



### MD'S ADDRESS



Dear Friends,

It is my pleasure to be celebrating the 75th Independence Day with you all.

The journey of TAURUS from the last independence day to this has been very eventful.

We learnt how to be successful even against all odds, COVID, Lockdown, and the business stress all around us.

The first wave was uneventful for us but the second wave hit us badly. Many of our team mates went through COVID themselves.

I respect their fighting spirit to win over it, and be back to business.

I like and encourage the fighting and winning spirit of TAURIANS. Keep it up.

I wish all the friends connected with power sector a Very Happy Independence Day and all the very best for their future.

Thanks and Regards,

**M N Ravinarayan**  
Managing Director

### RECOGNISING THE CONTRIBUTION OF INDIAN WOMEN ON THIS INDEPENDENCE DAY

In the era of globalization and rapid technological development, the world has changed people's lives dramatically. Science and technology play a particularly important role within contemporary society. Governments in developed and developing countries recognize the importance of the development of the S&T sphere. The roles of men and ladies have changed dramatically within contemporary society. Gender equality has been one of the foremost debated topics even today in the 21st century. Women deserve equal rights and opportunities as men, yet there are many challenges that a lady has got to face regularly. The contribution of girls in any field has been as worthy as men but somehow their contributions aren't much talked about or are forgotten with time.

This is true even within the field of science and technology. As per a 2018 report by United Nations Educational Scientific & Cultural Organization (UNESCO), there are approximately 39,300 women scientists working in various research institutions across India. As per reports, the share of girls contributing to science education at the college level and the percentage of girls in Government laboratories has increased.

While we all know about the priceless contribution of great scientists like C V Raman, Dr A P J Abdul Kalam, many folks are unaware of the contributions of Indian women in the field of science but some of the prominent names like Kalpana Chawla, Dr. Suman Sahai and Dr Indra Hinduja and many more.

There has been a gentle transformation within the status of the ladies as compared to earlier periods. Women of today participate completely in areas like politics, status, military sectors, economic, service, and technology sectors. Moreover, they need to contribute wholly to sports too. Thus, they need to occupy a dignified position in family and society. Indian women have come a long way. Having broken the proverbial ground ceiling a brief time back, they're now proving their mettle on the worldwide platform also as can be seen in the recent ISRO's Mangalyaan mission and Tokyo Olympics.

Our exemplary Sheras who bagged medals from the Tokyo Olympics are as follows.

Weightlifter Mirabai Chanu opened India's medal account at the Tokyo 2020 Olympics with a silver in the women's 49kg.

Lovlina Borgohain - Bronze medal - women's welterweight (64-69kg)

On her Games debut, Lovlina Borgohain won a bronze medal at Tokyo 2020.

Badminton queen PV Sindhu became the first Indian woman and only the second Indian athlete - after Sushil Kumar - to win two individual Olympic medals.

We give tribute and salute them for their commitment, dedication and sacrifice. We and India is proud of them.

Prepared by **Mr. Turjoy Dasgupta**

STITAM stands for **S**ubstation **T**ransmission line **I**nnovative **T**esting **A**nalysis and **M**aintenance.

STITAM TAURUS is our Testing services vertical, catering to the need of “Accurately Diagnosing the Health” of EHV Transmission Lines and Substations by the utilities.

These services are being used by some of the leading Transmission Companies to plan the Predictive Maintenance very effectively to keep the uptime up.

TTHA – **T**ransmission **T**ower **H**ealth **A**udit, SSHA – **S**ub **S**tation **H**ealth **A**udit and TLCT – **T**ransmission **L**ine **C**ommissioning **T**est are the three main packages offered by the STITAM TAURUS.

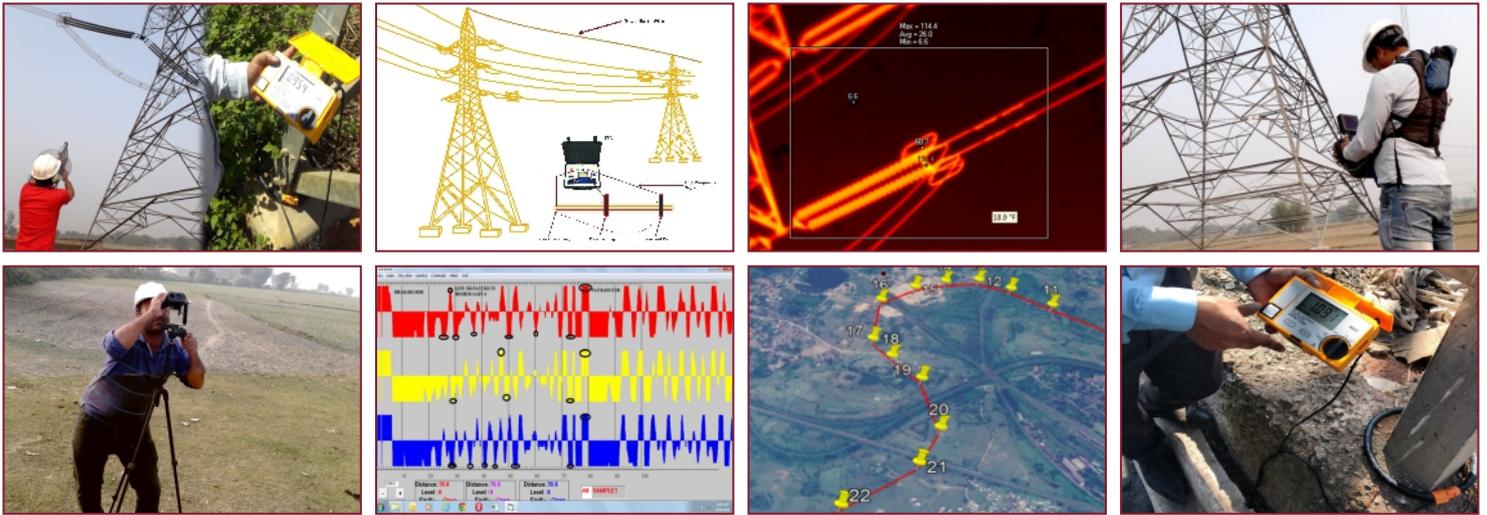
## TTHA- Transmission Tower Health Audit

Transmission utilities across the world are trying hard to achieve the uptime at 100%. This can be done only by keeping transmission line and towers in healthy condition by continuous testing, monitoring and by carrying out regular predictive maintenance.

