OF HOT LINES (LIVE LINE ) MAINTENANCE IN TRANSMISSION SYSTEMS:**

Increasing complexity of transmission networks coupled with inter-regional tie lines transmitting huge quantum of power and less redundancy in the transmission system has rendered shutdown on transmission lines & substations, almost impossible, thus resulting in need for hotline techniques.

## **Maintenance works carried out by Hot lines Wing:**

With the use of Hotline following are being carried out

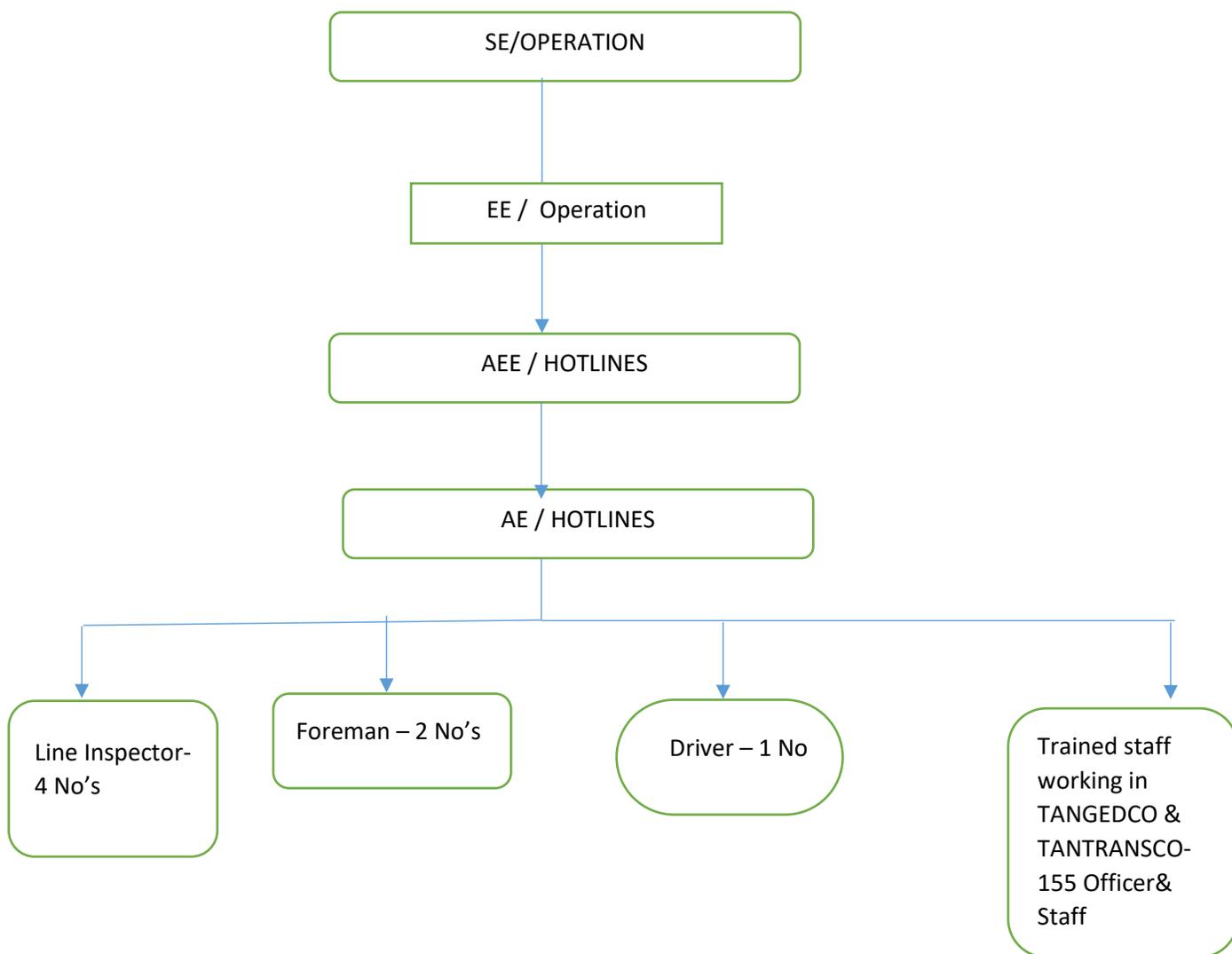
1. Bare hand maintenance works in EHT Substations to carry out to rectify high temperature hotspots by replacing switch end clamps, bus bar clamps /Fixtures and bolt & nuts
2. Live line replacement of defective insulator in 230/110 KV lines both suspension and tension points.
3. Phase identification of newly erected 230KV and 110KV lines, HT cables for paralleling with Bus of other lines.
4. Testing of Healthiness of surge arresters in all 230/10/66 KV SS in live line once in a year and on request.
5. Measurement of vertical and horizontal clearances on 230/110 KV transmission lines for railway crossing, Road crossing and building in liv line on request from concerned authorities.
6. Providing bye pass jumpers at hot spots
7. Replacement of bus bar droppers by bare hand method in substation switch yards
8. Binding of damaged conductors.

