BIMSTEC ENERGY CENTRE
Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation

Hot Line Maintenance in Transmission Lines

By

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पावरग्रिड POWERGRID

Objective

To Know about,

HLM Principle

Type of HLM Operations

Safety aspects

Insulated Aerial Work Platform(IAWP) / Hot Line Bucket Truck

HLM (Hot Line maintenance)?

A preventive maintenance Technique adopted in Transmission Lines and Substations for replacing defective insulators, Jumpers, Vibration Dampers, rectifying shutdown nature defects, etc. **without availing shutdown** on the Line / Bay, To achieve maximum availability.

Principle

- In 1937, Michel Faraday proved that there can be "NO flow of ELECTRICTY between two points at the same potential".
- This principle is made use of in working on hot line by the Bare Hand Techniques
- 1959: The new light weight EPOXY GLASS for Hot Line Tools were introduced

LIVE LINE MAINTENANCE:

- HOT STICK METHOD :

In this method the lineman will be at ground potential working with Hot Sticks (tools) keeping safe clearance from the line.

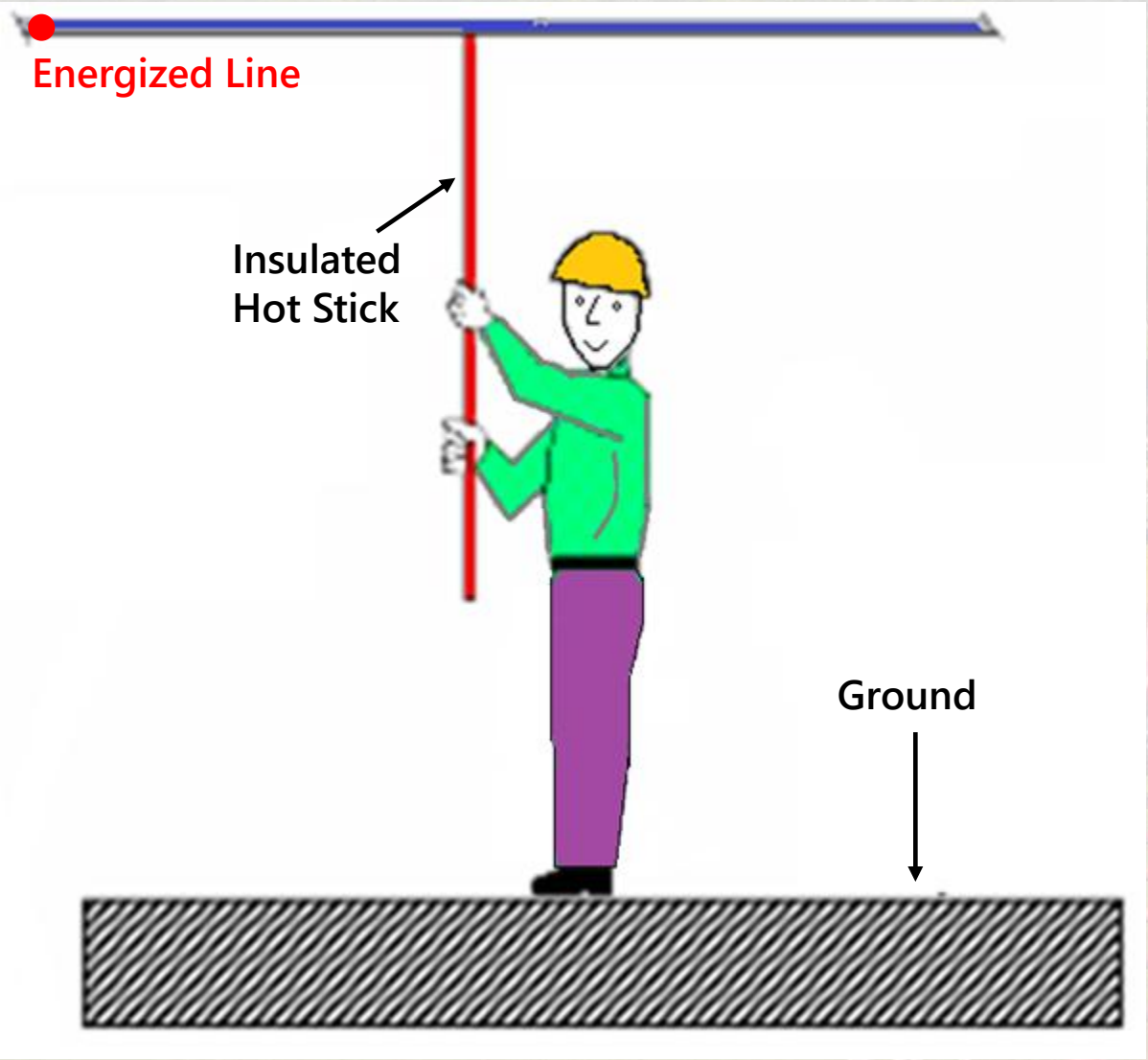
- BARE HAND METHOD :

Here the lineman will be working at line potential keeping safe clearance from ground. For this insulated suits made of 25% Microscopic Stainless Steel and 75% NOMEX will be provided.

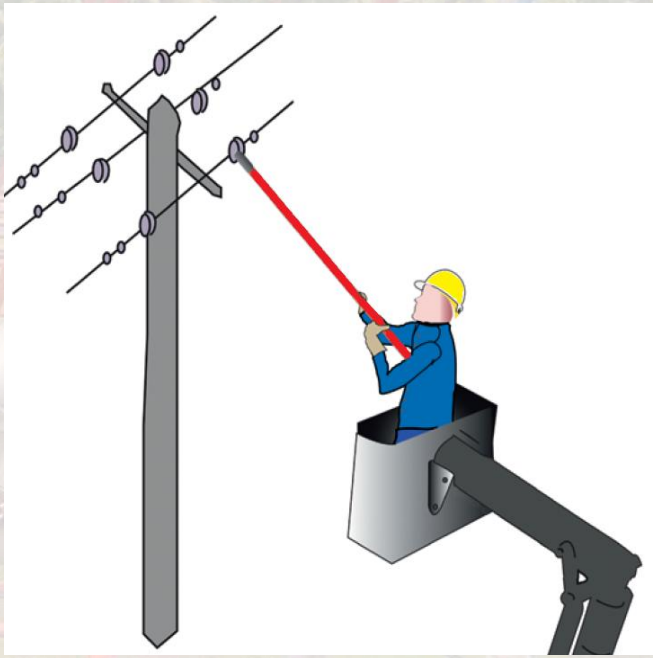
- COMBINATION METHOD :

