Electrical Research and Development Association

Testing & Evaluation
Field Services
R&D and Expert Services

Contributing to Build an Atmanirbhar Bharat

NEWSLETTER

Vol. 39; No.1

January - March 2022

CONTENTS

1.0 Achievement

ERDA had participated in the 31st AAYOM (Annual Award for Outstanding Young Managers) competition – 2022 organised by BMA with two teams of three members each. It was a competition where a total of 30 teams from around the country participated for four days. Team consisting of Ms. Rachana Dave, Ms. Presita Dodiya and Ms. Aastha Bhalgamiya has won 3rd prize in this competition.

ERDA congratulates and appreciates the efforts and dedication shown by both the teams. **Team I** – Ms. Rachana Dave, Ms. Presita Dodiya and Ms. Aastha Bhalgamiya and also **Team II** – Mr. Sunny Das, Mr. Ronak Thakkar and Mr. Virbhadra Solanki. Both the teams have shown a high level of result orientation and positive approach towards the competition along with dedication and commitment.

Here are some of the glimpses of the event:

Ms. Rachana Dave, Ms. Presita Dodiya and Ms. Aastha Bhalgamiya received 3rd Prize at the 31st AAYOM competition-2022

Two teams of ERDA participated in competition

2.0 R&D News

2.1 Expert Services

2.1.1 Root Cause Analysis of Evaporator Coil Tube of Fluidized Bed Heat Exchanger

Root cause analysis of evaporator coil tube was carried out for one of the power plants. The evaporator coil submerged in fluidized hot ash was installed in 2000 and ruptured after 21 years in service. The operating inlet and outlet temperatures were 394°C and 414°C.

The failed coil was located at the corner surrounding of water wall tubes. The failure of the coil tube resulted in multiple cracks/voids at two different locations and a transverse crack near the support plate weld. Dimensional measurements and visual examination did not indicate bulging of the tube. The region near the multiple cracks/voids showed significant thinning of the tube externally due to significant erosion of the tube. In the case of transverse crack at the weld, the crack was continuous on an internal wall of the surface and had no linkage with the

weld region at the external surface. It indicated that the transverse crack was not associated with weld failure.

The chemical composition and mechanical properties of the tube were as per the specification requirement. Microstructure at failed and away from failure region showed ferrite and spheroidized pearlite indicating thermal degradation of the structure. Deposition of red colour copper particles (confirmed using EDS analysis) was observed on an internal wall surface and inside the weld crack region structure.

It was concluded that the primary failure of the evaporator tube occurred due to corrosion cracking near the weld region. The deposition of copper on the internal wall surface near the weld area with residual stresses (originated during welding of support plate) might have resulted in corrosion cracks. The leakage of evaporator steam resulted in secondary failure of nearby water wall tubes and then further damage of evaporator coil due to secondary erosion by water jet from failed water wall tubes.

It was suggested to control the copper deposition at an internal wall of tubes. Also, it was recommended to take necessary care for stress relieving of evaporator coil at weld region after support plate welding as weld region seems to have residual stresses to promote the corrosion cracking.

Figure 2.1.1(a): Photographs of the failed evaporator coil tube

Figure 2.1.1(b): Photograph of internal wall and weld region indicating continuous crack in the inner wall below support plate but not linked on the external surface at weld region

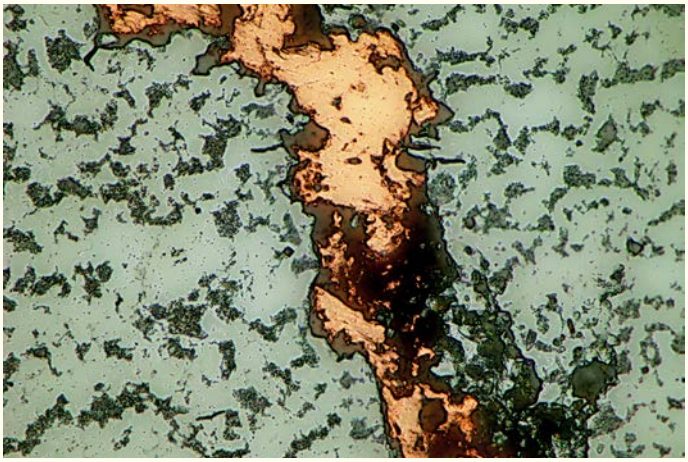


Figure 2.1.1(c): Optical microstructure of evaporator coil at failure. It shows a significant deposition of copper inside the crack