## **HOT LINES IN TNEB :**

In TNEB, Hotline Maintenance works started in TNEB from 1959 at Koratoor SS. At present, there are Five Hotline wings in TANTRANSCO.

1. Koratoor
2. Thiruvallam
3. Trichy
4. Coimbatore
5. Madurai

### **Present structure of Hot line wing in TNEB:**



### **Hotline staffs strength:**

Presently hotline staff / persons working in hotline section in only 2 persons are stationed permanently. This strength is negligible to need staffs requires at least 15 persons.

All other persons working elsewhere are posted during emergency for carrying out the maintenance works which takes time. This delay could be avoided if more persons are allocated exclusively for hotlines by maintain the crew strength to minimum of 15 persons per sub division.

Hence, we request sanctioning of additional posts in all categories. Moreover these trained persons should be retained in hotlines itself on their promotions by upgrading their posts to avoid depletion of staff strength.

### **Safety amenities:**

Safety amenities such as Insulated shoes, sunglass, Helmet, and special uniforms have ben provisioned for hotline crew members. Enhanced sanction for provisioning of these amenities was given during the year 2007 vide reference -1 cited above.

At present, the existing sanctioning powers for the provisioning of these safety amenities as per the prevailing market rate is not sufficient due to the increase in stitching charges and washing allowances too. Moreover, the replacement of these safety amenities have to be done every year instead of two years to ensure ultimate safety for the working personnel.

### **Hotlines special pay:**

At present, the staff of hotlines wing in TNEB are entitled to draw a special allowance of 25% of their pay. There exists a maximum cap of Rs.16,000/- for the allowance and this is very minimal considering the nature of work and life risks involved.

TNEBEA in this regard, requests for the **removal of this ceiling limit** altogether considering their nature of work and moreover these benefits are going to be extended to limited strength in the Hot lines wing which in turn incur less financial implications.

### **Barehand Risk allowance:**

As per Indian standard - IS 5613 : Part 3 : Sec 3 : 1989 - Code of practice for design, installation and maintenance for overhead power lines: Part 3 400 kV lines:

CEA (Safety requirements for construction, operation and maintenance of transmission lines) Regulation, 2011

CEA (Technical Standards for construction, operation and maintenance of Electrical Plants and Electric Lines) Regulation, 2010

Risk allowance of 10% of basic pay can be issued to those who completed Bare hand switchyard maintenance training, as the work involved so much of risk.

Considering the above said grid conditions, keeping hotline crew at all times is found need of the hour. A delay in execution of timely preventive maintenance at an early stage could avoid major

breakdowns, thus result in fetching revenue to our organization, as recent bare hand method of hotline work carried out on 08.07.2021, is detailed below,

- A) Requesting for hotline work sought by maintenance wing : 08.07.2021
- B) Work carried out on : 08.07.2021
- C) Duration of hotline work : 1 Hour
- D) Possible interruption to supply to the feeding 110 KV Substation : 110 KV LV-I  
110 KV LV-II  
110 KV LV-III
- E) Savings of energy sold out due to hotline Works (In units) : Recorded Station  
Consumption on 08.07.21  
2,11,000 Units for one hour
- F) Cost of energy (Revenue Calculation) : 2,11,000 x Rs.5/-Per unit  
Rs.10,55,000/-

If the maintenance works carried out by taking shutdown which would cause interruption to 110 KV Minnagar SS, 110 KV Gurubarapally SS, 110 KV Zuzuvadi SS, 110 KV Kempatty-I SS, 110 KV Kempatty-II SS, 110 KV GC -230 KV Hosur SS. Further, the shutdown would lead to a revenue loss to the tune of Rs.10,55,000/-.