This method is a combination of above two methods

Hot Stick Technique

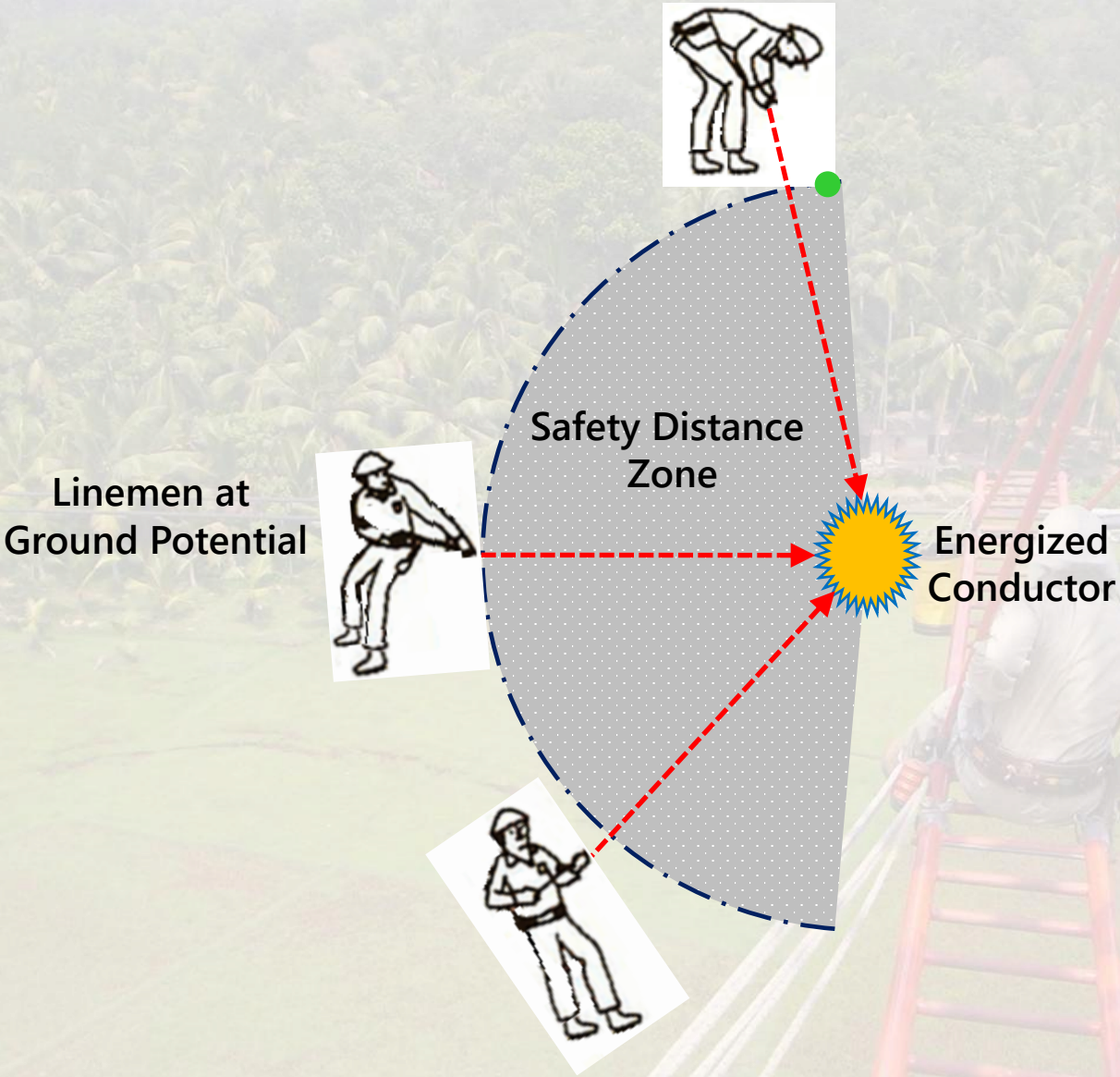


Hot Stick also known as a “Distance” Technique



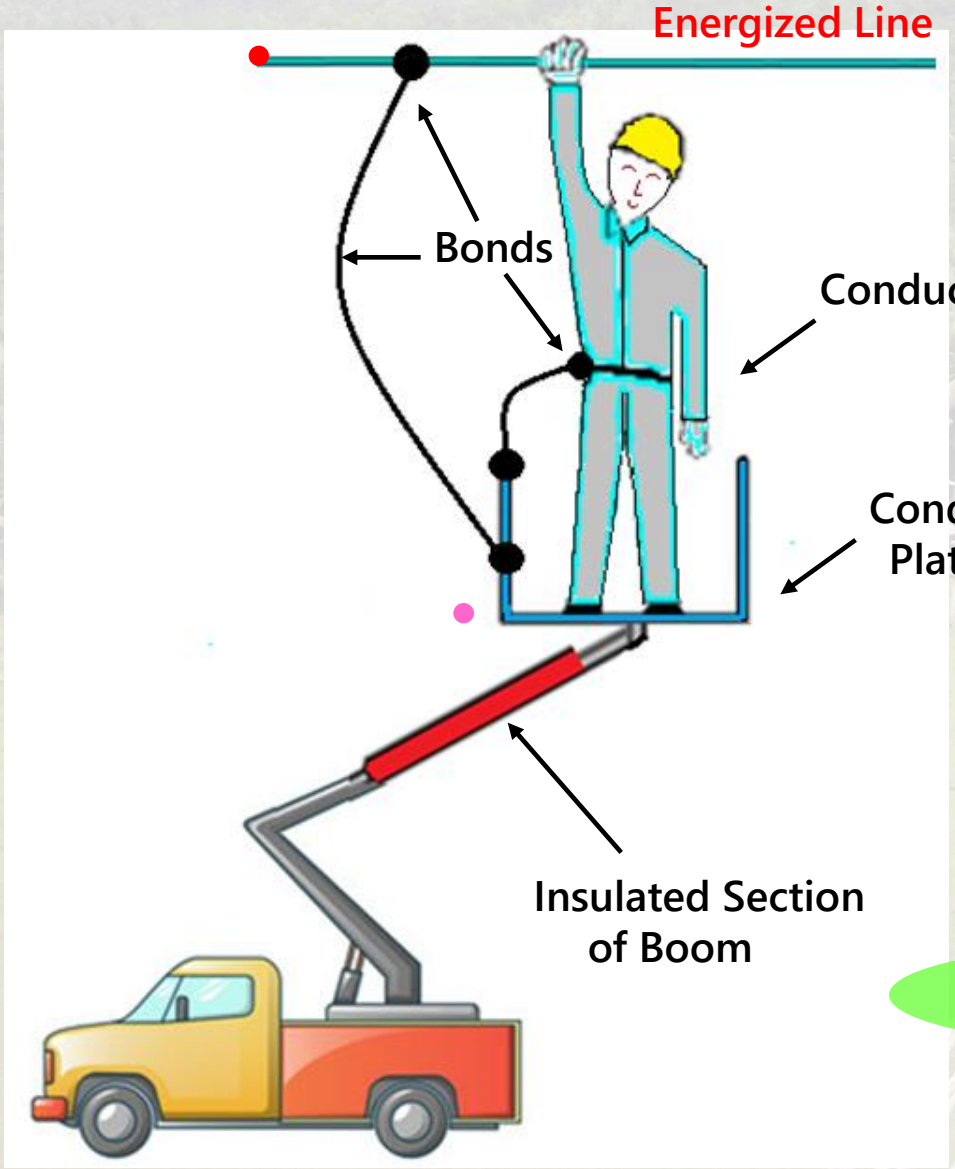
Up to 220 kV

Hot Stick Technique- Safety Distance

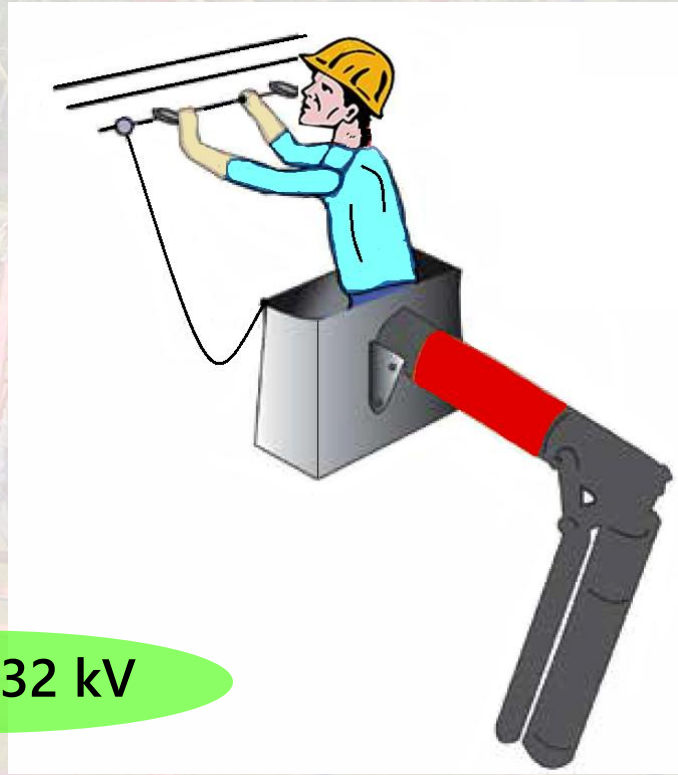


Hot Stick Technique- Approaching Methods

Bare Hand Technique

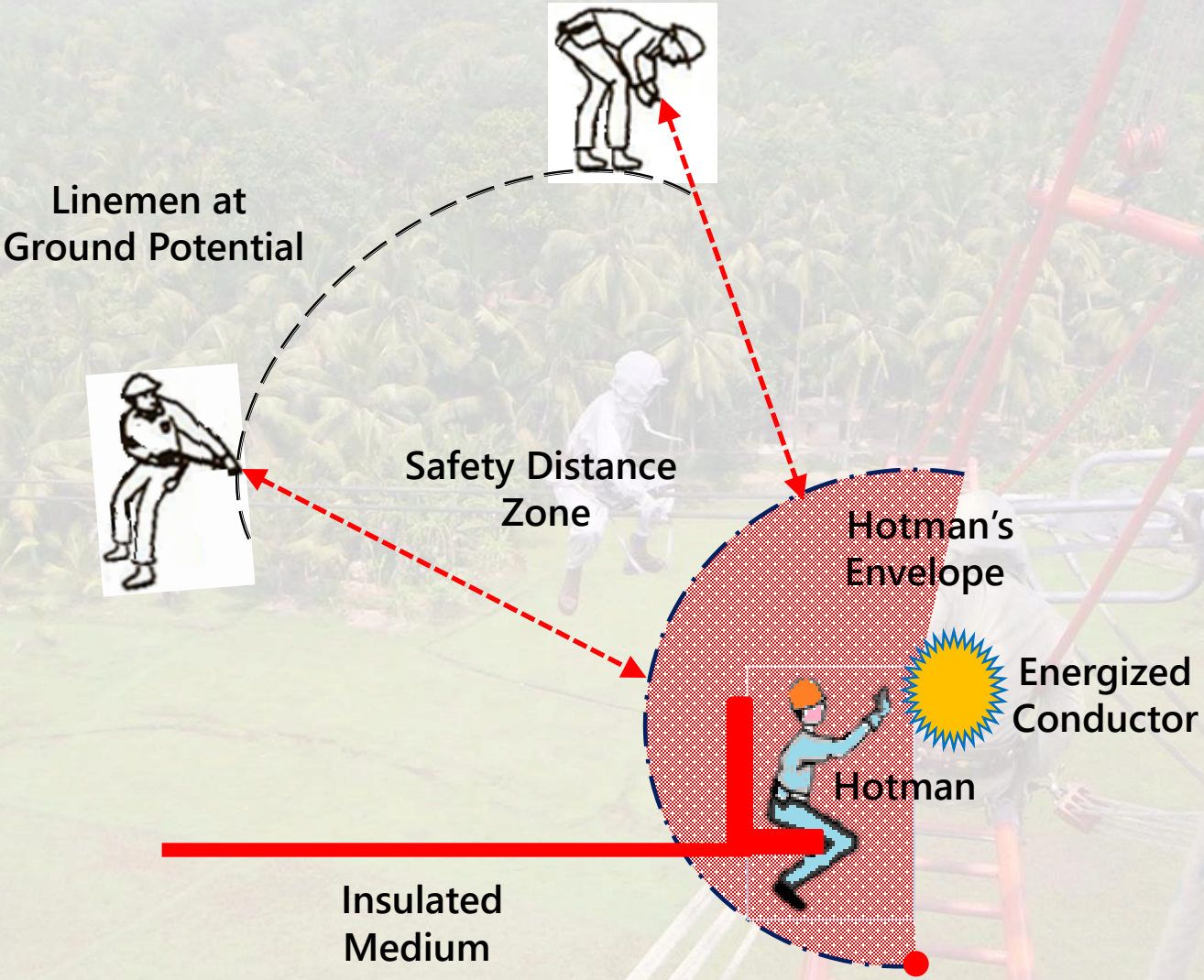


Bare Hand also known as a "Potential" Technique

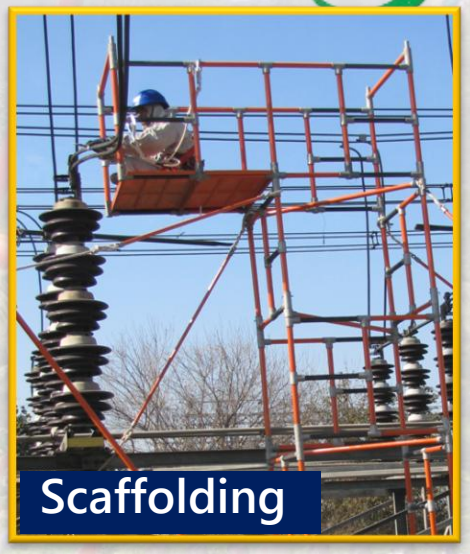


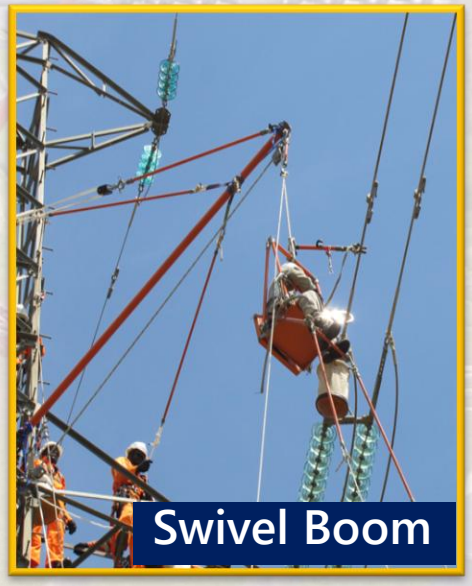
Above 132 kV

Bare Hand Technique- Safety Distance



Bare Hand Technique- Approaching Methods





Mixed of the above two methods

- Combination of HSM and BHM are used in all the voltages by observing the field conditions like clearances, atmosphere, line crossings etc.

Important Tools

- **Epoxy Sticks**
- **Conductive Suit**
- **Leakage Current Monitor**
- **Hotstick Tester**

EPOXY GLASS STICKS

- It is made up of thousands of epoxy glass resin impregnated glass fibre laid length wise and wound wise on a unicellular glass foam core, which is made up of millions of unconnected cells filled with inert gas. (The inert gas inhabits moisture absorption and condensation)

Advantages of Epoxy Glass Stick.

1. Higher Insulation value. (100 kV / foot)
2. Mechanically stronger.
3. No moisture absorption.
4. Orange colour for easy identification.
5. No effect on the sticks due to sudden changes in Temp. or atmospheric condition.
6. No effect of chemically polluted atmosphere.
7. Superior than wooden sticks.
8. Handling easy because of light in weight.
9. Maintenance is easy.

Conductive Suits

- Top, Bottom, Socks, Gloves, Grounding straps & Leg Straps
- Made Up of 25% Microscopic Steel Fiber & 75% NOMEX Aramid Flame Resistant Fiber, with repel finish
- High Conductivity of 144 Ohms/Sq.inch

Protective Conductive Wear- Bare Hand Work

Conductive Suit

Conductive Gloves and Socks

Conductive Boots

Leakage Current- Live Line Work on Transmission Line

This is the current that circulates through an insulating material placed between an energized point and an insulated point.

It flows through insulator strings, insulating poles, ladders, ropes etc. which are contact with potential.