2.1.2 Diagnostic testing of the transformers

In a transmission company, one interconnecting transformer rated at 315 MVA, 400/220 kV was tested for partial discharge activity after it observed abnormal DGA values in oil test results. On conducting acoustic emission test the discharge activity in the transformer could be located.

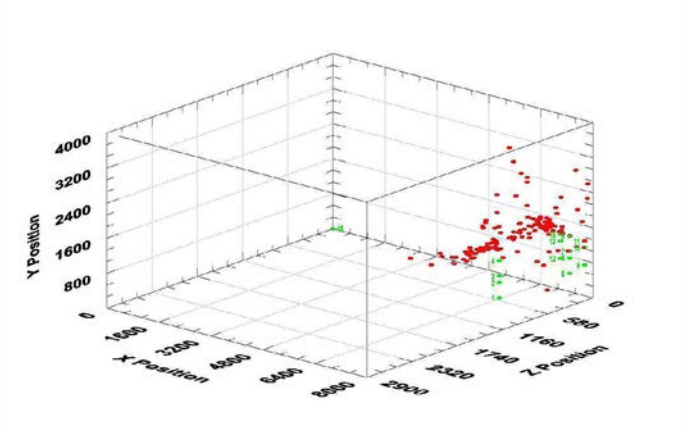


Figure 2.1.2(a): 3D view of transformer discharges

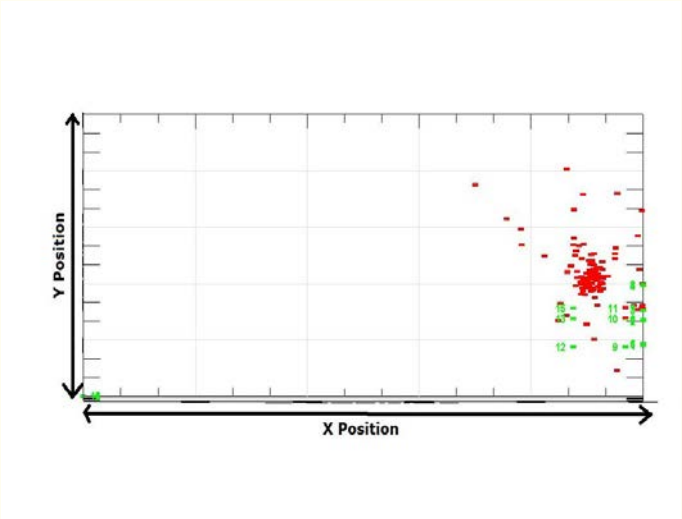


Figure 2.1.2(b): Front view of transformer discharges from 220 kV side

The discharges were observed due to looseness of the connection to the bushing of one phase which was recently changed. Thus, by locating the discharge with the help of the AE test, the transmission companies could rectify the problem.

2.1.3 Nonlinear FEM Structural Analysis of 5400 kVA Transformer Tank

The pressure inside the tank of power transformers is an important area of concern for utilities and equipment manufacturers. Possible consequences of such faults include oil spills and environmental pollution, projection of parts and flammable material, damage to adjacent equipment, fires and safety threats. To analyse the structural stability of the tank, the FEM analysis is one of the reliable tools.

The task of nonlinear FEM analysis of the 5400 kVA transformer tank was entrusted to ERDA by one of the transformer manufacturers.

In this job, the aim was to find out the pressure at which plastic deformation occursby applying pressure of more than 14.2 psi inside the tank. To analyse such a phenomenon, the pressure applied on all internal faces of the transformer tank followed by relieving the same pressure load was considered to determine the deformability of the pre-stressed tank.