Bare hand method works are being carried out with the recently procured and epoxy fibre insulated scaffolding and switch yard maintenance work under live conditions, which eliminates total bus shutdown.

Considering the above, it is felt prudent that effective utilization of hotline wing by providing full time regular staff permanently in the hotline wing section, would pave way for minimizing the interruption of supply, and it will fetch more revenue by avoiding breakdowns.

If the hotline trained personals are utilized effectively during all working days would result in planning for more maintenance works, in all EHV Lines & Substations, the volume of works will be enhanced and the proportionate revenue will be realized, besides interruption supply to consumers minimized. since, shutdown works are reduced considerably due to hotline maintenance works.

Hence, it is kindly requested to arrange for posting the trained Hotline staff in the Hotline Section permanent basis.

**About Hot line Tools:** Hotline works carried out using newly procured hotline tools (by adopting Bare hand method) in various 230KV &110 KV Substations in Thiruvalem Operation Circle.

1. Higher insulation value (100 KV / feet) and ensures the safety for the lineman.
2. Light weight and easy of maneuver
3. Ability for reducing fatigue on the work man.
4. Mechanically Stronger
5. No moisture absorption
6. No effect on the sticks due to sudden changes in temperature or atmospheric condition.
7. Maintenance of tools easy.
8. The Hotline tools are imported from AB Chance/ USA in the year 1995
9. The tools are tested at CPRI Bangalore once in two years.

With reference to the above, procurement of new set of hotline tools such as Epoxy fibre glass scaffolding arrangements, spliced heavy duty ladder, conductive suits and other associated hotline tools was made and the above tools are beneficially utilised by Thiruvalem hotline wing.

The performance of tools are satisfactory and the investment made towards the purchase tools in respect of Thiruvalem hotline division is Rs.41.30 Lakhs whereas the energy saving by effective utilisation of hotline works is 63.90 lakhs.

**The rate of return on investment (ROI) 154.72% upto May-2021**

With the new set of hotline tools, the following emergency hotline works were carried out without interruption of supply during the assembly elections -2021 and ongoing summer-2021 period.

<b>2021 February 2021 to May- 2021</b>					
Sl No	Date	Name of the Feeder/SS/Circle/ Region	Description	Savings in unit	Cost of unit @Rs.5 Per unit
<b>I February-2021</b>					
1	19.02.21	230 KV Thiruvalem SS	By using Barehand hotline method in 110 KV Bus coupler isolator -III, a damaged fixed contact( with Hotspot of 620°C) replaced by providing new fixed contact under live condition in "B" Phase at 230 KV Thiruvalem SS	2,87,250	14,36,250/ -
<b>II March-2021</b>					
1	15.03.21	230 KV Vinnamangalam SS	By using Bare hand hotline method in 110 KV Strung Bus dropper with T Clamp ( with Hotspot of 101°C) replaced by providing new bus dropper with T clamp under live condition in "R" Phase at 230 KV Vinnamangalam SS	2,09,400	10,47,000/ -
2	28.03.21	230 KV New Singarapet SS	By using Bare hand hotline method in 230 KV HV- I isolator, burnt bolt & nuts (with Hotspot of 533°C) replaced by providing new bolt & nuts (4 Nos) under live condition in	53,800	2,69,000/-