Leakage Current Monitor

- This kit is used for measuring leakage current passing through ladder used during hot line maintenance work.
- The Kit includes one coaxial cable and battery and hose clamps to connect to ladder rail
- The monitor sounds an alarm if leakage current reaches a preset level
- The actual current level is continuously displayed on the digital screen
- If the leakage current is less than 100μA, then it is safe to work

Hot Stick Tester

- Hot stick tester provides a means for testing epoxy hot sticks up to 3 inches
- This tester will detects surface contamination, internal moisture and internal conductive materials.
- Insulation level of epoxy glass hot stick is generally 100 KV per ft.

Safety during

Hot line Maintenance Works

HOT LINE MAINTENANCE - SAFETY RULES

- Only Authorized/Trained persons should do hot line maintenance.
- Make sure that weather is clear and there is no chance of rain.
- Equip with HLM safety PPEs.
- Keep high degree of coordination among all while working.

HOT LINE MAINTENANCE - SAFETY RULES

- Maintain the safe working distances.
- Do not climb towards the jumper: if clearance is less push the jumper.
- Make proper plan to carry out the work in advance
- In-charge of work should not do work with his own hands. He should take such a position on the ground from where he can see all the working persons and should instruct them properly.

HOT LINE MAINTENANCE

DO'S

1. While taking PTW for HLM work in lines, ensure that the auto Re-closure is kept on Non-Auto mode at both ends

2. Thoroughly understand the work to be done and the method of doing it. In case of doubt, discuss and get clarified from the HLM Engineer In-charge

3. Take up Hot line work only when the weather is clear and there is no chance of rain.

HOT LINE MAINTENANCE

DO'S

4. Remove the wrist watch, rings, bracelets and any other metal ornaments before climbing the tower
5. Inspect all the tools carefully before and after every operation
6. Clean the hot sticks with moisture eater before sending it to the tower
7. Be extremely careful while transporting/ handling/ using the tools so as not to damage them or foul/ hit the tower

HOT LINE MAINTENANCE

DO'S

8. Check the insulation strength of the sticks with the help of the Hot stick Tester, If required.

9. Do the Leakage Current Test on the ladders / Platforms before deployment/sending HOTMAN to the charged conductor.

10. Take proper position in the tower and ensure that you are safe to work with both hands.

HOT LINE MAINTENANCE

DO'S

11. The HOT MAN should use the static belt, Hot gloves and protective goggles without fail.

12. The HOT MAN should ensure that the conductive suit is electrically bonded to the safety shoes through the band provided in the shoes.

13. Lubricate the rotation parts with silicon lubricants (Graphite Powder) only.

HOT LINE MAINTENANCE

DON'Ts

1. Do not climb towards LIVE JUMPER

2. Do not use any tool or equipment that is not designed, tested and intended for live line work.

3. Do not use any tool or equipment that is defective or damaged.

4. Do not keep any tool directly on the ground, as it is possible that they may absorb moisture which would reduce the dielectric strength.

HOT LINE MAINTENANCE

DON'Ts

5. Do not over load/ over stress the platform, supports, hot sticks, etc., by attempting to lift or support weights in excess of the manufacturer's rating.

6. Do not engage in any other task during live line maintenance in progress.

7. Do not be in a hurry up or loose patience

HOT LINE MAINTENANCE
DON'Ts

8. Do not engage in to conversation with fellow workers other than absolutely concerning the work.

9. Do not throw tools or materials to or from linemen on the structure.

10. Do not carry any tools in the Safety Belt. Tool bags should be used for this purpose.

11. Do not change position on the structure without first making certain that the new position will place you with all clearances.

HOT LINE MAINTENANCE
DON'Ts

12. Do not change position without informing the fellow workmen as to what you intend to do.

13. Do not use grease or oil for lubricant as they do not provide the required insulation.

Any Doubts ?

As we proceed further

Working on Live Potential, one must aware the Effect of Voltage / Current on a human body

EFFECT OF CURRENT FLOW IN BODY

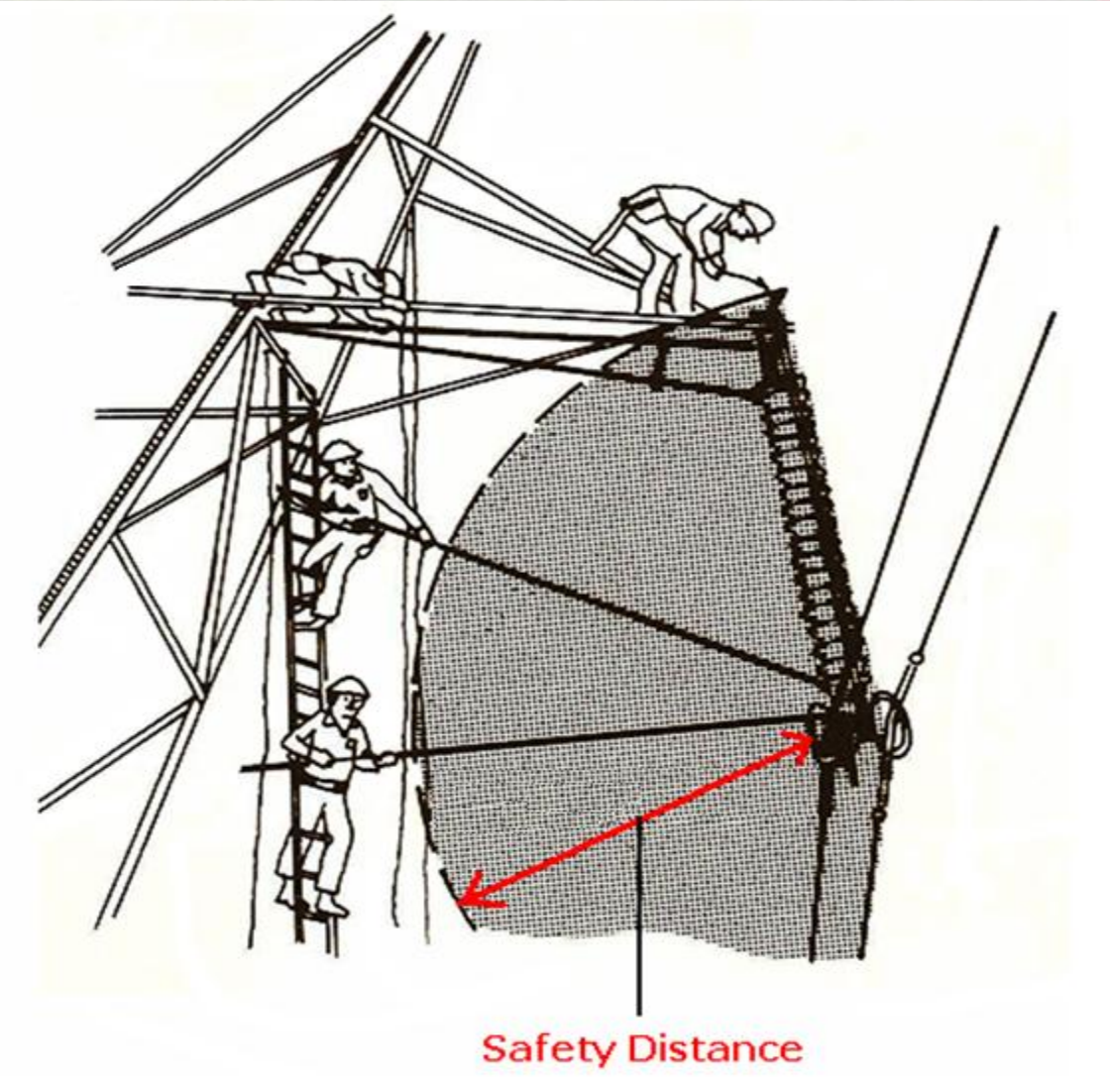
0 - 1 mA	Cannot feel anything
1 - 8 mA	Can feel but no pain
8 - 12 mA	Painful but can let it go
12 - 20 mA	Freeze, cannot let go
20 - 50 mA	Breathing stops
50 - 200 mA	Heart stops
200 and above	Sever Burns

In order to resist the passage of shock currents through the human body, the safe clearances has to be maintained between Ground and Live potentials.

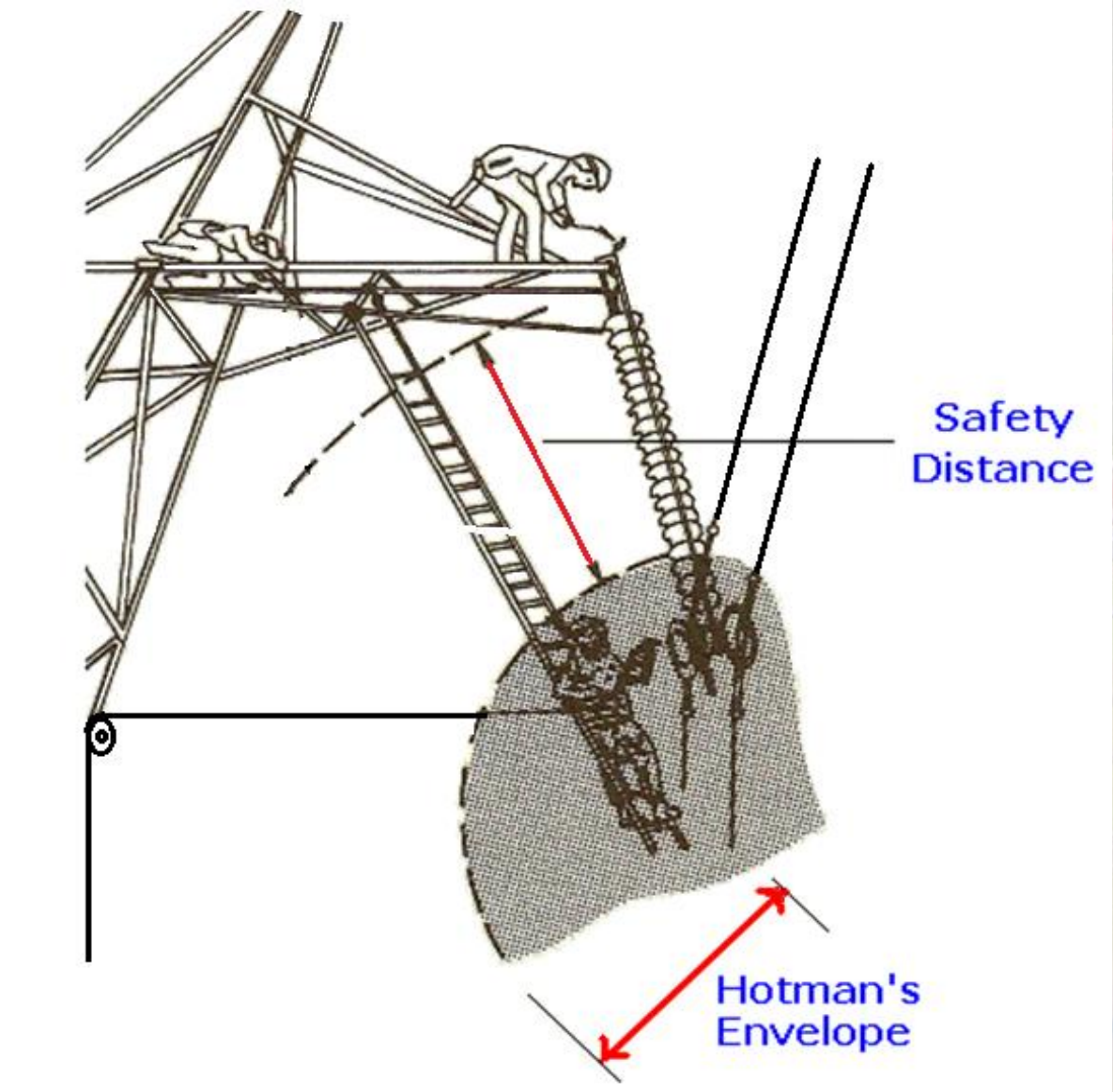
SAFE WORKING DISTANCE FOR HLM

Phase to Phase kV	FEET	METRE
11	2’0	0.61
33	2’4”	0.71
66	3’0”	0.91
110	3’4”	1.02
132	3’6”	1.07
220	5’0”	1.52
400	7’0”	2.13