The simulation results of plastic strain for pressure loading (14.2 psi) and unloading conditions are shown in figure 2.1.3(a) and figure 2.1.3(b) respectively. Further increasing the internal tank pressure from 14.2 psi to 72.51 psi revealed a noticeable plastic strain of 5.8% and a deformed region with localized stress value. These values indicate the highly deformed area of the transformer as shown in figures 2.1.3(c) and 2.1.3(d) respectively.

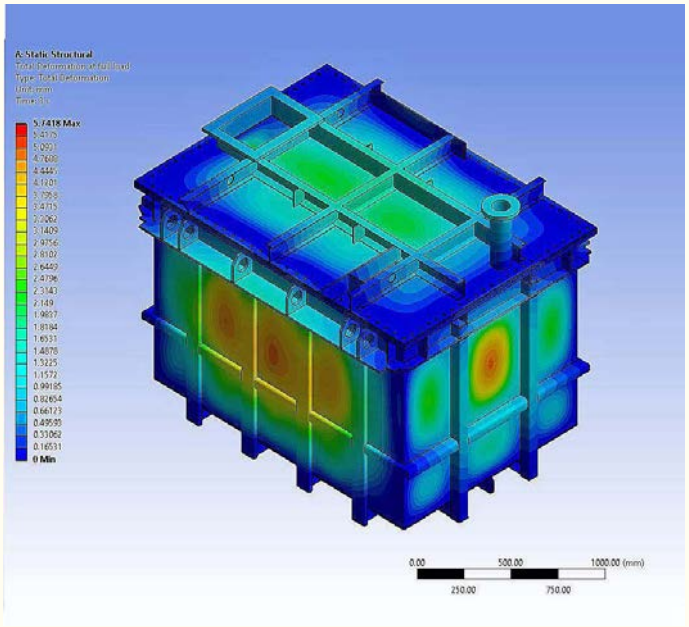


Figure 2.1.3(a): Total Deformation of Transformer Tank at 14.2 psi pressure

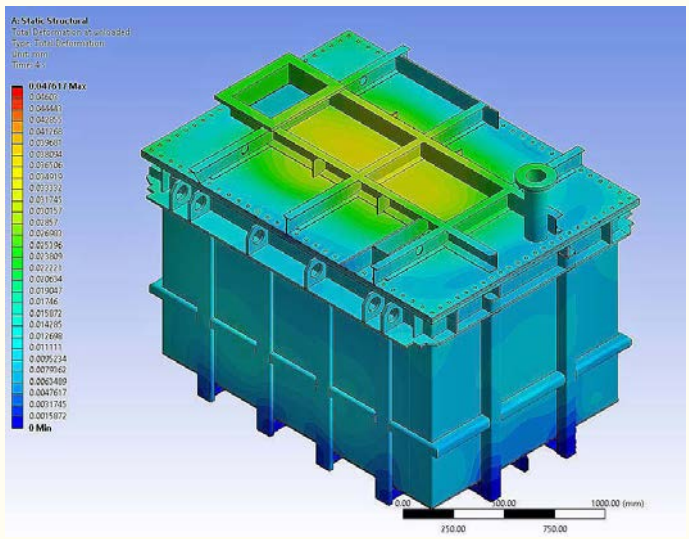


Figure 2.1.3(b): Total Deformation of Tank after relieving 14.2 psi pressure

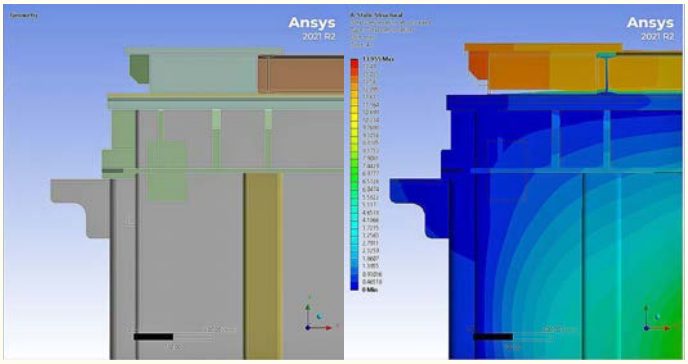


Figure 2.1.3(c): Original geometry of tank

Figure 2.1.3(d): Yielding phenomenon after relieving 72.51 psi pressure

2.2 In-house R&D Projects Completed

2.2.1 Reactive Power Compensated Solar Inverter

Solar photovoltaic inverters play a vital role in converting solar power into electrical energy and are programmed to operate at a unity power factor. The active power pumped

