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### 1.0 49<sup>th</sup> Annual General Meeting of ERDA

The 49<sup>th</sup> Annual General Meeting of ERDA was held under the Chairmanship of the President, ERDA, Dr. Vijay Shah on 14<sup>th</sup> Sep 2023 at The LaLiT Mumbai. This AGM served as a platform to highlight the ERDA's accomplishments over the past year and discuss the forthcoming research initiatives. The AGM was attended by members of ERDA from electrical industries, PSU and utilities across the pan India.



The AGM commenced with an opening address by chairperson, Dr. Vijay Shah, President of ERDA, who welcomed attendees and expressed

gratitude for the unwavering support from all the stakeholders of ERDA. He emphasized the ERDA's dedication to pushing the boundaries of research, service to electrical industries and fostering collaboration that contribute to progress of Power sector of India. Various milestones on research, financial overview, future initiatives, recognition and awards received by ERDA were presented during AGM.



AGM was concluded with the a question and answer session, allowing attendee to engage directly with ERDA's leadership team and get further insights into the organization's strategic direction.

### 2.0 President's Speech

**Delivered by Dr. Vijay Shah at the 49<sup>th</sup> Annual General Meeting of Electrical Research and Development Association held on 14<sup>th</sup> September, 2023**

My Dear Colleagues and Members of ERDA Family,

I heartily welcome you all to this 49<sup>th</sup> Annual General Meeting of Electrical Research & Development Association.

While this is my third year of serving ERDA as a president, I have been part of the managing committee since 2015, apart from my professional association with ERDA over the last three decades. ERDA, with its modest beginning in the year 1974, have successfully completed Forty-nine years of serving the Electrical Industry and now has entered into its glorious 50<sup>th</sup> year of service. After

starting initially as a national-level Research and Development Institute, ERDA today has clientele beyond national barriers. Today, ERDA is having backbone of more than 28 state-of-the-art laboratories and four business centres spread across India. ERDA serves its customers with the Head Office at Makarpura-Vadodara, Gujarat, through its major test facilities at Makarpura & Savli - Vadodara, Gujarat, along with three regional laboratories comprising, ERDA (West) at Navi Mumbai - Maharashtra, ERDA (North) at Gurugram - Haryana, and ERDA (South) at Rajahmundry - Andhra Pradesh. Also, it caters to the requirement of utilities with testing facilities at Narol (UGVCL) & Navsari (DGVCL) in Gujarat and Muradnagar, UP (PVVNL).

ERDA's spread across national industries is also reflected in ERDA's membership, which stood at 357 as of March 31, 2023, including 28 new members who were added during the year. Out of 357 members, there are now 297 Life Members and 60 Annual Members.

This year ERDA through its three verticals has achieved total revenue of Rs. 82.28 Crores, which is 4.76% higher than the revenue generated in the year 2021-22.

The Annual Report and Audited Statement of Accounts detailing ERDA's performance for the period from 1<sup>st</sup> April, 2022 to 31<sup>st</sup> March 2023 are already available with you and with your permission, I am taking them to have been read by all the members.

(Rs. In Lakhs)		
Particulars	2022-23	2021-22
Income (Total)	8,228.21	7854.47
Revenue Expenditure (Operational)	5,690.04	5196.36
Capital Expenditure	2,290.33	1626.29

In any case, I would like to summarize the key indicators of the financial results of the year 2022-23.

Further, I also feel happy to share & highlight key achievements and activities of ERDA during the year 2022-23 which also had been shared by the Director.

To start with, on the Research and Development front, ERDA has well well-established cross-functional R&D team to undertake Research and

Development activities. This team comprises experts from diverse fields, collaborating on relevant research projects which are aligned with industry needs. Engineers with specialized knowledge work also on various internal projects while contributing to contract research. The year 2022-23 witnessed the grant of two pioneering patents, setting new milestones in the domain of electrical safety. An additional two patents were filed during this period, further reinforcing ERDA's position as a leading force in innovation.

The patents filed showcase the dedication to safety in electrical panels, with breakthroughs in the form of a "Voltage Presence Indicator for Safety Application in Electrical Panel" and an innovative "Voltage Tester Device/System for Safety Application in Electrical Panel and Method thereof."

Moreover, ERDA's expertise extends to crafting transformative materials, evident in the grant of a patent for "Epoxy Nanocomposite Material for Insulation in Medium and High Voltage Electrical Appliances." Another granted patent is "Composition and Novel Process for Advanced Corrosion Resistant Paint."

During this year, ERDA successfully concluded two remarkable R&D projects namely "Nitriding of Dynamical Components of Switchgear for Life and Reliability Improvement," and "Development and Performance Evaluation of Potential Transformer (PT) with Epoxy Nanocomposite Insulation".

This unwavering dedication to research excellence is also evident in the remarkable pursuit of 11 research project proposals amounting to an impressive Rs. 322.71 Lakhs. These proposals were meticulously crafted and submitted to various esteemed government agencies and industries, showcasing ERDA's commitment to advancing the frontiers of knowledge and technology.

The accolades of ERDA's exceptional endeavours do not end here. ERDA's officers presented and published a staggering total of 27 Technical papers in prestigious national and international conferences. These prestigious platforms include the likes of CIGRE PARIS, CIGRE-GCC (RIYADH), CIGRE-GCC (MUSCAT), IEEMA - CABLES, WIRES & ACCESSORIES, DOBEL INDIA, NTPC, CBIP & SPE, among others.

During FY 22-23, eight new internal research projects have been taken up by the team. It is to be noted, that progress on R&D Projects gets reviewed by ERDA's Research Advisory Committee (RAC) apart from internal committees. The research team actively also participates in publishing technical papers in prestigious national and international conferences and workshops. Additionally, the members of ERDA R&D team guide post-graduate students from various universities in their dissertation work each year.

Further to ERDA's R&D project, ERDA facilitates, through upgradation & also introduction of new facilities across India in harmony with emerging technical needs. This in turn strengthens the developmental R&D activities of various manufacturers and utilities and helps them offer their products & solutions, in Local and global markets in compliance with governing standards.

On this front, ERDA augmented facilities of ERDA North Laboratory situated at Gurugram, Haryana and inaugurated them on 19<sup>th</sup> February 2023. The new facilities include New Transformer Oil including Ester Oils, Smart Energy Meter 3-Phase Tamper Simulator along with DLMS Facility and Cable testing facility.

During 2022-23, ERDA also introduced at Vadodara, a facility for the evaluation of DC Switchgear components. This includes short circuit evaluation facility of 10 kA at 270-1500 VDC, 15 kA at 290-1000 VDC, 30 kA at 690 VDC and making and breaking capacity of 1.5 kA at 1600 VDC.

The CTPT Laboratory started onsite evaluation of CTPTs up to 220 kV Voltage class for windmill plants. The lab also has completed on-site calibration of CT/PTs for customers in the Gulf Region.