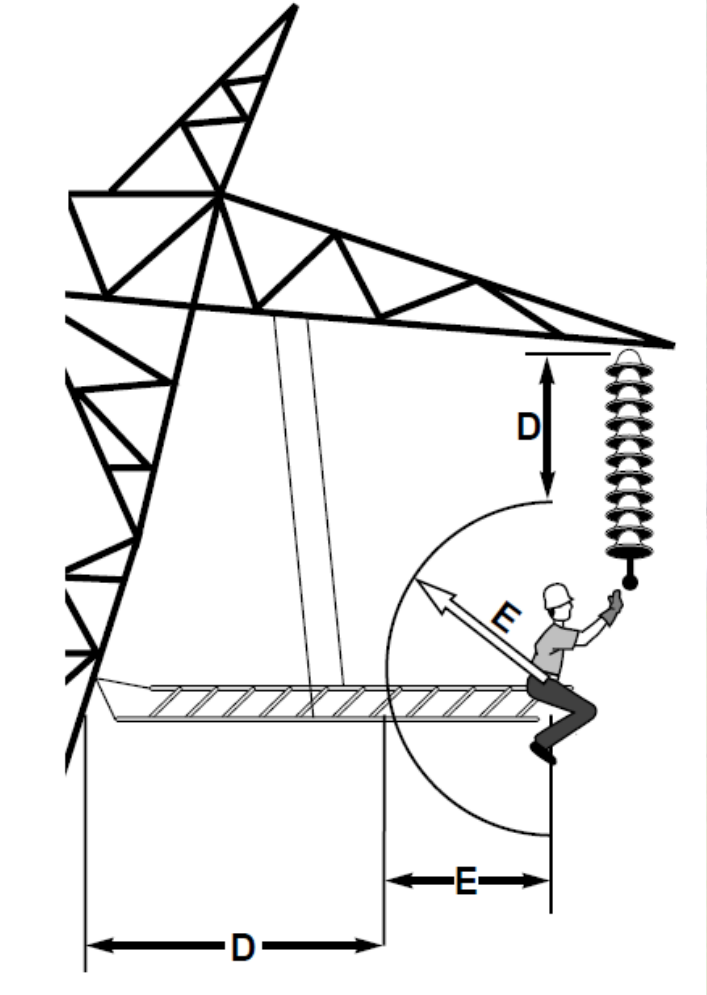
Hot Stick Method- Safety Distance Zone



Bare Hand Method- Safety Distance Zone



Bare Hand Method- Safety Distance Zone



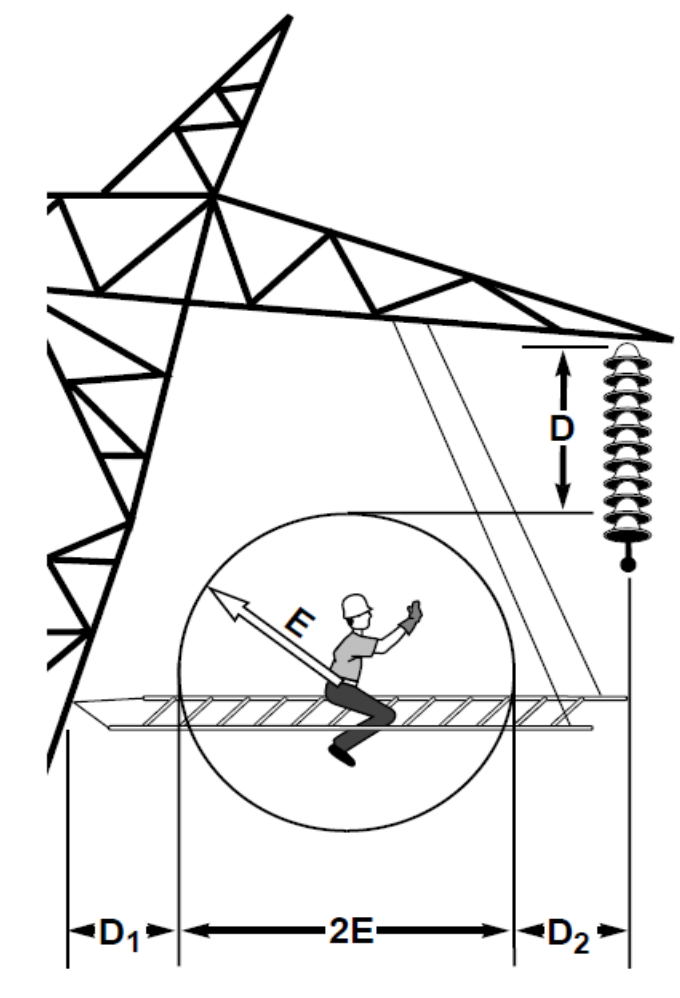
Hotman's Envelope

'E': Radius about 4 feet

'D' ≥ Safety Distance

Moving Ladder- Hoisted or Swung into the Working Position

Bare Hand Method- Safety Distance Zone



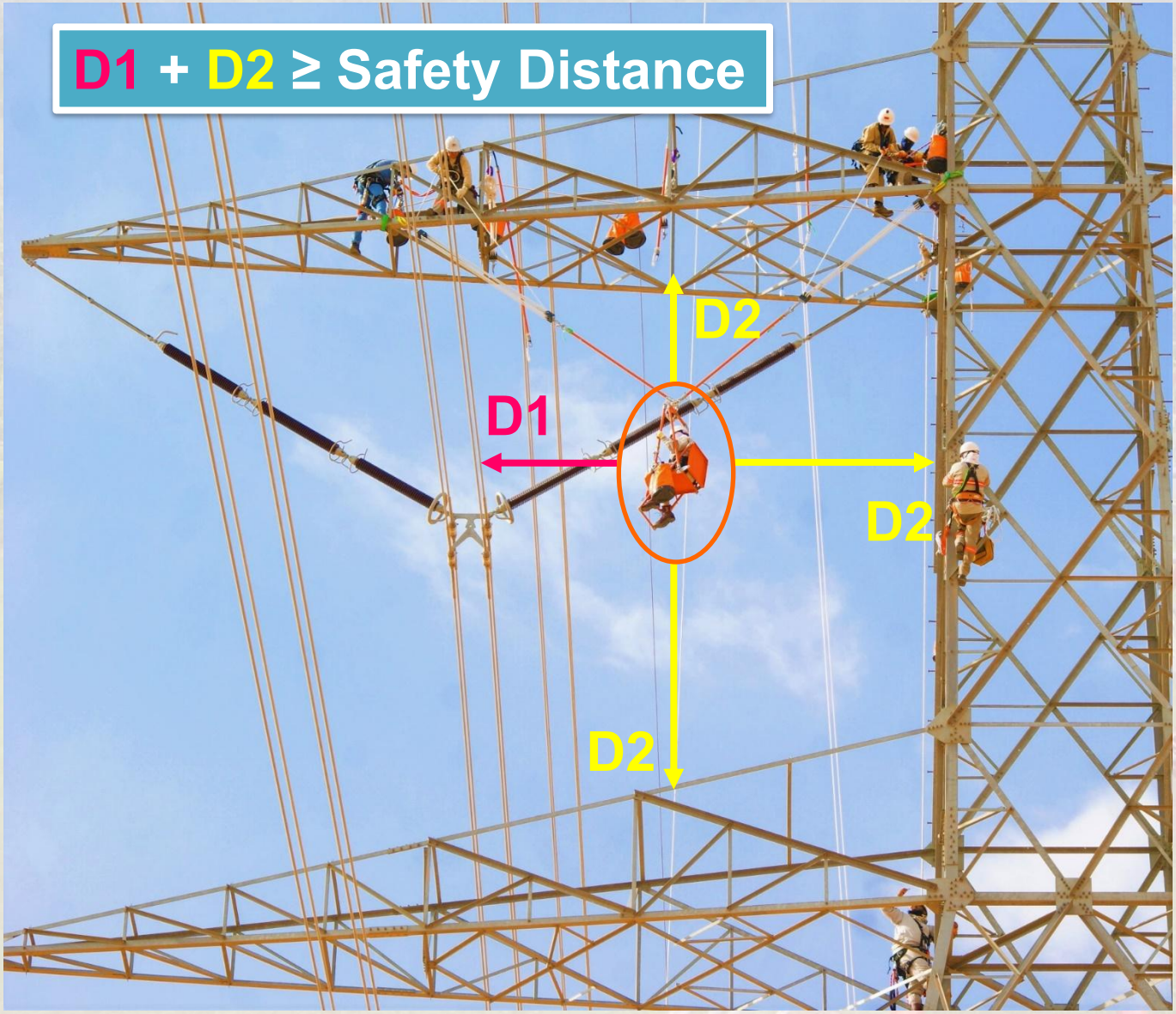
2E: Hotman's Envelope= 8 feet

'D' ≥ Safety Distance

D1 + D2 ≥ Safety Distance

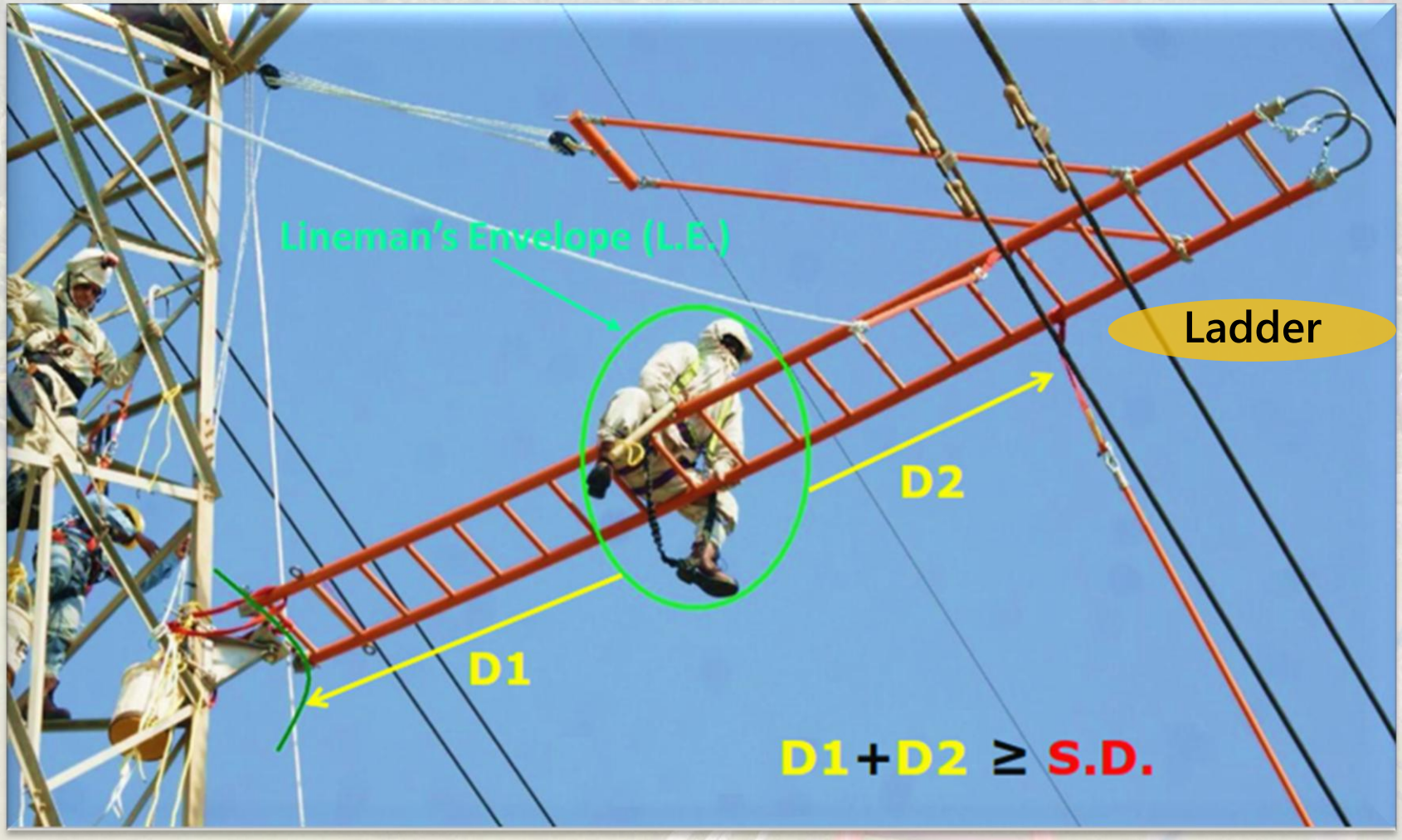
Moving Ladder- Hoisted or Swung into the Working Position