by a solar inverter into the grid is a function of solar irradiance which means that these inverters will not be able to operate at their rated capacity for the whole range of irradiance. This led to the underutilization of the solar inverter resource. The capacity utilization of the existing solar inverter for the whole operational irradiance range can be improved by programming the solar inverter for reactive power compensation.

The solar inverters produce active power only owing to unity power factor operation. Most of the loads are predominantly reactive and thus consumes more amount of reactive power. Currently, this reactive power requirement is catered to by the utility grid only. With the increase in penetration of the large number of Distributed Energy Resources (DER) which pump only active power into the grid, the burden on the grid to supply reactive power, increases. Thus integration of DER (which are programmed to operate at unity power factor) with the utility grid causes power quality issues in Low Voltage (LV) distribution networks such as poor power factor. Poor power quality issue of LV distribution network with high penetration of DER can be addressed by enabling the solar inverter to generate reactive power.

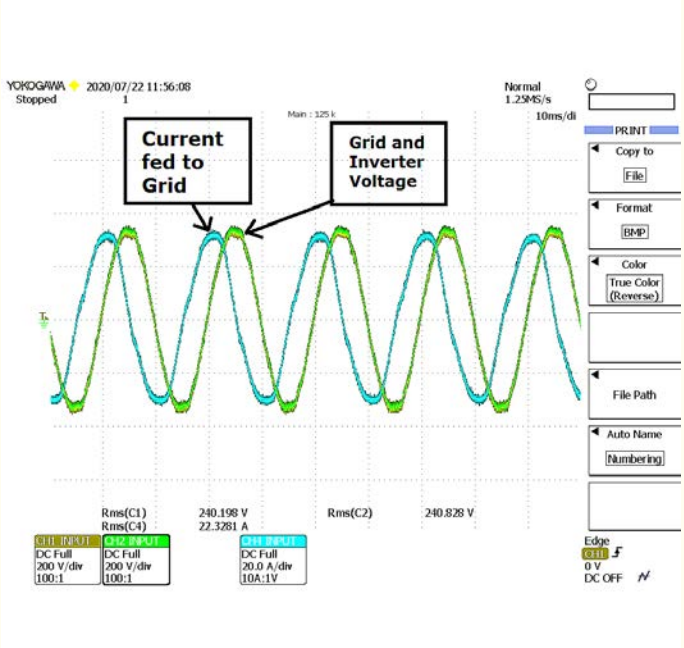
In this project, a prototype of a dual-stage, single-phase, grid-connected, 5 kW rating solar inverter was developed. The following modes of the solar inverter for reactive power compensation were demonstrated with hardware results:

1) Fixed reactive power mode

2) Fixed power factor mode

3) Volt – VAR mode

The developed inverter is able to produce both types of reactive power – lagging and leading type.



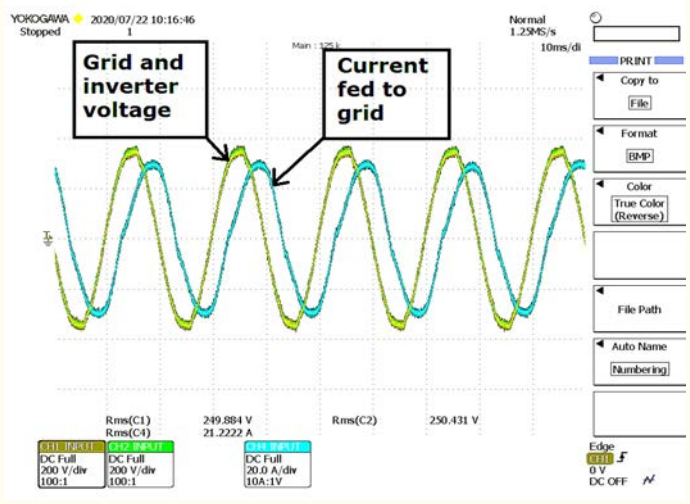


Figure 2.2.1(a): Inverter output voltage and current waveforms showing a) current lagging (top figure) b) current leading (bottom figure) the voltage waveform