			"R" Phase (Switch No: 89-TV) at 230 KV Singarapet SS		
<b>III</b>	<b>April-2021</b>				
1	05.04.21	230 KV Thiruvalem SS	A Live line through jumper provided in 110 KV Thiruvalem Vellore Feeder –I in all three phases using Bare Hand method at 230 KV Thiruvalem SS	20,250	1,01,250/-
2	10.04.21	110 KV Vaduganthangal SS	Two Numbers parallel jumpers provided using Bare Hand Method in 'R' Phase and 'Y' Phase in coming conductors towards 110KV Line isolator	75,225	3,76,125/-
3	15.04.21	110KV Vaniyambadi SS	Provided two numbers Parallel jumpers in "B" Phase of Incoming 110KV Vinnamangalam feeder using Bare Hand method Switchyard maintenance work with Newly procured Epoxy Fibre Glass Scaffoldings.	1,92,600	9,63,000/-
<b>III</b>	<b>May - 2021</b>				
1	07.05.21	230 KV Thiruvalem SS	By using Barehand method, 1 No switch end clamp replaced in "B" Phase of 110 KV LV-I Bus isolator	4,39,500	21,97,500/ -
<b>Total</b>				<b>12,78,025</b>	<b>63,90,125/ -</b>
(Rupees Sixty Three Lakhs Ninety Thousand One Hundred and Twenty Five Only)					

Certainly the above mentioned tools are important game changer in the maintenance practices in TANTRANSOCO.

#### **Advantages of Utilizing the Hot line Techniques:**

1. This live line maintenance methods are preventive maintenance without any shutdown thus there will not any overloading problems of the system. In view of this line losses are reduced.
2. As no shutdowns or line clearances are required for condition monitoring by patrolling of the line the frequency of the monitoring can be increased. Thus the cropping of the faults can be visualized in advance and suitable maintenance works can be taken up without shut down in planned manner.
3. As there are no interruptions the system stability and consumers satisfaction will be achieved.

4. As there are no interruptions the utilities can earn more revenues. When the interruptions are minimized the crysil rating will increase thus inviting more prospective investors to set up industries in the state. The more industrialization and agriculture will contribute to the national GDP growth
5. The stresses on power equipment due to the frequent on and off will be reduced due to live line maintenance.
6. By taking shutdown on a particular bus or a line carrying 100 MW of power for a period of one hour, revenue loss to the tune of approximately Rs.5 Crores is saved.
7. Due to shutdowns the other line is getting overloaded increasing the line losses, will contribute to the reactive power losses thus reducing the life of generator or transmission lines.

**Techno-Economic benefits of Hotline maintenance:**

**EXAMPLE 1**

230 KV Feeder feeding a load of 520 Amps (180 MW) – Replacement of insulator string – Outage of 8 hours under breakdown maintenance to locate the fault and for replacement.

Revenue loss for 1MW for a period of 1 hour = 1,000 KWh  
 Cost @ Rs.4.50 per KWh = Rs.4,500  
 Total Cost for 180MW for 6 hours = Rs.4,500 \*180 \* 6  
 = Rs.48,60,000

The above revenue loss can be avoided if the preventive maintenance work is done by Hotlines without switching off the line.

**EXAMPLE 2**

If one of the line is under shut down the load will be distributed through the other feeder where the line losses will be double. Besides

Let us consider two feeders fed with equal load of 100 Amps. If one of the feeder is under shut down the other feeder will have a load of 200 Amps. The I<sup>2</sup>R line losses will be 4 times for twice the increase in load current.

- I<sup>2</sup>R losses for 50 Amps = 2500 R
- I<sup>2</sup>R losses for 100 Amps = 10000 R
- I<sup>2</sup>R losses for 200 Amps = 40000 R
- I<sup>2</sup>R losses for 150 Amps = 22500 R
- I<sup>2</sup>R losses for 300 Amps = 90000 R

I<sup>2</sup>R losses for 600 Amps = 360000 R

This loss can be avoided if the work is done by Hotlines

### **Case : 3**

Bypass jumper provided at a Generating Station to avoid hot spot / glow.

Considering 12 hours restart time for 1MW power to light up and synchronization with the grid.

Loss of power generation = 12 MWh

Cost of power @ Rs. 4.50 per KWh(Rs.4500/-perMWh) =Rs. 54000/-

Cost for a generation of 220 MW generation =Rs.1,18,80,000

Oil fuel injection to light up and to run the generator =Rs. 38,40,000

for 80 KL @ Rs.48000 per KL

Total revenue loss =Rs.2,47,20,000

( Rupees two crore forty seven lakhs twenty thousand only)

### **Additional Improvement Proposal**

**Pilot study** by Provision of **Real time condition monitoring facility utilizing Drones** fitted with Infrared camera, Corona monitor, and Pollution check in vulnerable EHV Transmission elements & **Natural calamity damage assessment** system

Thiruvalem Hotline division is currently involved in carry out preventive maintenance works in EHV Substation and EHV Transmission lines in Vellore & Villupuram regions, along with condition monitoring of Substation equipment's. The following types of preventive maintenance works are being carried out using hotline maintenance techniques.

- 1) Defective disc insulator replacement in EHT Lines.
- 2) Hipot test on 230 KV & 110 KV Lighting arresters.
- 3) Vertical clearance measurement between EHT Lines roads, railway tracks and buildings.
- 4) Provision of Bye-pass jumpers in substation switchyards
- 5) Thermovision scanning of 230 KV Substation switchyards.
- 6) Phase sequence test for commissioning of new transmission lines.
- 7) Bare hand maintenance works in substation switchyards & EHT transmission lines (to attend emergency repairs)

Besides the above works, it is found essential to carry out Thermo vision scanning of EHV Lines, Corona discharge and periodical pollution level checking, since there were two incidents in 400KV Thiruvalem-Palavadi Feeders I & II on 24.05.2018 & 11.10.18 respectively. In both the incidents we found one jumper among the quad jumpers opened causing interruption of 400KV Circuits, due to jumper cone connecting bolt got damaged and found cut due to high temperature. To avoid such incidents in future, it is felt jumper connections needs to be monitored using IR Camera, since these types of faults could not be traced easily with usual patrolling procedures.

Since the regular patrolling in such long feeders is practically difficult, since so many tension point locations involving several thousands of bolts & nuts, which requires lot of man power and cost.

Considering the above difficulties, it is felt prudent to introduce a cost effective convenient method as well as accurate method to determine high temperature hotspots, heavy corona discharge in EHT transmission lines and Switch yards located close to coastal areas. Further with the help of digital highresolution visual images/video pollution levels could be monitored and corrective preventive measures will be carried out subsequently.

**Project feasibility:**

List of equipment's involved

1. IR Camera (For thermal imaging)
2. Corona Discharge monitor (off sun types to visualize corona discharge in day light)
3. Digital camera high resolution (For pollution monitoring purpose/damage assessment)
4. Aerial vehicle - Drone type (To fit the above instruments to capture close images)

The condition monitoring equipment supplier product catalogue, which is suitable to fit with air born vehicle is enclosed for kind reference.

**Man power resources:**

Existing man power could be trained to operate the drones as per statutory compliance from competent authority like DGCA and local police department. As for as scientific equipment's concerned, they can be procured from international vendors ,since such suppliers are having expertise in similar areas.

For the Special purpose drone type unmanned aerial vehicle, the National Aerospace Laboratory (NAL),Bangalore. Under council for scientific industrial under government India(CSIR), Ministry of Science, Govt of India. The technical expertise in the area of special purpose vehicle could be sought, as they are coordinating and providing solutions for industrial applications / challenges.

**Advantages of the pilot study:**

1. Real time IR ( Infra red thermal images) will exactly finds possible premature failures in Important vulnerable transmission elements thereby breakdowns can be minimized.
2. Real time off sun corona discharge images could be taken in coastal EHV Lines and switch yards. which would avoid cascade tripping of power evacuation corridors which we experience in Chennai region and other coastal areas during the months of April and May.
3. Real time high resolution images / video could be recorded for assessment of damages caused **after math of disasters like VARTHA & GAJA cyclones**. So that material requirement can be calculated at the earliest, since the drone can access remote locations with out waiting for road access clearances.

**Project funding:**

The project funding for the above condition monitoring of vulnerable transmission elements as a pilot study could be divided into two segments.