Bare Hand Method- Safety Distance Zone



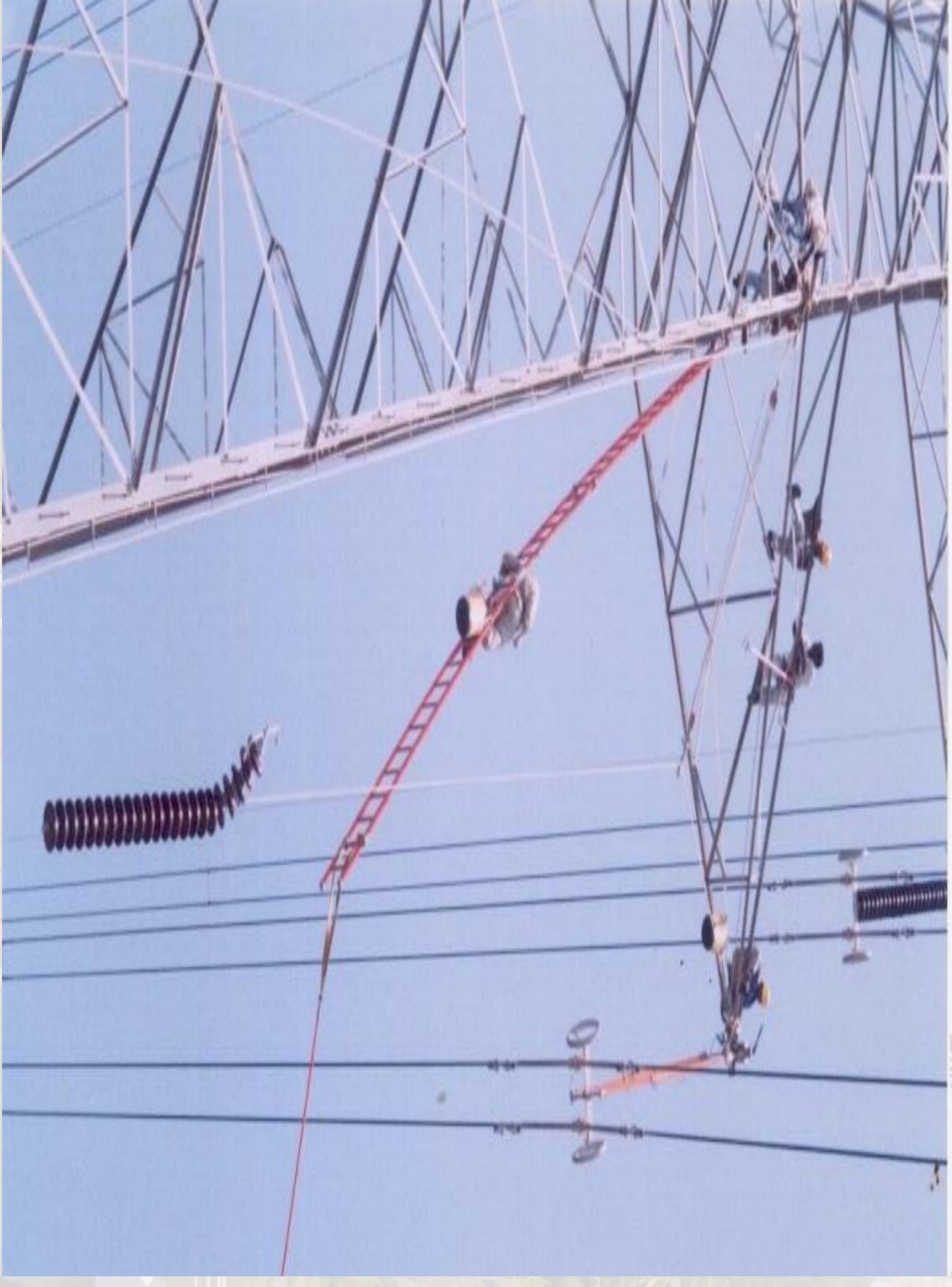
Bare
Hand Chair

Bare Hand Method- Safety Distance Zone



Effective Utilisation of HLM Type of Operations

- Insulator replacement works (I, V, Tension, Pilot) in Transmission Lines
- Vibration Damper, Spacer, Spacer Damper and conductor Repair (Providing Armourd Rods) in Transmission Lines
- Fixing Jumper Bolts, CC Rings & Rigid Spacer



Special Type of HLM Work: Replacement of single suspension insulator strings with double suspension insulator strings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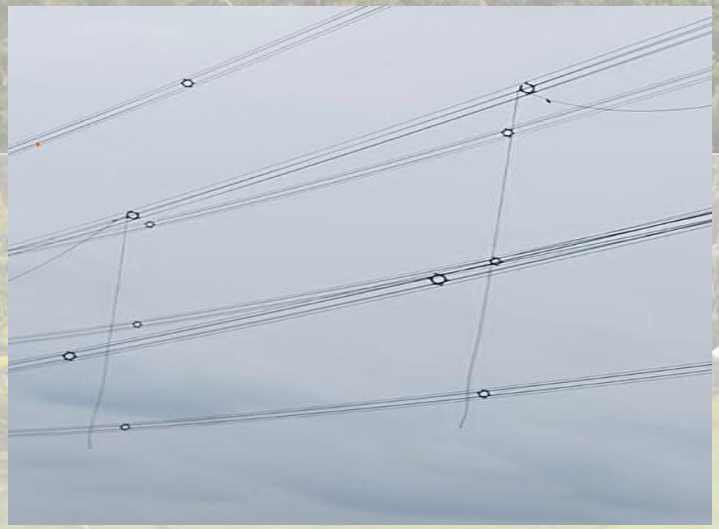
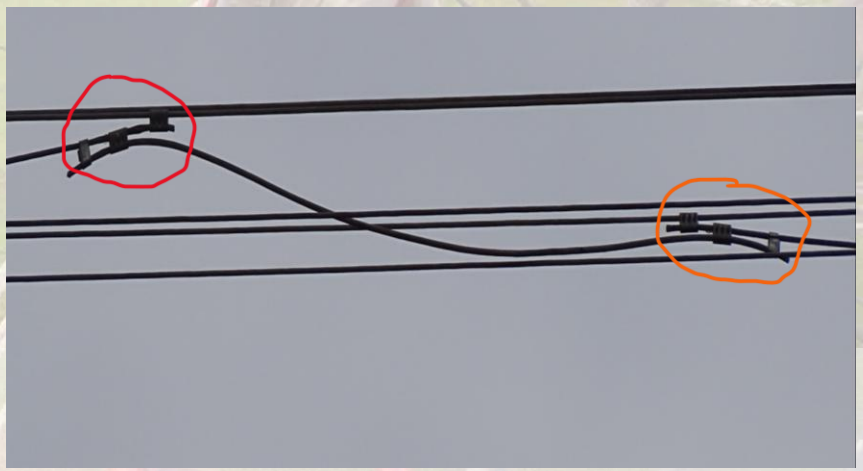
Innovative Method: By HLM method provided Bypass arrangement for Mid Span Compression Joints (MSCJ) of Sub-Conductors in 765kV Transmission Lines, by which conductor snapping / falling will be avoided due to MSCJ failure and line tripping/outage will be avoided.

Failure of Mid Span Compression Joint (MSCJ) in Transmission Line



- MSCJ failed in one of the 765kV line due to improper compression causing snapping of conductor.
- The said line is heavily loaded and getting outage is difficult due to system constraints.



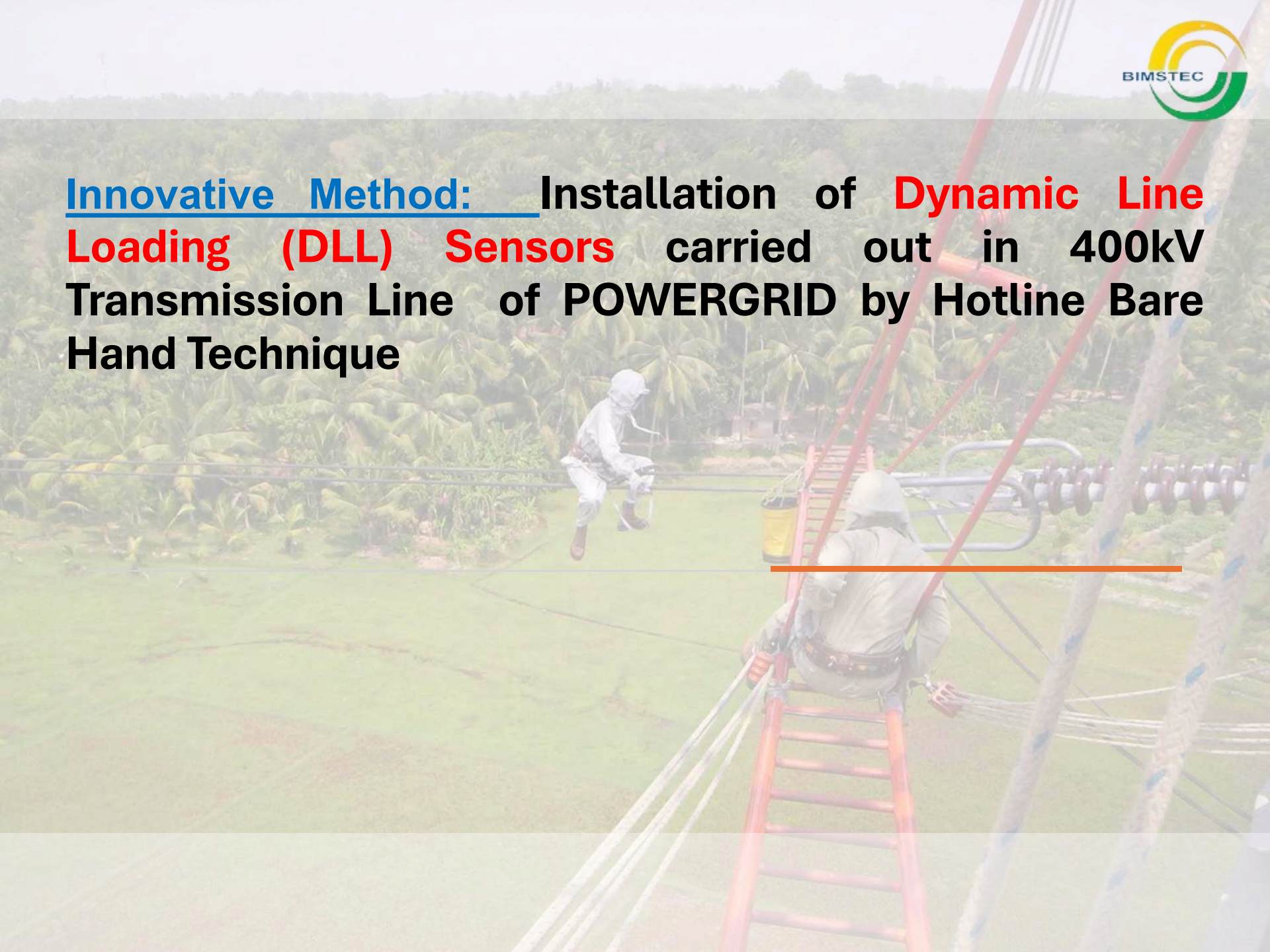
Innovative Hotline Maintenance work carried in 765kV Transmission Line

- The suspected MSCJ by passing activity was carried out in 765kV Transmission Line by **Hotline Maintenance Method**

Innovative Hotline Maintenance work carried in 765kV Transmission Line

Degree of System improvement: Averting long outage of Transmission element and maintaining the system availability and reliability of GRID in case of contingency.