The Partial Discharge Laboratory has been upgraded up to 900 kV to cater 400 kV voltage class product. The Laboratory has also developed Partial Discharge facility for Dry type transformers.

In Energy Meter Laboratory DLMS protocol verification tool has been updated to CTT 4.2 which will be useful to smart meter manufacturers to develop their meters with the latest version of DLMS Compliant standards IEC 62056 and the latest versions of IS 15959.

Additional two Automatic test set-ups have been added in the transformer laboratory during the year to maintain the constant power/current during the temperature rise test on the transformer. The laboratory is now equipped with six number parallel test bays to undertake routine, temperature rise and special tests for distribution transformers.

The Solar PV group added a new EL (Electro Luminescence) camera for the evaluation of micro cracks in Solar PV modules at the site. With the EL camera in place, the Solar PV group can now perform more accurate and thorough inspections, which will aid in identifying faulty modules early and implementing appropriate maintenance or replacement measures.

ERDA's Solar PV Module Laboratory has been providing solar photovoltaic module testing services to the nation for more than a decade. During the year, ERDA added new facilities in the existing Solar PV Module Laboratory which consists of type test facility as per IS 14286 and IEC 61215 standards. ERDA is now also equipped with the evaluation of EL image, Nominal Module Operating Temperature (NMOT), Outdoor exposure, Wet leakage current, Mechanical Load, Module breakage, Hail test, UV preconditioning, Bypass diode and Hot Spot endurance evaluation facility.

In Calibration Laboratory, facilities were added for various new equipment such as a Leakage current Monitor, Conductivity Meter, pH Meter, Pressure Gauge (up to 700 bar) & Weighing Balance (up to 15 kg), industrial gauges & ultrasonic thickness meter.

To enhance power transformer evaluation of the field service facility "Accurate Portable Loss Measurement System" is being installed. With this facility, ERDA will be able to test 500 MVA, 400 kV rating power transformers at manufacturing locations.

This system is the first of its kind in India. The NABL Scope is enhanced from 100 MVA, 220 kV class to 500 MVA, 400 kV rating of power transformer.

Further, New Impulse generator with a rating of 2400 kVp has been procured, Additional facility for 1000 hour Tracking and Erosion is also being rolled out and 5000 hour multistress test facility is also in progress and this will be introduced for use during 2023-24.



To further support the "Make in India" initiative keeping the objective of "Test & Certification in India", ERDA also put continuous efforts for obtaining numerous accreditations, & thereby enhancing services.

ERDA recently received UCA Accreditation for IEC 61850 Conformance testing of Numerical Relays and Intelligent Electronic Devices (IED). It is to be noted, that ERDA already has a state-of-the-art laboratory for communication protocol testing of substation automation devices. This laboratory is equipped with an array of DNV-GL, the Netherlands and test tools for complete conformance testing of communication as per IEC: 61850 – 5 to 10. ERDA is also accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL) for protocol testing as per these standards.

The cables and wires lab has received NABL accreditation for various specifications including,

- IEC 62067 - Power cable with accessories for rated voltage above 150 kV and up to 500 kV
- IEC 60840 -2020 - For SS EN 50397 -1 for Covered conductor
- IS 6162 part-1 and IS 6162 Part-2 - DPC wires and DPC strips
- The Sodium fusion evaluation facility for Halogen-free flame-retardant cable as per IS 17048.
- Bending test facility for HV and EHV cable up to 245 kV and up to 2500 sq. mm Copper cable.
- XLPE insulated power Cables of 110 kV tested as per IEC: 60840
- Ozone resistance evaluation facility augmented with the latest standard of BS and IEC.

The energy management Section has been empanelled with NTPC Consultancy Wing and PCRA for Performance Test and Energy Audit of Thermal Power plants.

In Lamps & Luminaires Laboratory, to the existing facilities, NABL accreditation was received for evaluation of LED Luminaires as per the new standard IES LM-79: 2019

version. NABL accreditation for Lux meter (LX) calibration and Luminous intensity (cd) parameter of Lamps was received.

In Liquid Dielectric Laboratory, following two facilities have been added to the NABL scope.

- i. Potentially Corrosive Sulphur Test of Transformer Oil as per IS 335 – 2018 and IEC 60296 – 2020
- ii. Stray gassing under thermo-oxidative stress of Transformer Oil as per IEC 60296 - 2020

In EMI/EMC Laboratory upgradation of radiated immunity for the field strength up to 60V/m and frequency below 1 GHz was commissioned. Earlier only partial evaluation was possible for equipment but with this new set-up, it will be possible to take up a full evaluation of Navy equipment as per MIL standards.

Providing another dimension of R&D expertise, ERDA also offers various expert services. During FY 2022-23,

Under the expert services, the Power System Group has carried out the following work:

- The Power System section received an assignment from GETCO for a protection audit of 400 kV / 220 kV substation & the group has completed the protection audit of all 111 Nos. substations.
- The section had received an assignment from GSECL for a protection audit of the power plant substation & the group has completed the protection audit of 17 Nos. substations.
- During the year section has completed the protection audit study of various Thermal Power Plants of Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd (Uttar Pradesh), Rajasthan Rajya Vidyut Utpadan Nigam Limited, (Rajasthan), North Eastern Electric Power Corporation Ltd (NEEPCO), Agartala, Tripura
- The section also completed the protection audit study for customers TATA Power and Jaiprakash Power Ventures Ltd.
- Power system group received the assignment from the Gujarat Energy Development Association (GEDA) for Third-party Inspection/Verification of Grid Connected Solar PV systems installed on Rooftops of

Government buildings/offices. The section has also carried out the assignment received from Adani Infrastructure Management Services Limited for the Earthing System Study and Lightning System study at pooling Substation and Wind Turbine

- During the year group has received an assignment for power quality measurement from Reliance Syngas Ltd, Jamnagar for 153 points; Hindalco for all voltage levels in their plant
- Switching surge measurement was carried out for L&T Metro rail (Hyderabad) Ltd.
- More than 10 Nos. jobs of Power quality measurement as per CEA guidelines for ReNew Power, Tata Power, Adani infrastructure, Mahindra teqo, Engie and Suzlon etc. were carried out during the year.

Similarly, the Energy Management Section has been awarded a prestigious assignment from Gujarat Mineral Development Corporation Ltd. (GMDC) for the Energy Audit of all 12 mines located across Gujarat. The Energy Management Section has also completed the prestigious Energy Audit job of Reliance Industries Ltd at Dahej and entered in Petrochemical Sector under the PAT scheme of BEE, Govt. of India. The section has also conducted Annual Energy and Accounting Audit for various DISCOMs like PGVCL, MGVCL, JVVNL, etc.

Further, In this year, the NDT Section has successfully participated in the Remaining Life Assessment Study of 3 no. of 500 MW Turbine & 1 no. of 210 MW Turbine from NTPC – Korba, 3 no. of 110 MW Turbine from NTPC – Tanda, 1 no. of 210 MW IP Turbine from GSECL, Wanakbori Thermal Power Station. The Section has also been awarded a prestigious assignment of In-situ Metallography of critical components of KRIBHCO Hazira and HAEP Plant, Surat.