2.2.2 Development of XLPE Nanocomposites for Enhanced Partial Discharge (PD) Resistance

Cross-linked Polyethylene (XLPE) is used in low to very high voltage cable insulation. XLPE combines good electrical, thermal and mechanical properties which makes it one of the most important and only materials for HV cable insulation. However, XLPE cable may fail due to partial discharge (PD) and the growth of water trees. PD starts at the site of cavity/defect with the growth of an electrical tree which progressively leads to complete failure of insulation. Water trees are water-filled micro-voids and interconnected channels which are lined up in the direction of an electric field. Water tree growth is the major reason for cable failures. Cable failures result in disruption of power supply and associated high cost of repair. PD resistance can be enhanced using nanofillers in XLPE, such nanocomposites can have improved PD resistance along with improved dielectric strength. In this project, XLPE was synthesized in the laboratory and subsequently, XLPE nanocomposite was prepared using surface functionalised nanoparticles. Properties of neat XLPE and nanocomposite XLPE were evaluated for comparative analysis.

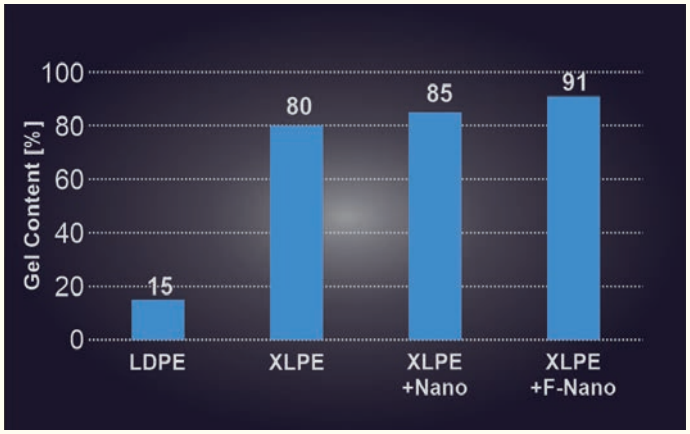


Figure 2.2.2(a): Gel content analysed by chemical method (XLPE – cross-linked polyethene, Nano – Nanoparticle without functionalisation, F-Nano – Functionalised nanoparticles)

Summary of results achieved:

- XLPE synthesized in laboratory and gel content results showed increased cross-linking in nanocomposite XLPE.
- XLPE nanocomposites showed enhanced dielectric strength and enhanced tensile strength.
- Dielectric dissipation (Tan δ) was higher in nanocomposites compared to pure XLPE.
- Both pure XLPE and nanocomposite XLPE did not show any PD at voltage stress up to 40 kV.

2.2.3 Development of Silicone Rubber Nanocomposite Insulator for Enhanced Tracking Resistance

Silicon Rubber Insulators (SRI) are replacing the ceramic insulators in medium and high voltage transmission lines (11 kV and above) due to their superior performance in wet conditions. However, silicone insulators may fail due to premature degradation of silicone rubber housing resulting from electrical tracking which involves electrical and chemical stresses on silicone rubber during their service life. In laboratory set-up, silicone rubber is tested for tracking resistance using the Inclined Plane Tracking test to correlate the outdoor performance of the material.

In this project, silicone rubber nanocomposites were prepared using surface functionalised nanoparticles to enhance the tracking resistance of base silicone rubber. The silicone rubber nanocomposites showed better electrical and thermal properties compared to the conventional silicone rubber.

Summary of results achieved:

- Tracking resistance in nanocomposite silicone rubber increased by 22% compared to conventional silicone rubber.
- Nanocomposite silicone rubber shows better erosion resistance.
- Dielectric dissipation (Tan δ) was reduced by 50% in nanocomposite silicone rubber.
- Nanocomposite silicone rubber has better thermal stability (degradation temperature in terms of TGA).