Innovative Method: Installation of **Dynamic Line Loading (DLL) Sensors** carried out in 400kV Transmission Line of POWERGRID by Hotline Bare Hand Technique



Uniqueness / Innovation: Installation of Dynamic Line Loading (DLL) Sensor in 400kV Transmission Line

- First Time in POWERGRID, has successfully installed DLL Sensors in 400kV Transmission Line by Hotline Bare Hand Technique.

- Dynamic Line Loading (DLL) is a key grid enhancing technology, crucial for the energy transition, designed to ensure optimal infrastructure usage by using real-time data to determine the capacity of the line.

Uniqueness / Innovation: Installation of Dynamic Line Loading (DLL) Sensor in 400kV Transmission Line

- This technology helps prevent overloads, optimizes transmission usage, and supports the integration of renewable energy sources.

Uniqueness / Innovation: Installation of Dynamic Line Loading (DLL) Sensor in 400kV Transmission Line

- By adapting to changing conditions, DLL reduces the risk of power cuts, mitigates bottlenecks in the grid, and ensures a stable power supply.
- These GPS enabled Sensors are capable of measuring Phase Current, Conductor Temperature, Inclination Angle (Sag), Wind Speed & Humidity and send data every 15 seconds via SIM (Airtel) installed in each Sensor.
- The received data can be monitored online by cloud based web-dashboard software.

Any Doubts ?

As we proceed further

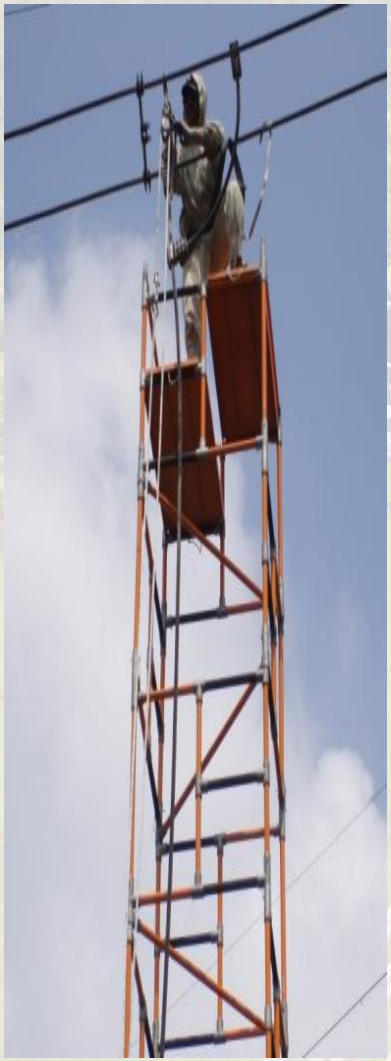
Possible HLM works in SS area

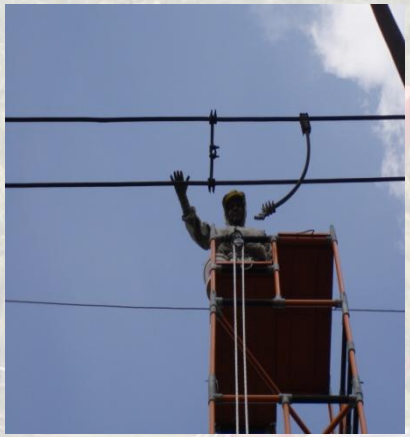
- Replacement of SS disc insulator strings
- Replacement of bus droppers
- Cleaning and lubrication of live EHT isolators
- Removal of bird nest sheltered under the protection covers of EHT isolators
- Tightening of red-hot / loosen bolts and nuts.
- Rectification of damaged conductors, etc.

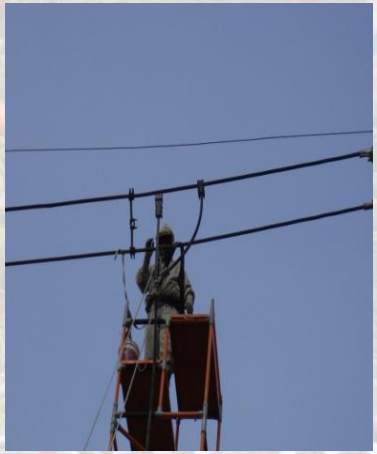
In Substation

In Substation

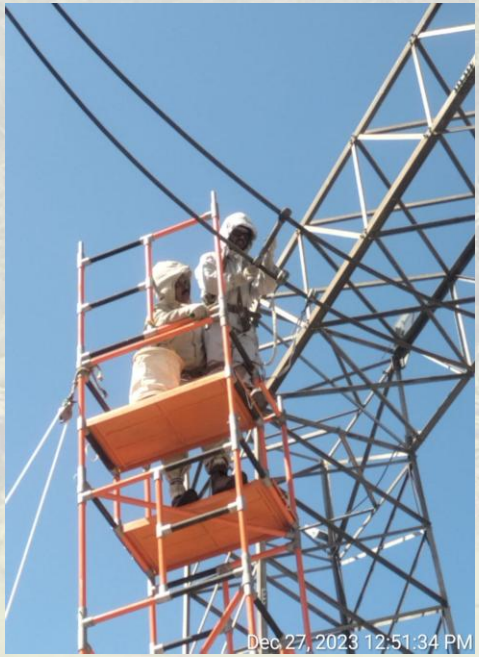
Scaffolding Operation in Substation







Hotline Maintenance Works using Insulating Modular Scaffolding Equipment in 220kV and 400kV charged level at 400/220kV Substation Switch yard

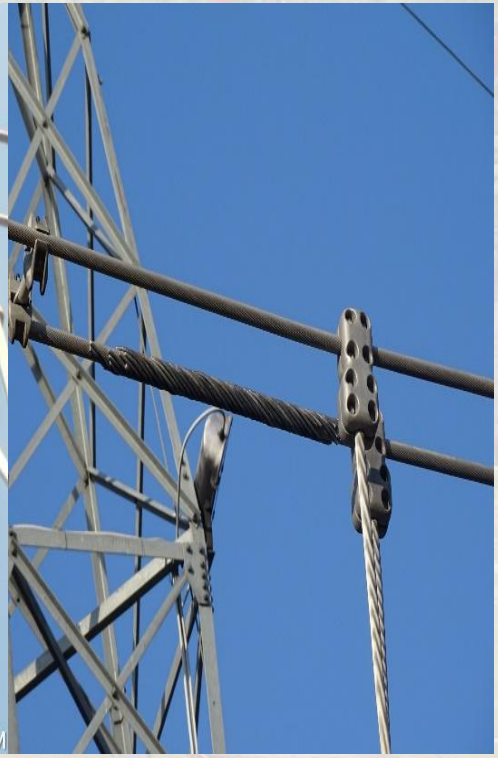


Replacement of damaged rigid spacer in Jumper in 400kV Switch yard was carried out using Insulated Modular Scaffolding Equipment

Hot Line Maintenance using Insulated Modular Scaffolding System

Rectification of T-Clamp of Jumper in ICT Bay of 400kV Switch yard was carried out using Insulated Modular Scaffolding Equipment

Scaffolding Operation



Rectification of damaged conductor of 220kV Jack bus connected to 220kV side of ICT in 220kV SwitchYard was carried out using Insulated Modular Scaffolding Equipment.

HLM Works using Hot line Ladder and Scaffolding System in 400kV Switchyard

Isolator Bypass Arrangement made in Hotline in 400kV Switch Yard

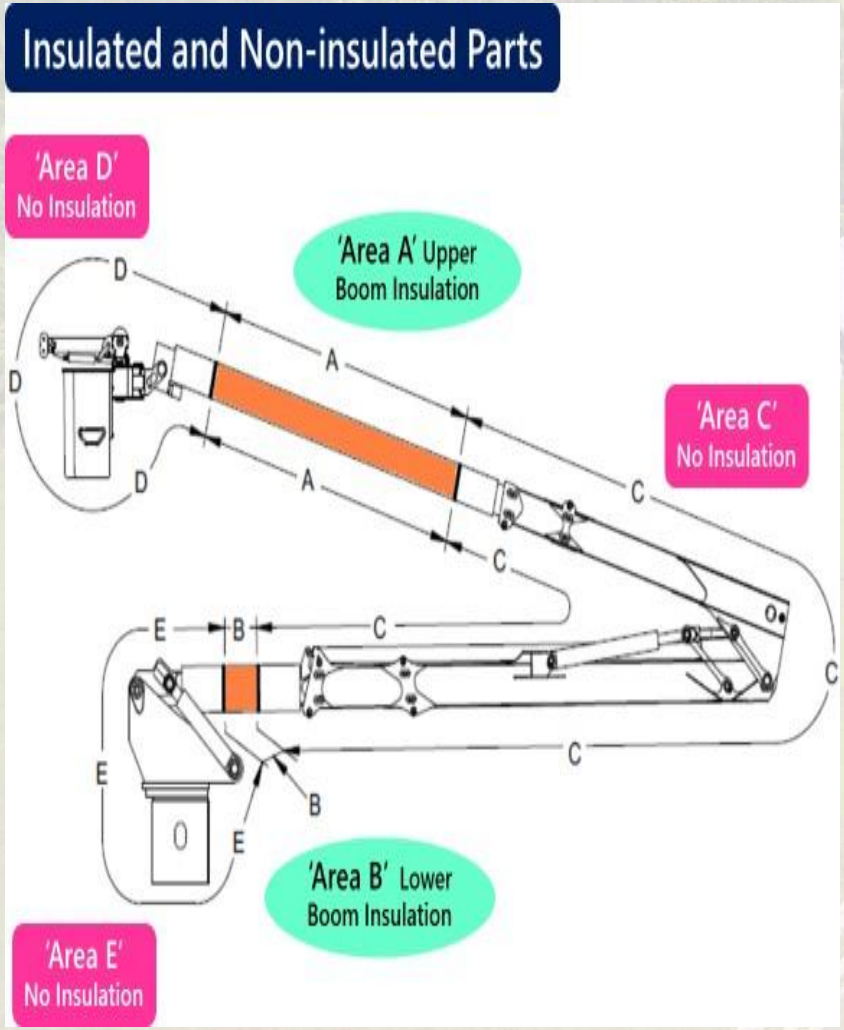
Rectification of jammed terminal stud of isolator was carried out in 400kV switchyard