Expert groups in ERDA have also undertaken various assignments which include Root Cause Analysis of failures of-

- Evaporator tube of Boiler
- TDBFP-6A OSG shaft and gear coupling of 500 MW power plant
- Rope hoist flange of coal plant
- High-Pressure Nut of Ammonia Pump of Urea Plant

- 220 kV silicone rubber insulators
- 66 kV cable joint

Reflecting the Technical prowess, ERDA in terms of Testing & evaluation during the year supported technically challenging varied Industry demands.

To illustrate, Short Circuit Laboratory, Makarpura has conducted the following evaluation in FY 2022-23:

- Earthing clamp used for the Transmission lines as per customer's specification as a development from 5 to 8 kA
- DC MCB evaluation of 6 kA at 525 V as per IEC and customer's specification
- Oil-cooled tap changer 11 kV, 200 A, 3 kA for 2 sec
- Short Circuit test on 3 phase Resin cast PT at 11 KV Test voltage as per IEC 61869 part 2 and 4 Specification.

In the transformer lab at Makarpura, 1400 nos. of transformers have been tested during this year. These include 500 samples received from BIS where ERDA has been playing an active part in the national cause of standardization of transformers. Also, the lab has carried out field testing of 96 nos. of power transformers at site.

In Impulse lab – Makarpura, 800 Nos. Power and distribution transformers of various ratings have been evaluated for impulse tests during the year. Various high-voltage products like Current Transformer, Potential Transformer, Cable and Bushing up to 220 kV have been evaluated for the dielectric test. A special Dielectric test on fire extinguishers was also performed during the year. More than 1200 Nos. insulators were tested for Utilities for the dielectric test. Further, On-site Calibration of High voltage source and Impulse measuring system was carried out for various customers in the Gulf Region.

At Impulse lab Savli, 33 Nos of EHV Class i.e., 245 kV Class high voltage products including, Bushings, Insulator, Circuit breakers, Isolators etc. were tested for various dielectric tests. Testing of the "Hot Line Washing Truck" used for online washing of Insulator string was done for "Leakage current measurement", to confirm safe operation during online washing of insulators.

In Magnetic Materials Laboratory, evaluation has been done for a large number of CRGO core laminations for transmission companies including PGCIL, KPTCL, PSPCL and GETCO as well as power transformer manufacturers of the country including Atlanta Electricals Pvt. Ltd., Transformers & Rectifiers (India) Ltd., GE T&D India Ltd., Hitachi Energy India Ltd. & Andrew Yule & Co. Ltd.

During the year, Third Party Inspection section received a New Order from M/s Southern Power Distribution of Andhra Pradesh Limited (APSPDCL), Tirupati for Material Inspection and Factory Inspection, M/s Eastern Power Distribution of Andhra Pradesh Limited (APEPDCL), Vishakhapatnam for Factory Inspection. The section has also received a new order from M/s Southern Power Distribution of Telangana Limited (TSSPDCL) - Hyderabad and M/s Ajmer Vidyut Vitran Nigam Limited (AVVNL)-Ajmer for Material Inspection. An extension of the order was received from M/s Paschimanchal Vidyut Vitran Nigam Limited (PVVNL), Meerut.

During the year 2022-23, ERDA evaluated more than 50,000 samples in its different laboratories. These included samples from more than 60 electrical utilities/Govt. Sector/ PSU companies in India.

Apart from in-house testing, ERDA catered to more than 2200 inspection calls for third-party inspection and 500 nos. of field services jobs.

ERDA has accreditations and recognitions from various agencies for different disciplines. Audits were conducted for the same during the year as follows:

- NABL assessment of ERDA-Vadodara in accordance with ISO/IEC 17025:2017 for testing discipline was conducted in May 2022 and for Calibration discipline in December 2022.
- NABL assessment of ERDA-North (Gurugram) in accordance with ISO/IEC 17025:2017 for testing discipline was conducted in June 2022 and for Calibration discipline in November 2022.
- NABL assessment of ERDA-South (Rajahmundry) in accordance with ISO/IEC 17025:2017 for testing discipline was conducted in November 2022 and for Calibration discipline in December 2022.

- NABL assessment of ERDA-West (Rabale) in accordance with ISO/IEC 17025:2017 for testing discipline was conducted in March 2023 and for Calibration discipline in February 2023.

Renewal of accreditations was received for the existing scope for all the above.

Apart from NABL audits for other accreditations and recognitions were conducted which include -

- NABCB surveillance assessment carried out in March 2022 as per ISO/IEC 17020: 2012, and continuation of accreditation has been granted.
- ISMS Surveillance assessment was completed in June 2022, and continuation of accreditation has been granted.
- ASTA (Intertek) Routine assessment was completed in November 2022, and continuation of accreditation has been granted.

ERDA consistently dedicates itself throughout the year to serve society and the nation, and because of its tireless efforts, it has been honoured with two prestigious awards.

ERDA received the "Mahatma Award for Social Good and Impact 2022" by virtue of impactful contribution to Social Impact through Research and Development for society. The award was presented by the Aditya Birla group to ERDA on 1<sup>st</sup> October, 2022 at India International Centre, New Delhi.

ERDA through its contribution in digital transformation, has been adjudged as a recipient of the "Digital Transformation Excellence" in the Electrical & Power Category at the 2nd Digital Transformation Summit Awards 2022. The award was presented to ERDA on 25<sup>th</sup> November, 2022 at Mumbai.

At ERDA, passion for knowledge-sharing knows no bounds. The team constantly strives to disseminate knowledge in every way imaginable. As a part of this, during the year, ERDA conducted 14 offline workshops on various topics for the benefit of industries and a total of 327 participants from various industries participated in these workshops.

In addition to the above, a training program was jointly Organized with IEEE Gujarat and

IEEE PES Chapter on 5<sup>th</sup> August 2022 on “Solar Photovoltaic – Bulk and Rooftop” to bring experts, developers, transmission utilities, distribution utilities and academics together to explore opportunities and challenges in adopting Solar PV generation.

ERDA also conducted a three- and a half-day customized training programme for ABB (India) limited by offering training sessions on “Professional Laboratory Operations” to ABB officials.

ERDA organized customized training on transformers and cables for BIS Officials. Adding to that, the Energy Audit Workshop was conducted at GSFC, Vadodara during the year.

ERDA participated in five Domestic and International exhibitions during the year. Domestic Exhibitions included ELECRAMA, REI, DistribuElec, CBIP exhibition on Power Reforms and IESS. ERDA also participated in the Middle East Electricity Exhibition in Dubai as a part of the International Exhibition.

To communicate new developments in ERDA to customers and to understand the requirement and expectations of customers, the Business Development group regularly organize online and offline customer interactions along with the technical team of ERDA. During this year, these included a discussion with:

- Manufacturers of HTLS Conductors in Silvassa Region
- Discussion with load dispatch centres and power committees like NRLDC (Delhi), WRLDC (Mumbai) & WRPC (Mumbai)
- Interaction with Transmission Companies of Maharashtra, Madhya Pradesh and Distribution Companies of Gujarat
- Discussion for various contract research opportunities with Panasonic, Eaton, HBL, Caterpillar, Signify, Luminous and Amararaja

During the year, BD Group along with the IT Section launched a new website of ERDA. The new website was inaugurated on 18<sup>th</sup> February, 2023 during the ELECRAMA 2023 exhibition. The new website is built with WordPress, a content management system (CMS) built using PHP programming language. The new website has more than 70 pages and it has a

responsive design which works same across all devices.

ERDA always believes that Employees are the real asset of the organization. To develop their competency and capability building, soft skills training such as “Self-Motivation and A Success Mindset” were provided for all levels of employees. A total of 2627 man-hours of training was provided about soft skills and 1477 man-hours of training was provided on the respective technical domains, totaling 4104 man-hours of training during the FY 2022-23.

Expert Lecture sessions also had been conducted wherein our employees were enlightened with a lecture on Hydroelectric Cells by Dr. R.K. Kotnala – NABL Chairman, Fellow National Academy of Sciences India; currently serving as an Advisor on ‘Magnetic Measurements of Indian Neutrino Observation (INO) as Raja Ramanna Fellow. Another expert lecture on POSH (Prevention of Sexual Harassment) was delivered by the expert Ms. Ashu Manchanda – A Certified Professional Trainer.

ERDA believes that continuous progress comes from ongoing learning and developing the knowledge, skills, and competencies of its most valuable asset – its personnel. Therefore, ERDA management has provided permission to pursue higher education to four employees during FY 2022-23 out of which one employee is pursuing doctoral studies, one for master of Engineering and two employees are pursuing a bachelor of Engineering.

During the year, ERDA organized employee engagement functions celebrating:

- World Environment Day
- Independence Day
- Republic Day
- Ganesh Utsav
- Dussehra Puja
- Swachh Bharat Abhiyan - Clean ERDA, Clean India
- Carrom & Table Tennis Tournaments
- 110 ERDA employees participated in the Vadodara International Marathon organized



on 8<sup>th</sup> January 2023 out of which 7 employees participated in the 5 km Fun run and 103 employees participated in the 10.5 km run.

Looking at ERDA's growth trajectory over the past 49 years, ERDA has emerged as a nationally reputed premier laboratory with financial self-reliance and technical competence, supported by a committed team of 376 employees spread over the length and breadth of the country.

ERDA, India's leading professional institute in applied Research has now successfully entered its 50<sup>th</sup> Year of Service. Reflecting this march, a unique 50<sup>th</sup> anniversary logo was unveiled at the ELECRAMA exhibition in February 2023, marking a significant milestone. Subsequently, from March 13, 2023, as ERDA officially entered its 50<sup>th</sup> year, this logo has prominently featured on all documents used for internal and external communication with our valued customers and employees.

As a part of the Golden Jubilee Celebration of ERDA, a series of Customer Outreach Programme – "Sampark" has been planned across various cities of India. The programme seeks to stimulate interaction and inspire knowledge sharing by obtaining insightful feedback from existing and potential customers regarding their requirements in various services provided by ERDA for the last 50 years.

To mark the incredible 50 years journey of ERDA, a series of employee outreach programs also have been planned throughout the year.

In summary, ERDA through its excellence in R&D, Testing & Evaluation, Field and expert services has been a catalyst for the country's industrial growth over the last five decades.

Before I conclude friends, I wish to express my sincere thanks to Vice President ERDA- Mr. Tapan K. Tripathy & EC members, Mr. S Srinivasan, Mr. Rajaram Shinde as well as all my colleagues in the Managing committee. I also would like to acknowledge the contribution of all past Presidents, Vice Presidents and previous MC members in this journey for the growth of ERDA. My thanks are also due to the Director General - CSIR, the Industries Commissioner- Government of Gujarat and the Director General- IEEMA, for their valued support.

Finally, I take this opportunity to thank all employees for their passionate contribution under the leadership of Director Dr. Satish Chetwani & his collegium team- Dr. Uday Puntambekar and Rajib Chattopadhyay, for all the achievements. There would be many more hands who have participated in today's growth of ERDA since its establishment, I also acknowledge their contribution. I would also like to thank our valued members and customers for putting their faith in ERDA's capabilities and utilizing ERDA's competence for their business needs. I look forward to receiving continued patronage of ERDA from you all in the years to come.

Jai Hind.

## 3.0 R&D and Expert Services

### 3.1 Expert Services

#### 3.1.1 Root Cause Analysis of 400 kV Failed Silicone Rubber Insulators

Root cause analysis (RCA) was conducted on failed 400 kV silicone rubber insulators (SRI). Two SRI located on the same tower failed, Insulator-1 failed after a service life of 4 years and Insulator-2 failed after a service life of approximately 5 years, as shown in Figure 3.1.1(a) and Figure 3.1.1(b). Both showed different failure mechanisms, Insulator-1 showed punctures in the silicone sheath and the silicone sheath was separated from the composite core rod. Insulator-2 showed a damaged silicone rubber sheath on the entire length of the insulator and no punctures were observed in the sheath. The corona ring and tower end metal fittings showed damage related to arcing, for Insulator-2. Both insulator composite core rods had electrical tracking marks on their entire length.

The tower on which the insulators were installed is located in a hilly region with continuous monsoon rain. The insulator silicone rubber housing was covered with algae. For the RCA job, 4 working insulators were removed from the tower and received at the laboratory for analysis. Among the 4 working insulators, three were found with punctured silicone rubber sheath near the line end. One SRI was in good condition with no indication of degradation. RCA analysis of the two failed SRIs indicated different failure mechanisms based on the analysis work carried out on



failed as well as working SRIs. One SRI failed due to arcing during monsoon due to lightning strikes, the arcing distance for the SRI was reduced due to algae-covered silicone housing. The punctured insulator had excess electrical stress due to tower geometry additionally with reduced hydrophobicity due to algae cover. The SRI quality did not show any problem. Recommendations were given for periodic inspection and preventive maintenance.