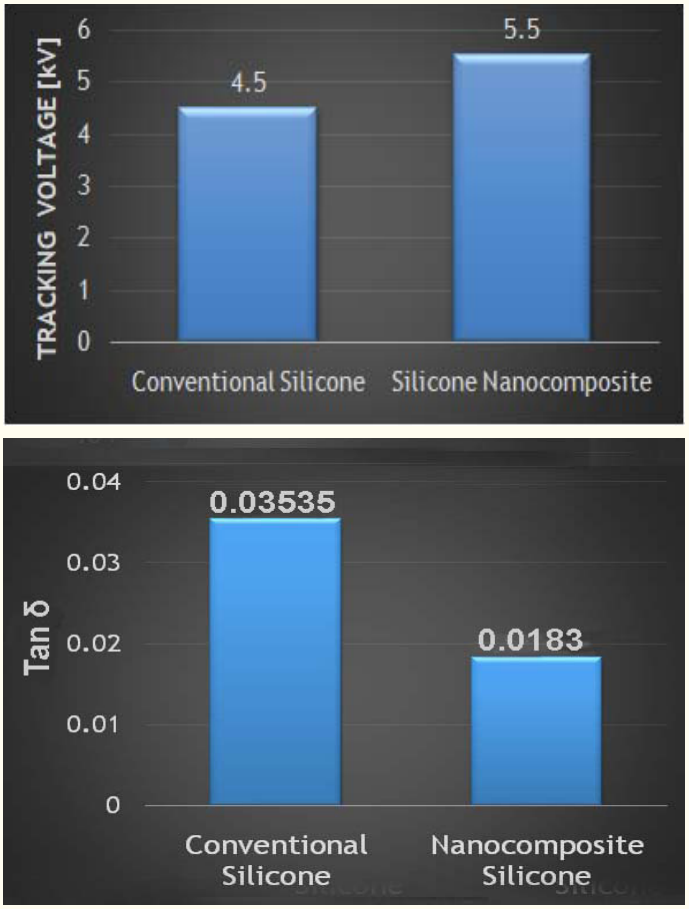


Figure 2.2.3(a): Comparison of tracking resistance (top) and Tan δ (bottom) of conventional silicone rubber and nano-composite silicone rubber

2.3 Papers Published / Presented:

Sr. No.	Title of Publications	Name of Authors	Name of Conference / Journal	Organized by
1.	Power Cable Evaluation Technique and case studies	Mrs. Sheetal Panchal, Mr. Shailesh Patel	11th International Conference on Power Cables "CABLETECH 2022" 10th -11th February, 2022	Central Power Research Institute
2.	Grid-Tied Solar Inverter To Control Active And Reactive Power	Mr. Asheesh Dhaneria, Mr. Hardik Khambhadiya	2nd International Virtual Conference Research & Development Technology Forum 18th -19th February, 2022	IONEX Technology
3.	Partial Discharge Measurement and Fault Finding in Power Transformer	Mr. Shailesh B. Patel	South Asia Partial Discharge Symposium (SAPDS) 2nd -3rd March, 2022	OMICRON
4.	Assessment of Rheological Behaviour and Thermal Conductivity of Non-edible Castor Oil for Possible Lubrication Applications	Mr. Vishal Vora, Dr. Rakesh K. Sharma, Dr. D.P. Bharambe	National Conference on "MODERN TRENDS IN CHEMISTRY" 13th March, 2022	Chemistry Department & IQAC, RR Mehta College of Science & CL Parikh College of Commerce, Palanpur

2.4 Invited Lectures and Presentations

Dr. Satish Chetwani, Incharge Director, ERDA was invited to deliver a keynote address as Guest of Honour at the 2nd International virtual conference: Research and Development Technology Forum. The conference was held on 18th and 19th February, 2022. The talk delivered included brief discussion on technologies developed by ERDA.