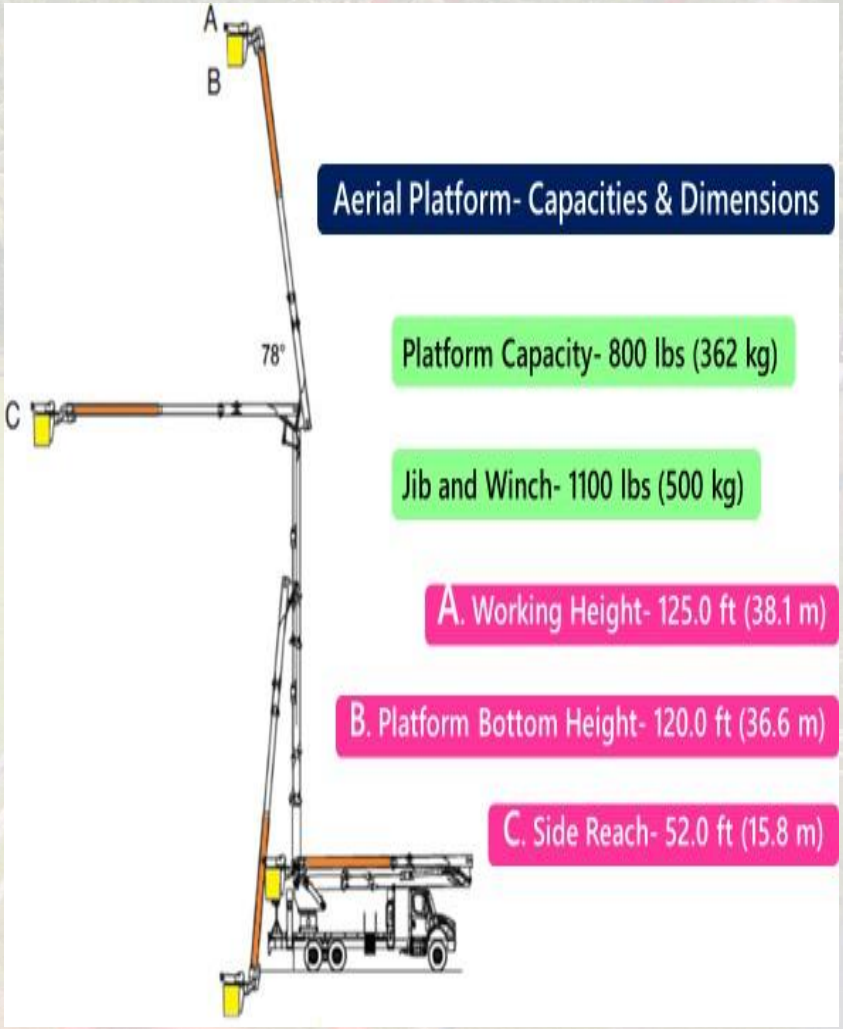
EXPERIENCE / KNOWLEDGE SHARING WITH INSULATED AERIAL WORK PLATFORM (IAWP) / TELESCOPIC INSULATED BUCKET TRUCK

Insulated Aerial Work Platform (IAWP) / Telescopic Insulated Bucket Truck

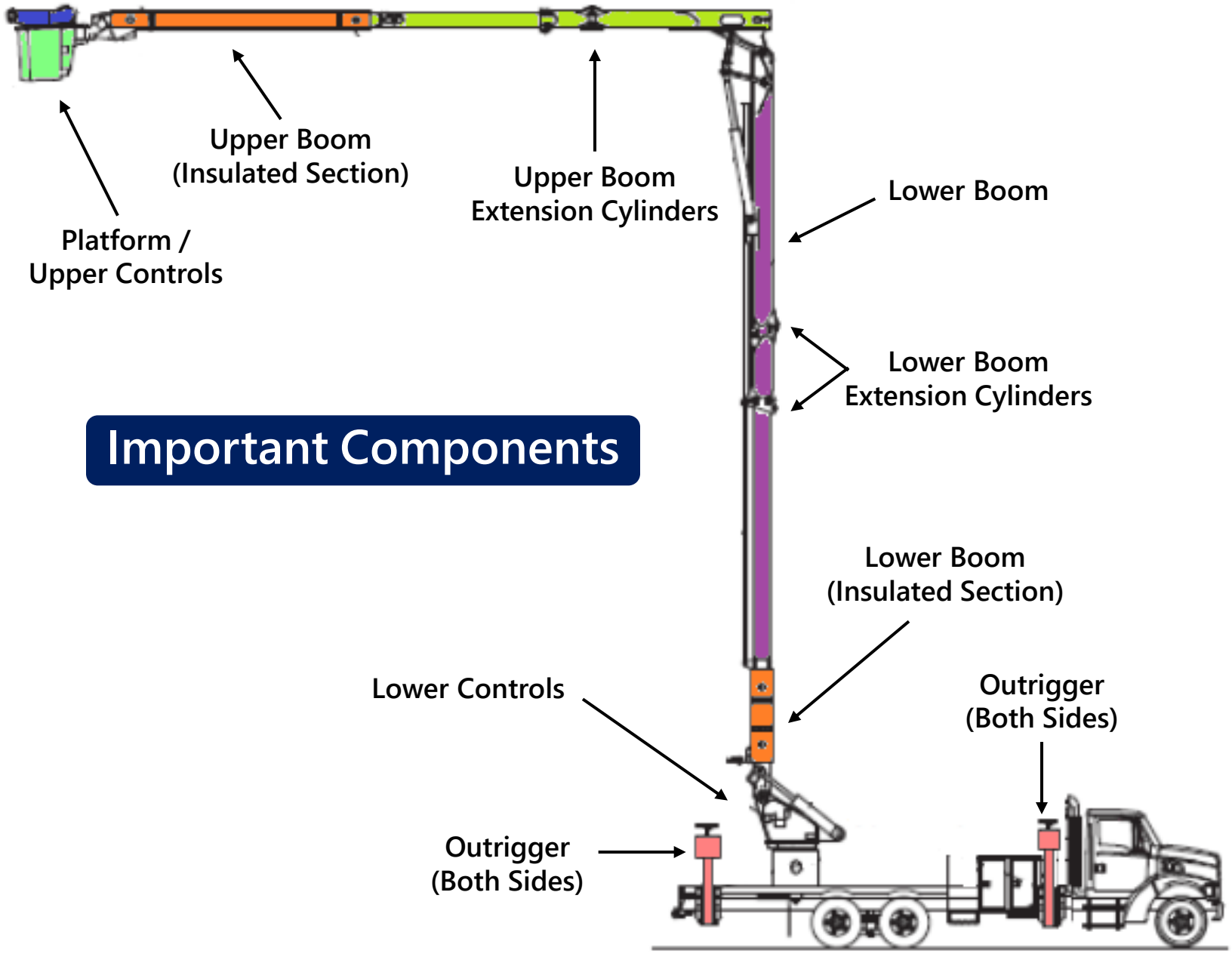
Details of 765kV AC Telescopic Insulated Bucket Truck

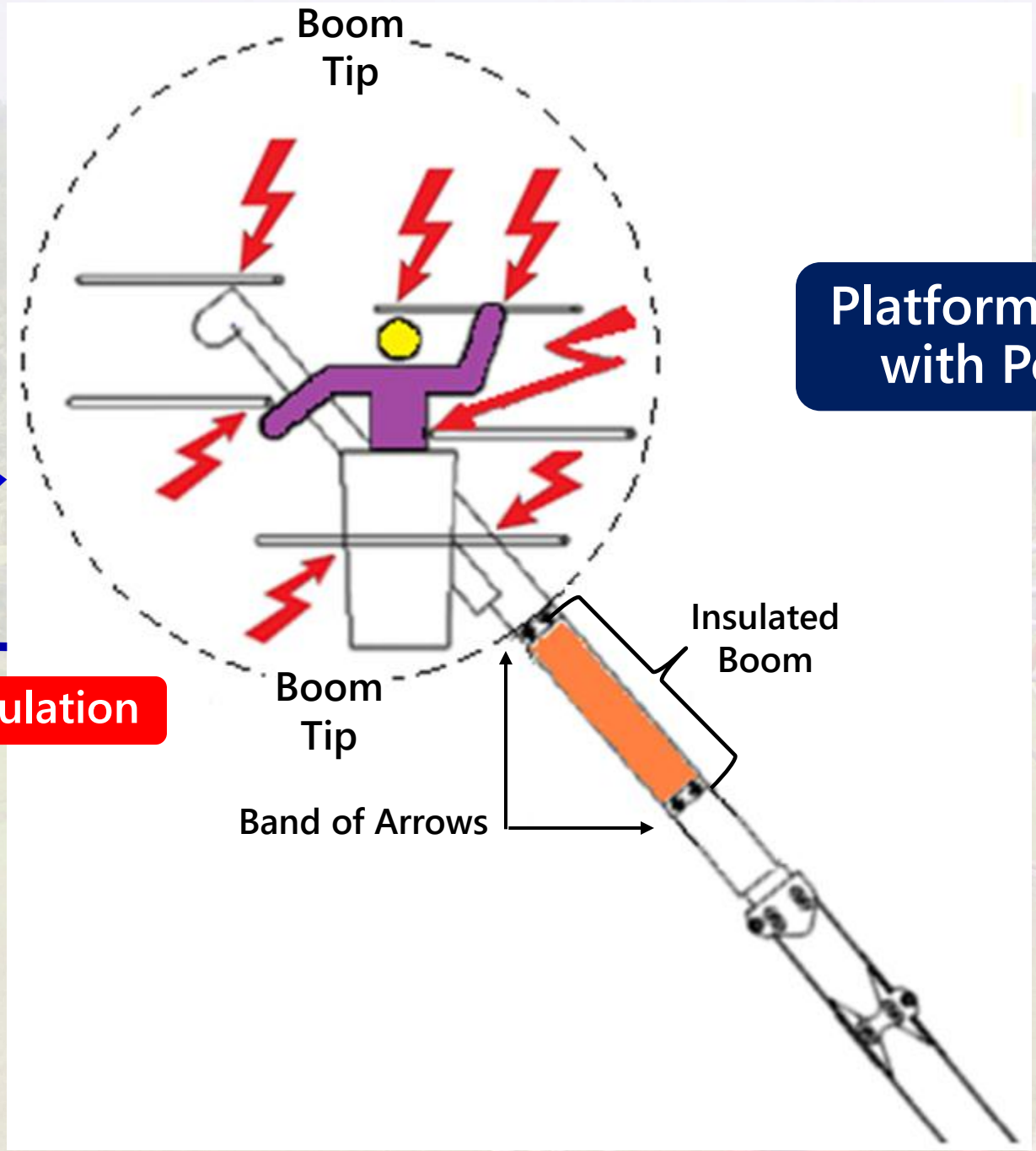
Key Features of the Bucket truck





Important Components





Platform Contacts with Potential

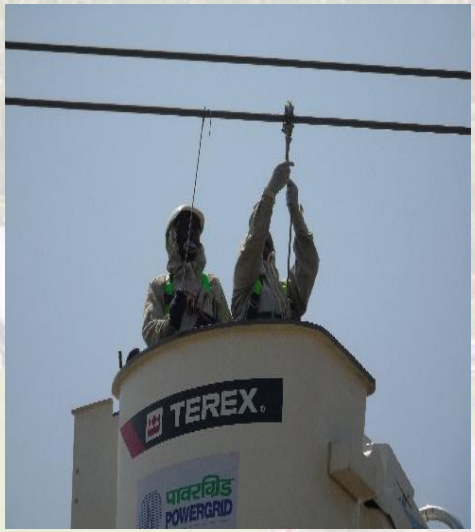
No Insulation

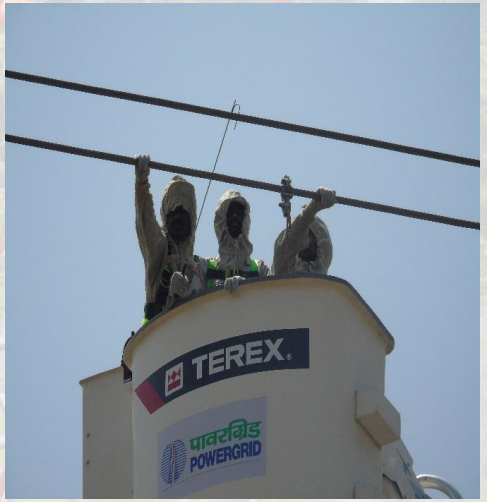
Insulated Aerial Work Platform (IAWP) :