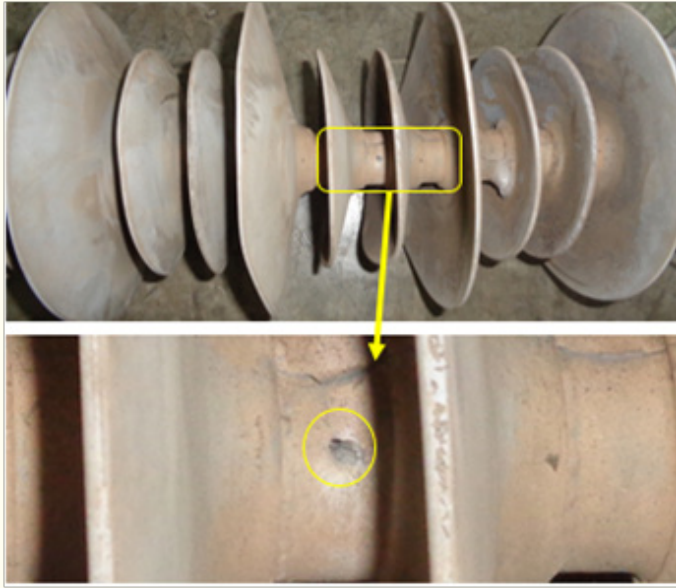


Figure 3.1.1(a): Failed Insulator-1, punctures in the silicone rubber sheath was visible



Figure 3.1.1(b): Failed Insulator-2, silicone rubber sheath damaged on entire length

### 3.1.2 Condition Monitoring of 400 kV Silicone Rubber Insulators

A utility wanted to assess the condition of 400 kV Silicone Rubber Insulators (SRI) which have been in service for the past 8 years. The SRI was located in a coastal region with high humidity and dust. During their 8 years of service life, no SRI failures were observed on the transmission line. However, the utility wanted to evaluate the condition of SRI to take preventive maintenance measures based on the report. For condition monitoring, a site visit was conducted for visual analysis. For laboratory analysis one SRI was removed from service and one insulator from the store was received. The service SRI is shown in Figure 3.1.2(a). Based on the site observations and laboratory analysis of SRI it was concluded that

the insulators were in good condition with no indications of degradation. Recommendations were provided based on the site observations as well as laboratory analysis for preventive maintenance of SRI.



Figure 3.1.2(a): As received SRI for condition monitoring

### 3.1.3 Root Cause Analysis of Broken Copper Conductor of 145 kV Reactor Bushing

Root cause analysis of broken copper conductor of 765 kV reactor bushing was carried out. The bushing failed within a year of installation. The rated current and voltage of the bushing were 1250 A and 145 kV, respectively. The investigation of the broken and unused copper conductor was done using various analysis techniques (OES, optical microscopy, SEM, EDS, Mechanical and electrical tests) to assess the integrity of the material and identify the failure mechanism.

The copper rod was fractured in two parts. The chemical composition of copper conductors matches with Cu-ETP grade. The electrical conductivity, hardness, tensile strength and % elongation of both failed and unused copper conductors met the IS 613 specification requirement. The microstructure of failed and unused copper conductors shows copper grains and annealing twins in them. No abnormality was observed in the microstructure of the failed conductor in comparison to the unfailed conductor.

The detailed fractography of the broken copper conductor showed the flat appearance fracture surface with three distinct fracture zones; crack initiation, propagation and final fracture. Ratchet marks at crack initiation and fatigue marks/beach marks in the crack propagation region were observed on the fracture surface. No dimensional changes were observed due to deformation/fracture during the failure of the copper conductor rod. SEM micrographs clearly showed the intergranular fracture in the propagation zone with the presence of fatigue striations which confirmed the fatigue failure of the copper conductor rod. Dimple formation occurred in the final fracture zone indicating

ductile fracture.

It was inferred from the detailed analysis that the failure of the copper conductor of the reactor bushing occurred due to fatigue. The presence of ratchet marks, fatigue marks and striations on the fracture surface confirmed the fatigue failure of the copper rod.

The fatigue fracture was observed where the bushing was connected to the transmission line through the terminal. This portion has a high possibility of bending stresses compared to another region of copper conductor. The reason for cyclic/fluctuating load could be vibrations in the reactor itself or aeolian vibrations of the transmission line.

As the failure of copper conductor has occurred due to fatigue, it was recommended to control the levels of cyclic or fluctuating load due to vibrations acting on the copper rod from the reactor and transmission line.

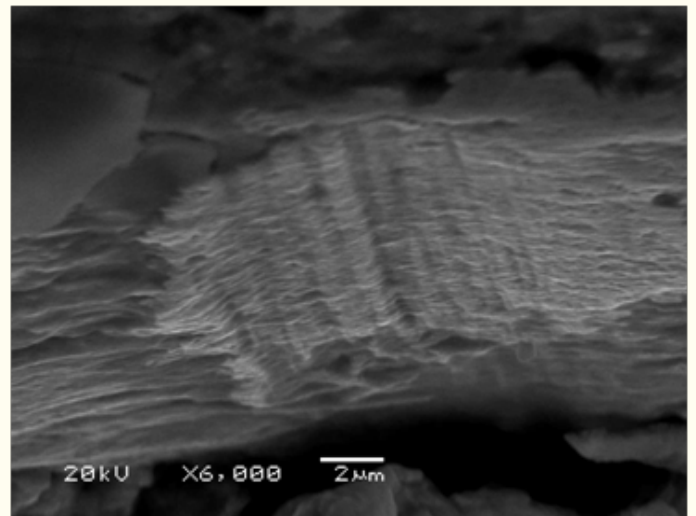
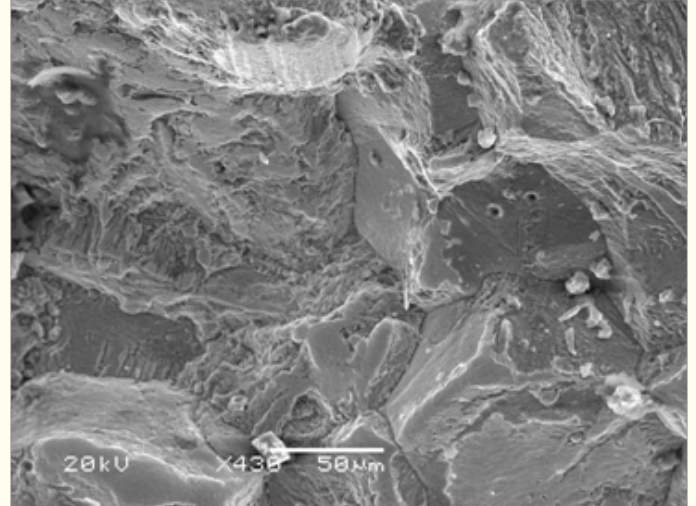


Figure 3.1.3(b): SEM micrographs of broken copper conductor fracture surface with fatigue striations



Figure 3.1.3(a): Photographs of broken copper conductor and its fracture surface



Figure 3.1.3(c): Optical micrograph of copper conductor. It shows copper grains and annealing twins inside it.

### 3.1.4 Bus Reactor planning study at 400 kV system of substations



One of the utilities has given a system study project on conducting the reactor planning study (Technical feasibility study) for the installation of a Bus reactor at 400 kV system of two generating stations. One of the generation stations having four units of 210 MW and one unit of 500 MW generator whereas the second generating station has two units of 500 MW generator.

Various data was collected i.e. (Generator Details, Transformer Details, Load Details and Line Parameters) for both the thermal power stations. Accordingly, load flow simulations were carried out on ETAP software for three different loading conditions (i.e. Peak Load, Average Load and Off Peak Load). In each loading condition, bus voltage at 400 kV (Nominal Value) was observed and compared with operating voltage limits mentioned in IEGC-2023 (Indian Electricity Grid Code-2023) and CEA- Manual on Transmission Planning Criteria-2023. It was found that in both of the generating stations, the voltage at 400 kV Bus was going beyond the permissible maximum limit (i.e. 420kV) as specified in the standards/norms in all three loading conditions (i.e. Peak Load, Average Load and Off Peak Load). Hence, two units of 125 MVAR reactor were suggested for one generating plant (considering the available rating as per CEA manual on Transmission Planning Criteria-2023) and one unit of 125 MVAR was suggested for another generating plant. The tentative costing of the bus reactor of 125 MVAR rating was also given.

### 3.1.5 Power Quality Measurement and Assessment at Wind Power Plant as per CEA Mandate

Power System section of R&D (TM4) has carried out power quality measurements for three Wind power plants at Gujarat site. Measurement was carried out at 220 kV line 1 & line 2 of 220/33 kV point of common coupling, where metering CTs and PTs were connected. Following power quality parameters were measured as per CEA guidelines:

- Current Harmonics
- Flicker
- DC injection

Measurements were carried out for one week. Based on measurement, the power quality profile of the plant was identified.

As per CEA mandates, renewable energy developers have to submit a detailed report to utility / LDCs. ERDA conducted detailed measurements based on CEA guidelines and a measurement report for the same was given to the customer for further submission to utility/LDCs.

### 3.1.6 Electrical Field Analysis of 220 kV - 90 kN, 120 kN Polymeric Insulator

A polymeric insulator design analysis study was undertaken for the client. Specifically, the work involved detailed Electrostatic Field Mapping (Electric field and voltage) at RMS voltage level on 132 kV single and double 90 kN suspension insulators. ERDA performed this study using 3D Ansys Maxwell software and provided the results of Electric Field Strength at various locations across the insulator profile.

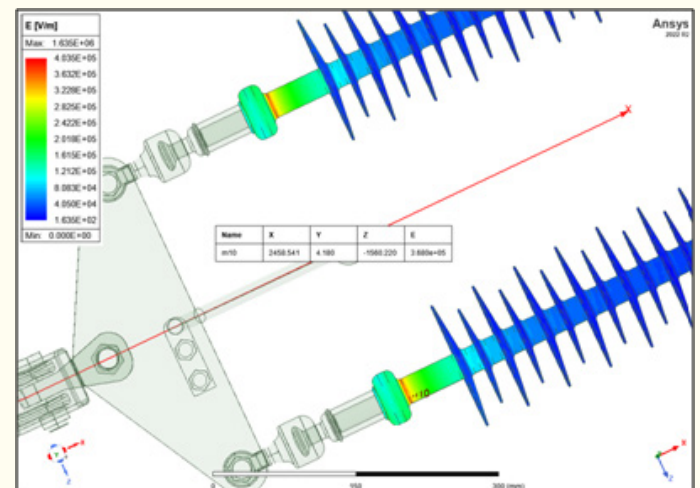


Figure 3.1.6 (a): Surface E-field magnitudes on weather-shed material

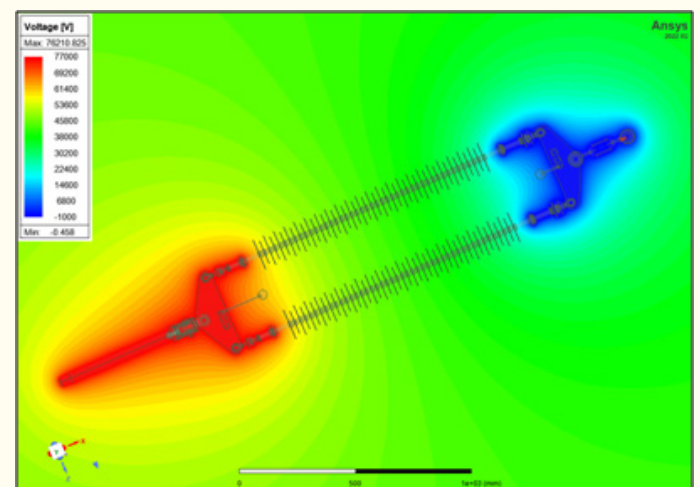


Figure 3.1.6 (b): Overall voltage distribution surrounding insulator

### 3.1.7 Line Impedance Resonance Analysis (LIRA)



LIRA is a Non-Destructive Testing of cables that does not require cables to be energized to high voltages. It is a safer technique where the risk of cable failure may be due to the application of High voltages. Line Impedance Resonance Analysis (LIRA) was developed as a Non-Destructive Testing of cables in the nuclear industry. LIRA can be carried out on electrical cables hundreds of kilometres in length and is becoming increasingly effective for condition monitoring, or fault location. LIRA relies on the correlation between the insulation's condition and its capacitance. The capacitance of a cable changes as a function of changes in the cable's permittivity and changes in the cable's geometry (i.e. bend or change in radius).

### LIRA Features

- LIRA can be used for long length of cables
- Suitable for cable testing where HV application is considered hazardous
- Can be used to provide initial cable 'fingerprinting', so you can easily recognize when a fault has occurred on a cable. This approach provides the best results
- Accurate detection of changes in impedance
- Localizing of faults to within 0.3% of the cable length
- Can locate joints on circuits where they would be otherwise unknown

### 3.2 Papers Presented

Below is the details of the paper presented by ERDA officials at a conference organised in the last quarter.

Sr. No.	Title	Author(S)	Conference / Seminar/ Journal	Organized by
1	Efficiency Improvement of Thermal Power Plant – Case Studies	Mr. Arunesh Dwivedi, Mr. Bhavesh Vasiyani, Mr. Anil Khopkar	Best O&M Practices for Thermal Power Plants under Energy Transition Regime, 1 <sup>st</sup> – 2 <sup>nd</sup> August, 2023	CBIP, Delhi

- LIRA can detect the following problems with cables:
  - o Global insulation degradation
  - o High-Temperature damage
  - o Moisture ingress
  - o Radiation damage
  - o Mechanical effects/defects

### LIRA measurement principle

LIRA measures the surge impedance of cable over a large range of frequencies from 100 MHz to 100 kHz. For an ideal cable where geometry is consistent & not affected by external factors, the surge impedance remains almost constant over the length of the cable. Any discontinuity due to joints, cable damages & defects will change the impedance. These changes are reflected in LIRA signatures. ERDA has now established this facility to provide services to the utilities.

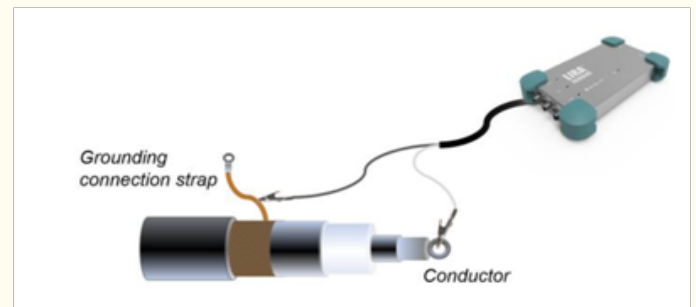


Figure 2.1.7 (a): LIRA Connections

## 4.0 New Facility

### 4.1 Product Testing Laboratory at DGVCL, Navsari

The establishment of the Product Testing Laboratory at DGVCL, Navsari by ERDA marks a significant development. The facility is now operational, focusing on conducting tests for Distribution Transformers exclusively catering to DGVCL. It specializes in testing transformers with capacities up to 500 kVA and voltage ratings of 22 kV/433 V. This state-of-the-art laboratory enhances ERDA's capabilities in ensuring the quality and reliability of electrical distribution transformers.



ERDA's Product Testing Laboratory at DGVCL, Navsari

## 5.0 Knowledge Dissemination

### 5.1 ERDA Workshops

During this quarter, ERDA organized workshops of one and two days duration. These workshops consisted of presentations covering a range of topics, along with practical demonstrations and visits to laboratories. Participants from DISCOMs, TRANSCOs, Government Utilities, and private organizations attended the workshops. The details of the workshops conducted are as below.

#### 1. Two days Workshop on High Voltage and Partial Discharge Measurement Techniques

ERDA organised two days workshop on High Voltage and Partial Discharge Measurement

Techniques on 5<sup>th</sup> - 6<sup>th</sup> July, 2023. The Workshop covered topics such as Basic High Voltage Engineering, Methods of protection against over voltage in power system, Insulation Co-ordination in Power system, Impulse Voltage Testing Techniques, High Voltage Testing Techniques, Basics of Partial Discharges, Earthing System for high voltage testing, Unconventional method of PD measurement and Calibration followed by demonstration of tests of HVAC Power Frequency Testing, Impulse Voltage and Partial Discharge Measurement.



Group photo of workshop participants with ERDA officials

#### 2. Two days workshop on Performance Assessment and Simulation Analysis of Rotating Electrical Machines

ERDA organised two days workshop on Performance Assessment and Simulation Analysis of Rotating Electrical Machines on 2<sup>nd</sup> - 3<sup>rd</sup> August, 2023. The Workshop covered topics such as Design aspects and selection of centrifugal pumps, Testing & Performance evaluation of Pumps, Solar Pumping Systems & Motors, Ingress Protection Testing, Electromagnetic compatibility (EMC) testing of rotating machines, Design aspects and selection of induction motors followed by Demonstration of Tests of pump sets & Tests of Motors.



Group photo of workshop participants with ERDA officials



### 3. Workshop on Quality Assurance of wiring Accessories – Switches, Plugs & Sockets

ERDA organized two days workshop on Quality Assurance of Wiring Accessories – Switches, Plugs & Sockets on 23<sup>rd</sup> – 24<sup>th</sup> August, 2023. Workshop covered topics such as Testing of Domestic Switches, Insulating Material, Plugs, Sockets, Lamp Holders, Ceiling Roses and Electronic Fan Regulator. Workshop was concluded by Demonstration of Tests and Laboratory Visit.



Group photo of workshop participants with ERDA officials

### 4. One-Day Workshop on Smart Meters

ERDA organised One day workshop on Smart Meters Evaluation on 12<sup>th</sup> September, 2023. Workshop covered topics such as Type Testing of Energy Meters, EMI/EMC Testing of Energy Meter, Calibration of Energy Meters and Reference Standard Meters, DLMS Protocol Verification for Energy Meters followed by Lab Visit and Demonstration of test facility.



Group photo of workshop participants with ERDA officials

### 5. Workshop on Evaluation HT, LT Cables and Accessories including Solar application Cables

ERDA organised Two Days workshop of HT, LT Cables and Accessories including Solar application Cables on 21<sup>st</sup> - 22<sup>nd</sup> September, 2023. Workshop covered topics such as Evaluation of Non-Electrical Properties of Cables, Special Tests on Cables and its Accessories, Testing and Evaluation of Solar

cable, FRLS Tests on Cables, Evaluation of HT Cables & Accessories: Electrical Test, Condition Monitoring of cable, Short Circuit Test on Cables, Impulse Voltage Testing followed by Demonstration of Tests.



Group photo of workshop participants with ERDA officials

### 5.2 Students Visit at ERDA

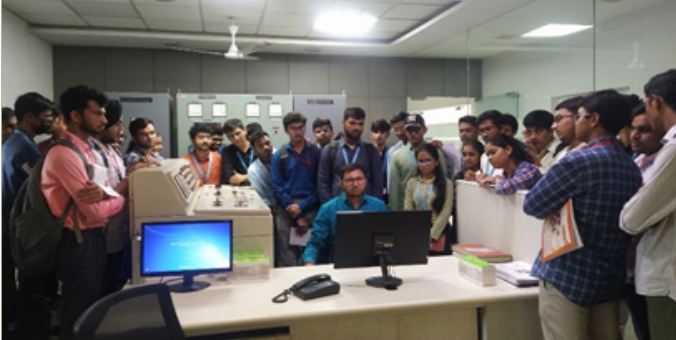
At ERDA, our passion for knowledge-sharing knows no bounds. We constantly strive to disseminate knowledge in every way imaginable. As part of this, we arrange industrial visits for engineering students, enabling them to explore a world of practical knowledge. These visits offer a remarkable opportunity for students to embark on a captivating journey through diverse laboratories, where they can acquire invaluable hands-on experience.

During the last quarter, we welcomed students from the following engineering colleges.

1. BVM Engineering College, Vallabh Vidyanagar
2. Chandubhai S. Patel Institute of Technology, CHARUSAT University, Changa







Glimpse of students' visit at ERDA

### 5.3 Courtesy Meeting

Team ERDA North (Mr. Brijesh Sachdeva, Mr. Gaurav Sharma and Mr. Rajat Varshney) visited the office of Shri Shashank Misra, IAS & Joint Secretary (Distribution), Ministry of Power, Shram Shakti Bhawan, New Delhi on 18<sup>th</sup> August, 2023. This meeting likely served as an opportunity to collaborate and share information ERDA's new offerings to the industry.



Team ERDA North with IAS Shri Shashank Mishra

## 6.0 Visit of Customers

### 6.1 Witness from M/s. ALAF CEKAL SDN BHD, Malaysia

On 11<sup>th</sup> July, 2023, officials from M/s. ALAF CEKAL SDN BHD, Malaysia visited ERDA, Savli to witness the testing of 4000 Amp. LT Panel. ERDA had the privilege of hosting Ms. Hazimah Mustafar from M/s ALAF CEKAL SDN BHD, Malaysia.