We Taurus Powertronics offer the package TTHA – Transmission Tower Health Audit to take care of your complete requirement of testing the Transmission Line. We collect the data, analyses it and suggest the remedial action. Hi-tech testing instruments, skilled & experienced engineers and the State of the Art software is used to carry out this activity.

### The tests carried out under TTHA package are

- Line Signature Analysis
- Tower Footing Resistance, Impedance & inductance measurement
- Leaky Insulator Detection
- Hotspots Detection
- Corona Scanning
- Clearance measurement
- Visual Inspection
- GPS Mapping



## SSHA - Sub Station Health Audit - Including GIS Substations

There are variety of equipment in a substation and to check the health of each one, we need a different testing device, skill, procedure etc. To do so, different agencies are appointed to carry out these tests. We Taurus Powertronics, being manufacturer and supplier of various testing equipment, have a big team of highly experienced engineers who are experts in operating the test equipment, knows the test procedures, standards and safety rules to be followed. We carefully read, understand and analyse the output produced by the test equipment and pinpointing the actual problem. Also we suggest the remedial action to improve the system. Your all testing requirements can be catered under one roof – STITAM TAURUS

- The tests carried out under SSHA package are
- Measuring 3rd Harmonics Leakage Current of LA
- DCDB health check and identification of Earth Faults
- Earth Testing - Soil Resistivity, Resistance of Earth Pit
- PD Measurement
- SF6 gas Analysis – for Breaker and GIS substation
- DCRM, Operation Timing, IR, Winding Resistance and many more..
- Visual Inspection of the Substation
- Leaky Insulator Detection
- Hotspots Detection
- Corona Scanning

## OUR TEAM IN ACTION



## M<sup>3</sup> – MEN, MACHINE & METHOD

The highly skilled and experienced Men (Team of Engineers), High Tech Machines (Test Equipments) and Innovative Methods (software & communication) are the three key ingredients for the success of TAURUS STITAM

At the work site, challenges such as difficult terrain, extreme weather, ROW issues and unexpected challenges are regularly faced by our engineers. They know how to deal with these situation with a smiling face. All our engineers are experts in handling different equipments.

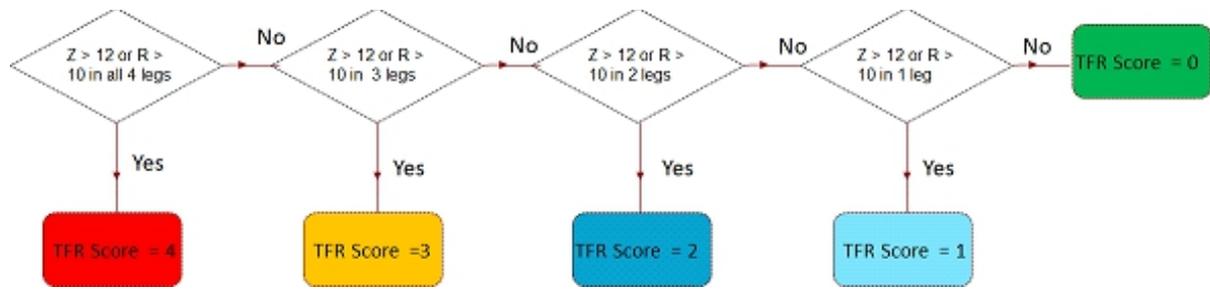
## PERILOUS BUT TAURUS WILL GET THE JOB DONE



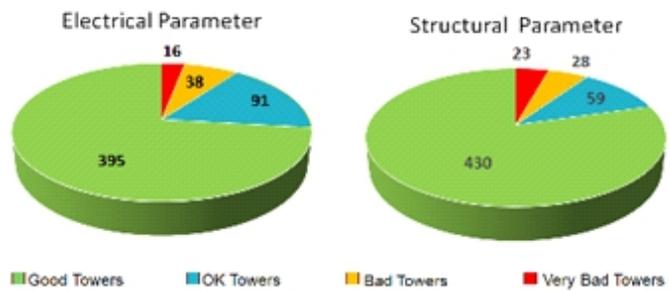
Many of the equipments used for these Health Audits are manufactured by us Taurus and we are the business partner to sell the rest of the equipment which are from leading manufacturers from USA, Japan & Israel. We always have these ready in our stock. Hence we can work at multiple sites simultaneously.



We TAURUS STITAM believe in constantly improving our speed and quality, hence always adopt innovative solutions to achieve this. We use various software tools to track our team, capture the data, analyze it and produce user friendly reports in the form of tables, charts and graphs etc.



Health Assessment of tower by leg									
Level Number	Z	R	Level Type	Score	Tower Type				
TFR Readings									
Leg A	1.50	0.00	20.25	A	0				
Leg B	1.50	0.00	20.25	B	0				
Leg C	1.50	0.00	20.25	C	0				
Leg D	1.50	0.00	20.25	D	0				
Structure	1.50	0.00	20.25	Total of Z	0				
Ultra Sound	Infected	Thermal status	Temperature	Corrosion	Count				
Cables	Insulated	Non-Insulated	Earth bond 1	Earth bond 2	ISA Rating				
Tower ID									
Tower Name									
Tower Location									
Tower Status									
Tower Type									
Tower Height									
Tower Weight									
Tower Material									
Tower Color									
Tower Finish									
Tower Condition									



Score	Level	Priority	Towers
10 to 12	Level 1	CRITICAL	51
7 to 9	Level 2	HIGH	12
5 and 6	Level 3	PRIORITY	31
Less than 5	Level 4	GOOD	300

**Tower Faulting: By Parameter**

**Impedance**

Level	Count
Level 1	53
Level 2	42
Level 3	54
Level 4	300

**Leakage Current**

Level	Count
L-1	2
L-2	28
L-3	18

**Towers by Distance**

Distance	Count
Less than 10 meters	35
10 to 25 meters	85
25 to 50 meters	1

**Hot Spots**

Level	Count
Level 1	2
Level 2	31

**Leaky Insulator Detection**

Level	Leakage Current	Score
Level -1	0.2 to 0.51 Amps	5
Level -2	0.1 to 0.2 Amps	2
Level -3	0.09 to 1 Amps	1

**Towers with leakage Current**

Level	Count
Level -1	2
Level -2	3
Level -3	2

**ULTRA SOUND**

Level	Count
Level -1	3
Level -2	5
Level -3	6

Prepared by Ms. Mamatha, STITAM Project Co-Ordinator

## EMPATHY IS A SUPER POWER IN THE WORKPLACE

A barrier to a more empathetic workplace often stems from a lack of understanding about how to start the conversation. This is where the power of common language comes into play.



Empathy is generally defined as "the ability to sense other people's emotions, coupled with the ability to imagine what someone else might be thinking or feeling." Today, as the workplace continues to evolve, empathy is often expected in the workforce.

We, in an organization generally concentrates on:

- Clear-headed leadership.
- Dedicated employees.
- A strong company culture.

These are undeniable attributes of a thriving workplace. So is another factor i.e. **EMPATHY**.

In fact, over 80% of CEOs in a recent survey named **Empathy as a key to corporate success**.

While soft skills are often considered less important than efficiency or professionalism to a company's success, that common misconception can be detrimental to company culture, where being able to understand and have compassion for other people's emotions is integral to working efficiently together and keeping up workplace morale.

### How to Cultivate Empathy in the Workplace:

- Daily communication. Empathy starts with simple interactions that show genuine interest....
- Honesty and authenticity. Owning your mistakes is one of the most empathetic professional moves you can make....
- Leadership and teamwork....
- Handling conflict...
- Listen to the quiet majority.
- Talk about empathy in the workplace to signal its value. Let leaders know that empathy matters.
- Encourage genuine perspective-taking.
- Show compassion when other people disclose a personal loss.

To succeed in making it part of our organization's DNA, we must pay close attention to how cultures build and change.

Prepared by Ms. Nandini M S - Asst. Manager - HR



## DISASTER MANAGEMENT IN TRANSMISSION LINE THROUGH OUT THE WORLD

Most of the natural disasters are unavoidable and many times the nearby transmission network gets affected during this. Now the objective is to restore the network as quickly as possible. Towers are damaged, conductors are snapped, mobile networks are down, increasing the communication challenges. The location of the damage is not known and also there is no immediate manpower available for the line patrolling. In such cases the Offline Fault Locator is extremely a must have and useful tool to be used from a substation to locate the fault quickly and accurately.

## DISASTERS IN TRANSMISSION LINES

### Structural Failures

A Transmission Line Tower collapses or the Conductor snaps during Heavy wind, Floods, Landslide, and Tsunami etc. which are due to Natural disasters. Also, the same can happen due to manmade disasters such as fire, theft, terrorist attack, excess water & fertilizers in the field, chemical outflow of gases and liquid from nearby factories etc.

### Electrical Failures

Mainly the Electrical Failure are due to failure of different equipment at substation or Generating stations. Also, this can be on the Transmission Line due to Corona on insulators, High Tower Footing Impedance & Resistance, Low clearance, Weak / damaged Insulators etc. Generally Electrical failures are restored quickly by alternate arrangements but restoring Structural Failures takes days or weeks sometimes.

### Situations we address in the Power Network pertaining to disasters

(i) Disaster Management

(ii) Disaster Prevention

With this faster recovery during disaster situations can be achieved.

It helps in:

- Quick fault-finding duration after disaster situation.
- Identify weak points of Transmission Line before disaster to avoid ambiguity.
- Assert safety for the manpower & assets deployed in the Substations & Lines
- Faster deployment of power during disaster management situations
- Safety of manpower deployed in the transmission lines and substations.
- Enhanced life of the deployed transmission lines
- Enhanced life of the deployed assets in the substations
- Regular preventive maintenance to avoid disaster

These critical approaches would immediately contribute to bring in the following benefits to Disaster Management and recovery.

- Disaster Management preparedness
- Maximizing availability / uptime of the transmission line.
- Attaining optimum transmission levels
- Effective and fast restoration of the transmission system.

## GROWTH OF POWER TRANSMISSION IN INDIA

India is seventh largest country in the world with total area of 32.87 Lakh Sq Km. Year on year the transmission line network is growing rapidly and as on today we have more than 4.2 Lakh Circuit km lines. This is only for the 220, 400, 765 kV AC lines and 500 & 800 kV HVDC lines. So far 5,97,121 villages are electrically connected and the number is growing every day.

### Natural Disaster Situations in India

India offers variety in geography such as it has Snow Mountains, Hills, Desserts, Coastal Areas, Plateaus and Rivers etc. Floods, Landslide, cyclones are the common natural disasters we face every year. Our transmission network is always exposed to these disasters and very often the system fails to withstand these disasters.

### Other un-natural disaster situations:

- Network Related Disaster Situations | - Complex geography of our country
- Land congestion | - Unplanned growth of the network
- Ageing of Lines & Components | - Erratic Incidents

## About TAURUSEHT 1250 MAX-3

Deploy one set of Taurus EHT 1250 MAX-3 at each sub-station of transmission utilities to ensure optimal uptime of the Transmission Network. This can be achieved through

- Enhanced life of the deployed transmission lines
- Identify any fault during commissioning
- Faster deployment of power during disaster management situations

The Taurus EHT 1250 MAX-3, is an Overhead Transmission Line Fault Analyser System designed & developed in India and is being utilized as a precise Fault Locating device with extended applications of line healthiness study, pre-charging and pre-commissioning checks.

Taurus EHT 1250 MAX-3 in fault location (Disaster Management) The Taurus EHT 1250 MAX-3 precisely detects any or all types of open & short faults that causes line breakdown. An important tool for accurate fault finding that can save enormous time and revenue for the utility. During Disaster Management situations, this is an indispensable tool to quickly identify the faults and restore the entire transmission system.

Taurus EHT 1250 MAX-3 can also be used in Line diagnostic study (Predictive maintenance)

Taurus EHT 1250 MAX-3 can also be used before charging a line

By Deploying the Over Head Offline Fault Locator and Analyser on the transmission lines and substations increase in uptime leading to faster ROI, safety of assets and manpower and faster recovery during disaster situation through deployment of our equipment in the power sector throughout the world.

Through deployment, we assure

- Increase efficiency/effectiveness in the predictive maintenance activities
- Identify the weak points along the line to avoid break down in disaster situation.
- Increase the efficiency of manual patrolling
- Decrease fault finding duration.
- Ensure safety of the equipment/lives/methods
- Enhance life of the assets deployed
- Capture data of the functioning of different assets
- Decision making through data analytics
- Reduce downtime during disaster management situations.

## EHT 1250 MAX-3 VS Relay system

One could ask, that there is already a relay system installed on all the lines with which many utilities locate the fault in the lines. To this the answer would be that No! Since Primary function of the relay system is to isolate/Break the circuit to protect the Costly equipments installed at the power substation and take care of protection system. Accuracy of the relay system depends on so many factors and accuracy may vary from 5 to 10% depending upon the input parameters.

Online relay system required some input parameters like Voltage rating & Impedance (Positive, Negative & Zero) sequences to calculate the fault distances in zone wise and we do not have any accurate measurement tools which can measure the required Input Parameters. Accuracy will be varying based on input parameters.

Online relay system required to connect at both Sx & Rx sides of the line which required more initial investment. These difficult faults like Multiple, Transient and developing faults can not be detected through online system and which requires special innovative supplement Concepts.

compared to the relay system which identifies only the First fault o the line, the Taurus EHT 1250 MAX-3, identifies ALL the faults along the line with an accuracy of +-50 meters. Not only dose it identifies all the faults but also the level of severity of the faults, for the operator to make a calculated judgement as how to handle the critical ones.

This kit has been very helpful in many disaster recovery situations in India and keeping that in mind we recommend that every substation have this critical disaster handling equipment.

Prepare by **Mr. Zohair Hazan** - AD General Manager

# ROLE OF ACCURATE MEASUREMENT OF SOIL RESISTIVITY FOR DESIGNING OF EARTHING & CONCEPT OF CHEMICAL EARTHING

**Abstract:** The main objective of grounding electrical systems is to provide a suitably low resistance path for the discharge of fault current which ultimately provide safety to working personnel and costly installed equipments in the substation. The flow of heavy fault current results in rise of potential in the substation area and with respect to remote ground. There is need to ensure that the ground potential rise, and touch and step voltages are within permissible limit, an accurate soil model is required to design grounding system of the substation that ensures that the resistance of the grounding grid through the earth is sufficiently low.

Soil resistivity data is of fundamental importance in performing grounding system analyses. Reliable data is required to achieve good correlation between design and measured grounding system performance. This soil model is derived from the accurate soil resistivity measurement structure at the proposed grid location. This paper provides a overview of 4 pin method for measurement of resistivity.

**Key Words:** Grounding, Soil Resistivity, Substation, Resistance, Single and Two Layer soil Model

## 1. INTRODUCTION

Grounding/ Earthing means making a connection to the general mass of earth. The use of grounding is so widespread in an electric system that at practically every point in the system, from the generators to the consumers' equipment, earth connections are made.

Earlier, the design criterion was to achieve lowest earth resistance, However, the modern design criterion for grounding system is to achieve low earth resistance and also to achieve safe 'step-potential', 'touch potential' and voltage gradient during an earth fault between conductor and any of the earthed bodies in the substation.

### The Objectives of Neutral Grounding are:

1. To preserve security of the electric system by ensuring that the potential on each conductor is restricted to such a value as it is consistent with the insulation applied.
2. To ensure efficient and fast operation of protective gear in case of earth faults.

### The objectives of General Grounding system include :

1. To provides a low resistance return path for fault current which further protect both working staff (freedom from dangerous electric shock voltage) and equipment installed in the substation.
2. To provide current carrying capability, **both in magnitude and duration**, adequate to accept the earth fault current permitted by the over current protective system without creating a fire or explosive hazard to building or contents.
3. To prevents dangerous GPR with respect to remote ground during fault condition.
4. To provides a low resistance path for power system transients such as lightning and over voltages in the system.
5. To provide uniform potential bonding /zone of conductive objects within substation to the grounding system to avoid development of any dangerous potential between objects (and earth).
6. To prevent building up of electrostatic charge and discharge within

the substation, which may results in sparks.

7. To allow sufficient current to flow safely for satisfactory operation (better performance) of protection system.

Grounding of electronic equipment is necessary for the safety of personnel and equipment (**Protective Earthing**) and for proper functioning of the equipment (**Functional Earthing**). Usual methods of grounding of various metallic structures and housing of equipments in the substation for the safety of personnel are also applicable to grounding of cabinets and housings of the electronic equipment.

Grounding of the electronic equipment minimizes unwanted electrical signals (**Electromagnetic Interference or EMI**) that might interfere with the functioning of the equipment and cause component damage. It also prevents accumulation of static charge on the equipment by providing a low impedance leakage path to the earth for the same. A typical earthing system for substation is shown in figure 1 below.

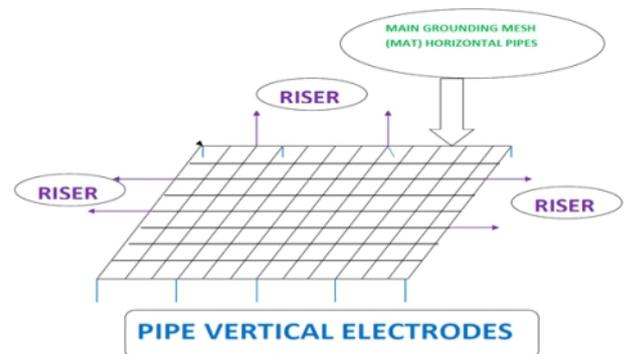
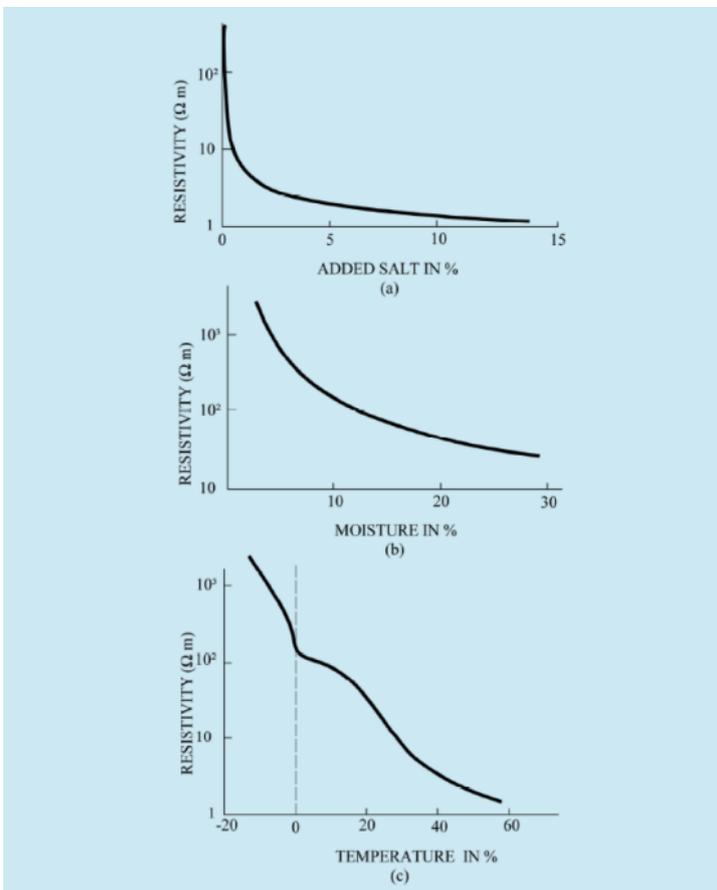


Fig 1 Grounding Mat of the Substation

## 2. CONCEPT OF SOIL RESISTIVITY

Soil resistivity can be defined as the resistance between the opposite sides of a cube of soil with a side dimension of one meter. Soil resistivity values in vary widely, depending on the type of terrain; e.g., silt on a riverbank may have a resistivity value around 1.5  $\Omega$ -m, whereas dry sand or granite in mountainous country may have values higher than 10,000  $\Omega$ -m. The factors that affect resistivity may be summarized as follows :

1. Type of earth (e.g., clay, loam, sandstone, granite).
2. Stratification of layers of different types of soil (e.g., loam backfill on a clay base).
3. Moisture content: resistivity may fall rapidly as the moisture content is increased, but after a value of about 20%, the rate is much less. Soil with moisture content greater than 40% is rarely encountered.
4. Temperature: above the freezing point, the effect of temperature on earth resistivity is negligible.
5. Chemical composition and concentration of dissolved salts. Presence of metal and concrete pipes, tanks, large slabs, cable ducts, rail tracks, or metal pipes. Figure 2 shows how resistivity varies with salt content, moisture, and temperature. It is found that earth resistivity varies from 0.01 to 1  $\Omega$ -m for sea water, and upto 109  $\Omega$ -m for sandstone. The resistivity of the earth increases slowly with decreasing temperatures from 250C, while for temperatures below 0oC, the resistivity increases rapidly. In frozen soil, as in the surface layer in winter, the resistivity may be exceptionally high.



**Fig 2 Impact of Salt, Moisture & Temperature on Soil Resistivity**

Table 1 shows the resistivity values for various soils and rocks that might occur in different grounding system designs. The electrical properties of the soil are determined by the thicknesses of layers and their changes in resistivity, resistivity is dependent upon water and chemical content, as well as soil texture. Usually there are several soil layers, each having a different resistivity, in which case the soil is said to be non-uniform. Lateral changes may also occur, but, in general, these changes are gradual and negligible, at least in the vicinity of a site where a grid is to be installed. In most cases, measurements will show that the resistivity,  $\rho$ , is mainly a function of depth. The interpretation of the measurements consists of establishing a simple equivalent function to yield the best approximation of soil resistivity's to determine the layer model.

**TABLE 1 TYPICAL RESISTIVITY OF SOIL**

TYPE OF SOIL OR WATER	TYPICAL RESISTIVITY (OHM METER)	USUAL LIMIT (OHM METER)
Sea water	2	0.1 to 10
Clay	40	8 to 70
Ground well & spring water	50	10 to 150
Clay & sand mixtures	100	4 to 300
Shale, slates, sandstone, etc.	120	10 to 100
Peat, loam, and mud	150	5 to 250
Lake and brook water	250	100 to 400
Sand	2000	200 to 3000
Moraine gravel	3000	40 to 10000
Ridge gravel	15000	3000 to 30000
Granite	25000	10000 to 50000
Ice	100000	10000 to 100000

### 3. METHOD AND PROCEDURE OF RESISTIVITY MEASUREMENT

There are many methods being used worldwide for measurement of resistivity. Four point method of resistivity measurement is quite common.

**Four-point method [2] :** A good method for measuring the apparent resistivity of large volumes of undisturbed earth is the four point method. Four auxiliary probes are installed in the earth, all at depth  $b$  and spaced

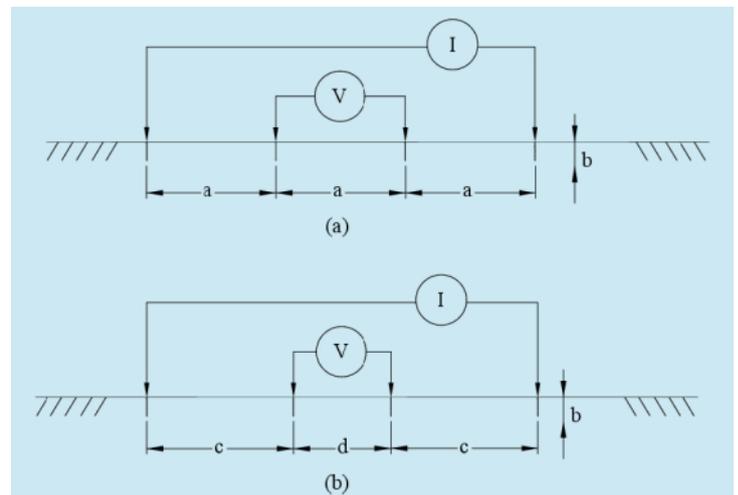
(in a straight line) at intervals  $a$ . A test current  $I$  is passed between the two outer probes, and the potential  $V$  between the two inner probes is measured with a potentiometer or high-impedance voltmeter. Then, the  $V/I$  ratio gives the resistance  $R$  in ohms. Two different variations of the four-point method are often used, as follows:

**a) Equally Spaced or Wenner Arrangement.** With this arrangement, the probes are equally spaced, as shown in Figure 3(a). Let  $a$  be the distance between two adjacent probes. Then, the apparent resistivity in the terms of the length units in which  $a$  and  $b$  are measured is

$$\rho = \frac{4\pi aR}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$

Theoretically, the electrodes should be point contacts or hemispherical electrodes of radius  $b$ . However, in practice, four rods are usually placed in a straight line at intervals  $a$ , driven to a depth not exceeding 0.1  $a$ . Then, the user can assume  $b = 0$  and the equation becomes  $\rho = 2\pi aR$  and gives the approximate apparent soil resistivity to the depth  $a$ .

A set of readings taken with various probe spacing gives a set of resistivity that, when plotted against spacing, indicates whether there are distinct layers of different soil or rock and gives an idea of their respective model.



**Fig 3 Wenner Method and Schlumberger-Palmer Method**

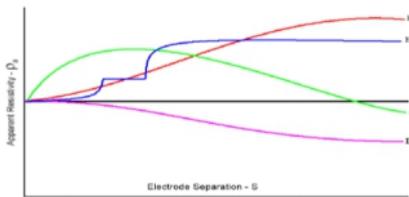
**b) Unequally Spaced or Schlumberger-Palmer Arrangement** One shortcoming of the Wenner method is the rapid decrease in magnitude of potential between the two inner electrodes when their spacing is increased to relatively large values. Historically, instruments were inadequate for measuring such low potential values, although improved sensitivity in modern testers mitigates this disadvantage to some extent. Another disadvantage with the Wenner method is the requirement to reposition all four probes for each depth to be measured. The arrangement shown in Figure 3(b) can be used to measure soil

resistivity successfully when current probes are separated by a large distance or to expedite testing for multiple current probe locations. With the Schlumberger method, the inner probes are placed closer together and the outer probes are placed farther apart. Unlike the Wenner method, which requires all probes to be moved to calculate soil resistivity at different depths, the Schlumberger method only required the outer probes to be repositioned for subsequent measurements. Reducing the number of probes to be repositioned for each test makes the Schlumberger method a faster choice for testing at different depths. The equation to be used in this case can be easily determined (Palmer [B50]). If the depth of burial of the electrodes  $b$  is small compared to their separation  $d$  and  $c$ , and  $c > 2d$ , then the measured apparent resistivity can be calculated as follows:

$$P = \pi(c+d)R/d$$

#### 4. Different Soil Models

Uniform soil model is seldom found in the field. Grounding design engineers usually come across the following types of soil models (Refer figure 4).



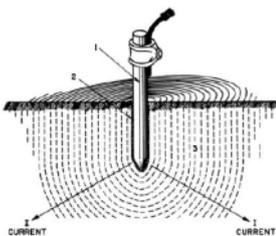
**Fig 4 Soil Resistivity Vs Electrode Separation Curve for Non-Uniform Soil**

- Curve (A) represents homogenous resistivity
- Curve (B) represents a low resistance layer overlaying a higher resistivity layer
- Curve (C) represent a high resistivity layer between two low resistivity layer
- Curve (D) represents a high resistivity layer overlaying a lower resistivity layer
- Curve (E) represents a low resistivity layer over a high resistivity layer with vertical discontinuity station.

#### 5. VARIOUS RESISTANCES OF AN EARTH ELECTRODE

During the flow of fault current through a ground/earth electrode three types of resistance appear in the circuit as shown in figure 5.

1. Resistance of the ground electrode itself and connection terminal or hardware fitting joining it with cable or riser.
2. Resistance at the point of contact between the ground electrode and the soil.
3. Resistance offered by the surrounding ground/earth.



**Fig 5 Different Components of Grounding Resistance**

1. Electrode Resistance: Rods, pipes, strips are usually used for making connections. These connections are made of sufficient size so that their resistance becomes very low and their contribution to the total resistance is negligible.

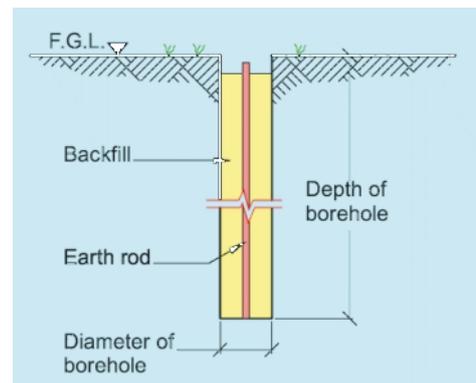
2. Contact Resistance of Electrode-Earth/Ground: This part of resistance is also very less.
3. Resistance offered by Surrounding Earth: During the fault the electrode surrounded by soil of uniform resistivity radiates current in all directions. The earth shell touching the electrode offers the smallest surface area and so it contributes the highest resistance. The next earth shell is comparatively larger in size and this shell has less resistance. Finally a distance will be reached where addition of more earth shells does not contribute much to their total resistance of the earth surrounding the electrode.

Generally, the resistance offered by the earth surrounding the electrode will be the highest of all the components discussed above. The first two factors can be taken as negligible compared to third factor, i.e. resistivity of soil. This is the reason, we generally consider resistivity of the soil only, when we deal with resistance of earth.

#### 6. EARTHING ENHANCEMENT COMPOUNDS AND MATERIALS (CHEMICAL EARTHING)

It is often impossible to achieve the desired reduction in ground resistance by adding more grid conductors or ground rods. An alternate solution is to effectively increase the diameter of the electrode by modifying the soil surrounding the electrode. The inner shell of soil closest to the electrode normally comprises the bulk of the electrode ground resistance to remote earth. This phenomenon is often utilized to an advantage.

Earthing (ground) enhancement materials are high conductivity materials, which are designed to lower ground system resistance and improve grounding effectiveness in high resistivity soil conditions. They can be used in sites installed in areas with poor soil conductivity (such as rocky ground and sandy soil), or on sites where ground rod electrodes cannot be driven to the desired depth. They are also often used when limited space makes achieving the required ground electrode resistance impossible with conventional methods. The concept of chemical earthing is depicted in figure 6.



**Fig 6 Concept of Chemical Earthing**

#### MAIN CHARACTERISTICS OF CHEMICAL EARTHING ARE

- It should absorb and retains moisture for long time
- It should have low resistivity
- It should be able to dissipate fault current very fast
- It should maintain compatibility of soil and rod contact
- It should need maintenance for longer time
- It should be able to maintain earth resistance same for longer time even with large temperature variation.

Earthing (ground) enhancement materials are available in many forms. Actual chemical earthing is shown in figure 7.

Bentonite clay is sometimes used as an earth enhancement material. Bentonite, naturally occurring clay mostly comprised of the mineral montmorillonite, is hygroscopic and absorbs moisture from the surrounding environment.

Because of this characteristic, Bentonite requires the presence of moisture in the ground to maintain its properties and may not function well in a very dry environment.



**Fig 7 Actual Chemical Earthing**

Several commercially available forms of earthing enhancement materials are available including powders, granules, pellets, gels and cement like mixtures. Many are comprised of carbon-based materials or clays like bentonite (or a mixture of both). Others contain copper sulphate or other copper-based compounds, which may not be environmentally friendly. Some earthing enhancement materials also contain cement (Marconite), which after installation sets up like concrete. This prevents the earthing enhancement material from leaching into the soil or washing away by groundwater.

## 7. CONCLUSION

Deep understanding of earthing system design is mandatory to have an appropriate and well designed earthing system.

Earthing (grounding) enhancement materials and compounds have been successfully used to lower grounding electrode system resistance

worldwide for decades. These materials have been especially useful in areas with high soil resistivity or where site limitations prevent achieving the required ground electrode using conventional grounding methods. IEC 62561-7 gives details of complete requirement for chemical earthing & this must be followed while choosing chemical earthing.

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**Dr. RAJESH KUMAR ARORA** obtained the B. Tech. & Master of Engineering (ME) degrees in Electrical Engineering from Delhi College of Engineering, University of Delhi, India in 1999 and 2003 respectively. He completed his PhD in grounding system design from UPES, Dehradun. He is also certified Energy Manager and Auditor. Presently he is working in D&E (Design and Engineering) department of DTL. His research interests include high voltage technology, grounding system, protection system, computer application and power distribution automation.

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## FATALITIES ON THE FIELD

As you all know that the electricity is an essential part of our lives but it is also very dangerous when one comes in contact to it, and there are so many incidents of injury or fatalities all around the world. There have been many incidents in the power industry, where our linesmen had to face many incidents, even though they took all the precautions to ensure their safety.

Today we would like to share some of our experiences and stories so that all of us can learn and improve our safety standards and protect lives of those people who ensure that the world gets uninterrupted electricity.

When it comes to electrical hazards, prevention depends on safe equipment, safe environment and safe work practices. Most commonly the victims of such hazards are experienced personals because of daily working experience. Due to repetition of work they tend to become compliant towards safety. This over confidence endangers life of the working personal.

**Case 1:** In certain part of South India, Employee #1 was accessing one particular line for routine maintenance. This line was taken on shut down but one of the consumers was using a generator with improper connection which back fire electricity to the line. Getting the line clearance, Employee#1

accessed the line without knowing there is a generator which feeds electricity back to the line. He has commenced his job and touched the line resulting in severe electric shock.

In such a situation, if there was a practise of using non-contact type voltage detector to make sure the line is completely dead, this event could have been avoided.

**Case 2 :** Employee#1 was accessing line after confirming clearance to work from the local substation. There was high induction present on the line and the Employee was not aware about it. As a routine procedure he connected the earthing rods without checking the proper connection. He climbed on to the line and got severe electric shock due to high induction.

In this scenario, if there was a practise of using non-contact type voltage detector to make sure the line is completely dead, this event could have been avoided.

**Case 3 :** In a certain region, Employee #1, a foreman, and Employee #2, an apprentice power line worker, both employed by a construction company,

were working at the site of a newly installed 345 kilovolt transmission tower. They were removing protective ground conductors from de-energized transmission lines. Employee #1 operated a crane truck, equipped with a personnel basket. Employee #2 was working from the crane's basket and using an 8-foot 6-inch fixed length shotgun stick (also known as a hot stick). The de-energized transmission lines ran parallel to other transmission lines that were energized at 138 kilovolts. Employee #2 received an electrical shock from induced voltage, lost consciousness, and fell across the basket's handrails. Employee #2 was taken to the hospital, where he was admitted and treated for electrical burns to his right hand and abdomen. During the subsequent investigation, it was determined that the crane's basket was not insulated, and the crane truck was grounded to the same source as the transmission tower. In addition, Employee #2 was not wearing electrical protective equipment.

**Recommendation  
Safe Work Practices**

Electrical accidents are largely preventable through safe work practices.

**Examples include:**

De-energizing electrical equipment before inspection or repair.

Repeated checking on de-energised electrical equipment/conductor by use of tools such as non-contact voltage detector to make sure the equipment/conductor is dead and there is no presence of induced voltage there.



Proper HSE training must be provided periodically to the team.

Use proper earthing at all times.

Lockout/tagout procedures should be practiced, to prevent accidental or unexpected incidents.

Maintain all tools and tackles as per industry standards.

Exercising caution when working near energized equipment.

Use appropriate personal protective equipment.

Proper guidance, safety and Tool talk to all individuals before starting work can avoid electric hazards.



Adapting to latest technologies to check whether the electrical equipment/line is live or has induced electricity, will guarantee more safety to the working personals.

For this we also recommend the use of non-contact voltage detectors. Such devices can detect the presence of voltage as well as induced voltage present after shutdown. The working area should be completely electric charge free.

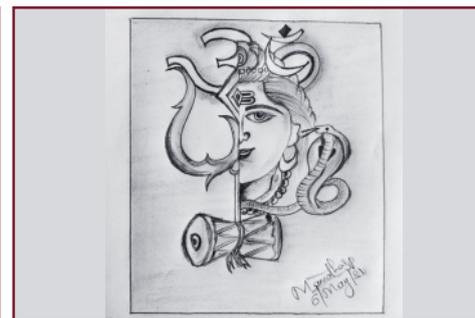
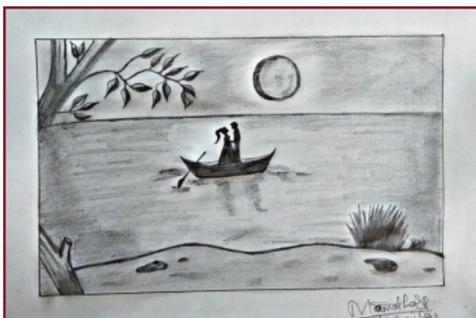
Keep unauthorised / untrained personal away from electricity works can enhance safety of entire maintenance team, by using visible markers such as isolation markers and danger tapes.

Prepared by **Mr. Suraj Makaram and Mr. Nijin Paul**

**HIDDEN TALENT**



By Sanchit



By Mamatha

## BIRTHDAY WISHES THIS QUARTER

Thippeswamy	08th Aug
Ranjan	13th Aug
Rajesh	18th Aug
Ajay	22nd Aug
Arvind	20th Sep
Naushad	27th Sep



## WELCOME NEW TAURUS COLLEAGUES



**RAVI PATNAIK**  
DGM  
Head Office



**RAHUL KRO**  
Engineer - Technical  
Guwahati

## TAURUS HOLIDAY LIST

02.10.2021	Saturday	Gandhi Jayanthi
13.10.2021	Wednesday	Saptami
14.10.2021	Thursday	Aayudha Pooje
15.10.2021	Friday	Vijayadashami
01.11.2021	Monday	Kannada Rajyotsava
03.11.2021	Wednesday	Narakachaturdashi
04.11.2021	Thursday	Deepavali
05.11.2021	Friday	Balipadyami/Bhai Duj/Deepavali
19.11.2021	Friday	Gurunanak Jayanthi
25.12.2021	Saturday	Christmas

## FROM EDITOR'S DESK



### Dear Readers,

To all the readers, I welcome you to our 5th edition of the WATTS UP magazine. This is a quarterly magazine released by Taurus Powertronics Pvt. Ltd, to educate, inform and update on the latest and greatest innovations, inventions and research in the field of Power.

Taurus is known for its cutting-edge inventions and innovations in the field of testing and measuring equipment for the power sector.

Taurus has over the years, contributed many life changing equipment and ideas in the field of Power, which were and are, widely accepted and appreciated all over the world.

Taurus is not only an inventor, designer and manufacturer of testing and measuring equipment, but Taurus is also engaging with partners from all over the world to bring the best of the testing and measuring technology out there.

This last couple of years have been hard on all the economies worldwide due to Covid. But life must go on and quality of electricity Generation, Transmission and Distribution, must be made better, so that this essential life dependent industry, is not only sustained but grows, to serve humanity.

I would like to make a quote here "Knowledge raises the Low, but Ignorance brings down the Mighty". To this I would remind and assert myself, that Covid is still very much a threat at the moment as it was a year ago. So lets come together and stand resilient against whatever this pandemic has to throw at us. We have, we can and we will be triumphant.

By Zohair Hazan, AD General Manager

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