3.0 Customer's Appreciation

Letters of appreciation have been received from various customers. The edited extract from one of such letters is presented below:

- **Mr. Ketan. Solanki, Deputy Manager – Design Ecofit (Field Services) Energy Business, Schneider Electric, Jarod, Vadodara**

"…Thank you 'Nilesh Bhai, Pankaj Bhai, Dhaval Bhai & Vishwakarma sir for your incredible work in Impulse testing. All of you provided good support. Thank you once again for your selfless assistance…"

4.0 Accreditations

- ERDA-Vadodara has completed the NABCB surveillance assessment for Inspection bodies as per ISO/IEC 17020:2012.
- ERDA-Rabale has received a Letter of extension of Accreditation for the Calibration discipline. Now, the ERDA-Rabale calibration certificate is valid till 31/03/2023 for ISO/IEC 17025:2017.
- ERDA-North has successfully completed Desktop Assessment and received continuation of accreditation for Calibration discipline for ISO/IEC 17025:2017.

5.0 Major Business Contracts

ERDA has bagged various prestigious contracts. Some of them are presented below-

5.1 ARC for Energy Meter Testing with IntelliSmart

The Government of India plans to install 25 crore smart meters in the next few years. With the replacement of 25 crore conventional meters with smart meters, billing efficiency can improve from 80% to 100%, and has the potential to increase DISCOM revenues by INR 1,104 billion. IntelliSmart Infrastructure Private Limited or "IntelliSmart", a JV company of EESL (Energy Efficiency Services Limited, a Joint venture of PSUs of Ministry of Power, Government of India) along with NIIF (National Investment and Infrastructure Fund, a Government of India, sovereign fund) is established with the focus to implement, finance, and operate the smart meter roll-out program of power distribution companies.

With a focus on expediting the deployment of smart meters across the country and ensuring performance as well as quality, IntelliSmart has entered into a rate contractwith the Electrical Research and Development Association (ERDA) for the testing of smart meters.

5.2 Protection Audit at Power Generating Stations

The Power System Cell (EPSC) has been awarded two projects for carrying out Protection Audit at a private organization in Madhya Pradesh and a government organization in Rajasthan. The EPSC Section is also awarded a contract for carrying out a protection audit of a Thermal Power Plant of a private organization in Maharashtra.

5.3 Third Party Inspection of Materials

The Third-Party Inspection section has been awarded work order from a DISCOM in Andhra Pradesh for carrying out Third Party Inspection of Materials for 2 Years.

5.4 Single Phase Energy Meter Testing

ERDA has been awarded a work order for carrying out Single Phase Energy Meter testing at DISCOM in Hyderabad.

6.0 Participation in Exhibitions/Conference

- ERDA participated virtually in a Conference on Smart Metering which was organized by CII on 27th January, 2022. The main objective of this conference was to understand upcoming Govt. policies regarding smart meter rollout in India.
- ERDA participated virtually in a knowledge sharing and Awareness training program on Revamped Distribution Sector Scheme (RDSS) organized by IEEMA on 28th February, 2022. The main objective of this training was to understand upcoming development in the govt. spending for the RDSS scheme.
- 10th Industrial and Engineering Expo – Indexpo was held from 25th -27th March, 2022 by Indore Infoline. ERDA visited the expo to interact with exhibitors. Detailed discussion related to ERDA's field and expert services were carried out with officials.

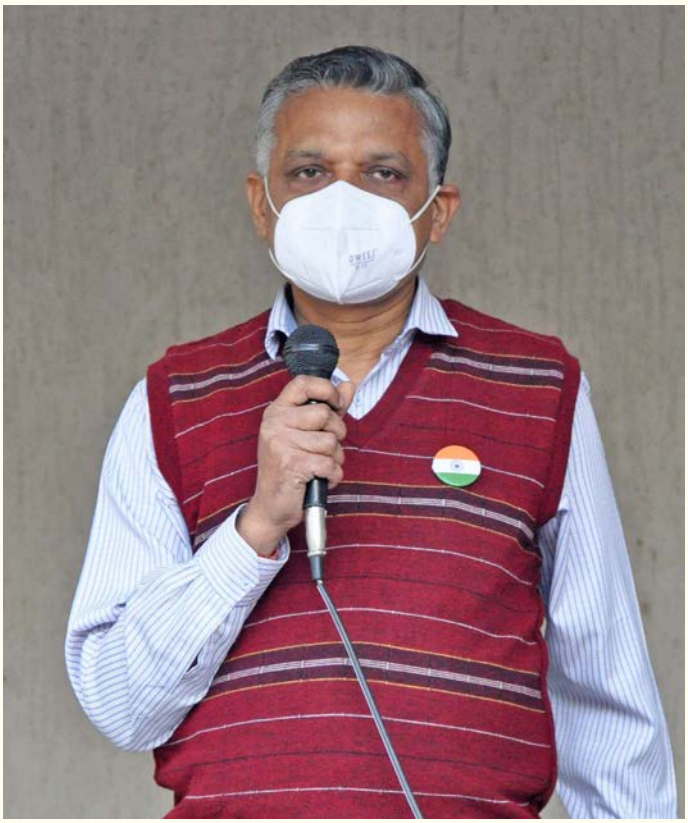
7.0 HR Initiatives

New Initiative by ERDA in Republic Day Function:

Till date the national flag was hoisted by some senior people like the Director ERDA. ERDA took a new initiative in this matter and called three employees (irrespective of their level in ERDA) who are going to retire from ERDA services in the next few months. These three employees are Mr. Nitin

Mehta (EMI/EMC section), Mr. M. K. Rohit (Short Circuit section, Makarpura) and Mr. R. S. Thakur (CRM section). Out of these three employees, one employee hoisted the National Flag and the other two employees supported him.

Later in the function, these three employees were called on the stage and the audience had a privilege to listen to them, their journey so far in ERDA, their feelings for ERDA and how they felt by this gesture from ERDA for making them hoist the flag.



Mr. Nitin Mehta sharing his thoughts and feelings on a journey so far in ERDA.

The excerpts of Mr. Nitin Mehta's speech

"My greeting to you all on the national day of the "Republic Day". I feel, honoured and patriot today. Thank you for giving me such a wonderful opportunity to hoist the flag and for showing gratitude towards my dedication to ERDA. I have many memories associated with ERDA throughout my working period and now one more memory is added of this auspicious day which will make me feel proud.

Tin rang ka tiranga ye dhwaj desh ki shan hai, har bharatiya ke dilo ka swabhiman hai aur yahi hamara Hindustan hai.

This day inspires us to take a pledge that we will not let down the sacrifice of freedom fighters for our nation and will work hard to take our nation to greater heights."

"Jay Hind Jay Bharat"

Mr. M. K. Rohit and Mr. R. S. Thakur shared their thoughts and feelings on their journey so far in ERDA.

8.0 ERDA Celebrations

Republic Day:

The Republic Day was celebrated in ERDA on 26th January, 2022 which included flag hosting and Employees' Children Merit Award distribution to the eligible children of ERDA Employees. Since ERDA did not organise the Annual Day Function(which is organized in the last week of every December) due to the pandemic, the Employees' Children Merit Award distribution was organized on 26th January, 2022 by inviting the winners. The event was followed by the snack takeaway.

Republic Day Celebration at ERDA

Flag Hoisting

Incharge Director presenting ERDA School Merit Award to the eligible children of ERDA employees

ELECTRICAL RESEARCH AND DEVELOPMENT ASSOCIATION
(Accrediated by the National Accrediation Board for Testing and Calibration Laboratotries Govt. of India)
ERDA Road, GIDC, Makarpura, Vadodara - 390 010

Contributing to Build an Atmanirbhar Bharat
NEWSLETTER

Edited & Published by Dr. U. N. Puntambekar for Electrical Research & Development Association
Registered Office & ERDA (West) Laboratory : R-336, TTC Industrial Area, Thane - Belapur Road, MIDC, Rabale, Navi Mumbai - 400 701
Head Office : ERDA Road, Makarpura Industrial Estate, Vadodara - 390 010
Tel. +91(0265) 3043129-31, 2642942, 2642964, 2642377 **Fax:** +91(0265) 2638382,
Toll Free No. 1800 233 2668 **e-mail :** uday.puntambekar@erda.org, erda@erda.org **website :** http//:www.erda.org