ERDA experts with officials from M/s ALAF CEKAL SDN BHD, Malaysia at Short Circuit Lab, Savli

### 6.2 Witness from Gathergates, Malaysia

On 25<sup>th</sup> July 2023, officials from M/s Gathergates, Malaysia visited ERDA, Savli to witness Short Circuit testing of 3 Ph, 50 Hz, 250A LT Panel. ERDA had the privilege of hosting Mr. P.C. Shah and Mr. See Kah Tang from M/s Gathergates, Malaysia.



ERDA experts with officials from M/s Gathergates, Malaysia at Short Circuit Lab, Savli

## 7.0 Letters of Appreciation

Positive feedback and letters of appreciation inspire us to continue striving for customer

satisfaction. Here are excerpts from some of the received appreciation letters.

## 7.1 Sunny Technical Services, Madhya Pradesh

"...Your work was commendable, and we appreciate it. Thank you..."

## 7.2 CG Power and Industrial Solutions Limited, Nashik

"...Thank you for promptly responding to our requirements and delivering reports on time. Your work and support are highly appreciated..."

## 8.0 Customer Outreach Programme – "Sampark"

### 8.1 Customer Outreach Program – "Sampark" at Raipur

Customer Outreach Program – "Sampark" was organised at Raipur on 25<sup>th</sup> July, 2023 under the theme "Simulating the optimum usage of Energy in Electrical Distribution Systems." More than 35 participants from member companies and customers in nearby areas attended the event. The program included presentations on Third – Party Inspection of Distribution Products, Root Cause Analysis of Distribution Components, Energy Saving Opportunities in Process and Steel Plants, Partial Discharge Diagnostic for Smart Distribution Networks, Expert Services for Distribution Systems and Protection Audit and Evaluation of T&D Conductors. The event was very well appreciated by participants present in the event.



Team ERDA with customers at "Sampark" - Raipur

### 8.2 Customer Outreach Program – "Sampark" at Bharuch

On August 26<sup>th</sup>, 2023, a Customer Outreach Program "Sampark" took place in Bharuch

under the theme "Enhancing Reliability of Electrical Systems." The event was attended by over 50 participants from member companies and customers in the nearby area. The main focus of the program was to highlight the expert services provided by ERDA, and it included informative presentations on various topics such as Energy Audit, Non Destructive Techniques, Expert Services on Power Systems for Industries, Root Cause Analysis of Failed Components and ERDA's Mobile Laboratory. All the attendees, including both members and customers, expressed a highly positive response and deep appreciation for the event.



Team ERDA with customers at "Sampark" - Bharuch

### 8.3 Customer Outreach Program – "Sampark" at Kolkata

Under the theme 'Enhancing the Reliability of Electrical Systems,' Customer Outreach Program 'Sampark' was held in Kolkata on September 26<sup>th</sup>, 2023. The event witnessed a strong turnout, with more than 45 participants from member companies and customers in the nearby area. The program's primary objective was to showcase ERDA's expert services, featuring informative presentations on a range of topics, including Evaluation of Distribution Transformers, Evaluation of T&D Conductors, Third-Party Inspection of Distribution Products, Partial Discharge Diagnostic for Smart Distribution Networks, Expert Services for Distribution Systems and Protection Audit and Root Cause Analysis of Distribution Components. The event was met with enthusiasm and appreciation from all the attendees, comprising both members and customers.





Team ERDA with customers at "Sampark" - Kolkata

## 9.0 HR Initiatives

### 9.1 Learning and Development

ERDA believes that continuous improvement comes through constant learning and by sharpening knowledge, skills and competencies of the most important asset - the employees

#### 9.1.1 Training on 'Promptness in Customer Response':

ERDA organised a training on 'Promptness in Customer Response' for the entire CRM section and all the Head of Sections of ERDA on 1<sup>st</sup> July 2023. The objective was to excel in terms of promptness in replying or responding to the customer. A timely response to the customer helps in removing misunderstandings and finally helps in the retention of the customer.



Mrs. Hiral Matalia from MPOWER Training Solutions delivering the training on 'Promptness in Customer Response'

#### 9.1.2 Testing & Calibration Laboratories as per ISO/IEC 17025:2017:

Training on Awareness of General Requirements for the Competence of Testing & Calibration Laboratories as per ISO/IEC 17025:2017 was organised by ERDA in July and August

2023 for all Head of Sections and Division. To strengthen the Quality Management environment in ERDA, employees are key drivers to ensure the quality of test results. Our experienced talented employees were provided exposure to growth opportunities based on their competency.



#### 9.1.3 Training on 'Inner Engineering at Isha Leadership Academy, Vadodara'

ERDA nominated two teams consisting of Group Head of Sections, Head of Sections – Technical as well as Corporate functions to attend the training on 'Inner Engineering' organised by Isha Foundation, Vadodara. The Inner Engineering is a technology for well-being, derived from the ancient science of Yoga. The program focussed on keys to meaningful and fulfilling relationships at work, at home, in the community and most importantly, within yourself.





Training Participants from ERDA at Isha Leadership Academy, Vadodra

## 10.0 ERDA Celebrations

### 10.1 Independence Day Celebration

ERDA celebrated Independence Day with great enthusiasm on 15<sup>th</sup> August, 2023. Mr. Harish Kharva from the P&A section and Mr. Ashutosh Joshi from the Liquid Dielectrics section were invited to do the honour of hoisting the National Flag. Mr. Ashutosh Joshi and Mr. Harish Kharva both are going to retire from ERDA in October and December 2023 respectively.



Mr. Harish Kharva and Mr. Ashutosh Joshi shared a few words on the occasion



Independence Day celebration at ERDA

### 11.2 Ganesh Chaturthi Celebration

The festival of Ganesh Chaturthi was celebrated in ERDA on 19<sup>th</sup> September, 2023 with great devotion and enthusiasm. The self-motivated employees took the initiative, renovated the Ganesh Temple Area, decorated the temple, performed the Ganesh Puja and distributed the Prasad with great devotion.





Ganesh Puja, Ganesh Aarti and ERDA Employees with Ganpati Bappa

A Satyanarayan Puja was organised by ERDA employees on the occasion of Ganesh Utsav on 25<sup>th</sup> September, 2023. The employees attended the puja and had Prasad.



ERDA and its employees gave a royal send-off to Lord Ganesh on Visarjan day on 28-Sep-2023. The employees showed tremendous enthusiasm and played Garba, danced and enjoyed the Visarjan. The visarjan was followed with a High Tea.

## 11.0 Achievement – Congratulations Mr. Anil Khopkar:



ERDA extends its congratulations and appreciation to Mr. Anil Khopkar, who serves as the Assistant Director and Head of Research and Development. The Bureau of Indian Standards (BIS) has nominated him as a member for the IEC Technical Committee "TC 99/JWG 13 - Insulation Coordination for HVDC Systems" from India, and this nomination has been officially accepted by the International Electrotechnical Commission (IEC).

### ELECTRICAL RESEARCH AND DEVELOPMENT ASSOCIATION

(Accrediated by the National Accreditation Board for Testing and Calibration Laboratories Govt. of India)

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