1. For the expenditure involved in developing a special purpose aerial unmanned vehicle could be sought from Ministry of Science &Technology, Govt of India through National Aerospace laboratories.

2. For the condition monitoring portion of the project could be sourced from funding agencies like Foundation for Innovation & Technology transfer, IIT Delhi through POSOCO, NITI AYUG, PSDF, National Disaster management Fund or other suitable funding agencies.

State Disaster Management Perspective Plan - 2018-2030, the reduce the downtime of electricity distribution, the aerial real time digital imaging could be used for **accurate damage assessment after math of disasters like VARTHA & GAJA cyclones**. So that material requirement can be calculated at the earliest, since the drone can access remote locations without waiting for road access clearance and hence funding can be sought from state disaster preparedness for the scientific instruments.

**Principle approval:**

In this pilot study with help of Grid operation wing the vital vulnerable transmission elements can be identified and the concerned operation circles will be roped in for the study. To proceed further in this pilot project a principal approval may kindly be issued from competent authority to proceed further to establish communication with external research institutions

1. **Provision of AERIAL bucket lift Platform**
2. **Provision Sun blind CORONA camera**

provision of **One number sun Blind CORONA Camera** for the condition monitoring and taking preventive measures in EHT Transmission lines due to **Corona effect** The proposal envisages procurement of one number "**Sun blind CORONA camera** " (for visualize corona discharge in day light) the use in Hotline wing to monitor and take preventive measures to maintain EHT transmission lines availability, particularly in power evacuation feeders from coastal thermal power plants. With the introduction of 765 KV transmission corridors across the state, the state of art condition monitoring of equipment and lines are inevitable.

There has been instances of cascade tripping's on 26/04/2017 and 30/04/2016 due to CORONA discharge over the surface of Disc insulator strings of EHV Transmission lines which are emanating from NCTPS.(Press reports enclosed) Which results in forced shutdown of many Units at NCTPS due to non availability of corridors for power evacuation. In order to avoid such recurrence of incidents in the Grid, during that time a night time line patrol was carried out to find the CORONA discharge at EHV Lines besides intensive Hotline washing carried out in EHV lines. Hence it is felt prudent, as a measure of scientific approach to find out the CORONA discharge using Sun blind CORONA camera ,( which can be used in day light) the proposal for is evolved so as to ensure availability of corridors in coastal areas.

Due to the heavy load carried by the power evacuation feeders & geographical location of the Generating Stations in coastal areas which are high humid , and the ash deposits over the disc insulators, which get contaminated due to conducive weather conditions( especially during prolonged non rainy days in the months of February & March ). The above said condition monitoring measure could be more useful to maintain the integrity of grid condition.

3. **Drone fitted Thermal imaging camera**
4. **Truck mounted Live line washing skid**
5. **Relacement of Aged Hotline tools**

## 6. Trained staff to be posted in Hotline sections permanently

### Hot Line Maintenance Training :

There is a great demand from various Utilities for Hot Line maintenance Training. There is an urgent need for augmentation of Training Capacity as this type of Training is presently being imparted by only one institute in India.

Hot Line Training Centre(HLTC) located at Bangalore, is the oldest Institute under National Power Training Institute (NPTI). It is the only one of its kind in South Asia. Established in 1958, training at HLTC enables trained personnel to attend to maintenance works on Transmission Lines and Switch Yards without power interruption. Since its inception HLTC had trained more than 3000 personnel including participants from Sri Lanka and Afghanistan in the field of Live Line Maintenance Techniques. HLTC imparts training on Live Line Maintenance of EHV Lines & Switch Yards, Punctured Insulator Detection, Live Line Insulator Washing etc. All the Power utilities in the country can make use of these training facilities.

**TNEBEA** herewith submit this proposals regarding the Hot lines wing with the requisite tools will be effectively utilized with the below benefits.

1. Preventive maintenance works would be carried out, without availing Line clear.
2. Increasing the availability of EHT Substations and Transmission lines.
3. Uninterrupted supply to the consumers can be ensured.
4. Revenue can be increased by continuous sale of power as the works are carried out under energized Circuit conditions.

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