Measuring of Leakage Current

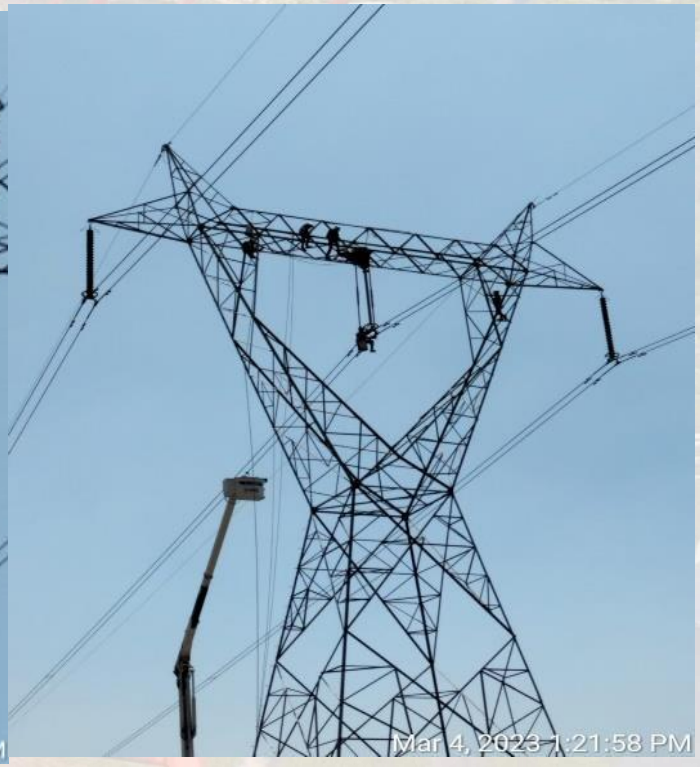
Insulated Aerial Work Platform (IAWP) :Sending Hotmen

Insulated Aerial Work Platform (IAWP) : HOTMEN AT LIVE POTENTIAL





Replacement of defective insulator string with new insulator String in middle phases in 400kV S/C Transmission line using Hot Line Telescopic insulated bucket Truck



HLM Operations with Telescopic Insulated Bucket Truck

Jumper Spacer Rectification work in Transmission Line

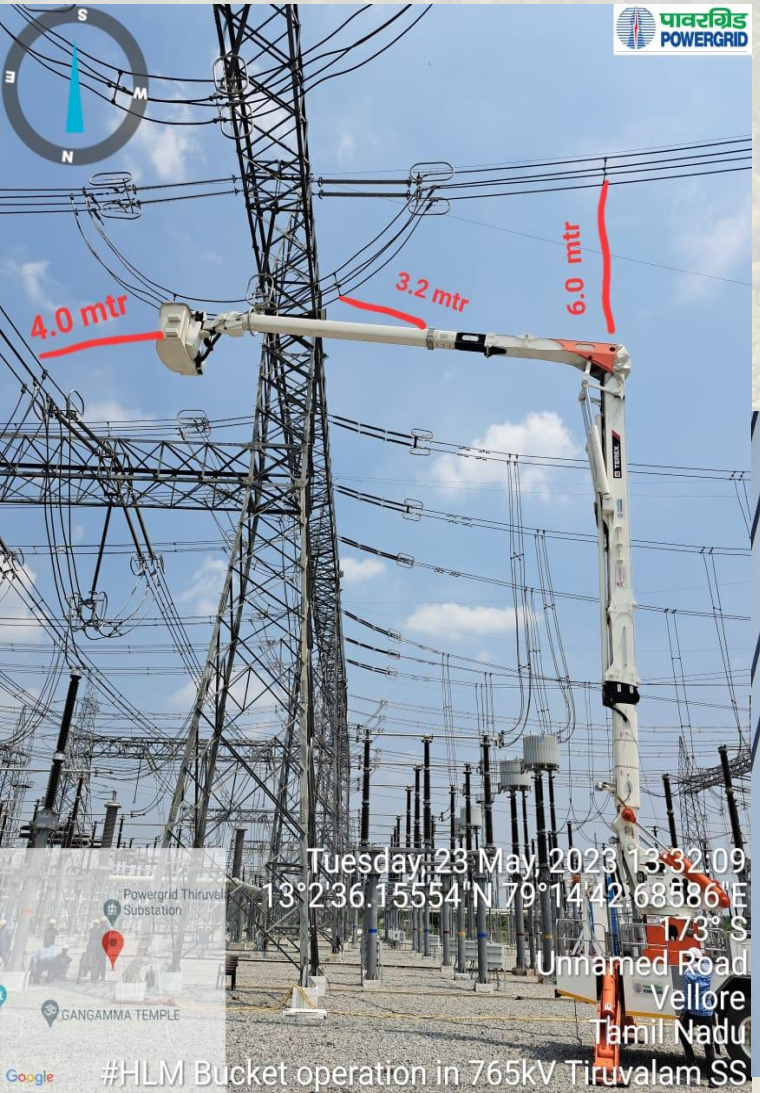
HLM Operations with Telescopic Insulated Bucket Truck

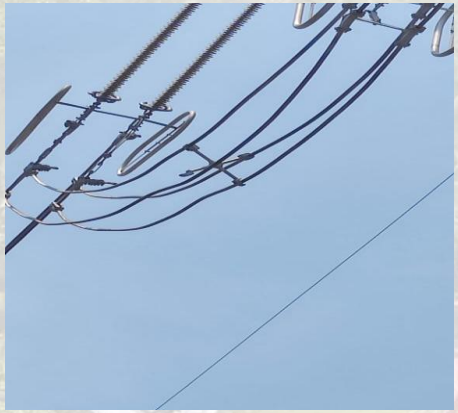
Replacement of defective insulator string with new string

HLM Operations with Telescopic Insulated Bucket Truck : Carried out in 765kV Switchyard :Spacer dropper rectification work

HLM Operations with Telescopic Insulated Bucket Truck

:Rectification of opened spacers of jack bus jumpers connected to ICT Bay in 400kV Charged Switch yard





Photos

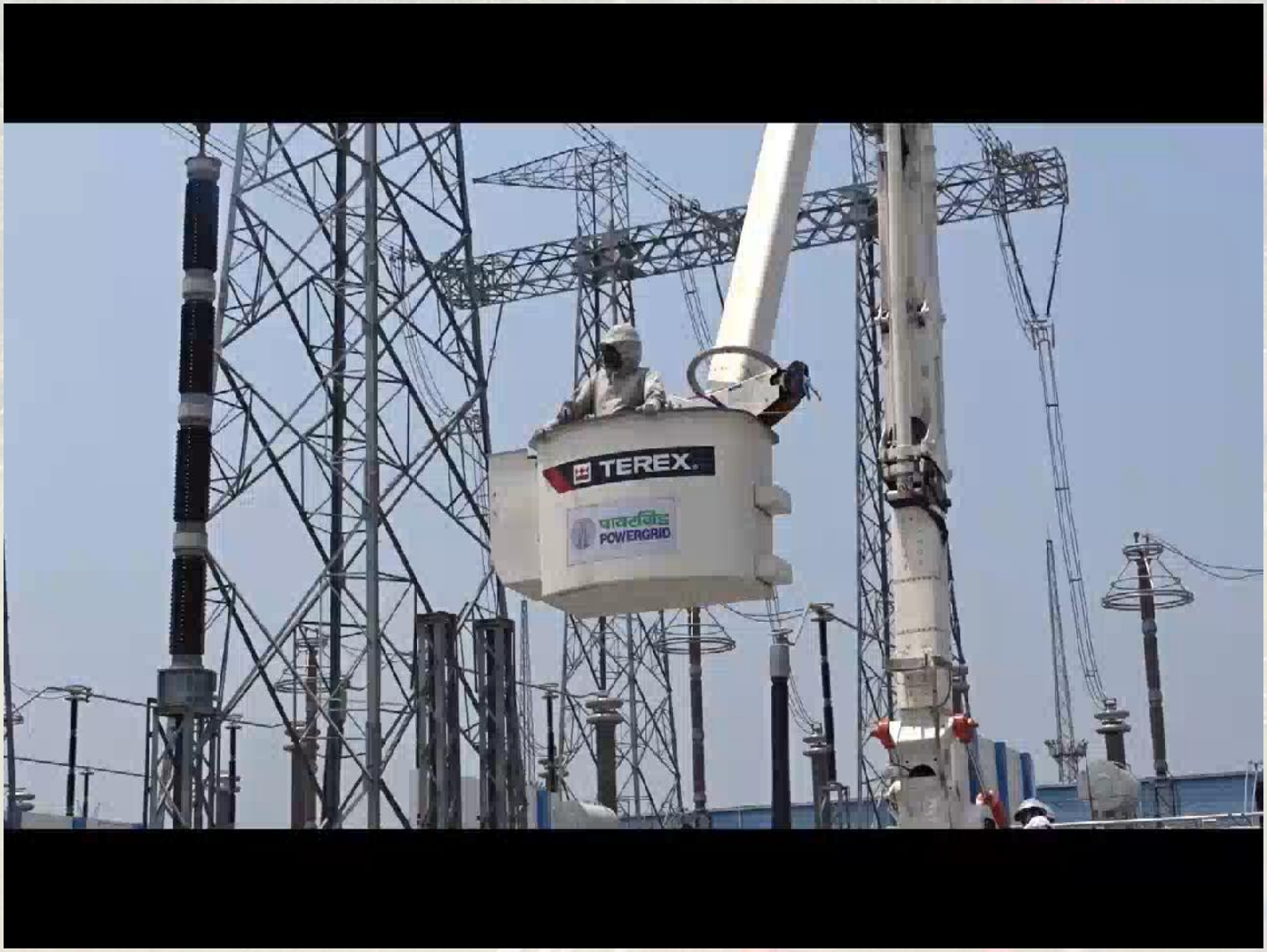

TEREX


Feb 2, 2023 12:08:42 PM


Feb 1, 2023 1:12:47 PM

Hot-man Travel

Bucket Operation @765kv Switch Yard



400kv Isolator Opening in charged condition by HLM Method

Provided Bypass arrangement for Mid Span Compression Joints (MSCJ) in 765kV Transmission Line by HLM Method


Think Safely
Plan Safely
Work Safely
Thank You
22 05 2023

Any Questions?

Thank You!

ধন্যবাদ

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धन्यवाद

ကျေးဇူးတင်ပါတယ်

धन्यवाद

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ขอบคุณ

For your valuable attention and commitment to a sustainable energy future across BIMSTEC nations!

BIMSTEC ENERGY CENTRE

Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation