the leading electrical & electronics monthly

ieema journal

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The AGE of Transformation

Energy Efficiency

IEEMA Events

32

INSULEC 2024


40

TECH-IT 2024


50

E3 2024

Inside...

leading electrical and electronics monthly

ieema journal

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IEEMA Journal is the leading electrical and electronics monthly and an official organ of Indian Electrical & Electronics Manufacturers' Association (IEEMA).

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IEEMA Journal covers original techno-commercial articles, interviews, international, national and corporate news, statistics, product showcase, country profile, seminars, exhibitions and services.

Since its inception in the year 1981, this Journal is published and posted on its scheduled dates. At present 10,300 copies of this journal are posted on 1st working day of every month. It is the only trade journal in India that enjoys readership of around 1,00,000.

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Dear Members,

I wanted to take this opportunity to wish you all on IEEMA's 76th Foundation day.

It is indeed a journey that makes all of us proud. Reflective of the nation's march towards energy independence. How much has the Indian Power sector and our electrical equipment sector grown..from a fledgling industry, we are today more than USD 60 bn industry, capable of meeting not only India's Power sector needs as also exports. And manufacturing a full range of products, offering cutting edge technology and smart & new age solutions.

IEEMA has also grown in its role, stature and resources. Today, we have a seat on the high table on policy dialogues. We play a pivotal role in setting industry benchmarks and manufacturing standards and are also crafting strategic dialogues.

All this because of the value system set by our visionary founders and each of the leaders and IoT of the past were steadfast to quality, integrity and resolve to make industry and nation grow.

I would like to congratulate each one of you, and the IoT for being an integral part of this remarkable journey of shared passion and shared vision.

It is a journey of an Institute whose credo is building for the Nation, growing the Industry and marking global footprint with underpinning of Quality, Safety and Reliability.

It is a privilege to be associated with this remarkable Institute.

Once again, I wish you all and congratulate you on 76th Foundation Day of IEEMA.

Warm regards,

Hamza Arsiwala

President, IEEMA (2023-24)

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CONTENTS

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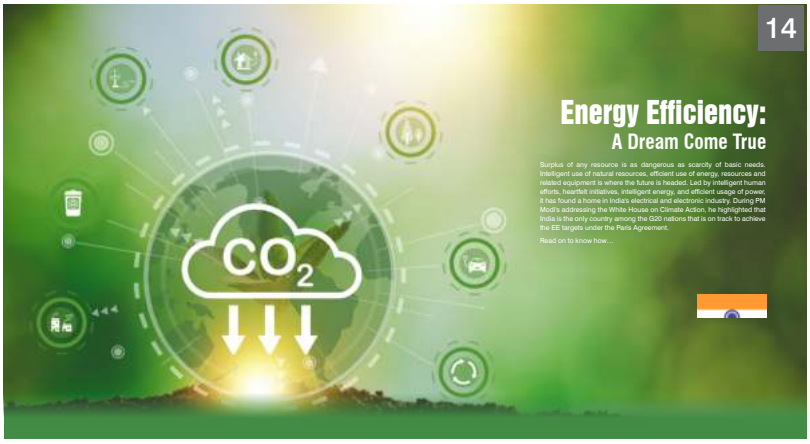

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Contents

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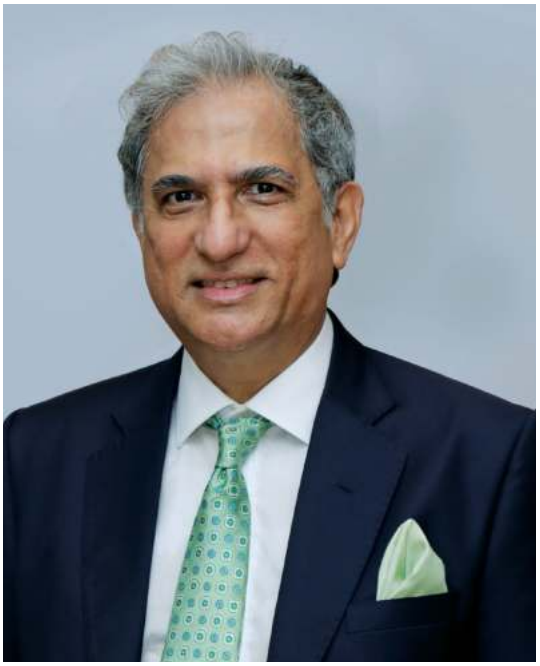
Dear Friends,

The growth of Power and allied sectors will be fuelled by the rising demand for electricity. Implementing efficient change management strategies could potentially reduce global energy consumption by 31%, resulting in savings of more than USD2 trillion in energy costs. This edition of IEEMA journal focuses on issues and opportunities on the path to achieving energy efficiency and how it can help in achieving Net Zero goals.

On the policy front, we at IEEMA continue to take up industry issues with the Government at all levels and we will continue to accent on policy advocacy.

This month we had a successful E3 – a dedicated B2B event for the electrical industry anchored by the Eastern region Council. We formally announced ELECRAMA 2025 – the flagship event of IEEMA and world's largest electrical show. The 16th edition of the show will see array of products and technologies on display showcasing everything from source to socket.

As we celebrate the 76th year of IEEMA's foundation, I'm filled with gratitude noting how the industry has grown and changed over the years and how IEEMA has contributed to this. Today, we are a USD 60 billion sector, meeting our needs, excelling in exports, producing a variety of



products with top-notch technology. IEEMA has become an influential organization, shaping policies and setting industry standards. Thanks to our visionary founders and the dedication of past leaders and members, we have been able to positively impact the industry and lay the foundation for a stronger future.

Going forward, IEEMA is augmenting its team and enhancing its resources to better support its members and provide new and innovative services.

I will be in touch soon to discuss future ideas with you.

Hamza Arsiwala

16th Edition
ELECRAMA
Powering the Future of Energy

22- 26 FEBRUARY 2025

India Expo Mart, Greater Noida, Delhi NCR

Dear Members,

The government has transformed the power sector from power-deficient to power-sufficient by adding about 200 GW of generation capacity in the past 9 years. We have connected the whole country with a unified grid, which is capable of transferring 1,16,000 MW from one part of the country to another. We have strengthened the distribution system and made it viable. All these steps are powering the future of India. ELECRAMA is a reflection of how we are powering the future. I am happy to see the new themes introduced for ELECRAMA 2025, focusing on new energies, renewables, digital energy, battery and energy storage.

These themes directly support the government's long-term vision and initiatives with a focus on reimagining energy for sustainable future, I believe this will contribute to a cleaner and more efficient energy landscape and pave the way for greater technological advancements and growth for the sector. I commend IEEMA for organizing this exhibition successfully and wish the entire industry for the grand success of the exhibition.

IEEMA@76

I extend my sincere congratulations to IEEMA on its 76th Foundation Day. The remarkable progress of IEEMA reflects its significant role and stature acquired over the years.

I urge the entire industry to strive for excellence in providing necessary equipment and technological solutions competitively. Let us leverage the Make In India policy to its fullest extent and aspire towards global leadership in the field of new energies.

Warm regards,

RK Singh
Cabinet Minister of Power
New & Renewable Energy
Goverment of India

ieema 76
SERVING THE NATION
Since 1948

Dear Members,

IEEMA has had an action-packed time with an impressive lineup of events throughout the month and an apt closure with launch of the biggest electrical show in the world ELECRAMA. It gives me great pride to announce the launch of ELECRAMA 2025 to all our readers. The 16th edition promises to be BIGGER, BETTER, BOLDER with new additions and bigger milestones.

We had the honour to host the Union Minster of Power and New & Renewable Energy, Shri R K Singh as the chief guest at the launch of ELECRAMA 2025, who gave us the vision for future advancements and the roadmap to bring the transition in the Indian Power Sector.

Earlier in the month the government announced provisions for the energy sector in the interim budget 2024-25.The Interim budget announcement laid the foundation for making India a "Viksit Bharat'" by 2047 and underscored the government's political will and roadmap towards building efficiencies and achieving sustainable development.

Taking cues from the latest development, IEEMA Journal's March edition is aptly themed Energy Efficiency and has some noteworthy papers on transformers.The initial section of the cover story Energy Efficiency: A Dream Come True highlights India's achievement in being energy efficient.. IEEMA ThinkTank Section features winner of IEEMA ElectraVerse – IEEMA's Startup Initiative.

The event section features E3 2024 - IEEMA's flagship eastern region event, INSULEC 2024 -International Conference on Insulating Machinery and Systems and TECH-IT 2024 – An international conference on Instrument Transformers.

This edition also has three case studies on current transformers ranging from modes of current transformer failures, internal arc fault testing in nuclear plants, critical issues in current transformers during short circuit testing, testing transient responses from current transformers, by experts writers.

Other interesting reads include - Product Showcase, Impact News,Ministry Updates and Shocks and Sparks.

I hope you all enjoy reading IEEMA journal as much as we enjoy presenting the latest from the world of energy to you all. Stay tuned for more exciting updates related to ELECRAMA and other IEEMA initiatives as we go along.

Thank you!

Charu Mathur

MITSUBISHI ELECTRIC
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Welcome to Mitsubishi Electric's vision for the future enabled by factory automation.

It is a place where sustainable manufacturing can be created for all.

We believe sustainable manufacturing supports the creation of a sustainable world.

Efficiency is not only good business sense, it also has less impact on the environment.

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It will transform our world and its future.

A sustainable world driven by factory automation means a brighter future for you and your children.

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Energy Efficiency means using less energy to perform tasks. Countries globally prioritise promoting energy efficiency and conservation to fight climate change and reduce greenhouse emissions. Despite India being the third-largest consumer of power globally, we contribute only 3.5% to the world's energy-related carbon footprint, which globally accounts to 4.7 tonnes per person according to The International Energy Agency.

India's demand for electricity is on an upscale and expected to rise further. According to governmental reports, the peak demand has gone up from 135918 MW in 2013-14 to 243271 MW in September 2023. This accounts for a rise of almost 79% in the span of a decade which has been met with no reported problems whatsoever.

India's population accounts for 17% of world population and with passing time, it is expected to grow and the

Energy Efficiency:
A Dream Come True

Surplus of any resource is as dangerous as scarcity of basic needs. Intelligent use of natural resources, efficient use of energy, resources and related equipment is where the future is headed. Led by intelligent human efforts, heartfelt initiatives, intelligent energy, and efficient usage of power, energy efficiency has found a home in India's electrical and electronic industry. When PM Modi addressed the White House on Climate Action, he highlighted that India is the only country among the G20 nations that is on track to achieve the EE targets under the Paris Agreement. IEEMA Research Group finds out how.

consumption too is expected to boom in the future. Global awareness events like COP26 and G20 have awakened the industry to focus intensely on energy conservation and sustainability.

The true concept of 'energy efficiency' is not limited to only saving power; it includes reducing carbon emissions, enhancing energy security, and promotion of sustainable options. India has also taken several steps to lower its carbon emissions and foster sustainable development.

Let us explore through the state and sector-wise EE status with the help of the State Energy Efficiency Index Report 2021-22 the Bureau of Energy Efficiency research data, and references from other governmental news and research papers.

Energy Efficiency in India

India ranks third globally in energy consumption only after China and the United States, with expectations of exponential growth in demand in the foreseeable future. At the 26th Conference of the Parties (COP26), India's Panchamrit of climate action - reaching a non-fossil fuel energy capacity of 500 GW by 2030, fulfilling at least half of its energy requirements via renewable energy by 2030; reducing CO2 emissions by 1 billion tons by 2030; reducing carbon intensity below 45 per cent by 2030; and finally pave the way for achieving a Net-Zero emission target by 2070.

India's commitment to reducing emissions and transitioning to a sustainable energy future is evident as India ranks 7th in the 2023 Climate Change Performance Index. According to a report released during the global climate conference (COP-28) in Dubai, India maintained its top 10 position for the fifth year.

In the recent past, the Government of India launched several measures, such as:

- Establishing the minimum proportion of non-fossil resource consumption by designated consumers, including Distribution Companies (DISCOMs), until 2029-30,
- Initiatives such as the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PMKUSUM), Solar Parks Scheme, Solar Rooftop Phase II, and 12000 MW CPSU Scheme Phase II,
- Expansion of transmission infrastructure and the establishment of new substations under the Green Energy Corridor Scheme to facilitate the transmission of renewable energy,
- Implementation of the Promoting Renewable Energy through Green Energy Open Access Rules 2022,
- Introduction of the Green Term Ahead Market (GTAM) to enable the trading of renewable energy via exchanges,
- Launching the National Green Hydrogen Mission with the objective of, among other goals, reducing reliance on imported fossil fuels.
- Carbon-credit initiative, creating a global platform for the exchange of green finance.

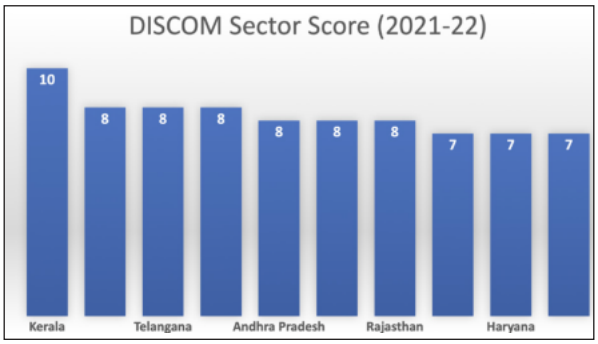
The government has also implemented numerous initiatives to enhance energy efficiency, including the standard and labelling scheme for the appliance sector, the UJALA scheme aimed at providing affordable LED bulbs, the PAT scheme targeting industries, and the introduction of Energy Conservation Building Codes and Eco Niwas Samhita for both commercial and residential buildings. Furthermore, efforts in the transportation sector focus on improving the efficiency of conventional fuel vehicles, promoting the adoption of electric mobility, and encouraging a modal shift toward railways.

Energy Efficiency Readiness in the DISCOMs Sector

The Indian power sector is moving towards a clean energy transition and transformation, and DISCOMs are a vital stakeholder group in this transition. The need for a low-carbon and climate-resilient future makes it crucial for the Indian electricity distribution sector to achieve operational efficiency, profitability, readiness for emerging and future demand and technological changes.

The Ministry of Power and Bureau of Energy Efficiency (BEE) released the State Energy Efficiency of India (SEEI) report 2021-22, which consists of the annual progress of states and UTs in energy efficiency implementation for FY 2020-21 and 2021-22.

According to the SEEI, Kerala is a top-performing state in the DISCOM State. Other top-performing states include Maharashtra, Telangana, Puducherry, Andhra Pradesh, Himachal Pradesh, Rajasthan, Delhi, Haryana, and Tamil Nadu.



In the realm of energy efficiency, T&D loss is an important yardstick to measure DISCOMs' operational efficiency. The Ministry of Power (MoP), Government of India, in consultation with BEE, has set a target for T&D loss percentage for 95 DISCOMs under PAT Cycle VII.

In addition, tthe BEE has enforced regulations mandating annual energy audits and periodic energy accounting in all DISCOMs holding distribution licenses issued by the State Electricity Regulatory Commissions (SERCs) or Joint Electricity Regulatory

Commissions (JERCs). According to BEE data, 25 states have implemented ToD/ ToU tariffs for industrial and commercial consumers, while only 7 states have implemented ToD/ToU tariffs for domestic consumers. Since the unit cost of electricity is different during peak and off-peak periods, ToD tariffs are implemented to reduce the consumption of electricity during peak hours through a higher peak tariff and a lower off-peak tariff to incentivise consumption during off-peak periods. 20 states appointed a nodal officer to conduct energy audits in DISCOMs.

'Filament Free Kerala' is one of the projects envisaged in the Urja Kerala Mission announced by the Government of Kerala to replace the incandescent lamps & CFLs among the entire population of domestic consumers in the state with LED bulbs. The project is being jointly implemented by the KSEB and Kerala EMC. Under this scheme, domestic consumers get a branded 9 W LED bulb at a discounted price of Rs. 65, and CFLs and incandescent bulbs are collected for disposal. All consumers under KSEB have to apply for replacement. KSEB has distributed one (1) crore 9 W LED bulbs to domestic consumers so far.

ADOPTION OF EE MEASURES IN DISCOMs

Smart meters enable real-time access to information on energy usage by consumers at different times of the day. This data helps customers manage their energy use more proactively and DISCOMs make informed decisions on load management and grid stability. Thirteen (13) states furnished data on the number of utility consumers with smart meters. Smart meter data are reported to be analysed and used for consumer awareness to enhance DISCOM operational efficiency only in DISCOM(s) in three (3) states. The data is analysed for energy consumption patterns, future trends, and improving collection efficiency and peak load management. Table 1 shows the status of smart meter installation in the states and UTs.

Table 1: State-wise smart meter status

Indicator	States – Wise Status
States with Smart Meters	Assam, Bihar, Chandigarh, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Meghalaya, Puducherry, Rajasthan, Telangana, Uttar Pradesh (13)
States that have analysed smart meter data	Kerala, Puducherry, Rajasthan (3)

Assam, Bihar, Chandigarh, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Meghalaya, Puducherry, Rajasthan, Telangana and Uttar Pradesh have adopted smart meters, while the states of Kerala, Puducherry and Rajasthan have analysed smart meter data. 28 states reported undertaking DSM programmes for the utility consumers.

All these actions will limit energy demand growth, decrease energy intensity, and foster innovation in energy technology. It also shows the government's strong leadership in advancing energy efficiency while addressing the challenges in achieving widespread adoption and execution.

Scrutinizing Buildings, Industries, Municipalities & E-Mobility Sectors

A. Building Sector

In India, the building sector is the second-highest in total final energy consumption (TFEC) and is projected to grow by 45% up to 2027 from the 2017 baseline, as per the same report. Energy consumption in Indian buildings is expected to go up due to rapid urbanization and economic development. The states and UTs are yet to make a concerted effort to develop institutional capacity on EE in the buildings sector.

18 states and UTs have notified ECBC 2017 and 10 have drafted ENS or ECBC Residential 2021

Rajasthan Housing Board is in the process of constructing an EE residential complex for MLAs in Jaipur, consisting of 160 flats, to achieve a 3-star GRIHA rating for this project. This is an exemplary demonstration of EE adoption in public buildings, led by the state government.

Adoption of EE Measures in the Building Sector

Adoption of EE measures in states and UTs is assessed based on penetration of certified green buildings, adoption of ECBC in new construction, and winners of BEE's National Energy Efficiency Roadmap for Movement towards Affordable & Natural Habitat (NEERMAN) awards.

An optimal measure of green building penetration would be the ratio of green building built-up area to the total built-up area in the state. However, in the absence of data on the state-wise built-up area, the indicator on green buildings has been normalised as the number of certified green buildings per million connected residential and commercial building consumers (i.e. electricity connections) in the state.

IGBC, GRIHA, and GBCI Leadership in Energy and Environmental Design (LEED) ratings have been aggregated for the total number of certified green buildings says the report. Out of 36 states and UTs, 29 states and UTs have a total of 3950 certified green buildings.

B. Industrial Sector

The industry sector accounted for the highest share of energy consumption, 41% of total electricity consumption in India, in FY 2020-2021. As per NITI Aayog's India Energy Security Scenarios (IESS) model, this sector is projected to have the highest energy savings potential in India by 2047 through EE management and innovative technology deployment.

The institutional capacity of the states and UTs in this sector is still not well-established. Only thirteen (13) states reported the existence of an entity to develop capacity and provide technical expertise on EE in industry for engineers, managers, business owners, city officials, and other stakeholders at the state level.

KDISC has introduced the One District-One Idea MSME Innovation Cluster programme for innovation promotion and local economic development. KDISC will provide monetary support to MSMEs for the innovation component and technology support for fostering innovation through green energy techniques, including DSM, sustainable development strategies, capacity building, and productivity enhancement.

Adoption of EE Measures in the Industries Sector

Energy conservation awards are given to industries and establishments in recognition of their commendable efforts to reduce energy consumption while maintaining their production. In SEEI 2021-22, industrial units in twenty-four (24) states and UTs won energy conservation awards through state/national/industry association awards. In Maharashtra, 59 industrial units won energy conservation awards, the highest number among all states. Out of 59, 30 awards came from the state energy conservation award, 26 awards from CII, and 3 awards from 37State Energy Efficiency Index 2021-22 NECA.

C. Municipal Sector

Municipal services sector/urban local bodies (ULBs) consume electricity for various utility services like street lighting, water pumping, and sewage treatment in various public buildings. Currently, around 30% of the Indian population lives in urban areas, and continuous migration from rural areas is burdening the ULBs16. Municipal EE limits use of scarce commodities and stretches tight budgets, giving citizens improved access to electricity, water, heat, and air conditioning. Energy efficiency in municipal water supply systems can save water and energy while simultaneously reducing costs and improving the service.

Energy Efficiency Highlights

Kerala and Telangana are the top performing states in the municipality sector. 29 states reported EE programmes in street lighting. 9 states reported EE programmes in water/sewerage systems. Sikkim SDA has undertaken a demonstration project for the replacement of conventional streetlights with LED streetlights in Rongli, East Sikkim and Sombaria, West Sikkim. 250 streetlights were identified and replaced with LED streetlights. The power consumption of the individual existing streetlights was 70 watts (W), compared to 45 W for the replacement LED lights.

D. Transport Sector & EE Update

The transport sector has the third-highest TFEC in India. The total energy consumed by the transport sector was 48,842 kilotonnes of oil equivalent (KTOE), nearly 9% of the country's total energy consumption. Most of the energy demand in this sector is met through crude oil.

Karnataka is the top performing state in the transport sector. All states and UTs have a policy about EE in place. Some states have reported having a state electric mobility policy, bringing the total number of states that have notified such policies in the state for EV promotion and penetration to twenty-two, up from nine in SEEI 2020. Draft electric mobility policies have been released in two states, Bihar and Punjab. Furthermore, eleven states have reported having transport policies or guidelines to advocate fuel efficiency. 14 states reported a policy for procuring EVs for government use.

22 states have EE programmes in public transport while only 6 reported in private transport.

The transition towards EVs is challenging due to the high upfront purchase cost, range anxiety, and lack of awareness. To overcome these challenges, there are financial incentives for all eligible EVs in the Rajasthan EV Policy18. Financial incentives are given upfront to vehicles based on the battery capacity and retrofit kit for two-, three-, and four-wheeler vehicles and buses. Further, in a commendable step, the transport department of Rajasthan has released an order to reimburse 100% SGST to EV vehicle owners to increase EV penetration.

Recommendations to States

Based on the findings from SEEI 2021-22, the following recommendations are proposed to enable faster and greater penetration of EE in the states, which can contribute towards the fulfilment of the SDGs and NDC.

1. Develop And Implement the State Energy Efficiency Action Plan
2. Facilitate Fiscal Support for Energy Efficiency
3. Strengthen Institutional Capacity
4. Collaborate With Financial Institutions, ESCOS, & Energy Professionals
5. Mainstream Monitoring and Reporting of Energy Data
6. Drive EE Implementation in MSMEs.

In conclusion, India's commitment to mitigate emissions while transitioning to a future of built by and on sustainable energy is on a high momentum. A steady rate of achieving state-level sustainable developmental goals in the most energy efficient manner and implementing those measures has helped us reduce carbon emissions and fulfil our global aspirations to lead the energy efficiency index internationally.

Europe's Road To Net Zero

IEEMA Research Group traces the roots of the energy crisis in Europe, the causes, and solutions adopted hence

CIRCA 2021, Europe was going through an energy crisis. Demand for gas was rising as the continent emerged out of the pandemic, but the supplies were limited, prices were sky rocketing. Gas is not envionmentally friendly, it is the source of emissions but it can also help to decarbonise electricity.

Rising energy costs had caused inflation in prices of daily essentials. The main reason why Europe went through a fuel crisis in 2021 was because Europe has always been dependent upon imports for their basic fuel of gas supply. Their internal resources like the North Sea gas deposits, among other gas fields in Netherlands were on the verge of running dry. Europe imports gas mainly from Russia and Norway. The war in Russia was another deterrent to Europe's already deplorable condition.

Amit Kumar Gupta
Chairman - International Business Division, Indian Electrical & Electronics Manufacturers Association

"Energy efficiency targets are not being met worldwide because of inadequate awareness and sense of urgency, lack of strong political and regulatory mandate and incentives to invest for energy efficient measures. A systematic approach with clarity of thoughts and actions among all stakeholders regarding the importance of energy conservation and the benefits of energy-efficient practices, current use of outdated technologies and need for high upfront expenditures, viability gap funding etc is impeding much needed progress in the energy efficiency area."

"Europe has already made a strategic decision to invest in an innovative, sustainable and globally competitive economy, centred around agile clean industries. Today, we are taking the next step to achieve just that, with an overarching aim to bring long-term prosperity, stable jobs, and the EU's greater economic security. We see industrial leadership and just transition as two sides of the same coin. As a strong global player in net-zero technologies, the EU will continue to keep fairness and solidarity front and centre of the European Green Deal.

Maroš Šefčovič

Executive Vice-President for European Green Deal, Interinstitutional Relations and Foresight

"We have just lived through the hottest year on record. The case for climate action is beyond doubt and requires planning now. Going forward, we will have to stand more firmly on two legs: a safe and healthy climate for all to live in, and a strong, resilient economy, with a bright future for business and a just transition for all. This communication we are presenting today is also a message to our partners around the world that Europe continues to lead the way in global climate ambition. Tackling the climate crisis is a marathon, not a sprint. We need to make sure everyone crosses the finish line, and nobody is left behind.

Wopke Hoekstra

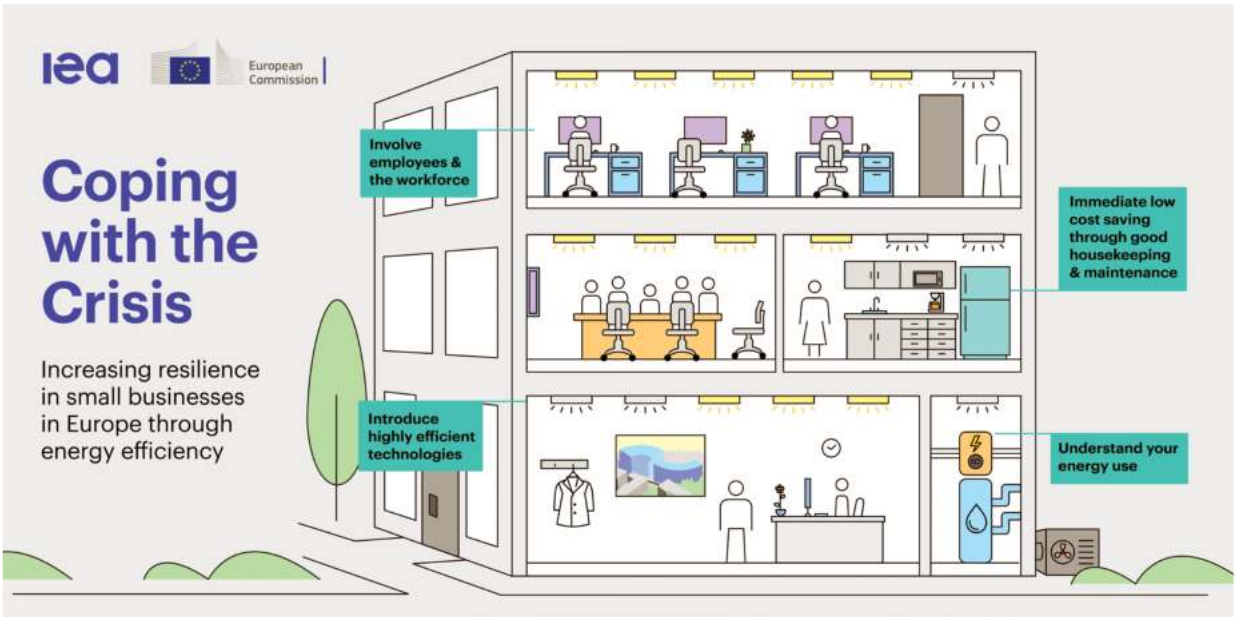
Commissioner for Climate Action

Energy commodity price volatility began mounting in December 2021 when reports of a potential Russian invasion of Ukraine increased. In the first two weeks after the invasion, the prices of oil, coal and gas went up by around 40%, 130% and 180% respectively as per official data. Gas prices also drove up wholesale electricity prices in the euro area. Touted as the greatest humanitarian crisis in Europe since the Second World War, thousands of lives were lost, millions of livelihoods disrupted through displacement, lost homes, and lost incomes.

The Europe reflected the global energy crisis that drove up cost of fuels and electricity, creating shortages and hurting consumers, businesses and entire economies. Small to medium enterprises (SMEs) across nations were among the most exposed economic players, lacking margins, economies of scale, and support staff that larger firms use to over come such downward trends. Notwithstanding the fact that universally it is the SMEs that form the backbone of a nation's economy and the very reason to sustain their businesses.

2021 – A Year of Crisis for Europe & A Change Propeller

The entire northern hemisphere was surged under the effect of inflation in 2021 the year when the crisis peaked with high demand low supply and of course emissions



At this point in the United Kingdom, the wholesale prices of gas shot up by 37% in one day that was October 6, 2021. The prices had already shot up by 600% since the beginning of the crisis. A high demand and reduced supply had upsurged prices still further. That's when Europe witnessed several leading UK energy firms collapse, many companies had stopped production and this was seen across sectors in many industries.

The Price of Warmth

At the beginning of the year, US and Europe was hit by a series of cold weather conditions that brought ice and snow along with freezing temperatures in the northern hemisphere. It was indeed a challenge to respond to the rising demand in the cold weather. There was not supply to meet the demand. The supply that was available was priced exorbitantly high. Thousands and millions of people could not afford to keep their homes warm. That's when CNNs business editor Angela Dewan reported, "Europe's gas crisis is also a renewables crisis, but there are ready solutions". The report stated how the region invested heavily in renewables, such as wind and solar, but there was not enough green power supply to reach the people who needed it.

Though gas has lesser emissions than coal or oil and is substituted for electricity too, it is a source of greenhouse gas emissions (GSG).

Transition from Fossil Fuels to Efficient Energy & A Sizeable Market

The IEA estimates, in its energy efficiency market report, that global investment in energy efficiency was between US$310 billion and US$360 billion in 2012.

Energy efficiency is called the "first fuel" in clean energy transitions, as it provides some of the quickest and most cost-effective CO2 mitigation options while lowering energy bills and strengthening energy security.

Energy efficiency is the single largest measure to avoid energy demand in the Net Zero Emissions by 2050 (NZE) Scenario, along with the closely related measures of electrification, behavioural change, digitalisation and material efficiency. All together these measures shape global energy intensity – the amount of energy required to produce a unit of GDP. Global energy intensity falls by around 4% per year on average this decade in the NZE Scenario, which compares with 1.7% over the last 10 years. Decarbonizing the gas system will need to be a priority to hit net zero emissions targets by 2050, says the IEA.

EU Market Stats: European Commission

Over €100 billion

is the value of EU's net-zero start-ups ecosystem in 2021, doubling since 2020

More than 400 GW

of wind and solar renewable energy production capacity in the EU in 2022, an increase of over 25% compared to 2020

4.5 million

green jobs in the European economy in 2019 up from 3.2 million in 2000

"The energy sector is leading the way in Europe's decarbonisation and emissions reduction, and we must continue on this path towards 2040. In the 2030s we should see major progress in the transition away from fossil fuels, and an increasing share of renewables in our energy mix. We are sending a clear signal to investors that Europe is staying the course and offers them long-term predictability and stability. For our citizens, we are giving a clear sign that cleaner solutions are on the way, and that we are accompanying them in the transition.

Kadri Simson
Commissioner for Energy

"We have a once in a generation opportunity to show the way with speed, ambition and a sense of purpose to secure the EU's industrial lead in the fast-growing net-zero technology sector. Europe is determined to lead the clean tech revolution. For our companies and people, it means turning skills into quality jobs and innovation into mass production, thanks to a simpler and faster framework. Better access to finance will allow our key clean tech industries to scale up quickly."

Ursula von der Leyen
President of the European Commission

Europe's EE Commitments

The European Climate Law,

Implemented since July 2021 it legislates the EU's commitment to reach climate neutrality by 2050 and the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

'Fit for 55'

A legislative package that will enable the 2030 targets to be delivered. The Climate Law also requires the European Commission to propose a climate target for 2040 within six months of the first Global Stocktake of the Paris Agreement, which took place in December 2023.

2040 Climate Target

Once the 2040 climate target is adopted, under the next Commission, that target will form the basis for the EU's new Nationally Determined Contribution under the Paris Agreement, which needs to be communicated to the UNFCCC in 2025.

Setting a 2040 climate target will not only bring clear economic benefits from lower risks of extreme weather events and their related losses, it also comes with several co-benefits including improved air quality and associated health benefits, a reduced dependence on imported fossil fuels, and benefits to biodiversity.

Why do energy efficiency gaps exist?

Energy efficiency gaps exist due to the presence of market failures. According to Hirst and Brown H&B (1990) these gaps are structural or behavioural in nature. "Structural barriers result from the actions of public and private organizations, and are usually beyond the control of the individual energy end user," H&B.

Instances include:

- **Alteration in Fuel Prices**
- **Ambiguity about Future Fuel Prices**
- **Tight Budgeted Monetary Resources**
- **Fiscal & Regulatory Policies by Governments**
- **Standards and Codes**
- **Inadequate Infrastructure**
- **Attitudes Towards Energy Efficiency**
- **Perceived Risk in EE Investments**
- **Disparity in Information and Incentives**

Climate change is causing more frequent and severe extreme weather events, that lead to significant and growing social impacts and economic damages. These economic losses far outweigh the cost of climate action. ■

Dr Harsh Sethi

Winner of the IEEMA EletraVerse Sparks Contest 2024 and Founder of TRI NANO

Reasons why the World is Lagging in Meeting Energy Efficiency Goals

There are several reasons why the world may be lagging in meeting energy efficiency goals:

Lack of awareness: Many individuals and businesses may not fully understand the importance of energy efficiency or the potential savings it can bring.

For instance, about Trinano Nano Coatings, regardless of panel maker, type and place of installation, if we have two sets of strings of Solar Panels, one is Trinano coated and other is not coated, (as compared to the non-coated panels), the coated panels would give higher energy/power output, have lower cell/panel temperature and reduced maintenance & cleaning frequency and costs. This is yet to be adopted at full Mass scale, even though MNRE, NCPRE and NISE have tested/validated and endorsed it.

Initial costs: Implementing energy-efficient technologies or practices often requires upfront investment, which can be a barrier for some businesses or individuals, especially in developing countries.

Policy and regulation: In some cases, there may be a lack of supportive policies or regulations that incentivize or require energy efficiency measures.

Infrastructure challenges: Outdated or inadequate infrastructure can hinder efforts to improve energy efficiency, particularly in regions where resources are limited.

Technological limitations: Despite advancements in energy-efficient technologies, there may still be limitations or challenges in implementing them on a large scale.

Untapped Global Opportunities

Regarding whether vast opportunities being left untapped despite evident progress; it depends on the specific context and region. In some cases, there may indeed be untapped opportunities for further improving energy efficiency, such as through different sources of renewable energy, better building design, industrial processes, or transportation systems. However, in other areas, significant progress may have already been made, and the focus may need to shift towards maintaining and expanding upon those gains.

Greatest Obstacles in Achieving Energy Efficiency

According to me, the greatest obstacles towards reaching energy efficiency goals can vary depending on the specific circumstances, but some common challenges include:

Economic factors: As mentioned earlier, the upfront costs of implementing energy efficiency measures can be a significant barrier for many individuals and businesses.

Lack of political will: Without strong leadership and commitment from policymakers, it can be challenging to implement the necessary policies and regulations to promote energy efficiency.

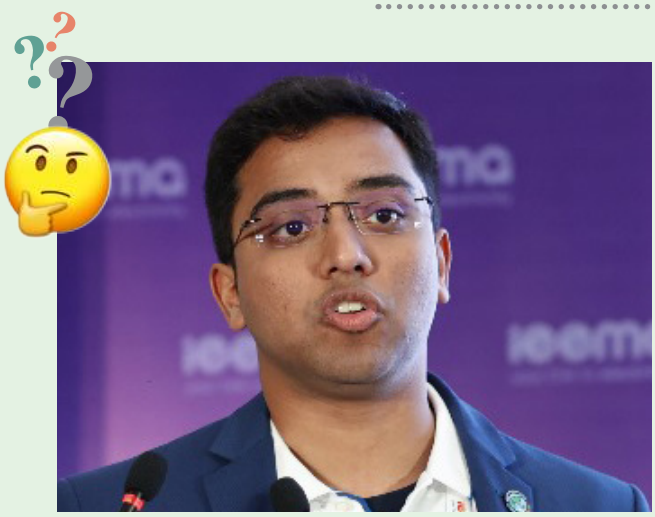
Technological barriers: In some cases, there may be limitations in available technologies or infrastructure that prevent more widespread adoption of energy-efficient solutions.

Behavioural barriers: Changing ingrained habits and behaviours related to energy use can be difficult, even with incentives or education efforts.

Limited access to financing: Especially in developing countries, a lack of access to financing can prevent individuals and businesses from investing in energy efficiency measures.

Overall, addressing these obstacles will require a multi-faceted approach involving government, industry, and individuals working together to prioritize and invest in energy efficiency initiatives.

For example, in India, PM Modi announcement of roof top solar systems in 1 crore homes and he has roped in PSUs for implementation of this program, benefitting not only the public, reducing the dependency on fossil fuel-based power plants and investment in them, but turning them to green energy and working towards India's goal of reducing carbon footprint by half by 2030. ■



Ronak Mistry Yogesh
ElectraVerse Sparks Contestant and Founder of Greenovate Solutions

Mitigating CO2

The world's most urgent problem is climate change. Of the entire carbon budget that is accessible to human race, we have already consumed 73%, and are expected to consume the rest 23% within next 20 years! This creates a global urgency for emission reduction.

We have already raised it above pre-industrial baseline by 1C, and transitioning to carbon free future is urgent, which is expected to come at a cost of $23 trillion by 2050. Prime Minister Modi has set an ambitious target of 1 billion Tonnes Carbon Reduction by 2030, which requires innovative new solutions.

Cost effective carbon capture systems from Industrial Off Gases. Industries are responsible for 33% of global CO2 emissions, of which 20% are from SME's. As per the 80:20 rule these minority emissions from the SME's get neglected. Hence, there is no feasible technology available & designed for SME's to participate in CCUS.

At industrial sites, CO2 capture is a very capital intensive and long-term (permanent) establishment, with heavy Op-Ex as well. This is due to the heavy volume operation and civil infrastructural establishment with lot of space occupancy. Also limiting to operational volume capacity rigidity. They also incur a need for expensive speciality chemicals for their operation with heavy energy duty.

The CCUS technologies across globe in order to handle the captured CO2 (treatment, logistics, storage, market sale, etc.) at the large volumes of thousands of tonnes requires a support of business model innovation for its full-scale execution. The CCUS technologies for its full-scale execution and impact would require a value chain involving treatment, logistics, storage, sequestration, utilization of captured carbon from the source is must essential to achieve net-zero after capture.

Our Solutions

Business enterprise combats climate change by converting industrial emissions into resources. We aim to capture industrial CO2 emissions to utilize them as a resource to alternate imports and production of LCO2. Leading to a carbon negative and revenue positive ecosystem. "Waste to Best for CO2 emissions"

End-to-end support of captured carbon, from source point to sink, with our industrial clusters, creating and developing global to local partnerships amongst stakeholders of the carbon market. We aim to capture and re-purpose 500 Tonnes (≈50 Units Deployed) of CO2 by developing value added products by the December of 2025 and 1 million tonnes by 2035.

Aiming for supporting the IPCC short-term goal to peak carbon emissions as soon as possible, maintaining under the carbon budget and avoiding irreversible climate change. Enable Medium & Small-Scale industries incorporate to CCUS at their sites. We enable Small & Medium-Scale Industries (i.e. Textile, Fertilizers, Chemicals etc.) to CCUS, with our plug and play, portable, zero-infrastructure, low-energy, modular CCUS

systems. Certifying them as Green Manufacturers & Green Industries by supporting their carbon auditing and compliance in CBAM, BRSR, ESG & GHG. Also, purifying captured CO2 emissions and supplying to up-cyclers (CO2 to fuel).

Currently conducting pilot projects:

- Power company for a coal fired furnace, in Mumbai, IN (CO2e 50TPY)
- A pilot cluster for Oil & Gas Industries of Gulf of Kutch, Gujarat, IN (CO2e 10TPD)
- A for pilot cluster at Jurong Islands, Singapore (CO2e 5TPD)
- A pilot for Hindu crematorium grounds at Pune, Maharashtra, IN for capturing pollutants after cremation and converting to green crematoria, a concept of Local Government Body (CO2e 100 TPY). ■

Sikinder Reddy
Thandra Co-Founder & CEO
Coral Innovations Pvt. Ltd. (Bharat Smart Services)

Energy Efficiency

G20 Summit committed to double the energy efficiency change to 7.3% globally. The decade ending 2020 saw an Energy efficiency change by 0.4% from 6.1% to 6.5%. The target of doubling the change means an improvement of 2 * 0.4% = 0.8% over the previous value of 6.5% to 7.3%.

The focus in all these years has been more and more energy efficient devices. This is necessary, but not sufficient if we want to accelerate (double) the growth.

But the real problem comes in replacing a working (though less efficient) equipment with a more efficient one. This needs a lot of investment by individuals in the domestic sector as well as industries. This is the challenge now facing everybody.

- We talk of doubling in a decade 1/3 of which is already gone. Now we are in 2024 and some of the reasons why the world is lagging the SDG 7.3 target are:
- Lack of awareness and information among consumers and stakeholders about the benefits and potential of energy efficiency
- High upfront costs and perceived risks of investing in energy efficiency measures, especially in developing countries.
- Insufficient regulatory and institutional frameworks to support and enforce energy efficiency standards and incentives
- Competing priorities and trade-offs between economic growth, social development, and environmental protection

Opportunities for improving energy efficiency in India

- Implementing the Energy Conservation Building Code (ECBC) for new and existing buildings, which can save up to 40% of energy consumption in the building sector.
- Expanding the Standards and Labeling (S&L) scheme for appliances and equipment, which can reduce the peak demand by 7.5 GW and save 8.6 billion units of electricity annually.
- Scaling up the Perform, Achieve and Trade (PAT) scheme for energy-intensive industries.
- Promoting the Market Transformation for Energy Efficiency (MTEE) program, which can facilitate the deployment of energy efficient technologies and products through innovative financing mechanisms.
- Enhancing the State Designated Agencies (SDAs) capacity and coordination for effective

implementation of energy efficiency policies and programs at the state level.

- Further a new kind of thinking is required to accelerate the growth rate of energy efficiency.
- The EE is calculated at Appliance / Equipment level all these years. More stars, revising star rating standards.

We have to come out from the Conventional EE at Equipment level to the Square kM area of earth's surface.

- Being an ElectraVerse Spark, I ask the these questions:
- What are the main drivers and barriers for adopting energy efficiency measures in your sector?
- How do you measure and monitor your energy performance and savings?
- What are the best practices and success stories that you can share with other industries and sectors?
- How do you engage and motivate your employees and customers to participate in energy efficiency initiatives?
- What are the challenges and opportunities for integrating renewable energy sources and smart technologies into your energy systems?

My efforts towards energy efficient goals and my solutions

- Our Bharat Smart Services App is live in Google Play Store with 4+ ratings & 4.5L+ downloads empowering domestic consumers to track their consumption and know their expected bill by just taking a photo of their Meter and doing a self-appliance audit and identify the actual wattage of the appliances being used by them.
- Further we have developed an AI powered Bijli Auditor to identify the appliance wise On/Off and consumption.

As part of our mission to transform Meter reading/ decentralised workforce as Climate warriors, we will empower them with our Bijli Auditor to do the home appliance and commercial establishments appliance/ equipment wise audit.

On the occasion of Ugadi - Telugu New Year, we want to start our journey of empowering 1 Lakh workforce by empowering at least 100 workforce to start helping consumers to identify wasteful consumption in their premises and enable them with actionable insights to improve the energy efficiency and reduce their electricity bills. ■

INSULEC 2024

11th Conference on Electrical and Electronic Insulating Materials& Systems

February 1-2, 2024, Holiday Inn, Mumbai, India

Theme: Changing Dynamics for Sustainable Growth in the World of Electrical Insulation

(I-R) Dr. S. V. Kulkarni, Institute Chair Professor, Electrical Engineering, IIT Mumbai, George Joseph, MD NewGen, Prashant Doshi, Vice Chairman, Insulating Materials and Systems division, and Past Chairman IEEMA Insulating Materials and Systems Division; Srikumar Ramakrishnan, MD, Elantas Beck India, Dr. G S Prabhu, Chairman of IEEMA Insulator Division

IEEMA's 11th International Conference on Electrical & Electronic Insulating Materials & Systems, I NSULEC 2024 launched in Mumbai's Holiday Inn on February 1 to conclude on Feb 2, 2024. The theme of the conference was "***Changing Dynamics for Sustainable Growth in the World of Electrical Insulation***".

With more than 200 registered delegates, INSULEC 2024 received an overwhelming response and was spearheaded with Technical paper presentations under five technical sessions and panel discussion over these two days.

Ensuing every four years, INSULEC was inaugurated by Dr. S. V. Kulkarni, Institute Chair Professor, Electrical Engineering, IIT Mumbai. The welcome address was delivered by Dr. G S Prabhu, Chairman of IEEMA Insulator Division.

As he set the context of the event, he said that the electrical and electronic industry has played an indispensable role in driving the economy of India. He spoke of the pivotal role and the tireless efforts of industry stalwarts setting new benchmarks in manufacture, inventions, services and research. Kulkarni emphasized upon the importance of rotating machines, transformers, insulating machines that form the cornerstone of the electrical and electronic industry. Sharing his outlook about the upcoming five years he said that they are powered with great challenges which could be diligently and successfully addressed with industry collaborations and sustenance objectives to become global leaders.

Srikumar Ramakrishnan, MD, ELANTAS Beck India, delivered the keynote address. A chemical industry sales and business development professional, Ramkrishnan has almost three decades of industry experience in the paints, engineering plastic, Polyeuthane and Silicon industry. In his address, this chemical engineer from Mumbai University who also holds a PG in Business Management from XLRI in Jamshedpur, focused on the critical role of insulating materials in the electrical and electronic industry. With a rich experience working across India, Africa, Middle East and Africa, Ramkrishnan elaborated

Srikumar Ramakrishnan, MD, ELANTAS Beck India

upon the renewable industry and spoke at length upon sustainable production as an important part of the industry. He pointed out the subjects of wastage reduction, responsible development of ecofriendly materials among other current topics.

Chief Guest SV Kulkarni was next to take on the podium. Institute Chair Professor in the Department of Electrical Engineering, Kulkarni has also held the position of the INEA Chair Professor, other than being a Fellow of IEEE Transactions on Power Delivery and IEE Power Engineering Letters, among many other academic and specialized positions.

He started his address to the august audience by emphatically suggesting that the "academia and the industry need to interact more vigorously". Author of a book titled 'Transformer Engineering: Design, Technology, and Diagnostics', this recipient of many distinguished awards further stating that 'insulation is a ubiquitous phenomenon' to set the tone of the conference as he touched upon topics that included internal insulation, air and other insulation systems, vacuum insulation systems, liquid insulation, solid insulation and composite insulation systems, in his introduction to the grand international conference. He concluded his welcome crisp welcome introductory talk by reiterating how important it is for academia and the industry to connect.

George Joseph, MD NewGen was conferred the Lifetime Contribution award for his selfless services to the Insulating Materials & Systems segment of the industry for three decades.

Suhrid Sanghvi, Past Chairman IEEMA Insulating Materials and Systems division, Prashant Doshi, Vice Chairman, Insulating Materials and Systems division were also present at the inaugural.

Enlightening Moment

The inaugural lamp lighting ceremony took off with a soft prayer when the dignitaries lit the auspicious lamp. The

Prashant Doshi, Vice Chairman, Insulating Materials and Systems division

event launched with an immaculate and relaxed pace, where industry experts freely expressed their opinions, shared ideas, gathered knowledge, exchanged views, laughed and learnt with each other.

Twenty-eight Technical Papers were presented (5 Overseas and 23 Domestic Papers) under the sessions of Insulation of Electrical Rotating Machines, Insulation for Electrical Static Machines, New Developments in Electrical Insulation Systems & Materials and Studies & Evaluation of Materials & Systems were presented from experts from organizations like Bodo Chemie GmbH, Siemens Ltd, Cargill India, Bhabha Atomic Research Center, DuPont, BHEL, ELANTAS Beck, Huntsman Solutions, Fine Finish Organics, IIT Mumbai, CPRI, ERDA etc.

The 11th edition of INSULEC – 11TH International Conference on Electrical & Electronic Insulating Materials and Systems was Powered by DuPont Specialty Products India Private Limited and had Sahney Kirkwood Pvt Ltd as Platinum Co-hosts along with BEICO Industries Pvt Ltd as the Dinner Co-host. Gold sponsors for the conference included ELANTAS Beck India Ltd, Senapathy Whiteley &

Dr. G S Prabhu, Chairman of IEEMA Insulator Division

Dr. S. V. Kulkarni, Institute Chair Professor, Electrical Engineering, IIT Mumbai

Lakshmanan Isola Pvt Ltd, NewGen Wires and Coils Private Limited, Fine Finish Organics Private Limited along with 3A Associates Incorporated as the Delegate Kit Co-host. Silver Co-hosts were Precision Wires India Ltd, CG Adhesive Products Limited, Sneham Taping Solutions Private Limited, ELMAS Magnetics and ERDA.

First Day @ INSULEC 2024

Industry acclaimed stalwart Ravindra S Barve moderated the initial session on the first day of INSULEC 2024. Titled "Insulation of Electrical Rotating Machines", the session had six paper presentations on topics ranging the impact of insulation in IGBT based Inverter-Fed Traction Motors covered by Prasad Telang from Bharat Heavy Electricals Ltd Bhopal; Shishu Pal also from the same company spoke about Enhancing the Field Circuit Reliability of Traction Machines through various techniques. Priyadarshi Rahul from BHEL HEEP, Haridwar addressed the topic of analysing the efficacy of the 'new synthetic zinc-based accelerator' with various criteria; Anirudha Tijare also from the Haridwar-based company presented a paper on the technical evaluation of candidate end Corona Protection System for establishing compatibility with insulation systems of high volatage rotating electric machines. The final two papers were on offline partial discharge of electrical machine insulation systems presented by Dilip Kumar Puhan from Central Power Research Institute while Nandu Gopan from Cape Electric presented his study on insulation coordination in low voltage.

Each paper presentation was received with much enthusiasm and contemplative interest and upon conclusion the moderator Barve threw open the session to the audience where umpteen doubts and queries were answered to the heart's content by all panelists.

Session II on the 1st day of IEEMA's 11th International Conference about Electrical & Electronic Insulating Materials & Systems called 'INSULEC', was themed 'Insulation Systems for Static Electrical Machines. The session was chaired by Dr Gunjan Gadodia.

Suhrid Sanghvi, Past Chairman IEEMA Insulating Materials and Systems division

Out of nine presenters, the first presentation was made by Dr T. V. Santhosh from the Reactor Safety Division of BARC, Mumbai. It was received with great interest and appreciated by many. Sailesh Purohit from Nomex Electrical Infrastructure DuPont, India presented a paper on Improved reliability and performance if K-Factor Transformers for Data Centers. Further papers were presented and topics were covered by Dr Venkatasami Athikkan representing Star Consultants in Pune, Dr Milind Bhagwat from Siemens, Naveen Jain from Cargill India, Nitin Shingne from ERDA, Ashitha Parambalath Narendran from Central Power Research Institute and The Tata Power Company's Bhanuji Alapati's paper was the final one for this session.

An interesting panel discussion themed "Change in Insulation Designs for the Modern Electrical Equipments" was organized with eminent experts like Dr Christoph Schnoll of Bodo Chemie GmbH, Germany, Kiran Borole of Digital Connexion, Dr Anirudha Tijare of BHEL, R S Barve, Consultant, and Dr S V Kulkarni of IIT Mumbai and moderated by Sailesh Purohit of DuPont India. The audience actively participated with queries and technical solutions presented by the esteemed panelists.

George Joseph, MD NewGen receiving the ILifetime Contribution Award

Sailesh Purohit moderating the Seession on Change in Insulating Designs for the Modern Electrical Equipments

The first day of INSULEC 2024 drew to a close with a grand cocktail dinner at Mumbai's Holiday Inn.

Second Day at INSULEC 2024

Day two began with a session on New Developments in Electrical Insulation Systems & Materials that was moderated by Sneha Sheth. Bapu Balkrishna Gawade from ELANTAS Beck India Ltd presented the first paper of the day New Generation Primary Insulating Materials For 800V Electric Vehicle Technology followed by Singubiru Machindra Khatake, from the same company who presented a paper on New Trends In Using High Performance Resins And Their Composites. Sailesh Purohit presented a paper on a new insulation paper with high electrical performance for high voltage traction motors of EVs and finally Manish Jaiswal representing Huntsman Solutions India Pvt Ltd shared his study about Advanced Electrical Insulation Materials for power-generators, hollow-core-insulators, dry-type transformers and E-mobility.

The third Session on the second day of INSULEC 2024 was titled New Developments In Electrical Insulation Systems & Materials and moderated by Inder Pal Singh Khandpur Founder of IPKS. Four papers were presented one after another, firstly by Kishore Prabhu from Fine Finish Organics Pvt Ltd, followed by Dr. Christoph Schnöll, Bodo Möller Chemie GmbH, Germany whose topic was Sustainable And Ecofriendly Synthetic Resin Solutions For The Electrical And Electronic Industry: Introducing Two Recent Approaches Based On Biomass Balance And Photopolymerization. R Hari from BHEL, Hyderabad presented a paper on Development Of High Thermal Conductive Insulation System For Electrical Motor Application and finally Amit Ghosh, Xpro India Ltd shared his paper on Development Of Semi Rough Film For Capacitor With Conventional Resin Replacing Non-Conventional Resin.

Session four was chaired by Kiran Ganachari. It had six speakers with Sailesh Purohit from Nomex, Swapnil Thakre from Finish Finish Organics, Anagha E R from the Department of Electrical Engineering, Indian Institute of Technology Bombay, Shalini Bajaj from Pla Tech Industries, P V Satheesh Kumar representing the Central Power Research Institute and Sneha Sheth from ERDA and they presented various papers on Studies & Evaluation of Materials & System.

The conference ended with the announcement of INSULEC 2024 - 3 Best Papers Awards. R Hari, BHEL, Hyderabad won the first prize for Best Paper in INSULEC 2024 for his paper on "Development Of High Thermal Conductive Insulation System For Electrical Motor Application". Dillip Kumar Puhan, Central Power Research Institute won the second prize for Best Paper at INSULEC 2024 for his paper on "Offline Partial Discharge Diagnosis Of Electrical Machine Insulation System - Case Studies". The third prize was bagged by Prasad Telang, BHEL, Bhopal for his paper on "Insulation Impact In IGBT Based Inverter-Fed Traction Motors: A Comprehensive Case Study".

Look forward to INSULEC 2028, which will be bigger in all aspects, brighter in prospects and deeper in knowledge!

Panelists of the Session on Studies & Evaluation of Materials & System

First Best Paper: R Hari, BHEL, Hyderabad for his paper on “Development Of High Thermal Conductive Insulation System For Electrical Motor Application”

Second Best Paper: Dillip Kumar Puhan, Central Power Research Institute for his paper on “Offline Partial Discharge Diagnosis Of Electrical Machine Insulation System - Case Studies”

Third Best Paper: Prasad Telang, BHEL, Bhopal for his paper on “Insulation Impact In IGBT Based Inverter-Fed Traction Motors: A Comprehensive Case Study”

INSULEC 2024 Organising & Technical Committee Members. (Top left -r) Dr. G S Prabhu, Chairman of IEEMA IMS Division, Prashant Doshi Vice Chairman IMS Division, K. Seetharaman, Assistant Director, State Head. Karnataka, Kerala & Tamil Nadu; Industry stalwart and Consultant Ravindra S Barve, Sailesh Purohit from Nomex and Abhey Kkulthe from ELANTAS Beck India. (Bottom left-r) Mihir Merchant of Permali Wallace, Dr Sneha Sheth from ERDA, Dr Gunjan Gadodia, Chief Technology Officier at 3A Associates Incorporated, Inder Pal Singh Khandpur Founder, IPSK and Kiran Gnanachari from Sneham Taping Solutions Pvt. Ltd.

Lighting of inaugural lamp

TECH-IT 2024 Makes a Mark

TECH-IT– 5th International Conference on Instrument Transformers launches in Mumbai

TECH-IT 2024 the 5th International Conference on Instrument Transformers, was held on February 6 & 7, 2024 at Hotel Novotel Juhu, Mumbai. The theme of the conference was 'Instrument Transformers for Safe & Reliable Power Systems'. The event was inaugurated by Guest of Honour Sandeep Kalantri, Director-Operations, Maharashtra State Electricity Transmission Co. Ltd. (MSETCL); Shashin Shah, IEEMA National Executive Council Member; Dr. Mira Parasuram Chairperson of both IEEMA Instrument Transformers Division and TECH-IT 2024 Organising Committee; G. V. Akre Chair of TECH-IT 2024 Technical Committee and Geeta Joshi, Vice Chair, IEEMA Instrument Transformers Division.

Inaugural Session

The function started on an auspicious note by the lighting of the inaugural lamp. G. V. Akre, TECH-IT 2024 Technical Committee Chair welcomed the dignitaries, authors, session chairmen and delegates. He said that TECH-IT is a "testament of the shared dedication of all stakeholders to the subject of safety and reliability of power systems". He assured the audience of two days full of knowledge sharing on latest developments, challenges and innovations in instrument.

IEEMA National Executive Council member Shashin Shah in his speech complimented the conference team on the topics and enlisted number of 29 expert papers to be presented across a span of two days. He further shared an overview of each session and bode the audience two action packed days ahead!

Dr. Mira Parasuram, IEEMA IT Division Chairperson and TECH-IT 2024 Organising Committee Chair, in her speech, thanked the audience and the industry at large, for the grand response to the conference. She presented an overview of all past editions of TECH-IT conferences starting from 2006 and the way it has taken evolved to a grander edition in 2024. She mentioned with fond remembrance, the successful webinar series 'TECH-IT Tutorials' conducted during the pandemic in 2021. She further shared brief information about the various activities undertaken by IEEMA Instrument Transformers division.

This was followed by the special presentation on selection of specifications related top each paper.

G. V. Akre, Chairman TECH-IT 2024 Technical Committee delivering welcome address

Shashin Shah, IEEMA National Executive Council member sharing his thoughts with audience

This presentation was made by Vrajesh Desai, TECH-IT 2024 Technical Committee member. The extensive presentation covered important points like Design & Construction Features, Importance of Right Specifications in Order to Have Cost of Product & Price Paid by Customer to a Minimum Without Compensating Usefulness to Customer, Application of Various Types of CTs, Useful Properties of Materials, Selection Ratings & Realistic Parameters of Different Types of VTs. The presentation was supported by some case studies.

Keynote speaker Sandeep Kalantri, Director Operations, MSETCL, in his speech stressed upon the subject of having safe and reliable instrument transformers for all stakeholders. He said that the approach should be such that "design and specifications are a part of planning itself, especially in a view many upcoming technologies like green hydrogen, RE, green ammonia, etc.". He made an encouraging mention of MSETCL going ahead with "one nation one specification on the lines of MOP guidelines issued in 2022 for generalisation of technical specifications on power transformers and reactors". He said, "For safe and reliable power systems, materials and updates on online and offline condition monitoring needs to be discussed with both parties as a team." He also suggested that IEEMA should look at having generic specifications for GIS, EHV Cables, HTLS, Monopole, etc on similar lines of MoP having issued generic specifications for power transformers. Kalantri mentioned that to have a safe, secure and cost-effective product, a dialogue between end users and manufacturers is required.

Book Launch

Towards the culmination of the inaugural session, two IEEMA publications were unveiled, namely the 'Bound Volume Of Technical Papers of TECH-IT 2024 and

Inaugural Session in Progress

Release of bound volume of TECH-IT 2024 technical papers

the booklet 'IEEMA Recommendations On Condition Monitoring Practices'.

Geeta Joshi, Vice Chair of IEEMA Instrument Transformers Division, in her vote of thanks reiterated the Guest Of Honours' remark that enthused the ensuring of design and specifications being an integral part of planning. She thanked all the authors for putting in hard work for writing papers and making presentations, the delegates for their enthusiastic participation and all co-hosts for supporting the conference.

The 2 days of the conference had 29 presentations spread over 6 sessions, as follows:

Session 1 Design & Construction & Standards chaired by Jyotirmoy Dutta, Siemens Ltd

Session 2 Materials & Panel discussion chaired by G.V. Akre, Hivoltrans Electricals Pvt. Ltd

Session 3 LV/MV Instrument Transformers chaired by Dr. Mira Parasuram, Kappa Electricals

Session 4 Testing chaired by Dr. Anil Khopkar, ERDA

Session 5 Asset Management & Condition Monitoring chaired by Pramod Rao, TECH-IT 2024 Technical Committee Member

Session 6 New Trends & Emerging Technologies chaired by Rajdeepak Pandey, Hitachi Energy

The initial session on Design, Construction & Standards had authors presenting highly informative studies addressing some of the most popular but very less experienced concepts like Internal Arc Test by Uday Sanvatsarkar, Transient Performance Class by Mayank Yadav. Dr Parasuraman presented some fine aspects of Inductive Voltage Transformers.

Green energy, green substation is a current subject that is much talked about. Session 2 gave all of us a flavour of developments in the field of materials relevant to Green Energy. Non-conventional materials such as composite hollow insulators, nanocrystalline core material and alternative insulating fluid to petroleum based mineral oil were the highlights of session.

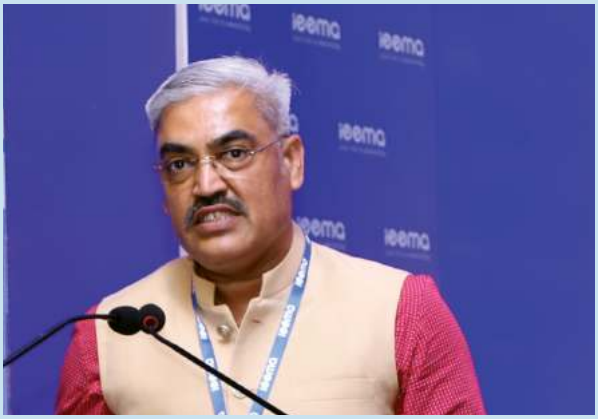
LV / MV in the Spotlight

It is not possible to manufacture excellent products in terms of quality, technology and cost, without support from raw material suppliers. For any new development, the designer of the product and the raw material supplier need to join hands. Thus, in this edition of TECH-IT IEEMA decided to have a separate session dedicated to materials.

The third session on the first day was dedicated to the LV/MV sector for the first time since the inception of TECH-IT. This session garnered much enthusiasm and was received eagerly by the august audience. Authors threw light on epoxy nano material and casting resin. Importance of the Right Approach Of Testing For Combined Metering Unit and Partial discharge were

Delegates

Dr. Mira Parasuram, IEEMA Inst. Tranf Division chair and TECH-IT 2024 OC chair sharing divisional activities info with the audience



Sandeep Kalantri, Director Operations MSETCL

well explained by CPRI and ERDA representatives. Vinay Kumar touched on the subject of CBCT which is generally a grey area for most of the industry.

Dr Parasuraman commenting upon how this session on LV / MV came about said, “The LV and MV-IT industry is equal in size to that of the HV and EHV segment. We had some very good papers on the design, construction, testing of these transformers.” This session also had papers on resins used in the LV/ MV segment, a separate session on insulating oils, special magnetics for the industry as well as on insulators. “We were thus able to give comprehensive insights, covering all aspects of instrument transformers through the inclusion of these two special sessions,” she added.

Reiterating the same Geeta Joshi, Vice Chair of IEEMA IT Division informed that feedback from previous editions mentioned that LV /MV sectors were not being addressed. “That’s how in this edition of 2024, we have scheduled a dedicated session on LV/MV being significant contributors to the Instrument Transformer family.”

Geeta Joshi, Vice Chair of IEEMA Instrument Transformers Division

Vrajesh Desai, Technical Committee member of TECH-IT, presented an overview on the Selection Of Specifications as an aspect of design and stated that with a revolution in the relay technology, it is crucial to relook into specifications apt for today’s application.

IEEMA NEC member Shashin Shah presenting token of appreciation to guest of honour Sandeep Kalantri, Director Operations MSETCL

Release of booklet on IEEMA Recommendations on Condition Monitoring Practices

Session in progress

TECH-IT 2024 Organising & Technical Committee members

Team IEEMA

Author presenting paper

Second Day @ Tech-IT 2024

Day two of the conference started with an introductory speech by R. Krishnakumar, IEEMA Technology Innovation & Support Council (TISCO) Chairman MD & Group CEO – S & S Power Switchgear which was followed by a presentation G. V. Akre on Condition Monitoring.

Reach-out to TISCO!

In his talk, Krishnakumar enlightened the delegates about IEEMA TISCO activities on the field to encourage R&D in the electrical industry, especially within IEEMA members. He informed, "TISCO is supporting IEEMA members to scale up their technology where it is required". He talked about Gross Domestic Expenditure in R&D (GERD) a key parameter for corporate organisations as well as India. "For our nation, GERD is less than 1% (0.65%) and has remained stagnant over the years, which itself is an indicator of the low investment in R&D activities," he stated. Further he revealed how it was through TISCO that technological gaps in the industry were identified and shared with premier technical institutes. He gave the instance of one such project that was picked up by IIT Gandhinagar wherein the proposal for the development of zinc oxide blocks for surge protection devices was implemented and another project in process was the development of Insulation Paper by IIT Roorkee.

Krishnakumar said "R&D is all about technology leadership. Investment in R&D is confidence in the future, just like we invest in SIPs, invest today in research to ensure your future." He concluded his talk by appealing to the delegates to reach out to TISCO with their top technical challenges and costs involved in resolving each challenge. TISCO would develop solutions through technology.

IEEMA Recommendations on Condition Monitoring Practices

G.V. Akre, TECH-IT 2024 Technical Committee Chairman presented the synopsis of the booklet 'IEEMA Recommendations On Condition Monitoring Practices' that was released during the inauguration session.

This initiative by IEEMA Instrument Transformer division was taken up when key members felt compelled to develop guidelines for condition monitoring of instrument transformers due to the numerous incidents of instrument transformer failures that have been reported in India and abroad. This guide is intended for maintenance engineers, technicians, and operators working in the electrical power systems field.

During the presentation, Akre explained how the dependability and effectiveness of High Voltage (HV) instrument transformers are crucial in the world of electrical power systems for maintaining the

Q-A session

Best paper award winner Mayank Yadav, GE T&D

Best paper award winner K. Baburao, Raj Petro

Best paper award winner Uday Sanvatsarkar, CGPIS

uninterrupted operation of vital infrastructure. He touched upon the topics like overview of equipment failure, overall advantages of condition-based monitoring, tests for condition monitoring, etc.

Summing up the two-day international TECH-IT 2024 conference in the concluding session of Day 2, the chairman noted the highpoints as follows:

1. Release of booklet – IEEMA Recommendations on condition monitoring practices & Bound volume of technical papers
2. Presentation of 29 papers under various sessions
3. For the first time, sessions on Materials and LV/ MV Instrument Transformers
4. High satisfaction index – average more than 4.5/5 on all parameters
5. Complete engagement of the audience from start to end of the conference

The conference ended with the declaration of best paper award winners as follows:

1. Mayank Yadav, GE T&D for the paper - Current Transformers (CTs) for Transient Application for HV Networks
2. Uday Sanvatsarkar, CGPIS for the paper - A Journey towards un-manned substations for instrument transformers – Internal arc test for safety and reliability
3. K. Baburao, Raj Petro for the paper - Usage of novel biodegradable dielectric fluids in high voltage instrument transformers

Two special-mention awards were given to:

1. G. Girija, CPRI for the paper - Right approach of accuracy & temp rise tests on combined metering units
2. Premkumar, Huphen Fabricators Pvt. Ltd. for the paper - Resilience of composite hollow insulators.

Reviewing TECH-IT 2024

This two-day technical conference brought together stakeholders from the industry, utilities, end -users and test labs. Audience consisted of right mix of manufacturer, Test and Research Institutes, Power

Special mention award winner G. Girija, CPRI

Special mention award winner Premkumar, Huphen Fabricators

sector utilities, students and industry seniors. Papers in each session were very informative and triggered lots of interest in participants.

KK Murty, an imminent author and the seniormost participant at the conference said that he had travelled all the way from Indore just to attend TECH-IT. Commenting on the sessions he said, "I found the content informative and educative. It was a wonderful experience for me," and informed that he would be traveling to Ahmedabad to attend another conference after this. Sandeep Deulkar, AGM of CG Power was a first time participant. Commenting upon the pace of the sector, he said, "The instrument transformer sector develops on a slow and steady pace where conventional methods are used. The direction of development is key. I found the session one and two most relevant and informative as they are my areas of keen interest. I enjoyed how new methods of testing, new standards, new materials were discussed. The segmentation of subjects is good and the sessions well planned."

Anil Khopkar from ERDA asked to increase the frequency of the event. He said, "ideally TECH-IT should take place every 2 years. A four-year time span is too long." Commenting upon the reasons, he noted, "Such deep technical communication can help the IT manufacturing community improve their products. Two new innovation techniques were discussed today and they ideally should be awarded and that's when the lab-person would be awarded." He observed and congratulated IEEMA that attendees covered the entire spectrum of the industry from all utilities, small manufacturers, raw materials, laboratories, standardising authorities and other important sectors.

Dr Parasuraman, expressed her joy at the success of the event. She informed that from the time of promotion of the conference, they had received a record number of papers from technical experts in the industry. Geeta Joshi noted an overwhelming response from the participants and said, "Time was well maintained as mentioned during feedback."

Commenting upon the enthusiasm of the industry to participate, she said, "Right up to the last week before the event, we were receiving technical papers. This points to the importance of brand TECH-IT. We are happy that so many stake-holders have chosen our platform to present their research and expertise." She informed that the committee had received a good response from the industry and utilities to participate in the conference. "This also underlines the need of the industry to understand and appreciate the intricacies of specifying, designing and using instrument transformers," she said.

"We have shared our expertise and have received insights from the end users. We have been able to highlight the need for the correct specifications for ITs and for condition monitoring, thus prolonging asset life. Standardized specifications across the country would help in optimum design and cost-effectiveness of Instrument Transformers." ■

Lamp Lighting Ceremony at Inaugural of E3 2024 at Kolkata

E3 Rocks Kolkata

Encompassing three days of exhibition, buyer-seller meets and a conference, E3 garnered great momentum in the east!

Energize Empower East 2024 better known as E3 was an extraordinary journey of exploration and collaboration, held at Biswa Bangla Convention Centre in Kolkata from February 7-9, 2024. The event brought together industry leaders, innovators, and stakeholders in the electrical sector for a dynamic and successful gathering. The event aimed to explore emerging trends, foster collaboration, and propel the industry towards a sustainable and resilient future.

The three-day event comprised of a conference, buyer-seller meets and an exhibition.

E3 The Conference

The Conference comprised of sessions on Policies and Schemes, sessions on Eastern & North Eastern Utilities sharing their next 3 – 5 years' procurement plan and upcoming projects and sessions on Opportunities beyond Utilities with representatives from sectors outside utilities.

The event was inaugurated by Debasish Banerjee – Managing Director (Distribution), CESC Ltd, Bibhu Bhuyan – Managing Director, Assam Power Generation Corporation Ltd & Reuben Ahimbisibwe – Director of Access and Distribution Department, Energy Development Corporation Limited (EDCL), RWANDA in presence of Sunil Singhvi – President Elect, IEEMA, Vikram Gandotra – Vice President, IEEMA, Devesh Goel – Chairman, IEEMA Eastern Region & E3 2024, Siddharth Bhutoria – NEC Member, IEEMA and Charu Mathur – Director General, IEEMA.

The Inaugural session was followed by a session on Policies & Schemes with addresses from Rudra Kumar Singh, CM (ERTCC) & Satyanand Singh – CM (CS), Power Grid Corporation of India Ltd, Diganta Goswami – General Manager, North Eastern Electric Power Corporation Ltd, Goutam Biswas – Director, Duragen Energy Pvt Ltd & Saurav Shah, IPS – Executive Director, Power Finance Corporation Ltd. The session was moderated by Vikram Gandotra, Vice President, IEEMA.

Welcome Address by Devesh Goel, Chairman, IEEMA Eastern Region & E3

Address by Vikram Gandotra, Vice President, IEEMA

The event also had sessions by Utilities from Eastern Region with presentations by Srinibasa Rout – Addl. CE, P&C Department and Ramesh Chandra Madhu – Addl. CE, P&C Department from West Bengal State Electricity Distribution Company Limited (WBSEDCL), Shyama Prasad Patra – Sr. GM (M), Engineering, Damodar Valley Corporation (DVC), Santanu Sen – General Manager, CESC Limited, Nasim Eqbal – Director (Operation), North Bihar Power Distribution Company Limited (NBPDCL), Vipin Chauhan – Centralized Contracts group, Tata Power Central Odisha Distribution Ltd (TPCODL). The session was moderated by Rajiv Agarwal, NEC Member.

This session was followed by presentations by Utilities from North-Eastern Regions like Bibhu Bhuyan – Managing Director, Assam Power Generation Corporation Ltd, Debajyoti Das – Managing Director, Assam Electricity Grid Corporation Ltd, Amiel Momin – Chief Engineer, Meghalaya Power Distribution Corporation Ltd, Madhusudhan Sarkar – Deputy General Manager, Tripura State Electricity Corporation Ltd and H.F. Shangpliang – Add. CE, Meghalaya Power Transmission Corporation Ltd. while Arjun Deb – Convenor, North-East Region moderated the session.

Focussed session on the Opportunities beyond Utilities i.e. the non-utility sectors was moderated by Mr. Parag Saraf, Vice Chairman, IEEMA Eastern Region & Mr. Siddharth Bhutoria – NEC Member. There were addresses by Brig Susheel Kumar – Military Engineering Service (MES), Mr. Sujit Saha – Dy. Chief Materials

Dignitaries at Inaugural of E3 2024 at Kolkata

Sunil Singhvi, IEEMA President Elect

Manager, Chittaranjan Locomotive Works (CLW), Suraj Sarkar – Sr. Manager & Mr. R. K. Pandey – Dy. Manager from Steel Authority of India Ltd (SAIL-Bokaro),

Anil Kumar Tripathy – Deputy General Manager – CGD Projects, Hindustan Petroleum Corporation Limited (HPCL), Mr. George Tharakan – General Manager – Electrical, Airport Authority of India, Mr. Ashim Kumar Bharali – General Manager & Mr. Dwip Jyoti Goswami from Oil India, Duliajan, Mr. S K Jana – General Manager (E&M), Coal India Ltd, Mr. M. Mahendran – Senior Manager (Vendor Development), Garden Reach Shipbuilders & Engineers Ltd, Mr. Sunny Das – Business Development Executive, ERDA.

There was also a Panel Discussion with Members of CREDAI on opportunities in Real Estate & Buildings. The Panelists were Deepak Kumar Viswakarma – Sr. General Manager – Engineering, Ambuja Neotia, Santanab Mukhopadhyay – Director, Saent India Engineering Consultants Pvt Ltd & Ravi Dugar – Director, PS Group.

A Virtual Session was also held on "Opportunities for Electrical Equipment Industry in accelerating Energy Transition" was conducted by Mustafa Wajid – Managing Director, Meher Group.

E3 Buyer Seller Meet & the Exhibition

The Buyer-Seller Meet was conducted in the second half of the day on all three days and emerged as a pivotal platform where key stakeholders gathered to explore opportunities, exchange insights, and foster partnerships in the ever-evolving energy landscape. The meetings served as a catalyst for dialogue, collaboration, and innovation, shaping the future of energy transactions and sustainability. There were over 750 meetings held with over 60 buyers coming from Utilities from West Bengal, Bihar, Odisha, Assam, Meghalaya, Tripura & Non Utilities like Airport Authority of India, Eastern Railways, Chittaranjan Locomotive Works, Kolkata Metro Railways, MECON, NEEPCO, Oil India – Duliajan, Power Grid, PWD – Kolkata, SAIL, SPML Infra Ltd, Star Cement, Sterling and Wilson, BTL EPC, Techno Electric, Universal MEP Projects & Engg Services Ltd, Syama Prasad Mookerjee Port, Urban Development & Municipal Affairs – Govt of West Bengal, Coal India, Garden Reach Shipbuilders, Hindustan Petroleum etc.

This three-day exhibition saw around 24 sponsors and exhibitors showcasing their products.

Dignitaries at Inaugural of E3 2024 at Kolkata

Current Transformers for the Transient Application for HV Networks

A normal protection core in a CT is vulnerable to saturation during high asymmetrical short circuit currents due to remanent flux in an auto-reclosing duty cycle of a circuit breaker. In which case, the output of a saturated CT is distorted which affects relay and protection system functioning and, consequently, the network availability and reliability.

Hence, for auto-reclosing application, it is important to specify CTs considering the transient parameters of the network, as during transient conditions the asymmetrical fault current may rapidly saturate a normal protection core within 2 to 5ms [1].

Aiming to show this scenario, the behavior of a typical class PX CT was simulated under an asymmetrical short circuit during auto-reclosing cycle using ATP software. Transient class TPY of IEC-61869-2 is being presented as a more reliable alternative to the conventional class PX for further review.

Keywords

Current Transformer (CT), IEC 61869, Saturation, Remanence, Transient Performance, Short Circuit (Symmetrical / Asymmetrical), DC Offset, Time Constant, Auto-reclosing, TPX, TPY, TPZ and ATP (Alternative Transient Program).

Introduction

With the mass integration of Renewable sources of power and push for green mobility infrastructure, Electrical Grids across the globe continue to become more and more complex with the obvious necessity to transmit bulk power over long distances. Overcurrents are expected to increase in the network and with it the time constant for the d.c. offset current is also increasing.

Very low fault clearing times are necessary to ensure network availability and reliability. Modern relays and circuit breakers can achieve such low fault clearing times (of 80 to 120ms) provided they receive accurate input from CTs during transient conditions.

A regular protection core in a CT (Class PX or 5P / 10P of IEC 61869-2 for example) when not specified and / or designed suitably, may saturate rapidly during high asymmetrical short circuit currents due to remanent flux in an auto-reclosing duty cycle of a circuit breaker in case the fault is not cleared successfully. In which case, the output of a saturated CT is distorted which affects relay and protection system functioning and, therefore, the network availability and reliability.

Hence, for auto-reclosing applications, it is important to specify CTs considering the transient parameters of the network, as during transient conditions the asymmetrical fault current may rapidly saturate an ordinary CT core within 2 to 5ms [1].

This paper aims to simulate this scenario and show the behavior of a reference PX core specification under asymmetrical short-circuit with auto-reclosing and compare with the output of a transient class TPY of IEC 61869-2, designed to comply with the same

specification. The results show a significant difference between both cases, especially during the second duty cycle of the auto-reclosing. Class TPY is a promising alternative for such application, which could be optimum and more reliable. This paper introduces and explains Class TPX and TPZ also, however they will not be considered in the case study. This article uses a CT model in ATP (Alternative Transients Program) for the simulations, validated by[2] based on results of real tests.

The Short Circuit Current

The short circuit current ik(t) is the sum of a sinusoidal short circuit current and a decreasing direct current. The amplitude of the DC component depends on the phase angle of the short circuit inception and has its maximum value when the short circuit occurrence is on the zero-crossing value of the voltage [3]. The DC component decreases with the primary time constant TP, which depends on the short-circuit impedance of the system (TP =LP / RP). Figure 1 shows the short-circuit current curve for the maximum direct current component and a primary time constant TP of 60 ms. Typical values of TP may vary between 60 and 120 ms based on network parameters.

The figure 1 shows the asymmetrical short circuit current (combination of ac & dc component) and the time decaying dc component.

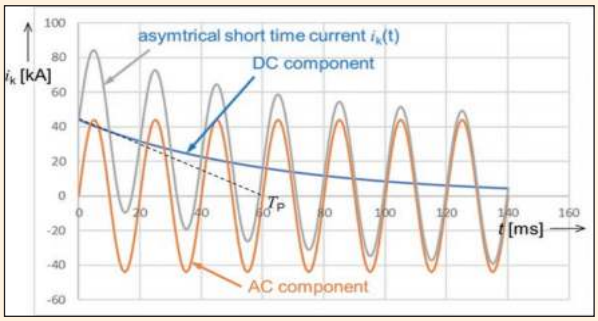


Fig 1: Asymmetrical short time current [5]

Auto-reclosing and CT saturation:

Auto-reclosing or automatic reclosing of circuit breaker is an important network operation for clearing faults and to ensure network stability and availability. In an auto-reclosing cycle the breaker tries to reconnect the line during a fault with or without an intentional delay. Following duty cycles are defined as per IEC 61869-2:

- Single Duty, C – O or Close – Open cycle (Without auto-reclosing);
- Double Duty, C – O – C – O or Close – Open – Close - Open cycle (With auto-reclosing).

Figure 2 shows a typical double duty cycle with auto-reclosing and the magnetic flux envelop change during the cycle.

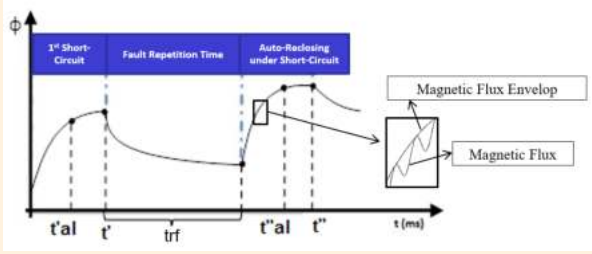


Fig. 2: Magnetic flux envelope of a Protection CT during an Auto-Reclosing [2]

Where t': duration of first fault, t'': duration of second fault, t'al: specified time to accuracy limit during first fault, t''al: specified time to accuracy limit during second fault, trf: fault repetition time.

As seen from the graphical representation of magnetic flux in Fig. 2, for an auto-reclosing cycle, which is a common fault clearing method of network operators, the magnetic flux during the second fault could be higher than first cycle due to the remanent flux in the CT cores, making the CTs more vulnerable to saturation and, hence, require special consideration while specifying and designing the CTs.

The Fig. 3 shows the primary current, secondary current and magnetic flux of a saturated CT during an asymmetrical short circuit, simulated in ATP software. The scale of each parameter was adjusted to improve the visualization of the impact of the flux saturation in the CT secondary current.

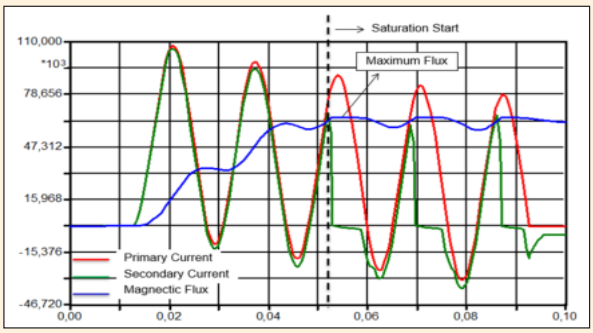


Fig. 3: ATP simulation of CT saturation under asymmetrical short circuit [2]

It is possible to notice that the secondary current (i2) adequately follows the waveform of the primary current (i1) until the beginning of saturation, and from this point on, i2 correctly reproduces i1 only when the instantaneous flux is smaller than the maximum flux (CT Saturation).

Protective CTs are mostly specified either to meet composite error requirements during symmetrical short circuit condition or by the magnetizing characteristics, i.e., knee point voltage and excitation current. Suitability for transient requirements is by virtue of inbuilt factor of safety & over dimensioning which is not always economical. CTs for transient requirements, specified

to comply with duty cycle and realistic transient parameters shall lead to optimum design with higher reliability to ensure network stability and availability.

Requirement of Protective CTs as per IEC 61869-2

Table 1 shows three different approaches to define a protective CT as per IEC 61869-2. In practice, each of the three definitions may result in the same physical realization.

Designation	Limit for remanent flux	Explanation
P PR	no [a] yes	Defining a current transformer to meet the composite error requirements of a short-circuit current under symmetrical steady state conditions
PX PXR	no [a], [b] yes [b]	Defining a current transformer by specifying its magnetizing characteristic
TPX TPY TPZ	no [a] yes yes	Defining a current transformer to meet the transient error requirements under the conditions of an asymmetrical short-circuit current
[a] Although there is no limit of remanent flux, air gaps are allowed, e.g. in split core current transformers. [b] To distinguish between PX and PXR, the remanent flux criteria is used.		

Table 1: Characterization of Protective Classes [6]

Table 2a and 2b show the limits for different accuracy classes as per IEC 61869-2. It is important to note that a limit for the remanence factor (Kr) is specified only for Low Remanence classes, this is an important factor which influences CT core sizing and performance when used in systems with multiple auto-reclosing cycles.

Class	Standard	Limits (%)					
		RE	PE	CE	TRE	ε	Kr
Protection	5P	±1.0	±60	5	-	-	-
	10P	±3.0	-	10	-	-	-
Sp. Protection	PX	-	-	-	±0.25	-	-
Transient	TPX	±0.5	±30	-	-	10	-

Table 2a: Accuracy Limits for Protective CTs [6]

Class	Low Remanence	Limits (%)					
		RE	PE	CE	TRE	Ɛ	Kr
Protection	5PR	±1.0	±60	5	-	-	10
	10PR	±3.0	-	10	-	-	10
Sp. Protection	PXR	-	-	-	± 1.0	-	10

Transient	TPY	-	±60	-	-	10	10
	TPZ	-	180±18	-	-	10	10

Table 2b: Accuracy Limits for Protective CTs (Low Remanence) [6]

Where: Sp.- Special, RE- Ratio Error, PE- Phase Error, CE- Composite Error, TRE- Turns Ratio Error, ε - Peak Instantaneous Error (AC for TPZ) and Kr- Remanence Factor

Transient Classes TPX, TPY & TPZ as per IEC 61869-2

Specification Methods

Based on IEC standard, there are two methods of specifying the transient classes as indicated in table 3[6].

Standard specification	Alternative specification
Class designation (TPX, TPY or TPZ)	Class designation (TPX, TPY or TPZ)
Rated symmetrical short-circuit current factor K_{ssc}	Rated symmetrical short-circuit current factor K_{ssc}
Duty cycle, consisting of for C-O cycle: t'_{al} for C-O-C-O cycle: t'_{al}, t', t_{fr}, t''_{al}	Rated value of transient dimensioning factor K_{td} Rated value of secondary loop time constant T_S (for TPY cores only)
Rated primary time constant T_p	
Rated resistive burden R_b	Rated resistive burden R_b

Table 3: Specification methods as per IEC 61869-2

Each parameter of the table is defined below:

- **Duty Cycle:** duty cycle in which, during each specified energization, the primary short circuit current is assumed to have the worst-case inception angle. t' and t" are linked to the time the circuit breaker opens, t'al and t"al are linked to the time the CT needs to be within the accuracy class, after that it is allowed to saturate. The exact definition is given in the item 1.2. Figure 4 shows an example of asymmetrical short circuit current during a C-O and a C-O-C-O duty cycle.

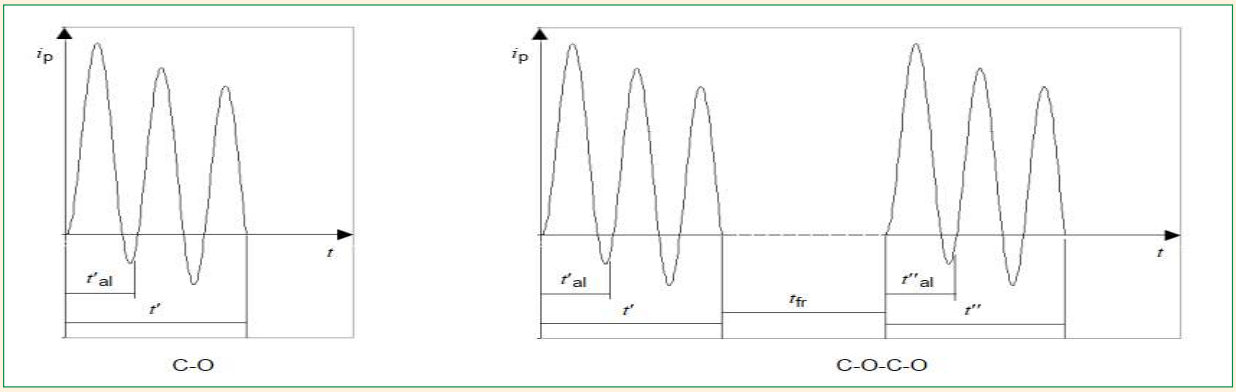


Fig 4: Example of Duty Cycle [6]

- **Specified primary time constant, T_p:** that specified value of the time constant of the d.c. component of the

primary short circuit current on which the transient performance of the current transformer is based.

- **Secondary loop resistance, Rs:** total resistance of the secondary circuit, considering the burden and the internal CT resistance. $Rs = Rb + Rct$
- **Rated symmetrical short-circuit current factor, Kssc:** ratio of the rated primary short circuit current (Ipsc) to the rated primary current (Ipr).

$$K_{ssc} = \frac{I_{psc}}{I_{pr}}$$

- **Transient factor, Ktf:** ratio of the secondary linked flux at a specified point of time in a duty cycle to the peak value of its a.c. component.
- **Transient dimensioning factor, Ktd:** dimensioning factor to consider the increase of the secondary
linked flux due to a d.c. component of the primary short circuit current.
- **Rated equivalent limiting secondary e.m.f., Eal:** that r.m.s. value of the equivalent secondary circuit e.m.f. at rated frequency necessary to meet the requirements of the specified duty cycle.
Eal = K ssc × Ktd × (Rct + Rb) × Isr
- **Secondary loop time constant, Ts:** value of the time constant of the secondary loop of the current transformer obtained from the sum of the magnetizing and the leakage inductance (Ls) and the secondary loop resistance (Rs).

$$T_s = \frac{L_m}{(R_{ct} + R_b)}$$

CT Sizing and Performance Comparison Between TPX, TPY & TPZ

All three transient classes have different constructions and are suitable for different applications, as described below:

- **TPX:** Typically, continuous or closed Magnetic core without air gap, remanent flux could be ~80% and hence not economical for auto-reclosing application as over dimensioning would be necessary for proper functioning. Physically, a TPX core could be identical to a PX, therefore it is just a different method of specifying a CT.
- **TPY:** Magnetic core with air gaps to control remanent flux <10% and hence more economical for auto-reclosing application. The instantaneous error is calculated based on ac and dc components of the short circuit current.
- **TPZ:** Magnetic core with air gaps and typically negligible remanent flux. The instantaneous error is calculated based on only the ac component of the short circuit, therefore, for its proper function, the dc component of the secondary current needs to be filtered out. Due to the phase angle requirements, usually has more gaps than the TPY and it is more complex to manufacture.

The typical hysteresis behavior of TPX/TPY/TPZ CTs is shown in the figure 5.

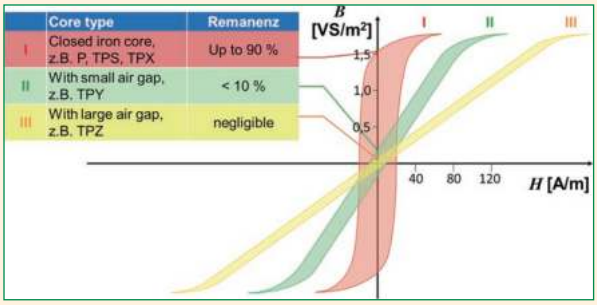


Fig 5: Hysteresis loop for TPX, TPY & TPZ indicating the extent of remanence [5].

A comparison of Vxl characteristics & magnetic core sizing for TPX/TPY/TPZ are indicated in figures 6a and 6b, respectively, for a 2000/5 ratio CT with following transient parameters:

Tp: 80ms, Ith: 40kA, Kssc: 20, t'/t': 67ms, t'al / t'al: 17ms, trf: 500ms and Rb: 12.5 VA, Duty Cycle: C-O-C-O.

On Fig. 6b, the core sizing is represented by a cross section of the wound core.

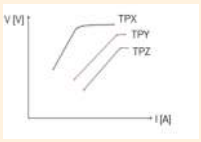


Fig 6a: Vxl Characteristic

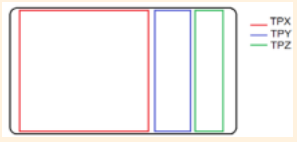


Fig 6b: Wound Core size (cross section area) comparison

As seen in Fig 6b, the cross section for class TPY and TPZ are significantly reduced compared with TPX. This indicates that we can achieve the same performance with optimum sizing provided the transient parameters are realistically specified and it is also important to highlight that the manufacturing and testing of class TPY and TPZ are more complex and, therefore, the constructive improvement needs to be evaluated case by case.

Manufacturing & Testing Considerations

Compared to the conventional CTs, the manufacturing & testing of cores for transient application (TPX / TPY / TPZ) require following additional considerations:

- **Magnetic core manufacturing:** Air gap formation in magnetic cores (except for TPX) is needed to comply with the limit of remanence factor. It is achieved by precise cutting of the cores and adding special fillers in between the sections to get

the desired air gaps as per design. This requires special skill set & equipment. Usually, number and thickness of gaps for TPY and TPZ are bigger than PR and PXR, as it is required also to demagnetize fast in case of C-O-C-O duty cycle.

- **Handling:** Special care is required while transporting and handling the cores as the air gap plays an important role in meeting the specified parameters and improper handling might cause issue with the air gap adjustment, causing problem during testing.
- **Testing:** Specific routine tests are the measurement of the secondary time constant (Ts) and calculation of Peak Instantaneous Error (ε) by the indirect method.

To have a better view of the test differences between transient classes and other types, the accuracy tests, as specified in IEC 61869-2, are summarized in the table 4a & 4b.

Class	Standard	Applicability								
		Ek	Ie	RE	PE	CE	TRE	ε	Ts	Kr
Protection	5P	✗	✗	✓	✓	✓	✗	✗	✗	✗
	10P	✗	✗	✓	✗	✓	✗	✗	✗	✗
Sp. Protection	PX	✓	✓	✗	✗	✗	✓	✗	✗	✗
Transient	TPX	✗	✗	✓	✓	✗	✗	✓	✗	✗

Table 4a: Accuracy test parameters for IEC, excluding low remanence classes.

Class	Low Remanence	Applicability								
		Ek	Ie	RE	PE	CE	TRE	ε	Ts	Kr
Protection	5PR	✗	✗	✓	✓	✓	✗	✗	✓	✓
	10PR	✗	✗	✓	✗	✓	✗	✗	✓	✓
Sp. Protection	PXR	✓	✓	✗	✗	✗	✓	✗	✗	✓
Transient	TPY	✗	✗	✓	✓	✗	✗	✓	✓	✓
	TPZ	✗	✗	✓	✓	✗	✗	✓	✗	✓

Table 4b: Accuracy test parameters for IEC low remanence classes.

The classes "P" must be tested for Ratio Error (RE), Phase Error (PE) and Composite Error (CE), when specified for low remanent flux ("PR"), the low remanence factor (K_r) and secondary loop time constant (T_s), if specified, must also be tested.

The classes "PX" must be tested for Turns Ratio Error (TRE) and, if PXR, for low remanence factor (Kr) as well. Additionally, the magnetizing characteristics need to be checked as the knee point (Ek) and limit of exciting current (I_e).

The transient Classes must be tested for RE, PE, Peak Instantaneous Error (ε). In case of TPY, Ts and Kr must also be tested and for TPZ, T_s must be provided by calculation and K_r tested. The test of ε by the indirect method requires the measurement of the magnetizing curve until the rated equivalent limiting secondary e.m.f (Eal), this is not always possible with standard test equipment and set up, especially for TPZ.

Details of the CT Model for Simulation in ATP

Figures 7and 8 show the CT model used to simulate the case study in the chapter 5.

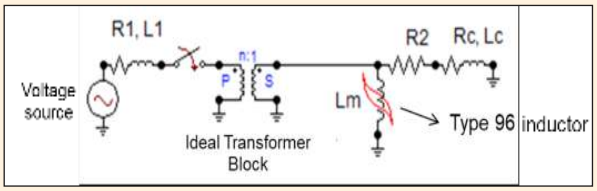


Fig. 7: PX core model in ATP

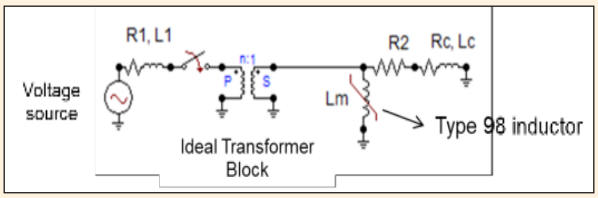


Fig. 8: TPY core model in ATP

Where:

- R1, L1: Linear resistance and inductance representing the system connected to the CT primary winding.
- Ideal Transformer: Ideal single-phase transformer which has as input only the transformation ratio and has no internal inductance or saturation.
- Lm Type 96: Saturable inductance of the magnetizing branch, this inductance considers the hysteresis of the ferromagnetic core.
- Lm Type 98: Saturable inductance of the magnetizing branch, this inductance does not consider the hysteresis of the ferromagnetic core.
- R2: Linear secondary resistance, internal to CT.
- Rc, Lc: Linear resistance and inductance of the load connected to the CT secondary.

The CT model with hysteresis was used to simulate the PX core and the one without hysteresis to model the TPY core. The hysteresis just needs to be modeled when the CT core has a high remanence and there is a CT demagnetization, otherwise the results of the inductor type 96 and 98 are practically the same [2].

The Fig. 9 compares the ATP simulation with a 19kA peak asymmetrical short circuit test performed on a 245kV CT, ratio 500-5A, Burden 50VA, showing that the simulation correctly represents the physical phenomenon of saturation.

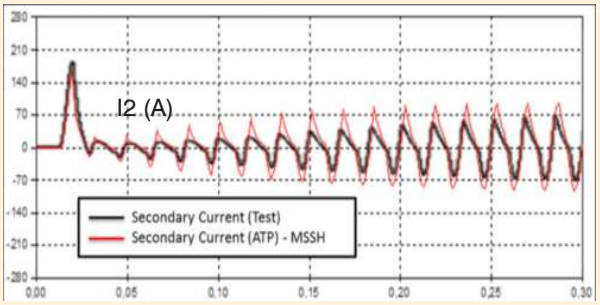


Fig. 9: Comparison between ATP simulation and test of a saturated CT Output during asymmetrical short circuit [4]

It is showing the results of the model without hysteresis, but [2] shows that there is no difference when compared to the model with hysteresis for simulations without core demagnetization.

Case Study

Aiming to support the understanding of the transient classes, a case study was conducted in which ATP simulations were carried out for the CT specifications in the table 5. Two different simulations were held, the first considering a symmetrical short circuit and a C-O duty cycle, the second considering a short circuit with maximum asymmetry and a C-O-C-O duty cycle.

Class	UOM	PX	TPY Std. Ref. Specification
Ratio	A/A	3000/1	3000/1
Frequency	Hz	50	50
Short circuit	kA / 1s	63	63
Knee Point Voltage	V	3000	-
Excitation Current	mA	120	-
Rct	Ω	15	-
Rb	Ω	-	2.5
Tp	ms	-	120
t'/t'	ms	-	65
t'al / t"al	ms	-	24
Trf	ms	-	1000
Kssc	-	-	21

Table 5: Standard (Std.) Reference (Ref.) Specification for performance comparison

Class PX with the presented specification was chosen because it is widely used in the field. The burden connected to it for the simulation was 2.5VA, a common value when digital relays are used. The TPY was chosen due to its good performance for such application and simpler construction compared to a TPZ, its specification is based on common parameters of the grid.

Figure 10 represents the wound core cross section of both designs under study, it is interesting to observe that the TPY size is considerably smaller than the PX. Some design details like the core dimension and material are not included as it is GE's confidential information.

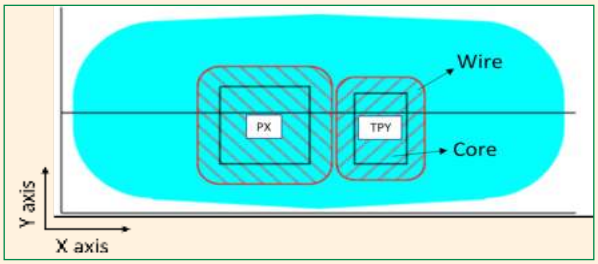


Fig. 10: Wound core cross section of cases under study

a. Case Study – Symmetrical Short Circuit Simulation

A 63kA symmetrical short circuit was applied to both PX and TPY cores. The CT secondary current can be seen in the figure 11a and 11b.

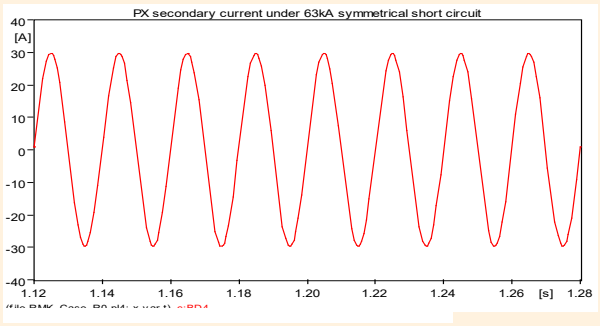


Fig. 11a: PX sec. current under symmetrical short circuit

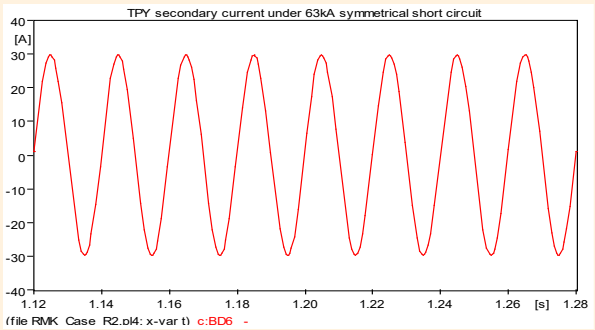


Fig. 11b: TPY sec. current under symmetrical short circuit

Both results are very similar and the cores are not saturating during the fault, hence, there is no performance differences between both classes.

b. Case Study – Asymmetrical Short Circuit Simulation

The same 63kA asymmetrical short circuit was applied to both PX and TPY cores, and a C-O-C-O duty cycle

was considered, as per figure 12. The dynamic current of 171kAp was achieved as a consequence of the simulation, due to the system primary time constant and short circuit inception angle, that was chosen to be at the zero-cross of the voltage, giving the highest DC offset.

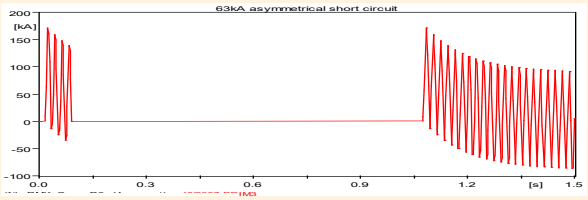


Fig. 12: 63kA Asymmetrical short circuit

The CT secondary current can be seen in the figure 13a for the first duty cycle and in the figure 13b for the second duty cycle.

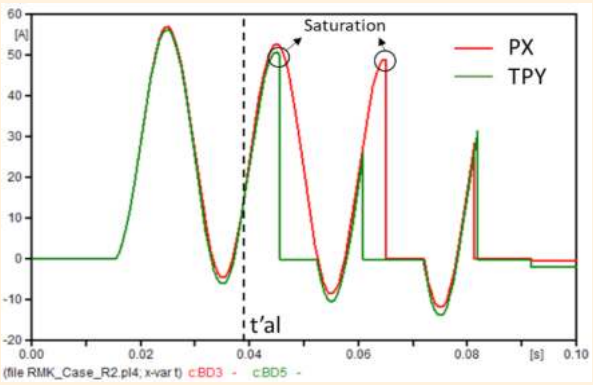


Fig. 13a: Sec. current during 1st duty cycle of asym. fault.

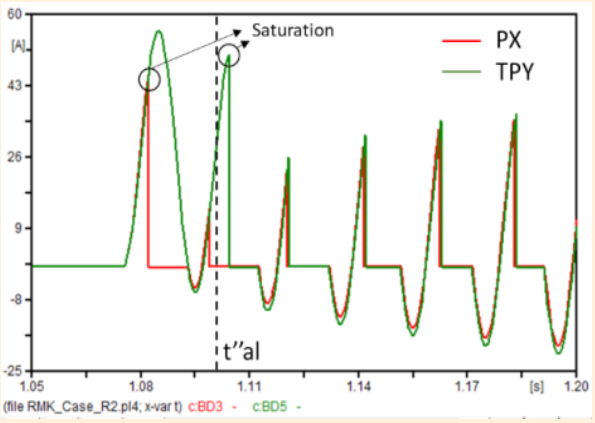


Fig. 13b: Sec. current during 2nd duty cycle of asym. fault.

For the first duty cycle, both PX and TPY cores just saturate after the time the accuracy limit is required (t'al), after that it is acceptable for the CT to saturate as the relay had enough time without saturation to see the actual short circuit and process it. Therefore, both cases are complying with the transient needs. The TPY, though, saturates earlier than the PX due to its smaller core, however there is no negative consequence to the protection system.

For the second duty cycle, PX is saturating before t"al and TPY after. The earlier saturation of PX may lead to protection malfunction, however, an actual protection failure depends on many other parameters like the type of protection, relay manufacturer, relay algorithms to compensate saturation, among others. On the other hand, TPY is ensuring that accuracy is kept within the limits at least until t"al and no risk is added to the protection system. The table 6 shows a summary of the time the cores are not saturated, called here "linearity time", and compares with t'al/t"al, considering that the reference (time = 0s) is when the short circuit occurs for each cycle.

Minimum Requirement	1st duty cycle Linearity Time		2nd duty cycle Linearity Time	
t'al / t"al	PX	TPY	PX	TPY
24 ms	50 ms	30 ms	7 ms	29.4 ms

Table 6: Cores linearity time during a C-O-C-O duty cycle.

As observed, the linearity time for TPY is very similar on both cycles, this is due to the low remanence in the core at the moment of the second short circuit. The PX, though, has a big decrease in the linearity time from the first to the second duty cycle, being only 7 ms, this is due to the high remanence on its core.

This phenomenon can be seen in the Figure 14, which shows the linked flux for both CT classes. For PX class it is higher because the core cross section is bigger, however both cores are working on the same maximum flux density, as they have the same material.

The remanence on PX in the beginning of the 2nd short circuit of the auto-reclosing cycle is 89%, while on TPY it is only 6.8%.

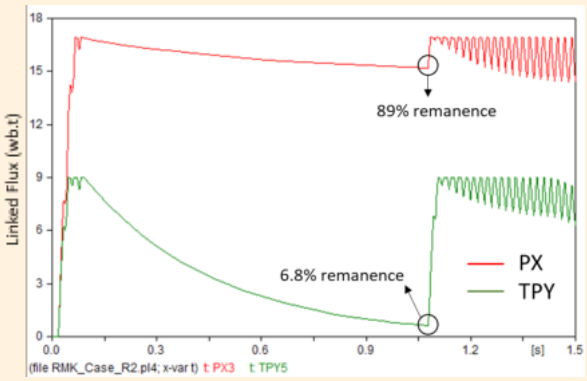


Fig. 14: Linked flux during an asymmetrical short circuit and C-O-C-O duty cycle

It is possible to conclude from this case study that the performance of the PX is deteriorated during the

second duty cycle of the auto-reclosing and the TPY is a reliable alternative for such application. It is important to highlight that a premise of the case study is that this PX specification is being subjected to a C-O-C-O duty cycle with the parameters defined on Table 5. This is not based on an actual scenario but represents a possible situation as many PX are installed in system with automatic reclosing cycles. The performance of each PX installed depends on its own specification and duty cycle parameters, therefore each case needs to be investigated independently.

Conclusion

The conventional approach of specifying protective CTs, such as classes "P" and "PX", is both type and time tested, however the transient classes of IEC 61869-2 are an alternative and could be utilized to improve reliability, especially during asymmetrical faults in an auto-reclosing cycle. They could also help in optimum CT sizing since the design would be based on the realistic network parameters and requirements.

For auto-reclosing cycles, the remanence factor and secondary time constant are very important parameters to avoid core saturation. CT core air gaps are key to optimize the performance for such application, specially when using TPY or TPZ, in which demagnetization is usually faster, due to smaller Ts, than the conventional cores designed for low remanence like "PR" and "PXR".

The case study showed a premature saturation of the class PX, considering the parameters defined in 5.0, for the second duty cycle of the auto-reclosing, suggesting increased vulnerability. TPY as an alternative solution presented a reliable and saturation free behavior up to the time the relay needs to process the data, It presented not only a more reliable response but also an optimized core sizing.

The performance improvement for such application comes with increased manufacturing and testing complexity, therefore, requires a specific study for each different case.

This paper explained and showed the benefits of the transient classes as an alternative for some applications to conventional CTs, opening discussions for further studies and improvements of the grid.

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Usage of Novel Biodegradable Dielectric Fluids in High-Voltage Instrument Transformers

It is well known that electricity is the engine that powers the economic development and growth of a country. India is one of the fastest growing economies in Asia and its demand for power is ever growing to sustain development. In order to achieve the ambitious target 'power for all' India has placed enormous emphasis on accelerated development to achieve a target of 800 GW by the year 2030 To satisfy this ever-growing demand for electrical power continuous expansion is taking place in both generation and transmission sectors.

For large and growing urban agglomerations driving economic growth the uninterrupted availability of quality electrical power is crucial. To ensure that the system is reliable it is of utmost importance that all power equipments like transformers, reactors, instrument transformers can perform at rated capacity and are absolutely safe.

Instrument transformers are very crucial parts of transmission & distribution domain since they are directly related to protection and metering purposes in the system. Instrument transformers, being hermetically sealed units, require dielectric fluids which ensure excellent performance and absolute safety. Biodegradable novel ester based dielectric fluids having extraordinary properties are ideal for these instruments.

In this paper we present the results of the study undertaken by us on a novel biodegradable ester dielectric fluid in accordance with IEC 62770, 61099, 60296, 61125 Method C, OECD 301B & IEEE C57.104.

Keywords: natural ester, synthetic ester, novel biodegradable dielectric fluids; high fire point; high flash point; oxidation stability; total acidity; ddf; water tolerance;

Introduction

For large and growing urban agglomerations driving economic growth the uninterrupted availability of quality electrical power is crucial. Demands on the performance of transmission equipment in the world have been constantly growing for the past 20-25 years. New transmission systems are continuously created and energized to meet ever growing demands for electrical power. Rapid changes are taking place in the design technology of instrument transformers also to meet the challenges in the complexity of transmission and distribution requirements.

Small cities are growing into mega cities and becoming highly congested. The energy consumption in such areas necessitates non-hazardous distribution networks. Medium and small voltage transformers of several MVA are built in congested residential areas and safety aspects like fire point and environmental effects become more and more critical. In these circumstances trouble-free performance of the entire system is crucial.

Instrument transformers i.e., Current Transformers, Inductive Voltage Transformers, Capacitive Voltage Transformers, Combined Current/Voltage Transformers and Station Service Voltage Transformers, bushings etc., are a key component in energy networks and systems for protection & metering purposes. Although they are inconspicuous and require only low maintenance during operation, especially when compared to other key assets, they are nonetheless necessary for the safe and reliable operation of electricity grids. Metering and protection applications throughout all voltage levels would not be possible without them.

Historically, mainly oil - paper insulation systems were used for high-voltage instrument transformers. Although MO has outstanding electrical & physicochemical

properties with some major disadvantages such as flammability, high environmental impact in case failures and the RM being non-renewable. In this paper we present the results of the study undertaken by us on our vastly superior, biodegradable, fire safe natural & synthetic ester dielectric fluid and Bio-HC based dielectric fluids in accordance with IEC 62770, 61099, 60296 and 61125 Method C, OECD 301B and IEEE C57.104.

Why Use Esters?

Currently ester dielectric fluids are very widely used in a variety of transformer applications such as transformers for distribution, power, UHV, traction, coal mine, marine, turbine, mobile transformer & instrument transformers all over the world and are sustainable.

Natural & synthetic ester dielectric fluids are superior dielectric fluids with far less risk of fire & water pollution and can be used at higher temperature special applications. They have special features as per IEC 62770, 61099 and IEC 61100 as shown in Table I.

Table I. Ecological, fire & water hazard classification of developed ester fluids [1]

Characteristics	Natural Ester DF	Synthetic Ester DF
Flash Point, °C, min	327	280
Fire Point, °C, min	>340	312
Auto Ignition Temperature, °C	>435	>430
Rate of Heat Release - Net calorific value, MJ/kg	37.5	31.6
Class	Class 3	Class 3
Classification as per IEC 61100	K2	K3
Biodegradability OECD 301B	>99%	72%
Renewable Carbon Content (By calculation)	95%	61%
nwg	Non-hazardous to water	Non-hazardous to water
Kin. Viscosity @ 40 °C	33	28
Gassing Tendency, μL/Min	-42	-9
Permittivity, ε at RT	3.2	3.2

Why Use Bio-Hydrocarbon Based Dielectric Fluid?

Bio-hydrocarbon based dielectric fluids [2] are governed by IEC 60296:2020 and are biodegradable in nature. They have an advantage of being sustainable with ease of operation in instrument transformers. They have special features like higher permittivity with gas absorbing properties as shown in Table 2.

Table 2. Fire, ecological & water hazard classification of Bio-hydrocarbon based fluids [1]

Characteristics	Bio-hydrocarbon Based MN	Bio-hydrocarbon Based MS
Flash Point, °C, min	155	156
Fire Point, °C, min	166	168
Auto Ignition Temperature, °C	>260	>260
Rate of Heat Release - Net calorific value, MJ/kg	46.0	46.0
Class	Class 1	Class 1
Classification as per IEC 61100	O	O
Biodegradability OECD 301B	>63%	>60%
Kin. Viscosity @ 40 °C, cSt	9.7	10.7
Gassing Tendency, μL/Min	-15	-2
Kin. Viscosity @ 40 °C	10.64	9.37
Permittivity, ε at RT	2.33	2.32

II a. Natural Ester, Synthetic Ester & Bio-Hc Based Dfs In The High-Voltage Instrument Transformer Insulation System.

The insulation system in instrument transformer -ITs particularly in CT consists of a high-quality insulating Kraft paper as a dielectric impregnated with high dielectric strength degassed insulating oil with aluminium electrodes. A typical view of a CT insulation (dielectric) is as shown in fig. 1. The insulation system in the high-voltage CTs largely varies as compared to power transformers due to its end use applications.

The insulation system in the ITs is more sensitive to the minute ppm levels of contaminants coming from manufacturing defects and the heat. The construction methods involve a typical vacuum drying process

followed by oil filling and hermetic sealing. This process is inadequate in removing the contamination coming from construction materials.

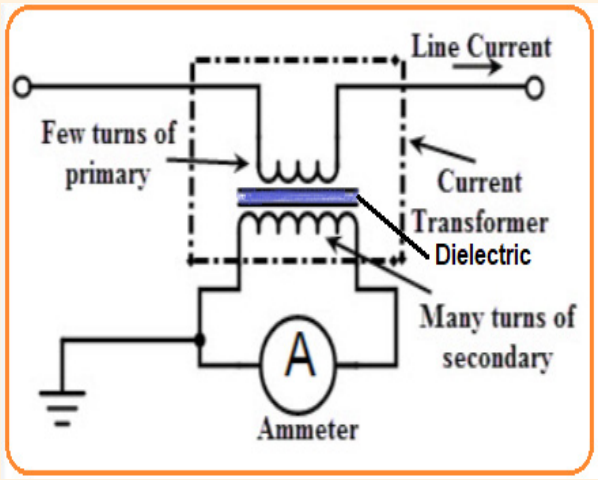

Figure 1. A schematic view of a CT

Currently ester dielectric fluids and bio-hydrocarbon based dielectric fluids are used in high-voltage ITs for special properties such as partial discharge resistance, gas absorption i.e., negative-gassing tendency, fire-resistance, biodegradability, etc. Ester dielectric fluid & bio-hydrocarbon based DF applications in electrical power equipments are as shown in Table 3. and a typical view of high-voltage instrument transformers & bushing impregnated with synthetic esters, bio-hydrocarbon based & natural ester based dielectric fluids is as shown fig 2, 3 & 4.

Figure 2 A view Natural Ester filled ITs [2]

Figure 3. A view of SE filled CT & Bushing [3],[9].

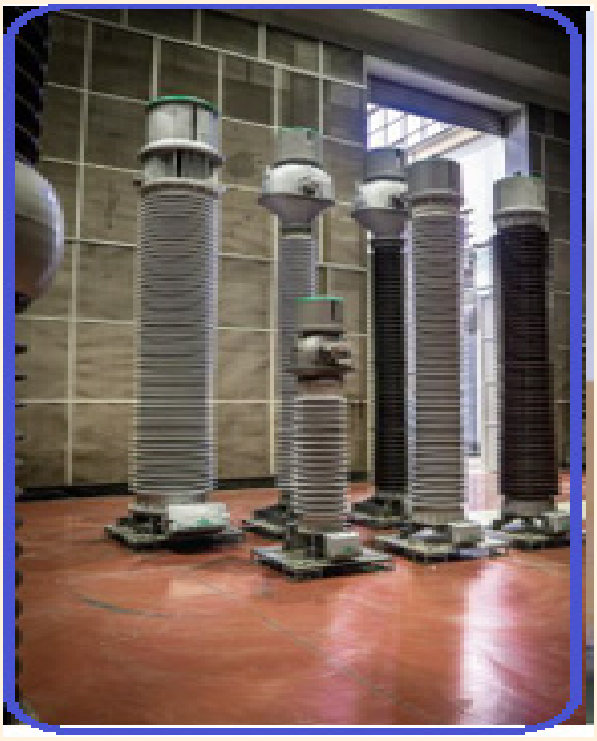

Figure 3. A view SE & Bio-HC based ITs [4]

Table 3. Application of Biodegradable DFs in HV Apparatus

Dielectric Fluids	Standards	Applications
Synthetic Ester	IEC 61099:2010	ITs, Bushings Capacitors, Distribution, Power, Traction, Turbine & Mobile Trans.
Natural Esters	IEC 62770:13 ASTM D6871:15 IEEE C57.147:18	ITs, Capacitors, Traction, Distribution, Power & UHV Transformers
Bio-Hydrocarbon Based	IEC 60296:20	ITs, Capacitors & All types of specialized transformers

II b. Factors Causing Defects In The HV It Insulation System[5]

The present transmission and distribution system has HV, EHV & UHV equipments which operate under severe electro thermal stress. Under lightning or switching impulses the severity of electro thermal stress will increase tremendously. For improving the design of the insulation system one can understand better from the learnings from these defects.

High Tan Delta

A high Tan Delta or power factor or DDF in the IT insulation is an indication of the presence of contamination or deterioration of products such as carbon or other conducting matter, metal soaps and products of oxidation etc., due partial discharges. Power Factor or DDF of dielectric fluid is the cosine of the phase angle between a sinusoidal potential applied to the fluid and the resulting current. Tan Delta / DDF indicates the dielectric loss of fluid thus the dielectric heating. When dielectric fluid starts to deteriorate, an increase in tan delta can be found at the beginning of the oxidation process, followed by sudden increase leading to thermal breakdown. The results reveal that the processing is done improperly in an unclean environment or due to the usage of non-compatible insulating materials or Incomplete removal of moisture during processing of instrument transformers.

Moisture

Moisture is known as a slow poison or as limiting factors for OIP systems. Ingress of moisture accelerates damage from voltage stress. Insulation resistance will fall. Residual moisture or the ingress of water entered from the atmospheric changes through bad hermetic sealed joints or leakages from bellows present in in the system or due to leakage from rubber gaskets or due to the usage poor quality rubber gaskets for sealing the joints.

Partial Discharges

Inception of partial discharges in the insulation system could be due to faults in manufacturing, installation, in-service, ingress of excess of moisture, contaminations, temperatures, presence of small air packets, dust particles etc., and lack of quality control during manufacturing. Partial discharge is the consequence of a small breakdown in the dielectric insulation system under high voltage stress. PDs within an insulation system in-service may or may not reveal any visible symptoms as it is sporadic. The effects of partial discharges within High -Voltage instrument transformers should not be treated lightly as it can even lead to catastrophic failure causing huge collateral damage.

Particle Contamination

The paper is often only microns thick, microscopic metallic / dust particles can cause shorts between the conductive layers. This is caused by less than perfect clean-room conditions in manufacturing. The short will not necessarily occur at the time of manufacture but can occur hundreds or thousands of hours later when cold flow has allowed the particle to penetrate the dielectric. Similarly, particles influence both AC and DC voltage breakdown in dielectric fluid. Larger and conducting particles decrease the breakdown voltage most. For both DC and AC, the ratio of breakdown voltage for clean oil to oil with non-conducting particles is nearly the same. For conducting particles, the ratio for DC is generally larger than for AC. The failures due to particles were related to the actual design of the HV power capacitors inclusive of the quality of materials used and the absence of effective quality control during manufacturing process. Partial discharge test is an indicator of i) presence of air pocket in dielectric and/ or ii) loose electric contact and/or iii) external corona discharge. This is subject to the condition that the properties of insulating material are in conformance to the specifications/ requirements.

Voltage stress

Electrons, in the form of leakage current, collide with paper molecules causing them to break down leading to dielectric failure. Any kind of defect in the paper or between windings will speed up this process creating voltage gradient-hotspots causing damage. In high voltage AC applications, UV light generated by charge movement deteriorates the dielectric film.

Ester Dielectric Fluids [1]

Worldwide sustainable ester dielectric fluids are very widely used in a variety of transformer applications such

as distribution, power, UHV, traction, coal mine, marine, mobile, turbine transformers & instrument transformers.

The hydrocarbon compounds in mineral oils are categorized as paraffinic, isoparaffinic, naphthenic, aromatic & polyaromatic which are non-polar contribute to flash point, pour point, viscosity & oxidation stability. The structure of natural esters is based on a glycerol backbone to which 3-naturally occurring fatty acids denoted as R'. Similarly in synthetic ester there is a 4-membered hydrocarbon block joined with 4- membered synthetic fatty acids as R'. In ester dielectric fluids the building blocks are polar in nature & categorized as Carbon (C), Oxygen (O) & Hydrocarbon chains represented as (R) & (R'), with single & double bonds (C=O) & (C=C) in their chains contributing to their higher flash point, fire point and biodegradability [1] as shown in fig.5.

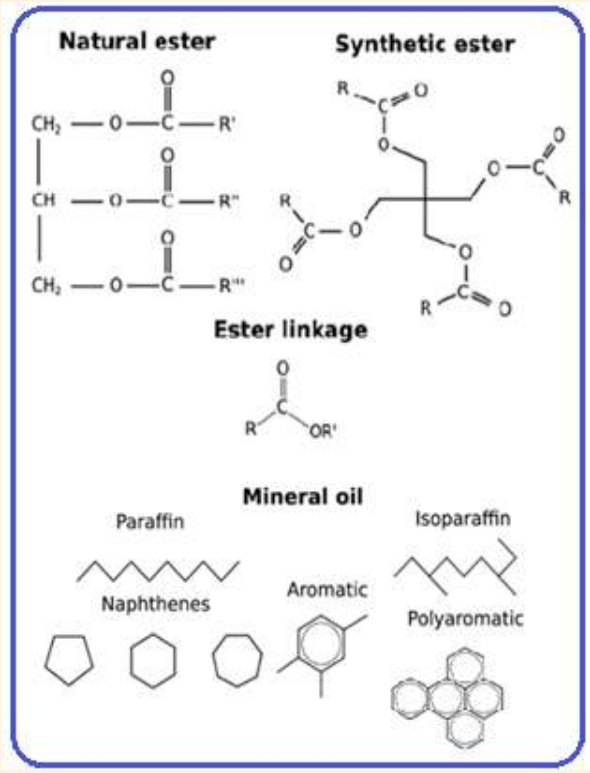

Figure 5. Molecular structure of MO & ester DFs

I). Moisture Tolerance Of Ester Dielectric Fluids

In general moisture is known as a slow poison for oil impregnated paper systems.

In sustainable fluids like natural & synthetic esters the phenomena is high moisture tolerance. They absorb far more water than mineral oil without compromising their dielectric properties and have the potential to keep cellulose always dry, thus extending the life of the instrument transformer.

Because of polar nature, ester bonds attract water molecules in large quantity by forming hydrogen bonding. Natural esters have 3-Ester linkages per molecule as compared to 4-ester linkages per molecule in synthetic ester dielectric fluids. Water solubility increases as we reach from RT to 80 ^{0}C by forming hydrogen bonding as shown in figure 5 & in Table 4. The benefits of moisture tolerance in instrument transformers would be.

- Potentially keeps the cellulose paper always dry and slows down the rate of cellulose ageing.
- It reduces the risk of bubble formation and less worries of low energy discharges in the IT insulation system.

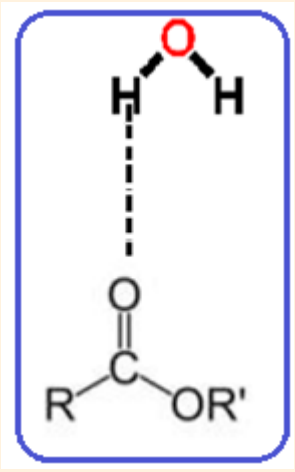

Fig. 6. Water attraction due to hydrogen bonding [1]

Table 4. Solubility of Water in Sustainable DFs [1]

Dielectric Fluids Type	Ester Linkages	Water saturation at 23 °C, Approx. ppm	Water Saturation at 80 °C, Approx. ppm
Mineral DF	0	55	130
Silicone DF	0	220	190
Natural EDF	3	1100	1800
Synthetic EDF	4	2600	5500

ii. Relative Permittivity of Ester DFs

Relative permittivity or dielectric constant is a measure of the amount of electric potential energy, in the form of induced polarization that is stored in a given volume of material under the action of an electric field. It is expressed as the ratio of the dielectric permittivity of the material to that of a vacuum. Natural & Synthetic ester

fluids have higher permittivity as an added advantage for the designers to design the instrument transformers.

Experimental Results & Discussios

In our study we have mainly stressed on the oxidation stability the life test of developed natural & synthetic esters including the studies of capillary action for impregnation of paper. Bio-hydrocarbon based sustainable dielectric fluids are governed as per IEC 60296-20 & hence not taken in this study.

i. Oxidation Stability Test of Natura Esters –

Oxidation Stability Test is the life test on superior natural ester dielectric fluid was conducted as per IEC 61125 Method C from IEC 62770-2013 to investigate the response after 48 Hours of oxidation & was extended to 164 Hours as shown in Table 5.

Table 5 Oil parameters After Extended OST

Characteristics	Developed Natural Ester Dielectric Fluid			
Test Temperature, °C	120			
Test Duration, Hours	Spec. Limits	48	96*	164*
Total acidity, mg KOH/g	0.6	0.134	0.297	0.511
Viscosity @ 40 °C	30% over the initial	23%	51%	159%
DDF (Tan Delta) at 90 °C	0.5	0.1753	0.2630	0.2900
Colour	<1.0	<1.0	<1.5	>4.0

*Optional no requirement

Comments: Natural esters are susceptible to oxidation because of their chemical structure & origin from plants & hence natural esters are strictly advised in sealed power systems only.

ii. Life Test OST of Synthetic ester DF

Oxidation stability tests on synthetic ester dielectric fluids were conducted in the laboratory for 164 hours as per IEC 61125 Method C at 120 °C to understand the formation of harmful oxidation by-products such as polar compounds i.e., acids, insoluble sludge etc., in the oil and its impact on dielectric properties [6]. SEDF are based on saturated acids and pentaerythritol, it oxidises very slowly, at temperatures above 125°C, and darken as they oxidize after 500 Hrs. Oxidation of developed synthetic esters does not produce sludge, but organic acids are produced. The properties are as shown in Table 6.

Table 6 Typical Results of OST

Characteristics	Recommended IEC 61125 Method C Limits	Synthetic Ester DF Test Results	
Time, Hours	164	164	500*
Total Acidity, mg KOH/g	0.3	0.013	0.014
Total Sludge, by Wt. %	0.01	Nil	0.013
Tan Delta @90°C	No Requirement	0.018	0.0214
Resistivity @90°C, 10^{12} Ω-cm	No Requirement	10	0.155
Colour	No Requirement	<0.5	1.5

*Optional no requirement

Comments: Synthetic esters have good oxidation stability.

iii. Kinematic Viscosities & Capillary Action for Impregnation [8].

Viscosities of developed superior synthetic & natural ester dielectric fluids are of varying in nature as compared to conventional naphthenic oils as shown in Fig. 7.

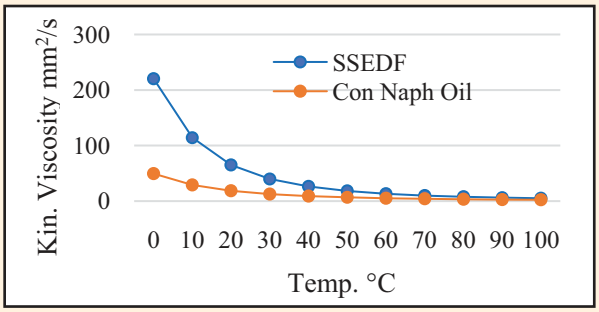

Figure 7 Comparison of Kin. Viscosity

Based on the viscosity differences it had necessitated us to study in-depth in the laboratory and understand the capillary action of crepe paper, 3 mm thick pressboard i.e., 1.5 cm long strips dipped in superior ester dielectric fluids in beakers at room temp. and at 60 °C and the distance of the fluid travelled against time was plotted. The rate of rise of capillary action of superior synthetic ester dielectric fluid at 60°C was found to be equivalent to the rate of conventional naphthenic oil at room temperature ~26 °C. Further it was tested to check the impregnation rate in laminated pressboard blocks. This learned that the rate of impregnation for synthetic and natural esters at 60°C was equivalent to the rate of mineral oil impregnation at 20°C as shown in Fig. 8, 9 & 10.

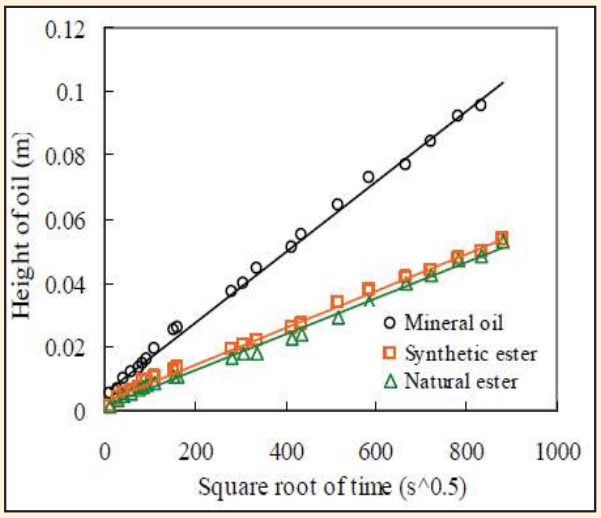

Figure 8 Graph of capillary action at RT[1]

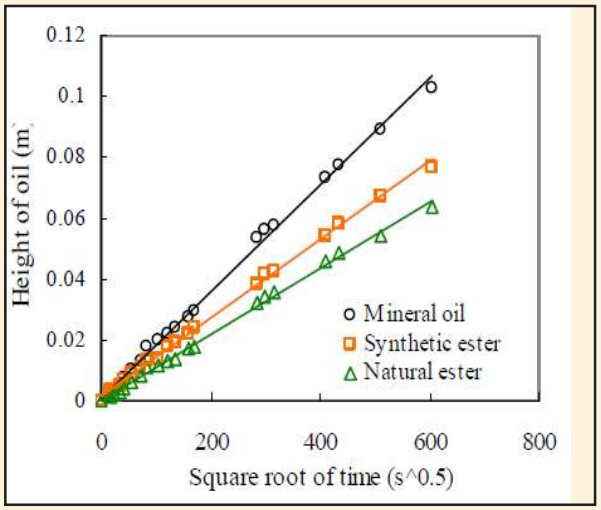

Figure 9. Graph of capillary action at 60 °C [1]

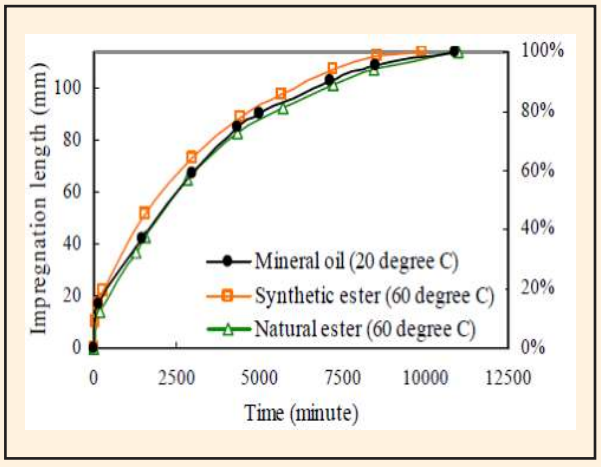

Figure 10. Graph of impregnation [1]

This study is utmost important for the process engineers during the manufacturing of instrument transformers [7].

vi. Compatibility of Transformer Construction Materials [8]

Compatibility with transformer construction materials is very important factor to design instrument transformers with sustainable ester dielectric fluids to understand their reactivity. It was conducted in the laboratory in accordance with ASTM D 3455 with most of the materials used in modern transformer manufacturing except few elastomers such as natural rubber, poly-isoprene rubber, nitrile rubber with less than 30% nitrile content, EPDM, chloro sulfonated polyethylene Hypalon which are found as non-compatible as shown in table 7.

Table 7 Compatibility of Transformer Construction Materials with SE DF

Compatible materials with superior synthetic ester dielectric fluid				Non-compatible materials with SSEDF
Seals, O-rings & Joints	Tank Coatings, Insulating Varnishes & Paints	Films	Miscellaneous	Elastomers
Viton (FKM)	Acrylic	Cellulose Triacetate	Kraft Paper	NR (Natural Rubber)
Nitrile Rubber (NBR) >30% nitrile	Epoxy	Mylar	Cotton Tape	IR (Polyisoprene Rubber)
Silicone (VMQ)	Polyurethane	-	-	(NBR) Nitrile Content <30%
Fluoro Silicone (FVMQ)	Alkyd	-	-	EPDM (Ethylene Propylene)
Polyurethane, AU	-	-	-	CSM (Chlorosulfonated
Teflon	-	-	-	
Nylon	-		-	-
Nitrile Cork Rubber	-	-	-	-

Conclusions

Ester DFs have unique properties – can tolerate substantially larger amounts of moisture w/o deteriorating dielectric properties, keeping the cellulose paper always dry.

Ester dielectric fluids are the best option to address fire and environmental risk in ITs

Sustainable ester DFs have the same DGA fingerprints as conventional mineral oils with lower volumes of gas generation.

Thanks to the ester technology overall, ester DFs, protects the equipment maintaining the reliability of the grid, the environment & extending the life of ITs.

European nations started using natural ester, synthetic ester & bio-hydrocarbon based dielectric fluids in instrument transformers.

Acknowledgement

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A Journey towards Un-Manned Substations for Instrument Transformers – Internal Arc Test For Safety & Reliability

Monitoring of the instrument transformers (IT's) in service has become a topic of key concern of the utilities now a days since majority of the utilities are moving towards un-manned substations. Present monitoring system uses partial discharge (PD), a gradual growing defect in the insulation system, as a primary tool to detect the defects in the instrument transformer (IT's). This is further re-confirmed using dissolved gas analysis (DGA) as a secondary tool. In-spite of this, there are cases where failures are reported, few of them are catastrophic failures resulting into threat to the surrounding equipment's and the human life. This article discusses on the effectiveness of these monitoring tools on ITs, its inadequacy for un-manned substations and thereby taking a dispassionate view of the internal arc test specified as a special test on instrument transformers by IEC 61869. This test is used to demonstrate agreed level of safety in the product design in case of an internal arc fault in the instrument transformer (IT).

Internal arc, current transformer, safety, reliability, voltage transformer, insulating oil, rupture disc etc.

Introduction

In today's world, bellows is used for hermetic sealing of all EHV class instrument transformers which takes care of volumetric change in oil due to ambient temperature variations and serves the purpose of fault indicator also. Level of bellow needs to be monitored daily as per the schedule recommended by the manufacturer. Any increase in bellows height might be due to fault inside the product and downward movement as the possibility of oil leakages. This is the basic visual monitoring tool. In case of MV or HV instrument transformers, nitrogen cushion is used as hermetic sealing mechanism, where oil level indicator is available for monitoring the oil level.

There are periodic tests for capacitance and tan delta measurements, ratio test, dissolved gas analysis, insulation resistance measurement, thermos-vision but major fault indicator which can be monitored by substation operator is either bellows, oil level or oil colour. These all are the visual checks. Moreover, these are relative checks as there is no digitally clear yes or no as a guideline and thus person dependent. It is practically difficult for any utility to carry a team of operating personal for each substation who will rigorously conduct this visual check on each instrument transformer and maintain the records that too daily.

Can utilities having 1000+, 2000+ or 5000+ instrument transformers (ITs) in system practically do this or maintain or review the records on daily basis or analyse it? How to take care of the relative measurement inaccuracies as there is no exact measuring unit which can be specified for visual check? **It's practically impossible …. Hence it is all the while important that the instrument transformer is designed, manufactured,**

and tested for a robust constructional features so as in-spite of the over pressure generation inside, it should either contain the pressure within or should release the pressure from a predefined path and avoid explosion causing damage to human life and surrounding equipment's.

Best Engineering Practices For Manufacture of Instrument Transformers

Before we study the internal arc test, it's application and usefulness for the safety of the substation and operating personals, we briefly should understand the best engineering practices which will ensure manufacturing of healthy product. It is the responsibility of each quality manufacturers to follow these best engineering practices to supply reliable product to the utilities or customers.

Electrode design – To form a perfect and defect free insulation one needs to work on voids free insulation containing pure form of dielectric (i.e. OIP) applied either on ground electrode on live tank CTs or on the primary conductor in case of the dead tank CTs. Ground and HV electrodes form two parallel plates of the capacitor, separated by the OIP insulation as `dielectric. Ground electrode in case of live tank CTs must be designed with well-defined contours, so that no portion of the electrode is highly stressed. Theoretically, for the best designs, ratio of peak stress to average stress should be limited to 1.5

Insulation - It is necessary that cellulose rich paper, manufactured from wood pulp is used for head side and bushing side insulation. Fine capacitor grading is designed across the length of the bushing. With use of multiple grading foils, voltage stress can be uniformly distributed across the length of the bushing. This helps in reducing the flashovers across the insulator in service. It is essential to maintain design safety factor of 2 for the partial discharge free operating voltage stress. All the other material must be tested for compatibility with insulating oil. In absence, these materials can deteriorate the insulation quality and can cause inception of partial discharge reducing the product life.

Insulation Drying and Oil Impregnation - The Paper Insulation needs to be dried under vacuum with various heating and evacuation iterations to remove the moisture content and keep it below 0.1%, before oil impregnation. The insulating oil needs to be degassed before its use. Water content and tan delta of insulating oil needs to be limited to 10 ppm and 0.002 respectively.

Quality evaluation – Each instrument transformer should be subjected to partial discharge (PD) test with stringent acceptance norms and PD should be measured while reducing the voltage from one minute power frequency test voltage. It should be ensured that there is no inception of partial discharge during this testing cycle. In case of any PD activity, reconfirmed by DGA on oil sample is must. It is also necessary to check the capacitance and tan delta before and after high voltage test. Majority of the utilities are referring to the limiting value of tan delta to be 0.0035.

Leak-proofness - One needs to ensure design of foolproof sealing system to ensure hermetic sealing and retain insulation quality of the product by eliminating moisture entry. It is necessary that the stainless-steel bellows be deployed for this application which will also take care of compensating oil volume due to changes in ambient temperature. Superior grade rubber O Rings placed in well machined grooves should be used for leak proof life for > 15 years.

It is a statistics which tells us that even with strict routine tests 15% defects goes un-noticed.

While quality parameters are defined as a part of specifications, vendor selection criterion is applied to identify quality manufacturer, products are manufactured in strict quality control and they are monitored in line with the recommendation of the manufacturer, still there will be cases of product failures, catastrophic failures, and few of them will be violent as,

- There Is major manual content in the insulation application activity. Thus piece to piece variation is un-avoidable
- It is practically not possible to exercise visual monitoring and controls on 100% instrument transformers during manufacturing and while in service at a substation.
- There are many fault incidences in the substation or nearby network which puts the product on temporary over voltage or over current which is detrimental to the life of the product.
- Momentary switching, lightning impulses, earthing issues, harmonics, power quality issues at the substation, wind, pollution, and rain causes stress enhancement on the product.
- Some of the faults in the product remains un-noticed even after periodic testing and preventive maintenance is carried out as all these are indirect methods.
- End of the life for the product.

Internal Arc Test - Importance, Necessity and Limitations

Explosive failures causing fire are typically due to a power arc fault, which releases a high-power discharge resulting into a large amount of heat energy in a very

short span of time, sufficient to overpass the designed withstand pressure of the instrument transformer tank or the insulator. To improve the performance of instrument transformer under power arcs normally resulting into catastrophic failures, internal arc testing was introduced in international standard IEC 61869 for instrument transformers in 2007. Inclusion of this test itself is most controversial in the instrument transformer industry. The test requirements, procedure and acceptance criteria is always a subject for technical debate between the experts and the utilities. The test procedure is under refinement and will be released as a part of revision of international standard in 2023.

As per CIGRE Report No 394 by Study Committee A3 on State of the art of instrument transformers the committee has examined what can be done to improve the behaviour of paper-oil ITs in case of internal arcing. According to the statistics the risk of faults within the bushing portion (adjacent to the insulator) were extremely low; faults occur in the active part at the top or the bottom where the voltage gradient was highest. The committee has also studied that in most cases the fault current was eliminated after 100 ms, and thus in their opinion the test duration can be limited to 200 ms and in case if the test is conducted then during the test, the fault should normally be located at the position in the active part where the voltage gradient is at a maximum. For paper-oil and resin ITs, there should be no projection of fragments of porcelain; for SF6 ITs, the transformer should withstand the test without explosion. The main objective has to be to design an instrument transformer to avoid breakage of the porcelain insulator during internal arcing. (Some utilities do not accept breakage of the porcelain at it shatters and can create excessive damage to the surrounding equipment). Most important part in this case will be to create effective internal earth bonding connections of the IT so that it should be able to withstand internal fault current without failure.

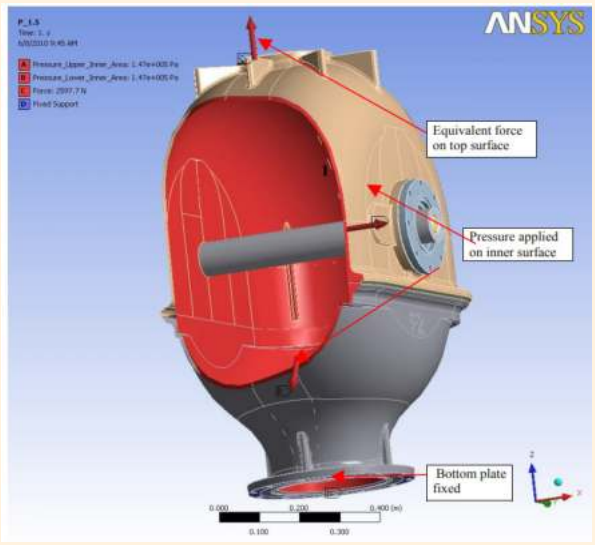
The main controversy of the test is that it assumes a high energy fault, neglecting the electrical impedance of the main insulation system, thus testing only the withstand of the enclosure consisting of the tank or housing, insulator, bottom support, and the pressure relief device of instrument transformer. Similarly, the test is sufficient only for internal faults incepted inside the tank portion of an instrument transformer (e.g., upper portion for live tank current transformers or bottom portion for dead tank current and voltage transformers), while the bushing portion remains untested. Thus, it it is obvious that one wonder that the other contributors that can cause explosive failures (i.e. interturn failure between the windings, insulation aging failures, quality assurance mischiefs, and electrical design faults) are not yet part of this test procedure.

Internal Arc Test – Why it is a challenge for Oil Impregnated Paper (OIP) instrument Transformers

Here faults are of two major categories, thermal faults, and energy faults. Thermal faults are gradual faults and will take time before the instrument transformer ruptures, fault indications will be seen. We have time to take out the instrument transformer from circuit. Low energy faults will give rise to the partial discharge activity and slow increase of pressure however for high energy faults in oil paper insulation (OIP) of instrument transformer, the pressure rises extremely fast after a power arc as oil is non compressible medium and is homogenously distributed inside the enclosure independent where the arc is ignited. Here limiting the pressure rise by the pressure relief is extremely difficult unless and otherwise the designs are thoughtfully worked out. Nevertheless, a decision was taken to proceed with the design, manufacture, and testing of current transformer as a first product to be subjected to the internal arc test.

Design of Current Transformer for Internal Arc Test

The current transformer for Internal Arc Protection test was designed to meet the requirements for Internal Arc Protection Class I, Stage 1 of IEC 61869 Part 1 and 2. Significant risk increase in the test was introduced by using porcelain insulator as an external insulation so as to check the effects of fire and projectiles (if any) resulting from an internal arc, which is the largest cause of transformer fires. For additional protection a momentary pressure release, the current transformer was equipped with stainless steel bellows at the top to release the pressure. The tank pressure withstand was evaluated by the finite element analysis and conducting the actual static pressure test.



The 3D geometry of the tank was first simplified for the software simulation by excluding small components. From preliminary simulation results, it was observed that inside parts of the tank does not influence tank movement, and hence the shell with wound cores, primary winding and insulating material was removed. While the simulation, welding was considered between the upper and lower tank.

The simulation software takes care of plastic deformation of the material during the simulation. The tank and welded joint were assigned stress-strain curves to define the elastic and plastic region. The strain-based failure (rupture) criterion was used to predict failure according to the ultimate strain of the tank material. The tank mesh size has been refined according to the shape and complexities involved. The regions with higher strain were identified and investigated during the simulation.

The arc energy was calculated using below formula,

$E = 0.9\ V.I.t\ (MJ)$

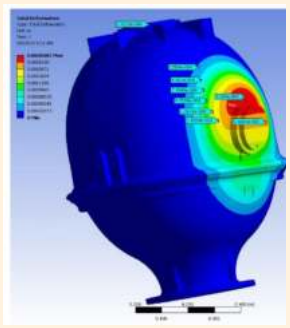
Where V = Arc Voltage (kV), I = Arc Current (kA), t = Arc duration (second). As per IEC standard 61869-1, the test requirements for the substantial protection level of Stage 1 with 25kA/40 kA (r.m.s) fault current for a duration of 0.2 s. The arc voltage was predicted based on the previous test results. Accordingly, target withstand arc energy was determined. This arc energy was converted into a steady pressure with below equation. The pressure was used as a mechanical load in the static simulation. Below equation demonstrated by a technical paper of one of the global OEM has been used for design applications when comparing the calculated results with the experimental results.

$$P_d = F\left[100\sqrt{0.25 + \frac{k.E}{100.C}} - 50\right] + P_h$$

Where,

Pd	Design pressure (kPa)
E	Arc energy (kJ)
K	Arc energy conversion factor
C	Tank expansion coefficient (m3 /kPa)
F	Dynamic amplification factor
Ph	Hydrostatic pressure (kPa)

Multiple design iterations were conducted to arrive at optimum tank design which will tolerate the calculated arc energy.



Software Simulation

While the CT was manufactured for the type test,

- Tank was subjected to the pressure test and its pressure withstand was verified to be in line with the simulation test results.
- Cementing of the porcelain insulator was verified for the adequacy in view of sudden pressure development in the current transformer envelope during the test.
- Arc initiation was conducted by a copper wire of 1.5 to 2 mm diameter between the primary terminal and ground electrode.

Multiple locations were judged to be a high stress locations based on the finite element simulation and the final location decided was at the top region of the current transformer in line with IEC standard recommendation.

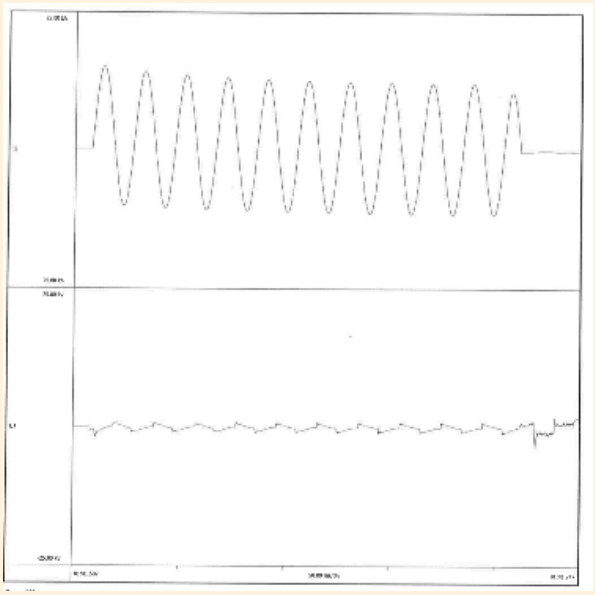
The high voltage connections between the tank and the high voltage screen of the insulated active part were selected based on the fault current similarly the connection between the condensers pipe and the base structure were also designed for suitability of the fault currents.

Prototype Tank under Hydraulic Pressure Test

Test Result

The test was successfully conducted at an independent laboratory.

complying to the Clause No 7.4.6 of IEC 61869 Part 2 with the test observations as no abnormalities found. and there were no projected parts found outside containment area. The open circuit voltage was 19.3 kV at the source and the test was conducted for a period of 200 ms.



Test Current and Test Voltage Oscillogram

Conclusion

Internal arc test demonstrates that it is possible that if the instrument transformer is designed, manufactured, and tested for a robust constructional features in compliance of the test requirement then in-spite of the best engineering practices in design, material selection, state of the art manufacturing facilities, testing facilities and quality assurance, in case if, over pressure generates inside the instrument transformer, it can either contain the pressure within or will release the pressure from a predefined path and avoid explosion causing damage to human life and surrounding equipment's. Thus we can install these instrument transformers in unmanned substations where daily or weekly monitoring of instrument transformers is not required and periodic on line/ off line maintenance can adjust the defective which can be replaced in the maintenance schedule. Catastrophic and explosive failures can be avoided causing safe and environmental friendly substations for operating personnel.

Oil-filled instrument transformer tanks design to protect against internal arc fault can be achieved from nonlinear finite element simulations. The method needs to be developed taking the useful clues from the formulas, equations developed for power transformers and needs to be carefully adjusted to the instrument transformer tanks. The analytical calculations shows that use of pressure relief device will not necessarily solve the problem as the oil being non compressible fluid, the over pressure generates instantaneously after the inception of power arc and it may result in to the explosion of the oil filled instrument transformers before the pressure relief device operate. An actual current transformer prototype was built with several design iterations based on the simulations. The prototype successfully passed the internal arc test in line with IEC standards. The methodology of simulations helped the current transformer design pass the internal arc test at its first attempt.

Indian Utilities incorporated the internal arc test in Technical Specifications

Below utilities in India have incorporated internal arc test as a part of their technical specifications in recent years due to the effectiveness and the technical advantage noted for this special test.

- Power Grid Corporation of India (PGCIL)
- National Thermal Power Corporation (NTPC)
- Maharashtra State Elect. Transmission Corp. Limited.
- Orissa Power Transmission Corp. Limited
- Punjab State Elect. Transmission Corp. Limited
- Madhya Pradesh Power Transmission Corp. Limited

In absence of the internal arc test, CTs needs to be supplied with polymer insulator to ensure shatterproof performance of insulator. Rest of the utilities are in the stage of technical review of specifications of instrument transformers and soon it will be seen. that all the state transmission utilities will incorporate this test as a part of their specifications.

Extension of Type Test Report for other voltage ratings

As per IEC 61869 Part 1 – 2023, type test report extension criteria has been specified as per Clause F 3.4. Instrument transformers for which an internal arc classification has been assigned should be subjected to an internal arc test for verification, as specified in 6.9 of IEC Standards. Depending on the purpose of the extension of validity, criteria should be considered. with respect to the transformer design and with respect to the ratings.

Details about design parameters and acceptance criteria for an instrument transformer with arc fault current and duration equal to or smaller than assigned to the tested transformer of the same.

product ranges are given in Table F.4.

Table F.4 – Extension criteria for internal arc fault tests

Item	Design parameter	Acceptance criterion	Condition
1	Rated arc fault current	≤	
2	Rated arc fault duration	≤	
3	Frequency		Type tests performed at 50 Hz or 60 Hz may prove the validity for any frequency
4	Transformer design (liquid-insulated)	Same	Same transformer principle Same shape of HV and ground electrodes, Same insulation design
5	Insulating material exposed to the arc	Same	
6	Location of the point of arc initiation	Same	
7	Thickness of the enclosure walls	≥	Same material
8	Net compartment volume	≥	For gas-insulated instrument transformers
9	Rated pressure	≤	For gas-insulated instrument transformers
10	Exhaust system design	Same	Pressure limitation principle, opening pressure
11	Exhaust cross sectional area	≥	The position of the exhaust in the compartment is the same in case of liquid-insulated ITs.
12	Provisions for material expulsion	Same	Design of gas flow deflector, screens, part attachment...

References

1 IEC 61869 Part 1 to V for Instrument Transformers

2 CIGRE Study Committee A3 Report No 394 on State of the art in Instrument Transformers

3 IEEE Standard C57.156, “IEEE Guide for Tank Rupture Mitigation of Liquid-Immersed Power Transformers and Reactors,” 2016

4 Method for Internal Fault Testing of Instrument Transformers With Sectioned Active Parts DORA GAZIVODA1 , IGOR ŽIGER 1 , (Member, IEEE), IVAN NOVKO2 , AND TOMISLAV ŽUPAN 2

5 Article on Internal arc testing of bushings by Giovanni Testin and Paolo Cardano in Transformer Magazine Volume 5 Issue 1

6 Development of SF6 free Clean Air Instrument Transformers and Power VTs UDO PRUCKER1) , Detlef Fredrich2) , Johannes Rickmann3) , Mana Yazdani4) , 1) Trench Germany, 2) Siemens Energy China, 3) Siemens Energy Germany, 4) Trench Limited Canada

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9 J.-B. Dastous, J. Lanteigne and M. Foata, “Numerical Method for the Investigation of Fault Containment and Tank Rupture of Power Transformers,” IEEE Trans. Power Delivery, vol. 25, no. 3, pp. 1657-1665, July 2010. ■

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Offshore Wind Application Transformers

The last decade has seen a significant increase in renewable energy generation. More and more wind power plants are being built around the world. This paper discusses the key points to consider for offshore transformers design, with a focus on more compact, and lighter design. It also discusses the use and benefits of ester oil in transformers as well as high temperature insulation materials. It is observed that the weight and footprint of the transformer has a greater impact on offshore platform than the cost of losses, thereby resulting the use of compact transformers which can be a very useful solution to achieve optimal offshore substation cost.

Introduction

The wind power can be generated from two types, Offshore wind power and Onshore wind power. The onshore wind power is generated by the wind turbines located on the land. This solution of renewable energy generation is well established and very successful technology to harness power from wind energy. While the Offshore wind power is generated from the wind turbines and farms which are installed in the sea and generates electricity from the wind that is blowing across this sea water. The wind speeds offshore are typically higher than on land, which means that offshore wind farms can generate more electricity per unit of capacity installed. As of 2022, the global installed capacity of offshore wind power was 64.3 gigawatts (GW). China accounted for 49% of this capacity, followed by the United Kingdom (22%) and Germany (13%)[3]. These three countries together account for more than 75% of the global offshore wind power market.

As compared to onshore wind power generation the offshore wind power generation has biggest advantage that it can generate more electricity per unit of capacity installed than the onshore wind turbines due to the fact that the offshore wind speeds are typically more consistent and stronger than onshore wind speeds.

In a conventional onshore substation, the size and weight of the transformer are not major considerations since they are installed on the land. Whereas the size and weight of the transformer are primary factors that affect the offshore substation cost. This is because the platform must be large enough to support the transformer and strong enough to withstand the forces of the ocean. Therefore, these factors must be given careful consideration in the design of offshore transformers.

The Picture 1 and Picture 2 below show a typical offshore substation and typical equipment arrangement in offshore substation respectively.

Picture 1. Ref. - https://www.hitachienergy.com/products-and-solutions/transformers/special-application-transformers/transformers-for-floating-applications

Picture 2. Ref. - https://www.hitachienergy.com/products-and-solutions/transformers/special-application-transformers/transformers-for-floating-applications

Challenges in offshore transformer design

The design of offshore transformers poses a number of challenges, which are discussed below.

- It is surrounded by sea hence no place to escape in case of incidents. Hence, safety and reliability are very important.
- Logistics is difficult which requires materials by supply boat and personnel transfers by chopper.
- Expensive real estate, hence, relatively small footprint of transformer is required to reduce the size of the platform.
- Hostile Marine environment with salty sea spray, constant humidity, and hot sun.
- Extreme weather conditions, Hurricanes, and typhoons with around 250kmph wind criteria. Hence external components like conservator, terminal connection, coolers, etc. shall be suitably designed.
- Marine motions – transformer shall be designed for pitch and roll values specified for both transport and operation and Lateral and vertical accelerations for both transport and operation.

Electrical Design of Offshore application transformer

The wind turbine generates at a voltage level between 690V to 3.5kV voltage. This voltage is transformed to the collector voltage level of 36kV or 66kV via a two winding or three winding transformers.

At the off-shore substation, the collector circuit voltage must then be stepped up for further transmission to on-shore i.e., Up to 132kV to 245kV voltage. This step-up transformer are either two winding or three winding transformer.

A two winding transformer design is simpler and is cheaper as compared to three winding transformers. While a three winding transformer offers the opportunity for the collector circuits to be split between the two secondary windings. Since both the secondary winding are run in split the impedance is increased which has an advantage of reducing the fault levels at the collector circuit levels.

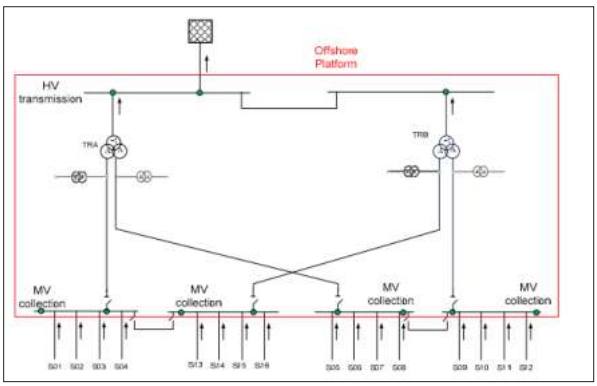

Figure 1. Typical Three winding connection arrangement (CIGRE TB-483 Guidelines for the Design and Construction of AC Offshore Substations for Wind Power Plants)

Main transformers are the largest and most critical components on offshore platforms, impacting the overall electrical and physical layout. While conventional transformer design methods can be used to achieve the required performance, there are unique challenges to consider in the offshore environment.

Off-shore platforms are exposed to harsher conditions than on-shore substations, with limited to no manpower resources and more difficult logistics and environmental concerns. In addition, the compact nature of offshore platform means that transformer failure or fire could damage adjacent equipment. Nevertheless, the risk of oil leakages and fire are negligible but the impact in such a scenario can be significant as it can be a major threat to the nearby equipment.

As a result, offshore transformers need to be lightweight, compact, reliable, and low maintenance, to minimize overall platform costs.

When designing offshore transformers, the following key parameters shall be carefully considered,

- Environmental impact: The type of insulating oil like Ester fluids can be chosen to minimize environmental risks.

- Fire safety: Transformers should be designed to minimize the risk of fire and explosion (e.g., use of Ester oil, flexible tank).
- Compact size and weight: Transformers should be optimally designed to minimize their weight and footprint on the offshore platform.
- Reliability: Transformers need to be highly reliable to minimize downtime and operational costs.
- Maintenance requirements: Transformers should be designed to be low maintenance, to reduce the need for costly interventions.

Ambient Temperature Offshore

According to IEC-60076-1, the normal ambient temperature is indicated as not below -25°C and not above 40°C. The average yearly temperature is assumed as 20°C. The transformer active part and cooling system is designed based on oil and winding temperature rise limits based on these temperatures.

It is common to increase the ambient temperatures for the transformers that are to be installed in the hot areas. While the situation is very different in offshore location because ambient temperatures in offshore are lower than inland. The highest ambient temperature in offshore is less as compared to that onshore. Hence it is desirable to identify the real ambient temperatures of the place where the offshore substation will be installed to design the transformer cooling system optimally.

Optimization parameters in Off-shore transformers

For Off-shore wind power plant transformer footprint and weight are major factors that directly impact the cost of the off-shore substation and its structure. As a result, transformers for offshore wind substation must be designed to minimize footprint and weight.

For offshore transformers usually the capitalization rates for the losses are specified and, in many cases, limits and capitalization rates for total weight and overall dimensions are also specified.

For example: Total Cost = Equipment cost + Capitalization of Weight + Capitalization of footprint + Capitalization of losses.

Compact design

High temperature insulation materials

By adapting the high temperature insulation materials in the winding at the location of hotspot can be effective solution for extended life of the insulation system. It may also result effective in overloading conditions of the transformer.

In case of Offshore equipment's, the reliability of the equipment is one of the key issues since the maintenance and repair works may result very costly. Although, the

thermal failure of insulation in the conventional network connected transformers is very rare, all measures must be considered to ensure the long-term performance of the insulation system of the transformer.

Insulation materials with a higher thermal class than conventional cellulose can be used to improve the long-term performance of transformer insulation systems. Also, the aramid conductor insulation can be used for all transformer technologies, while thermally upgraded papers can be used in liquid-immersed transformers.

High thermal class conductor insulation material is useful since it is advantageous as it provides extended life of the insulation in case of normal operating conditions as well as in case of sudden overload conditions.

IEC-60076-14 suggests four different types of hybrid insulation system that can be used other than conventional insulation.

- Semi hybrid insulation system
- Mixed hybrid insulation system
- Full hybrid insulation system
- High temperature insulation system

The temperature limits mentioned in IEC-60076-14 are mentioned as below,

Table 3 – Maximum continuous temperature rise limits for transformers with hybrid insulation systems

	Conventional insulation system [a]	Hybrid insulation systems				
		Semi-hybrid insulation winding	Mixed hybrid insulation winding	Full hybrid insulation winding [b]		
Minimum required solid high-temperature insulation thermal class	105	120	130	130	140	155
Top liquid temperature rise (K)	60	60	60	60	60	60
Average winding temperature rise (K)	65/70	75	65	85	95	105
Hot-spot temperature rise for solid insulation (K)	78	90	100	100	110	125

NOTE 1 Liquid operates at conventional temperatures.

NOTE 2 The temperature rise limits for hybrid insulation systems do not depend on cooling mode.

NOTE 3 The temperature rise limits shown are based on normal cooling medium temperatures according to IEC 60076-1. For alternate ambient temperature conditions, see IEC 60076-2.

a Conventional insulation system included only for reference purposes.

b Essentially oxygen-free applications where the liquid preservation system effectively prevents the ingress of air into the tank.

Table 1. Refer IEC-60076-14 Table 3

Table 4 – Maximum continuous temperature rise limits for transformers with high-temperature insulation systems

	Ester liquid				Silicone liquid			
Minimum required high-temperature solid insulation thermal class	130	140	155	180	130	140	155	180
Top liquid temperature rise (K)	90	90	90	90	115	115	115	115
Average winding temperature rise (K)	85	95	105	125	85	95	105	125
Hot-spot temperature rise (K)	100	110	125	150	100	110	125	150

NOTE 1 Essentially oxygen-free applications where the liquid preservation system effectively prevents the ingress of air into the tank.

NOTE 2 The temperature rise limits shown are based on normal cooling medium temperatures according to IEC 60076-1. For alternate ambient temperature conditions, see IEC 60076-2.

NOTE 3 The high-temperature insulation frequently includes different temperature classes, all above conventional.

NOTE 4 For cellulose/ester insulation systems, see 5.3.

Table 2. Refer IEC-60076-14 Table 4

For High temperature designs, the allowable limits of temperature rise for top oil, average winding rise, and Hotspot temperature are higher than conventional design with Class A insulation. In order to design a compact transformer, advantage of high temperature insulation is taken by increasing the load losses.

High temperature transformer designs will increase the capitalization of losses, however this will reduce the overall transformer footprint which in turn will reduce the offshore platform cost.

Cooling system

Cooling of transformers is a major challenge in offshore substations. Failure of the cooling system can lead to reduced transformer lifetime due to high oil temperature and increased risk of failure. Hence, adequate maintenance, although expensive, can help transformers meet their anticipated design life.

Different cooling system options can be used for offshore transformers including Natural air cooling, Forced air cooling and Forced water cooling. The below table shows the comparison of different cooling types with their advantages for offshore transformer.

	Natural air	Forced air	Forced water
Initial cost	Δ	O	X
Transformer size of weight	X	O	O
Auxiliary power	O	X	X
Big maintenance (ex. exchange of coolers)	Δ	Δ	O
Small maintenance (ex. exchange of fan bearing)	O	Δ	Δ

Good: O Δ X : Bad

Table 3. Refer CIGRE TB-483 table 3-8.

The use of radiators is very common in offshore design. It has the main advantage that this system is independent of any auxiliary system supply. However, the radiators will have a comparatively larger footprint.

The use of ONAF cooling i.e. Using forced air (Fans) mounted on radiator reduces the footprint of transformer as compared to that of ONAN (radiators only) cooling.

The water-cooled system is very compact type of cooling method which helps in high loss dissipation. Due to the high efficiency in this system, the total number of water coolers required are significantly lesser and the total cooling equipment weight can be reduced significantly.

Hence, the design of cooling system is one of the governing parameters for the footprint of transformer.

Alternative Fluids

A number of alternative fluids as an alternative to the mineral oil for transformer insulation are discussed in IEC-60076-14.

The most common and commercially available fluids are Synthetic ester, Natural ester, Silicon fluid.

The table below gives a brief comparison of key properties of these alternate fluids.

	Mineral oil	Synthetic ester	Natural ester	Silicone fluid
Fire safety	Low	High	High	High
Environmental safety	Low	High	High	Low
Corrosive sulphur	Possible	None	None	None
Paper longevity	Moderate	Good	Good	Unknown
Oxidation stability	Moderate	Good	Poor	Good
Moisture tolerance	Poor	V. High	High	Poor

Table 4. Refer CIGRE TB-483 table 3-3.

Of the fluids listed above, silicone fluid is the least suitable for use in larger power transformers. It is not biodegradable to the same extent as esters, and it has other properties that make it less desirable for this application.

Fluids that are both fire safe and biodegradable are synthetic esters and natural esters.

A variety of biodegradable dielectric fluids (natural or synthetic esters) are commercially available. They do not leave any toxic residues that could harm the environment if they spill. They are all readily or completely biodegradable. Hence in case if the leakage occurs and liquid flows into the sea, they can be rapidly degraded by naturally occurring bacteria in short time, resulting in a low environmental impact.

The comparison of biodegradation rates for different insulating fluids is show in below graph.

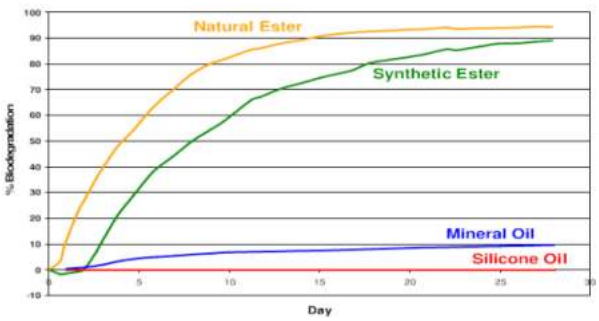

Figure 2. Refer CIGRE TB-483

In high-temperature designs using ester fluids, the cooling equipment can be optimized by increasing the maximum allowable temperature rise. Kraft paper is most commonly used insulating paper in the transformer industry which is composed of cellulose. The maximum hotspot admissible according to the IEC standard is 118ºC (absolute value).

As an alternative to this kraft paper is the high temperature insulation paper which is based on aramids since it has better thermal performance that the kraft paper. According to IEC-60076-14[4], it can withstand 165°C (absolute value) without damage.

The table-2 above shows the maximum continuous temperature rise limits for transformers with high temperature insulation systems.

Mechanical Design of Offshore application transformer

Acceleration and vibration considerations

The ground acceleration forces and vibrations on transformers for offshore substations are more complex than those on transformers for onshore substations. These forces can be divided on five groups according to their frequency and duration:

- Forces related to land transportation.
- Forces related to transport of fully assembled transformer to the offshore platform.
- Forces of lifting platform from the barge and placing on the transformer foundation at the sea
- The vibrations resulting from earthquakes, wind gusts and waves when installed on platform.
- The vibrations occurring from electrical equipment transferred through construction components.

Painting and Accessories for Offshore application

If the transformer is located outdoors, the materials used should be resistant to the harsh conditions of the offshore environment. The offshore environment is salty and can rust the transformer tank. Generally, transformer is installed on the upper floor of the platform, so it does not come into direct contact with seawater. Therefore, the rust prevention measures for the transformer are not as severe as those for the platform jacket. However, the transformer should still be protected from the elements, and the paint should be applied in accordance with ISO-12944 standards and agreement with the customer.

The accessories and painting system used on the transformer of Offshore application must be suitable for the corrosive atmosphere. It is advisable to consider anti-corrosive coating system in accordance with the latest issue of ISO-12944 standards.

Conclusion

The optimal design must be developed not only based on the standard transformer solutions with capitalized loss evaluation but also considering the transformer weight and footprint with a goal to minimize the total cost of the entire offshore substation (i.e., Transformer as well as the platform).

The reduction of weight and footprint on offshore transformers results in a higher cost of losses, which is often overly-compensated by the cost reduction of the offshore platform which is also resulting smaller and lighter.

Therefore, the use of the compact transformers can be a very useful solution to achieve optimal offshore substation cost.

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[4] J.Reyes, M. Oliva, A. Prieto, A. Fernández, M. Cuesto and M. Burgos, “Compact Transformers for Offshore Wind Power Plants Applications”. International Conference on Renewable Energies and Power Quality (ICREPQ’14), Cordoba (Spain), 8-10 April 2014, RE&PQJ, Vol.1, No.12, pp. 587-593. ■

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Modes of CT Failure during Short Circuit Tests

- A Case Study at 100 MVA On Line Testing Station, CPRI, Bhopal

Current Transformers (CT) are used for metering & protection of power system. CT plays vital role in measurement of current during short circuit fault in power system and provides this information to relays which in turn operates circuit breakers to clear fault. CTs are first line of defense in protecting power system against short circuit faults. Although power systems are designed in such a way that no short circuit fault occurs. However short circuit cannot be totally avoided even after utmost care. This implies that CTs have to face a few short circuit currents and as such they should sustain those short circuits without any failure. Hence, they are subjected to short circuit test as per IS and IEC standards. In this paper an effort is made to explore various modes of failures during or after short circuit tests so that it will be helpful for manufacturing reliable CTs.

Introduction

When CT is subjected to short circuit faults, two important factors come in to play. First is thermal effect due to due to heat generated from heavy current flowing and second is mechanical stress due to electro dynamic forces exerted.

Thermal Effects

The conductor used in primary section of the winding is designed for carrying rated current an overload current of up to 120 %. During short circuit current levels are many times of the rated current thus generating tremendous amount of heat is developed. Since this happen during very short period of time, i.e. one or two second, this excess heat generated doesn't dissipate completely to surroundings thus causing excessive temperature rise. This excessive temperature rise in very short duration may result in

- Burning of solid and liquid insulating materials and even fire and smoke can occur.
- Melting and deformation of the conductor if its cross sectional area and quality are not adequate.

Dynamic Effects

In the event of short circuit electro-dynamic forces of immense magnitude comes into play. Magnitude of asymmetrical current is very high and many times in comparison to rated current of CT. These forces are proportional to square of Ampère turns and is given by

$$F = C(NI)^2 eq.\ 1$$

Where,

C is constant.

N is number of turns and

I is rms value of current.

The force developed during the first major half loop of short circuit current is several times greater than that produced during steady state value of current as

evident from equation below

$$I_{peak} = nI_{rms}\, eq.\ 2$$

Minimum value of n is 2.5 and putting this in eq. 1 we get

$$F_{peak} = C(N2.5I_{rms})^2 = 6.25 \times C(NI_{rms})^2$$

$$F_{peak} = 6.25 \times F_{rms}$$

This means electrodynamic forces during first major half loop is minimum 6.25 times that of steady state short circuit current. This peak force imposes severe electrical and mechanical stresses on windings and their mounting arrangements of current transformer. Especially primary windings require sufficient mechanical supports to sustain these forces and restrict any movement caused by forces during short circuit period otherwise it may come in contact with zero potential surfaces like tank and explosion may occur.

Effects of CTs Performance after Short Circuit

The current transformer subjected to short circuit tests may not perform adequately in normal service conditions even if no abnormality is observed during short circuit test. Some diagnosis tests are conducted on CT in order to assess its performance. Some tests are conducted before short circuit to set benchmarks. Following tests are performed on CT

- Tests for ratio error and phase displacement
- Composite error
- Turns ratio,
- Secondary winding resistance
- Knee-point voltage/ e.m.f
- Exciting current
- Inter-turn Over-voltage test-IOVT.
- Power frequency voltage withstand tests-HV.

Short Time Current Tests

Current transformers connected in power system are expected to withstand short circuit faults. It is imperative and essential to verify short circuit withstand capabilities of CTs as per national and international standards. To verify these capabilities and requirements of rated short-time thermal current and of rated dynamic current, the two following tests are specified.

The thermal and dynamic short time current test shall be made with the secondary winding(s) short-circuited and thermal current or rms current is maintained by I2t calculations as given below

$$I'^{2}_{test} \times t'_{test} \geq I^2_{thermal} \times t_{thermal}$$

Where,

t-is the specified duration of the short-time thermal current & test duration should be between 0.5 s and 5 s. In dynamic test peak current value equal to 2.5 times of thermal/ symmetrical short circuit current is applied. In some cases CTs are used in vicinity of power generation stations. In such cases due to very low sub transient reactance CTs must be capable of withstanding peak/dynamic current equal to 2.8 times of thermal/ symmetrical short circuit current. Depending upon application of CT, the dynamic current can be suitably chosen for verifying short circuit tests. Test set up is shown in figure 1.

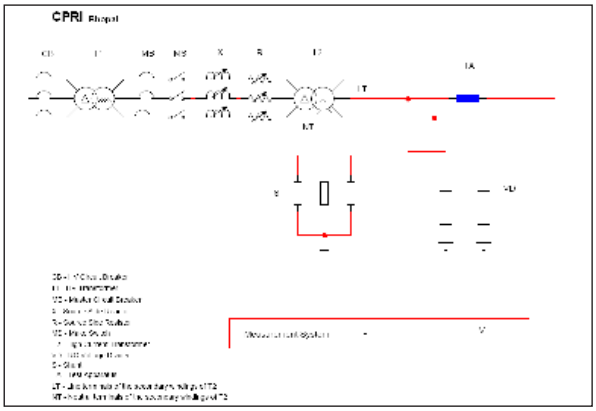


Figure 1 CT Test ArrangementCurrent oscillogram of CT successfully withstanding Dynamic and thermal is shown in figure 2.

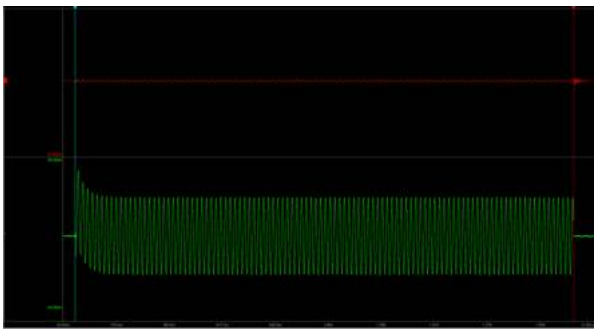


Figure 2 CT Withstood Dynamic + Thermal Test

CT which could not withstood thermal test is shown in figure 3.

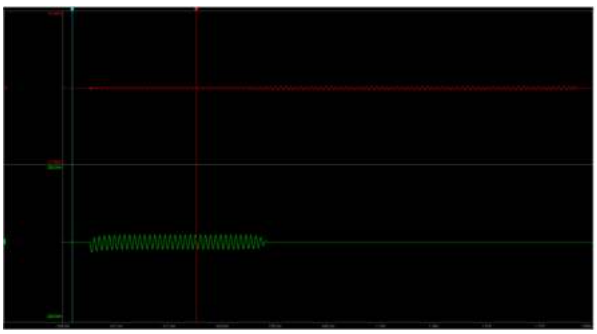


Figure 3 CT did not withstood Thermal Test

Type of Failure

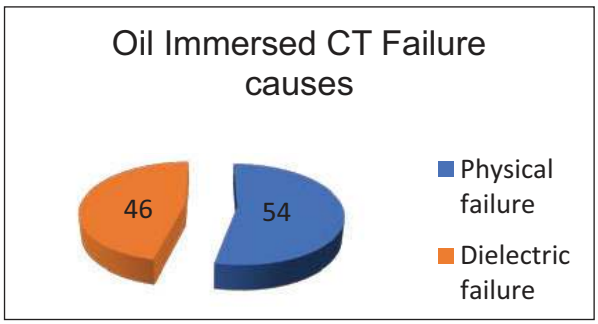
Test data of CTs and CT-PT units over 10 years is accumulated. 12 kV and 36 kV CTs were studied. Test data of more than 1200 tests was studied and failure cases were separated. Based on this failure types and data is accumulated and it is categorized by CT construction type.

- Oil Immersed CT
- Resin Cast CT
- Oil Immersed CT PT

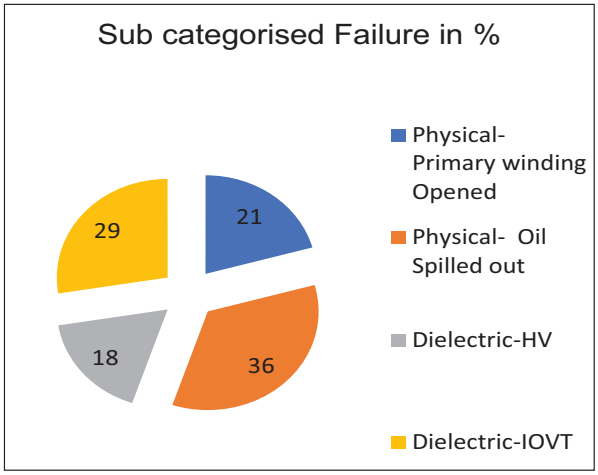
According to type of construction of CT, Types of failures are enumerated in this section. Analysis of these failures will be done in next section.

Oil Immersed CT

Oil immerse CT tested were having metering cores. Two major type of failure were observed. Namely physical and dielectric failure and these are given below in percentage of total failures.

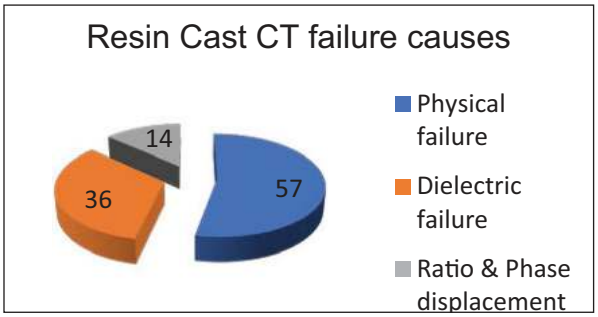


These failures are divided in further sub categories and results are given below.

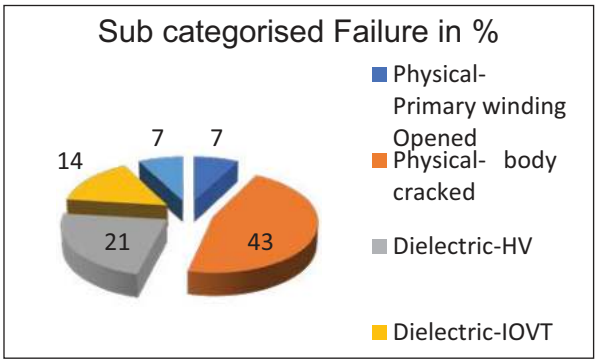


Resin Cast CT

Similar to Oil immersed CTs, in Resin Cast CTs two major type of failure were observed. Namely physical and dielectric failure and these are given below in percentage of total failures

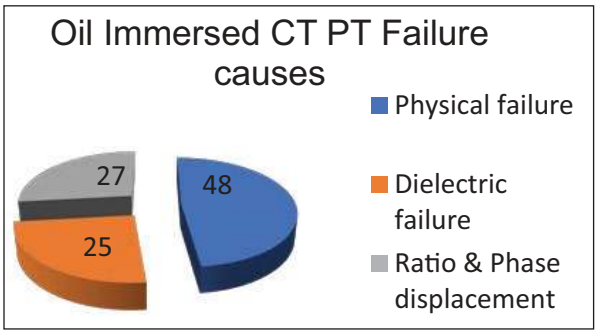


These failures are divided in further sub categories and results are given below.

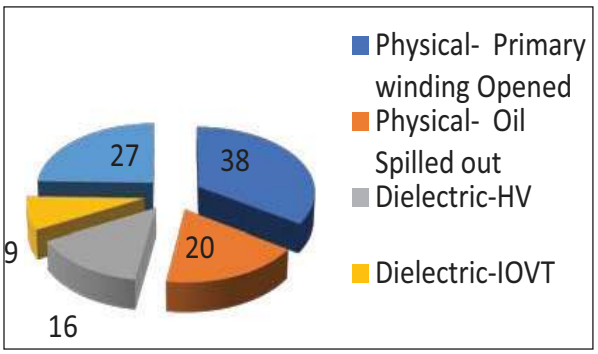


Oil Immersed CT PT units

Opposite to Oil immersed and Resin Cast CTs, three major type of failure were observed. Namely physical, dielectric and ratio phase angle failure and these are given below in percentage of total failures



These failures are divided in further sub categories and results are given below.

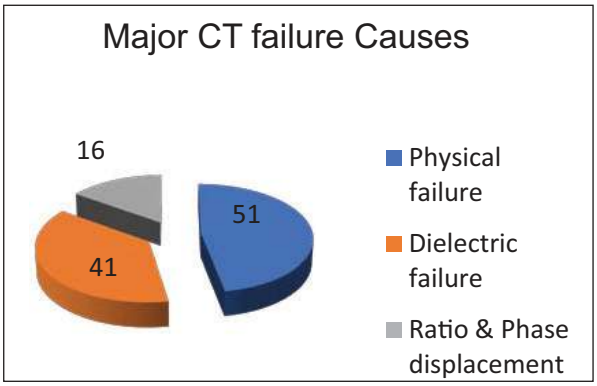


Analysis of Failure causes

As shown in previous section, following are major causes of failures in CTs during or after short circuit tests

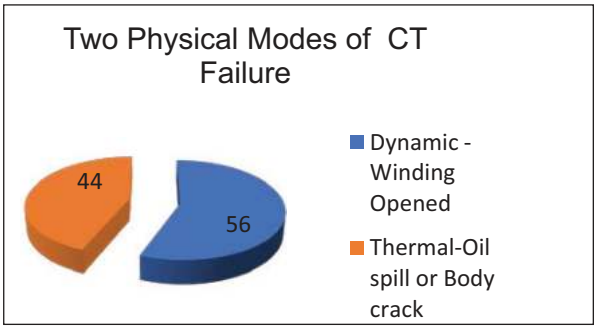
- **Physical Failure**
  - i. Primary winding opened
  - ii. Body cracked(Resin Cast)
  - iii. Oil spillage (Oil Immersed)
- **Dielectric Failure**
  - iv. Inter-turn Over-voltage test-IOVT.
  - v. Power frequency voltages withstand test-HV.
- **Ratio error and phase displacement**

All major causes of failure for all types of construction is given below



Physical failure

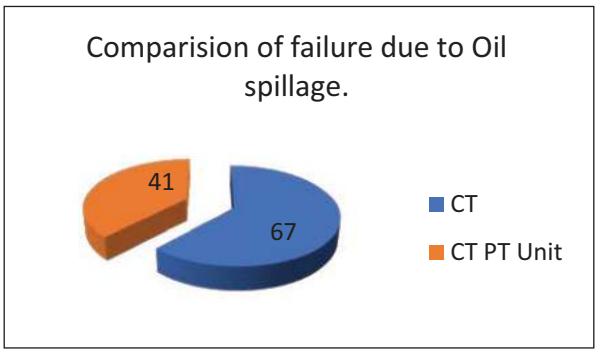
Physical failure is occurs during or just after short circuit tests. Physical failure can be attributed to two effects as discussed in section 1. Breakdown of failure based on these two causes is given below.



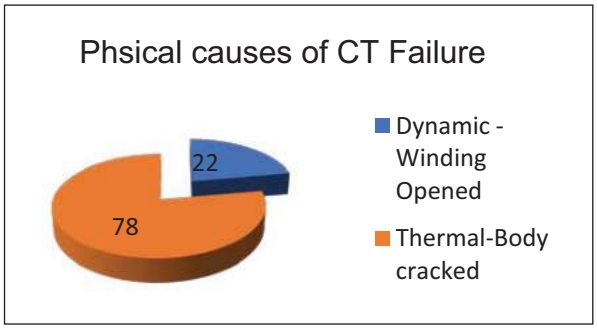
Dynamic effect caused by heavy electromagnetic forces of short circuit current acts on primary and secondary windings and their mechanical support. If proper care is not taken then primary winding gets opened due to snapping of conductor or terminals or lack of mechanical support.

Thermal effects caused by short circuit current create immense heat which has to be dissipated by CT with in very short span of time. In case of Resin Cast CTs heat dissipation is different than oil immersed CTs. In oils immersed CTs heat is dissipated by circulation whereas in resin cast CTs phenomenon involved in heat dissipation is conduction.

In Oil immersed CTs this immense heat has to be absorbed by oil and if quantity of oil is not sufficient then its volume increases considerably owing to sudden temperature rise. This results in oil spillage from pressure release valve. If oil quantity is very less in comparison to quantity required for heat absorption then CT tank gets deformed or bursts open due high pressure created in side tank by increased volume of heated oil. Sometime oil starts burning due to temperature rising above its fire and flash point. Moreover excessive heat generation and inability to dissipate heat fast results in burning of solid insulation and carbonized oil can be observed in spillage. Quantity of oil in CT-PT units is more in comparison to CT because it houses three CTs and three PTs. Hence failure due to oil spillage is less in CT-PT units when compared with oil immersed CTs. This is supported by data accumulated. For CTs 67% of total failure was due to oil spillage and for CT-PTs it is 41 % of total failure which less compared to CTs.

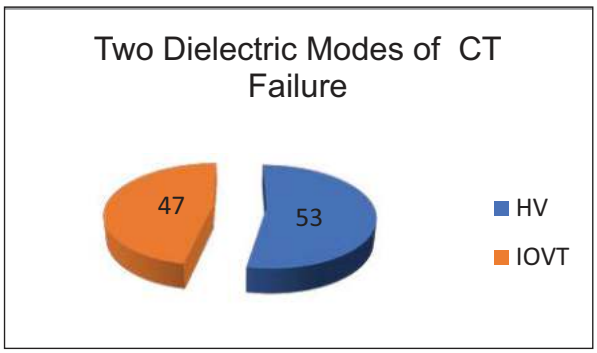


In case of Resin Cast CTs heat dissipation is due to conduction. During short circuit test most of the heat generated is absorbed by resin nearer to conductor. Then it is dissipated to outer parts slowly. Maximum temperature of outer surface of resin cast CTs will be reached only after few minutes of short circuit test. This conduction process gives rise to very steep temperature gradient across its cross section. If the casting is mechanically poor or resin used is not resistant to high heat then crack are developed on surface resulting failure. These cracks are normally visible after sometime. Moreover due to resin casting mechanical support to windings is good in comparison to oil immersed CTs so winding opening due to dynamic effects is very less. Hence cause of failure in resin cast CTs is predominantly cracks developed in body due to high heat and collected data also suggest the same and it is depicted below.



Dielectric Failure

After short circuit test CT is subjected to post tests which include dielectric tests Inter-turn Over-voltage test-IOVT and Power frequency voltage withstand tests-HV. Both tests are done to verify dielectric strength of primary and secondary windings along with insulation between phase windings, turns, coils, tapping leads and terminals. During short circuit tests due to thermal effects solid and liquid insulation may get damaged and to check them these tests are done. 37 % of all failures are because of dielectric failure and it is detected during these tests. Share of both type of Dielectric failure i.e. HV and IOVT is given below. It is clear that both types of failure are almost equal in all most all CT construction types. This failure arises from deterioration occurred in insulation due to excessive heat generated by thermal effects of short circuit currents. Moreover in cases of IOVT failures, thermal hot spots plays a major role which are created in and around nearby two turns thus diminishing dielectric properties of winding insulation.



Conclusions

From the above data and its analysis it is clear that various types of failure mechanism of CTs the following conclusions are made.

1. The physical causes are responsible for a major part of the Current transformer failures. Physical causes account for half of CT failure.
2. Dielectric causes are second most important failure modes. Both HV and IOVT are equally responsible for CT failures.
3. As discussed physical causes comprises of dynamic and thermal effects. Both can be mitigated with proper design and care
4. Dynamic effects are account for physical damage to current carrying parts or their supports like snapping of conductor, brazing, leads etc. Dynamic effects are arrested in Resin Cast CTs where mechanical support is provided by casting by default as against to oil immersed CTs.
5. Thermal effects have major impact on dielectric properties of insulation. Excessive heat causes sever deterioration to insulation which is reflected in physical damage which is visible to eyes like carbonization of oil, oil spillage; tank deformation or bursting in oil immersed CTs and cracked body in resin cast CTs.
6. Deterioration of insulation, caused by thermal effects, are sometimes not visible but they are detected in post short circuit dielectric properties test like HV and IOVT which requires applying high voltage. After witnessing excessive heat dielectric properties of insulations are deteriorated and when this insulation is subjected to high voltage it causes dielectric failure.
7. Thermal effects also contribute to current carrying path failure if short circuit current density is very high (greater than 180 A/mm2).
8. These modes of failures can be minimized if they are factored in while designing and manufacturing.

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Internal Arc Fault Testing as per IEC 61227 on **EHV Current Transformers used in Nuclear Power Plants**

Large numbers of failures of EHV Current Transformers (CT) are reported in the recent years. The failures of EHV CTs leads to scattering of the debris at a considerable speed due to accumulation of gases inside a CT subsequent to a fault and further leads to failure of nearby switchyard equipment. In order to improve this, Internal Arc test has been introduced in IEC 61227-1:2007. To qualify this test EHV CTs shall be designed to withstand the internal pressure developed during internal arc test or shall be provided with fail-safe design. This paper presents the need for introducing this test, requirements of internal arc test and experience of carrying out these tests for NPP. It also highlights the engineering judgment required to be taken to successfully execute the testing.

Introduction

EHV Switchyard acts as an interface between Power Plant and Grid for evacuation of generated power as well as for the supply of station auxiliary power supplies from the grid. In case of Indian NPPs, common switchyard for evacuation of generated power and supply of station auxiliary power and separate switchyard of different voltage levels for evacuation and auxiliary power supply, both are present. These switchyards are equipped with oil filled EHV CTs as well as SF_6 CTs.

In recent years, catastrophic failures of EHV CTs are reported for operating NPPs. The scattering of debris followed by the incident leads to damage of other equipment located in switchyard and can cause a threat to human life. This further leads to a considerable outage time and a considerable amount of revenue loss due to generating plant shutdown. In view of this, Internal Arc Fault Test for CTs has been introduced in the technical specification of EHV Instrument Transformers of NPP in line with IEC to confirm the performance of current transformer as per the desired level of safety given in standards.

Impact of Failure of EHV CTs in NPP

Failed EHV CT shown below in Fig.1 belongs to Kaiga Atomic Power Station 400kV Switchyard. Failure of CTs leads to the actuation of respective electrical protection system which may lead to isolation of the generating unit from the grid. The isolation of the unit can sometimes lead to tripping of the nuclear reactor due to non availability of power supply to primary coolant pumps. Replacement of the failed CTs requires several man hours. It involves replacement of damaged equipment due to the impact of scattered CT debris to restore normal condition and taking care of casualty happened, if any. Also tripping of nuclear reactor causes a huge revenue loss.

Fig.1 Failed 400kV Current Transformer in Switchyard

Internal Arc Testing of 220kV Oil Filled CT

Internal Arc Test was first introduced in the Technical Specification for EHV Instrument Transformers for 220kV switchyard extension of TAPS-1&2. The 220kV CT supplied was an oil filled CT with porcelain insulator. Various discussions with supplier happened to understand the applicability and requirement of the test. The test was finally decided to be performed at the designed fault level of 220kV i.e., 40kA for a duration of 0.1 sec corresponding to protection stage-I at CPRI Bangalore. The current transformer shall be equipped with all accessories and shall be mounted to simulate operating conditions as per the procedure given in standards. Qualifying criteria for this test is as stipulated in clause 6.9 table-8 of IS 16627 (Part 1):2016/ IEC 61227-1:2007 f*or class-I category, fracture of housing and fire are permitted but all projected parts to be confined within containment area.*

However the 220kV CT failed to qualify the test with above fault current. CT porcelain housing sheared into pieces and the porcelain pieces were found outside the containment area.

The CT is having inbuilt of pressure release device (PRD) on top of the tank which is mechanical device for relief of excessive pressure buildup within the CT. PRD didn't operate as it will take time to operate due to sluggish nature to release the pressure during internal arcing and hence failed to pass the qualifying criteria.

Application of Practical Approach

After the experience of above internal arc fault test, it was discussed with manufacturer to introduce a fast acting device as part of tank to release pressure immediately before failure of the CT. Manufacturer came up with solution of diaphragm (pressure vent) as part of the tank to release developed pressure. Selection of diaphragm is such that it remains intact during normal operation and during internal arc fault, it ruptures and opens up before built up of maximum withstand pressure of hollow porcelain insulator inside the CT. One sample diaphragm was tested for its design burst pressure before installation. Accordingly, CT tank was modified to fit diaphragm as part of tank and it was also integrated with vent pipe externally fixed to the tank. The vent pipe assembly is an outside add-on fitting provided for mechanical/ physical protection of diaphragm. Vent pipe also guide the oil flow downwards during the event of operation of pressure relief vent.

Also it was decided to carryout internal arc fault test with reduced fault current for second attempt. This is decided based on the Clause 6.9 of IS 16627-1 : 2016 / IEC 61227-1 : 2007 which describes *"Reduced internal arc test levels should be agreed between the manufacturer and the purchaser. Experience has shown that selection of test currents equal to 100 % system fault level, statistically requires a degree of over-design of the transformer, since local fault levels are usually significantly lower."*

Existing 220kV switchyard was designed for system fault level of 40kA. Line to ground fault can only occur inside the single phase CTs. Hence, fault analysis was carried out in 220 kV Bus of TAPS-1&2 for line to ground fault. The fault analysis was carried out considering all the 220 kV Lines, Tie Lines, Transformers, Generators, back feed from Motors on 220kV bus at TAPS-1&2 and fault current obtained is about 21 kA. Hence, it was decided to conduct internal arc fault test with 21 kA fault current for duration of 0.2 sec corresponding to protection stage-I.

The test was again performed at CPRI Bangalore at the reduced fault level of 21kA on modified CT. During the test, fire & fumes were observed and diaphragm (pressure vent) was ruptured & open. There was no damage to the porcelain insulator and insulator was found intact. All other parts of the CT were found intact except the vent pipe of 150mm pressure relief diaphragm. Relief diaphragm vent pipe fitting got dislodged and was found outside the containment area. All fabricating parts of CT were found intact except for minor bulging in bottom tank. This vent pipe does not have any direct implication on the performance of CT and hence it was concluded that the test was nearly successful.

Further Modification In Diaphragm and Vent Pipe

Vent pipe design and fixing arrangement was analyzed for strengthening of attachment to avoid dislodgement from CT tank to meet safety requirement. It was observed that V-notch holes were provided on the vent pipe flange for fixing on CT tank. The position of nuts provided on the tank and V-notch holes provided on vent pipe were mismatched. Because of mismatching of

holes and nuts position, the vent pipe was not properly fixed as per the design.

The slotted fixing hole (V-notch) of vent pipe flange did not provide any resisting area for holding bolts / pipe during explosion of internal arc test. Therefore, the vent pipe assembly was thrown by excessive pressure generated during internal arc test.

Also the slotted hole (V-notch) was changed to full round hole on mounting flange. This round holes shall offer necessary resistance against induced force during rupture. Diameter of vent pipe flange also increased for proper mounting. Vent pipe was modified to semi cut shape instead of full bend to avoid direct pressure on the vent pipe. Fixing hardware also replaced with high tensile strength hardware. The manufacturer ensured by analysis that with these modifications, EHV CT will release the pressure developed during internal arc fault without dislodging of vent pipe. With test results and analysis submitted by manufacturer, this 220kV CT was considered to be qualified for this test. With the same modifications all the CTs were supplied by the manufacturer.

Internal arc testing of 420kV SF6 filled CT

420kV, outdoor, SF_6 gas filled, hermetically sealed live tank current transformer with Polymer insulator was offered to one of the NPCIL station. Manufacturer was in an apprehension that Internal Arc Test is not applicable for SF_6 Insulated Polymer insulator CTs. IS / IEC [1] does not state anything regarding the non-applicability. Finally, agreement was made from the manufacturer side to perform the test as per the requirement of IS / IEC [1] for 50 kA fault current for a duration of 0.1 sec.

Manufacturer conducted a worldwide survey for test facilities for conducting internal arc test on SF_6 Gas Filled CTs. But most of the test facilities do not allow testing of SF_6 CTs as SF6 gas is a greenhouse gas with a very high global warming potential. Also it is not advisable to release high amount of SF_6 gas to atmosphere as per the norms. In view of this, manufacturer proposed to conduct the internal arc fault test with N_2 gas in place of SF_6 gas with same rated pressure 6 bar at 20°C as the dielectric strength & arc extinguishing properties of N_2 gas is less compare to SF_6 gas. Decision was taken to perform the test with N_2 gas in place of SF_6 gas and no change in any other parameters / components of 420kV CT.

CPRI Bangalore agreed to conduct the test with fault current of 50 kA for duration of 0.1 sec corresponding to protection stage-I with CT filled with N_2. All the waveforms recorded for RMS current, Peak current & Arc voltage were found within the limits (Refer Fig. 2). During the test, diaphragm (pressure vent) available on top of CT tank was ruptured and opened (Refer Fig. 3). Smoke exhausted from diaphragm on top of CT tank and no projected parts found outside the containment area. During and after the test no abnormalities found and test was declared as successful.

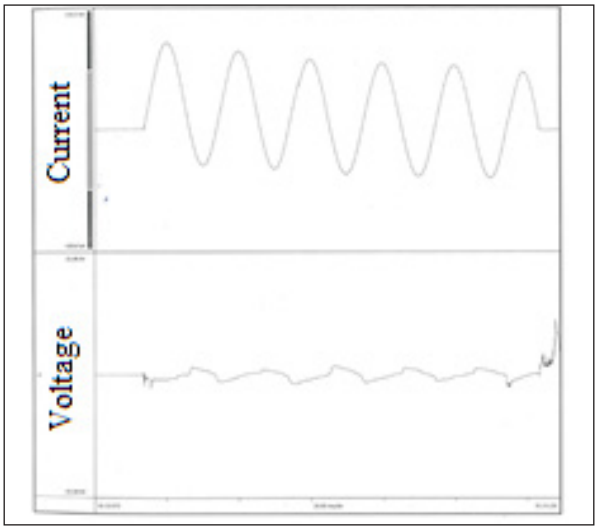

Fig. 2: Current and Voltage wave form

Fig. 3: Condition of the sample during internal arc fault test

Conclusion

EHV CTs if qualified for internal arc fault test as per the standards will definitely improve the safety aspect which is of great concern in switchyard. Many injuries, casualties, damage of nearby equipment due to the impact of scattered CT debris can be avoided. The internal arc fault testing is not always an easy going task. With some practical approach and mutual understanding between the utilities and manufacturers, test can be successfully conducted. SF_6 gas filled CTs have their own limitation but can be overcome by using alternative gas like N_2.

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Acknowledgement

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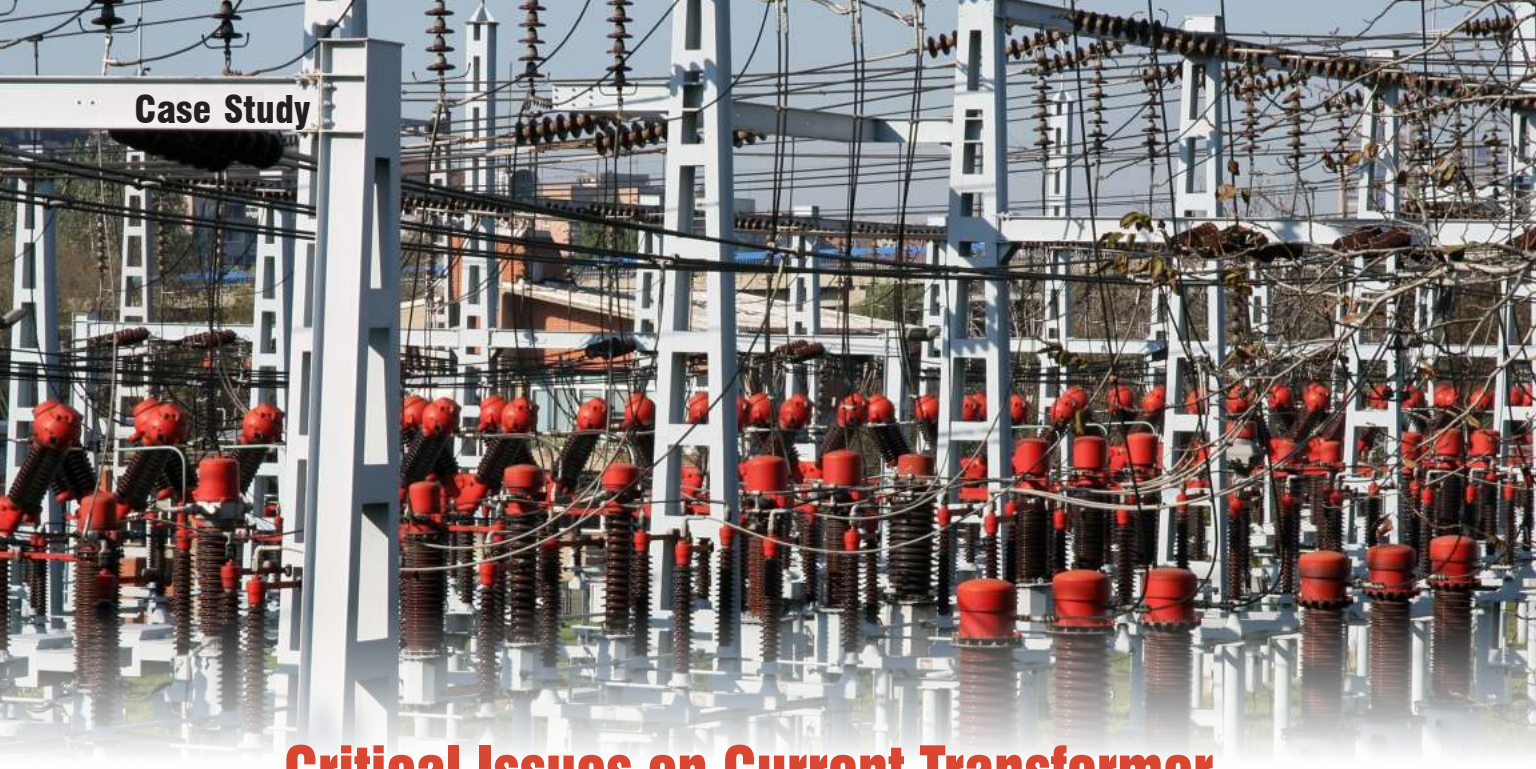

Critical Issues on Current Transformer
During Short Circuit Test

Current Transformer acts an important role in protection of power system network in terms of differential protection, earth faults and over currents. Current Transformer plays a crucial role in achieving an efficient power system network, providing a high degree of protection, and ensuring accurate measurement of various parameters involved. The failure of the current transformer goes to a disruption in the power network. The primary cause of the current transformer outage can be attributed to design flaws, short circuits, and material deficiencies. This document examines the crucial concerns pertaining to current transformers in the perspective of short circuit testing. In this paper failure cases of current transformers are reviewed and results are examined.

Keywords: Current Transformers (CT), Short Circuit Testing, design flaws and causes of failure.

Introduction

Current Transformer serves as the sensing devices for the activation of relays and the operation of circuit breakers. The proper functioning of both the circuit breaker and the system as a whole is contingent upon the integrity and dependability of the current transformer and its corresponding relays [1]. The operational flux in a current transformer is not consistent, as it is directly influenced by the actual primary current, which changes extremely widely. These fluctuations in primary current result in the current transformer operating under a wide range of flux densities [2]. Therefore, it is essential to assess the performance of current transformers both during steady state and fault conditions. Current transformers are divided into two primary types based on their applications and design,

1. Measuring Current Transformer
2. Protective Current Transformer

Short Time Current Rating of CT

The determination of temperature rise in a winding during short-time conditions is predicated on the presumption of adiabatic heating [3]. This implies that all the energy generated within the winding throughout the duration of the short circuit is retained as heat within the winding. The short-time mechanical current rating refers to the highest peak value of a fully asymmetrical primary current wave that a transformer can endure with its secondary winding short-circuited. This value must be 2.7 times the short-time thermal rating [4] . The term “capable of withstanding” denotes that the current transformer must not sustain any harm and must satisfy all other relevant requirements of this standard when subjected to this duty [6]. The thermal rating allotted to a current transformer for a short duration must ensure that the permissible current density is not surpassed in any of its windings. In the case of current transformers, the primary winding typically accounts for the majority of the stray conductor loss. The ratio of stray conductor loss to I^2R loss, denoted as K, should be exclusively employed in the computation of the temperature rise in the primary winding. The value may be computed from the formula,

$$K = [P_z - (I^2R)] / [I_p^2 * R] \quad \text{---------- (1)}$$

Where,

I^2R is the cumulative direct current (dc) loss incurred by both the primary and secondary windings.

$I_p^2 * R$ is the dc loss incurred by primary winding

P_z is the watt is determined during an impedance test.

The assignment of short-time ratings for Current transformers shall be determined as a multiple of the rated current and shall be applicable to the maximum current ratio, unless explicitly specified otherwise [5]. The computation of short-time thermal ratings may be conducted by considering the cross-sectional area of the magnet wire utilized in the secondary winding.

This rating is presented as a symmetrical root mean square value. In order to ensure consistency with power circuit breaker ratings, short-time thermal ratings may be offered for durations of three seconds. It is essential for the user to be aware that these short-time ratings may not necessarily be identical to those of the primary conductor, as the latter may have distinct limitations.

Installation of Current Transformer

It is imperative to regard an instrument transformer as an integral component of the circuit to which it is linked. It is advised to refrain from handling the leads, terminals, or any other parts of the current transformer unless it is confirmed that they are sufficiently grounded. The insulation surface of the molded current transformer should be treated with the same level of caution as that of a porcelain bushing. This is due to the presence of voltage stress across the entire insulation surface, extending from the terminals to the grounded metal parts. The secondary component ought to be grounded in close proximity to the current transformer. In the event that the secondary components are interconnected, it is crucial to ensure that there is only one grounded point within the circuit to prevent inadvertent paralleling with the system grounding wire. Figure 1 shows the Schematic diagram of Current Transformer.

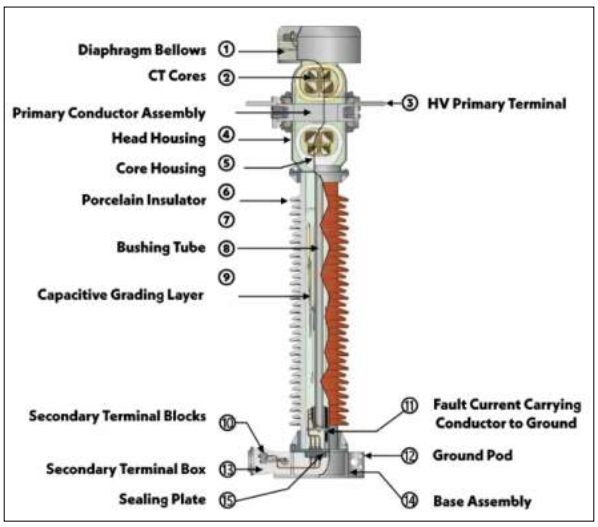

Fig 1. Schematic diagram of Current Transformer [2]

It is imperative to refrain from opening the secondary circuit of a current transformer while it is energized, as well as avoiding energizing it while the secondary circuit remains open. This precaution is necessary owing to the potential development of open circuit secondary voltages i n the current transformer, which can pose a hazard to personnel and cause damage to both the transformer and any equipment connected to the secondary circuit.

A good, permanent low impedance ground is essential for adequate protection. The current transformer is equipped with a secondary grounding provision, and the current transformer base features a ground connector specifically designed to accommodate ground wires. When wiring instrument transformer circuits, it is crucial to uphold the appropriate polarity association between the line and the devices linked to the secondary. The polarity of each winding is denoted by a marker located near each primary and secondary terminal, indicating its relative instantaneous polarity.

A discourse pertaining to the factor of saturation then the temporal impact of saturation will be presented. Theoretically, the saturation of current transformers can be circumvented under certain circumstances. The IEEE Std C37.110-1996 outlines various factors that can influence CT saturation. As the CT can function accurately for duration of one to three cycles subsequent to saturation, the time it takes to reach saturation is crucial in designing the relay. The subsequent variables ascertain the saturation of the CT.

1) The extent of fault current offset is influenced by various factors, including the DC component present at the primary side. This DC component contributes to an elevation in the flux density of the CT core. Additionally, the ratio of X/R and the fault incidence angle, which determine the offset of the DC component, exert an influence on both the primary and secondary waveforms.

2) The amount of fault current. In the occasion of an identical offset scenario, a fault current of significant magnitude will result in the direct saturation of the CT.

3) Remanent flux within the CT core refers to the residual magnetic flux that persists within the core when the primary current is interrupted. This remanent flux has the potential to either decrease or increase the time required for the core to reach saturation, depending on its polarity. In the event that the remanent flux is exceptionally high, the core will rapidly approach saturation.

4) Secondary circuit impedance plays an important role in the saturation of current transformers. In similar circumstances, higher impedance on the secondary side of the CT will result in a faster saturation. Substantial burden on the CT will lead to an elevated voltage across the core. Consequently, the corresponding flux, which is directly proportional to voltage will increase, thereby reducing the time required for saturation to occur.

5) The turns ratio is a determining factor in the reduction of secondary current when a known primary current is increased. It is remarkable that the CT will not saturate even if the fault current does not reach the upper limit of the primary current. Figure 2 indicates the Relationship between Vs and Ie for CT.

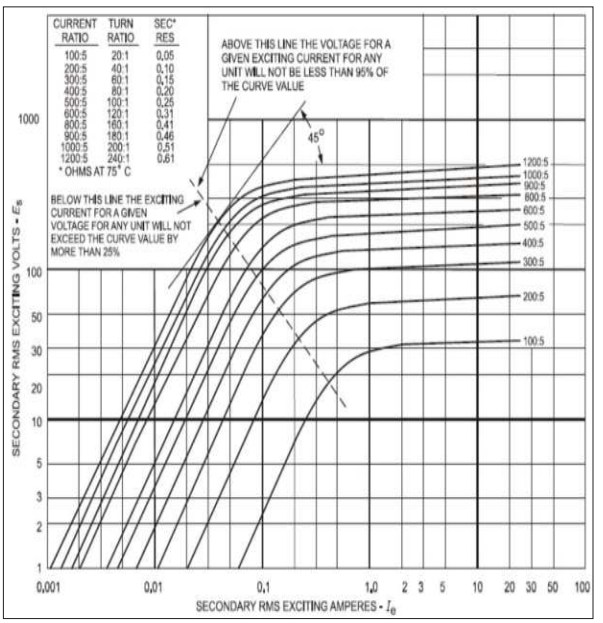

Fig 2. Relationship between Vs and Ie for CT [2]

Demagnetizing Ct

The current transformer has recently experienced significant electrical currents during the short circuit test, potentially including a substantial direct current component, or has become magnetized due to the application of dc voltage. In order to rectify this, it is necessary to demagnetize the CT. It is advisable to demagnetize the CT once the tests have been completed. One approach to demagnetize the CT involves applying an appropriate, adjustable alternating voltage to the secondary winding of the CT. Initially, the magnitude of this voltage should be sufficient to exceed the saturation point of the CT's flux density.

The test connections utilized for this demagnetization method are the same as those necessary for the excitation test. An alternative approach employed by transformer experts to demagnetize a CT involves gradually altering the secondary loop resistance from low to high to low at a constant pace.

For instance, assuming that the current transformer (CT) being tested generates a minimum secondary loop current of 2.5 A, a sequential adjustment of the series resistance is connected, starting from 0.1 Ω and gradually increasing it to 8Ω, before returning it back to 0.1 Ω at a steady pace. This procedure effectively imposes excessive load on the CT and demagnetizes its core. Figure 3 shows the Circuit for Demagnetizing for CT

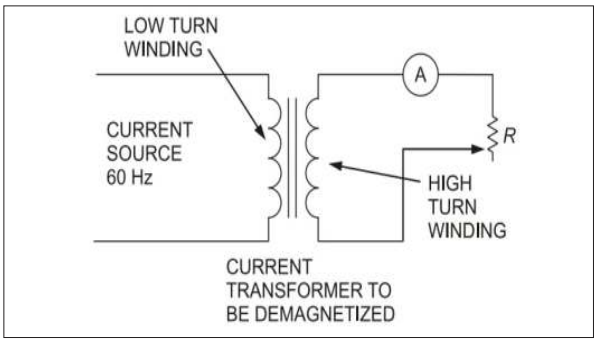

Fig 3. Circuit for Demagnetizing for CT [6]

Test Results

The present study examines the impact of radial and axial forces on the current transformer. Several noteworthy instances of short-duration current tests conducted at the Central Power Research Institute are demonstrated.

Case study 1: Short time current Test conducted on 11kV, 50/5A, current transformer. The test involved applying a test current of 31.50 kA for 3 sec with initial peak of 78.75kA on the current transformer. current transformer was open circuited at 0.95 second during the test as shown in figure 4. During untanking it was observed that secondary of current transformer was open circuited.

Case Study 2: Short time current Test carried out on 33kV, 100/5A, current transformer. 25.00 kA for 1 sec with initial peak of 62.50kA test current should be applied on the current transformer. During test, a significant occurrence of arcing was observed on the current transformer. Subsequently, current transformer is isolated from test circuit at 0.74 second as shown in depicted in figure 5. After test a hole was observed on tank of current transformer at the place of arcing and oil came out of current transformer.

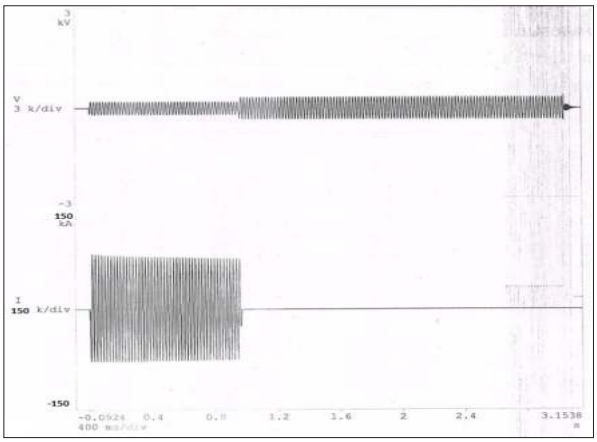

Fig 4. Oscillogram of Current Transformer

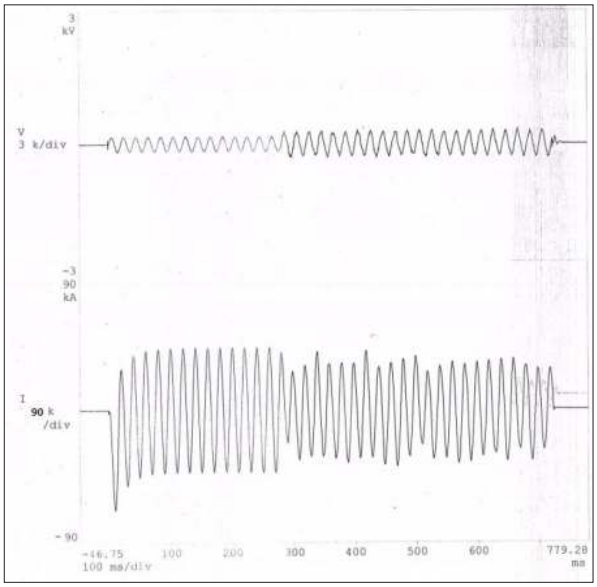

Fig 5. Oscillogram of Current Transformer

Case Study 3: Short time current Test carried out on 33kV, 200/5A, current transformer. 26.30 kA for 1 sec with initial peak of 65.75kA test current should be applied on the current transformer. During test, voltage and current oscillogram distorted after 280 ms as shown in figure 6. During test, oil started coming out from a tank and heavy arcing observed.

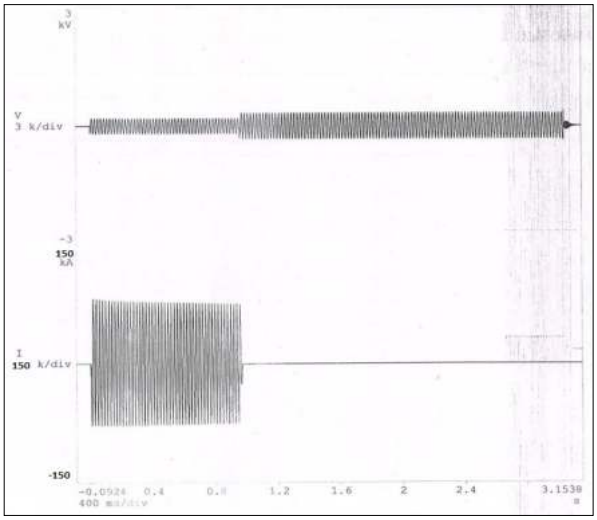

Fig 6. Oscillogram of Current Transformer

Conclusions

The saturation of current transformers can result in distortion of the secondary current, thereby causing non-linear proportionality with the primary current. This can lead to malfunctioning of protection devices, which is a critical concern. To ensure the quality of current transformers, it is imperative to conduct short circuit tests. Analysis of fault cases has revealed that the protective relaying may not function or may malfunction

due to the saturation of current transformers. Therefore, it is essential to discuss the significance and consequences of using such current transformers during high fault currents. During the manufacturing process of current transformers, it is crucial to carefully examine the maximum temperature location of winding temperature rise. High quality current transformers capability of withstanding short circuit test in the power system network will decrease failures and supply blackouts. ■

Acknowledgement

The authors acknowledge all colleagues related with 100MVA online short circuit testing laboratory, CPRI, STDS, Bhopal for this carrying out this work.

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Testing of Transient Response Current Transformer as per IEC 61869-2

General PX class CTs generally have a slower response time and are not optimized for capturing high-frequency transients. Hence, transient core CTs are commonly used in applications, where accurate measurement and analysis of transient currents are essential for system performance and equipment protection. In general, transient core current transformers employ a unique design to enhance their performance during high-frequency transients. They typically feature a specialized core material and construction that allows them to accurately measure transient currents. During this transient period, the secondary current has to be reproduced precisely and without reaching saturation. TPX, TPY & TPZ core current transformers are used to handle these transient fault conditions. In this paper, the transient performance of these current transformers is analyzed through testing. Test methodologies as per IEC 61869 -2 have been discussed clearly. Tests are conducted on the TPX core as per standard, and test results are discussed.

Introduction

Power System network and interconnections are growing very rapidly by large additions of generation capacity. To maintain the system stability in this scenario, it is very much required to clear the fault very fast, i.e fault clearing time shall be lower. Though Numerical relays and fast acting / High Speed circuit breakers are developed to achieve the lower fault clearing time, Protective Current Transformer should have capability of feeding the fault information to relay correctly without saturation during transient fault period.

Instantaneous value of the short circuit current is defined as

$$i_k(t) = \sqrt{2}\, I_{psc}\left[e^{-t/T_p} \cos(\gamma - \varphi) - \cos(\omega t + \gamma - \varphi) \right]$$

Ipsc: rms value of primary symmetrical short circuit current

Tp: Primary Time constant: Lp/Rp;

γ : Fault Inception angle

Φ : Phase angle of the system short circuit impedance

ω: Angular frequency

Current Transformer is subjected to above mentioned instantaneous value of short circuit Current during fault condition. CT performance also depends on its own core size, secondary time constant etc. Hence, Current Transformer performance will be governed by the following parameters under Transient condition:

(i). Fault level or fault current at the particular location

(ii). Primary time constant (TP)

(iii). Secondary time constant (Ts)

(iv). Burden of CT secondary

(v). Remanence flux of the CT core

(vi). Number of secondary turns and the cross sectional area

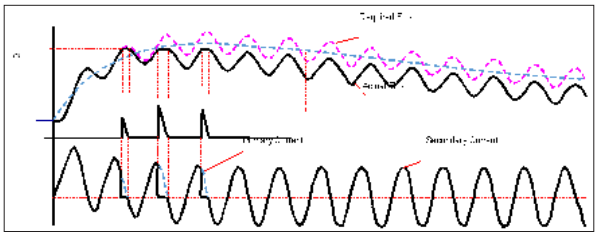


Figure 1: Typical waveform of Primary and secondary current during Transient fault

Figure 1 shows an example that how much flux required against actual flux produced. Due to this incapability of core to handle flux required actually, small portion of primary current is lost and it is not reproduced in secondary. If the Protection need to act during this initial period, Relay will malfunction and protection will fail to act. Transient class Current Transformer performance has to be satisfied for the given protection relay parameters and fault duty cycles. During C- O fault or C-O-C-O fault, t'_{al} and t''_{al} is the time period at which CT is expected to maintain the specified accuracy class to fulfill the protection requirement. To check the Transient Performance of Current Transformer, IEC 61869-2 specifies the testing methodology

Transient Class Current Transformer

Sizing

The dc component contained in the fault current during the transient period makes the flux in the CT core to increase and it thus the core has to have sufficient cross section to avoid its saturation. CT dimensioning has to be studied carefully for specified protection. For optimum CT sizing, Transient dimensioning factor K_{td} & Transient Factor K_{tf} have to be properly estimated during design phase. In-general K_{td} is derived from current transformer requirements given by the relay manufacturer, gained from relay stability type tests or from worst-case considerations based on the K_{tf} curves.

Transient class Current Transformer need to be over-dimensioned by considering the factor K_{td} and K_{tf}, remanence factor, K_{ssc} and relay parameters.

Types of Transient Class CT :

There are three types of Protective current transformer to meet the transient error requirements under asymmetrical short-circuit current namely TPX, TPY and TPZ. TPX is almost same as PX core, but core will be sized to meet the transient condition, TPY and TPZ are gapped core. so that remanent flux will be reduced and core saturation will be avoided. TPX cores having a high secondary time constant, and having no significant flux declination after first fault *t'*. TPY and TPZ cores having a low secondary time constant, the secondary linked flux declines exponentially with the secondary time constant T_s during the fault repetition time t_{fr}. Table 1 Shows the Performance requirement of Transient class Current Transformer.

TPX (High Remanence)	No limit of Remanent Flux	Saturation behaviour is specified by peak value of instantaneous error
TPY (Low Remanence)	With Limit of Remanent flux Kr ≤ 10%	Saturation behaviour is specified by peak value of instantaneous error
TPZ (Non-Remanence)	With Limit of Remanent flux Kr ≤ 10%	Saturation behaviour is specified by peak value of alternating error

Table 1 : Performance requirement of Transient class Current Transformer

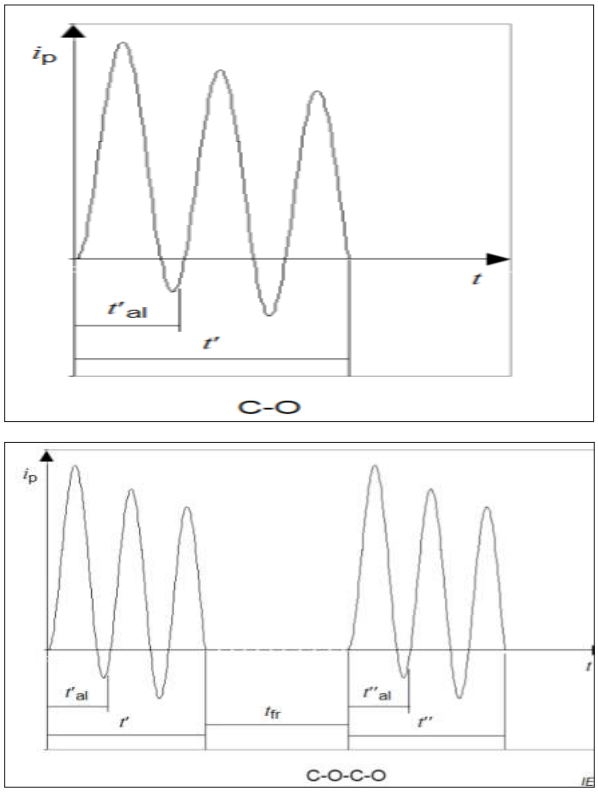
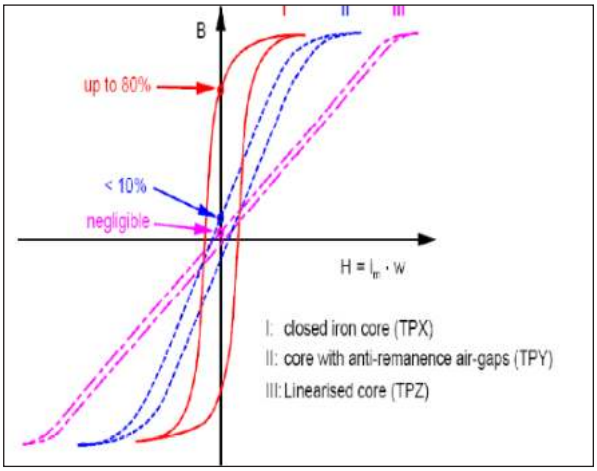


Figure 2: Typical Duty cycle of Breaker in protection System

Figure 2 shows a typical duty cycle of Breaker in protection system. In C-O cycle , fault current duration is t' where t'_{al} is the time at which current Transformer is expected to meet its accuracy and send signal to protection relay. Similarly C-O-C-O cycle especially in Auto Reclosure, t' and t" are first and second fault duration. t'al and t''al are time at which Current Transformer is expected to meet the declared accuracy and send signal to Protection relay without saturation



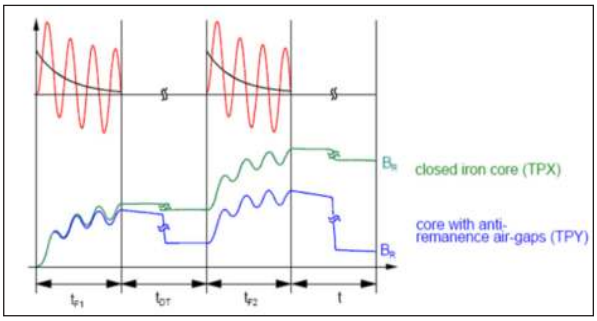


Figure 3 : Non-linear B-H curve and Transient performance of Transient CTs

Figure 2 shows the B-H curve and remanent flux for TPX, TPY and TPZ current Transformer. It clearly shows that TPX has higher remanent flux and it starts from that point of flux for next operation of Auto Reclosure. Hence it will reach saturation fast. TPZ having negligible remanent flux and hence, In second operation of Auto Reclosure, core will almost handle the same amount of flux as first operation.

Specification for Transient Class Current Transformer

There are two specification methods (namely Standard and Alternative) have been described for TPX, TPY and TPZ class current Transformer.

Standard Specification	Alternate Specification
Rated Symmetrical Short Circuit Current K_{ssc}	Rated Symmetrical Short Circuit Current K_{ssc}
Duty Cycle consisting For C-O Cycle : t'_{al} For C-O-C-O cycle : t'_{al}, t', t_{fr}, t''_{al}	Rated Value of Transient Dimensioning factor K_{td} Rated value of Secondary loop time constant Ts(for TPY cores only)
Rated Primary time constant T_p	
Rated Resistive Burden R_b	Rated Resistive Burden R_b

Table 2: Transient Class Current Transformers Specification

Based on the specification methods mentioned in Table 2, Transient Class Current Transformers shall be marked as per Table 3

Transient class CT	Compulsory marking based on alternative specification	Complementary part (compulsory only if a duty cycle is specified by the customer
TPX	KSSC, Ktd, Rb, Rct	For C- O Cycle, Cycle time Tp, t'al For C-O-C-O Cycle Cycle time, Tp, t'al t', tfr t''al , Tp
TPY	KSSC, Ktd, Rb, Rct, Ts	
TPZ	KSSC, Ktd, Rb, Rct	

Table 3: Marking details of Transient Class Current Transformer

Review of Test Requirements as per IEC Standards

Transient class Current Transformer shall be within the limits of error specified in the Table 4 at rated primary current and at Transient fault current. Table 5 shows the list of type and routine tests to be performed on each Transient class Current Transformer

Class	At rated primary current			Transient error limits under specified duty cycle conditions
	Ratio error	Phase displacement		
	±%	Minutes	Centiradians	
TPX	0,5	±30	±0,9	$\hat{\varepsilon}$ =10 %
TPY	1,0	±60	±1,8	$\hat{\varepsilon}$ =10 %
TPZ	1,0	180±18	5,3±0,6	$\hat{\varepsilon}_{ac}$ =10 %

Table 4: Limits of error for Transient Class Current Transformer

Transient class CT	Routine test	Type test
TPX	i) Ratio error and phase displacement at rated primary current corresponding to secondary winding resistance at 75 deg.c. ii) Secondary winding resistance Rct iii) Error at Limiting condition by indirect method for low leakage reactance or if CT already have been type tested.	i) Error at Limiting condition

TPY	i) Ratio error and phase displacement at rated primary current corresponding to secondary winding resistance at 75 deg.c. $\Delta\varphi_{75}$ to be calculated. ii) Secondary winding resistance Rct iii) Error at Limiting condition by indirect method for low leakage reactance or if CT already have been type tested. iv) Determination of Secondary loop time constant	i) Error at Limiting condition ii) Determination of the remanence factor
TPZ	i) Ratio error and phase displacement at rated primary current corresponding to secondary winding resistance at 75 deg.c. $\Delta\varphi_{75}$ to be calculated ii) Secondary winding resistance Rct iii) Error at Limiting condition by indirect method for low leakage reactance if CT already have been type tested.	i) Error at Limiting condition

Table 5: Test to be performed on Transient Class Current Transformer

I. Ratio and Phase Displacement Error at Rated Primary Current

Accuracy test to be performed at rated primary current, correspond to 75 deg. C. Therefore, the actual value of the secondary winding temperature to be measured and its difference to 75 deg,c to be added with burden value while conducting accuracy test at rated primary current. Ratio and Phase angle error shall be within the limits specified in Table 4. For TPY and TPZ cores the phase displacement at 75 °C to be calculated using

$$\Delta\varphi_{75} = \Delta\varphi_{amb}\frac{R_{ct}+R_b}{R_{ct\,amb}+R_b}$$

II. Error at Limiting Condition by Indirect Test Method

There are three methods available for testing Transient class CT.

1. AC method, 2, DC method 3, Capacitor Discharge method.

As AC source is generally available, AC method only has been discussed in this paper. For low leakage reactance type current transformer, Secondary limiting emf to be calculated as

$$E_{al} = K_{ssc} \times K_{td} \times (R_{ct} + R_b) \times I_{sr}$$

By applying the calculated Accuracy limiting emf by considering the Ktd, Kssc, exciting current to be measured and it shall be less than the limits of error specified for Transient class CT.

For TPX and TPY :

$$\hat{I}_{al} \le \sqrt{2} \times I_{sr} \times K_{ssc} \times \hat{\varepsilon}$$

For TPZ :

$$\hat{I}_{al} \le \sqrt{2} \times I_{sr} \times K_{ssc} \times \left(\frac{K_{td}-1}{2\pi f_R \times T_S} + \hat{\varepsilon}_{ac}\right)$$

This error ensures the performance of transient class CT at Transient fault condition i.e it gives error at Kssc and Ktd times of rated primary current.

III. Secondary Loop Time Constant Ts

This test is required for TPY cores only. Secondary circuit of current transformer will have Magnetising inductance L_m , Winding resistance R_{ct} and burden resistance R_b.

$$T_S = \frac{L_m}{(R_{ct}+R_b)}$$

Magnetizing inductance L_m will be calculated by measuring the difference between peak value of exciting current at 70 % of saturation voltage and 20% of satuaration voltage

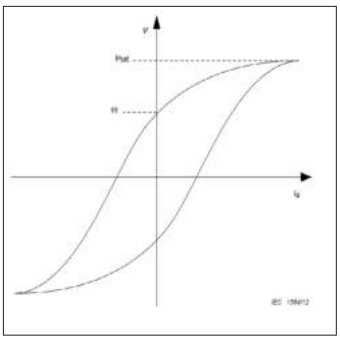
$$L_m = \frac{0{,}5 \times U_{sat} \times \sqrt{2}}{(\hat{i}_{70} - \hat{i}_{20}) \times 2\pi f'}$$

IV. Remanance Factor

It is the ratio of the remanent flux to the saturation flux in percentage. Remanent flux is the value of secondary linked flux which would remain in the core, 3 minute after

the interruption of fault current of sufficient magnitude, which causes saturation flux

Figure 4 shows the typical B-H Curve / Hysteresis loop of particular core. The integrated exciting voltage with the corresponding magnetising current i_e display a hysteresis loop and it shows the saturation flux ψsat . The secondary linked flux value at zero crossing of current is representing the remanent flux ψr



$$K_R = \frac{\psi_r}{\psi_{sat}}$$

Figure 4: B-H Curve

(V) Type Test – Error Limiting Condition by Direct Method

For TPX, TPY current Transformer to be demagnetized before the direct test. Two direct tests to be conducted at rated frequency and with rated secondary burden:

1) The rated primary short-circuit current at rated frequency is applied without any offset. The a.c. component of the instantaneous error is measured

2) To verify that the current transformer meets the accuracy requirements of the specified duty cycle, the rated primary short-circuit current at rated frequency is applied with the required offset at specified duty cycle.

Peak value of instantaneous error and peak alternating error shall be calculated from the difference between primary and secondary current by capturing the oscillogram during short circuit current test.

Results and Discussions

Test conducted on 170 kV, 750-1500-3000/1-1-1-1-1 A Current Transformer having 5 cores at CPRI. Out of 5 cores, Core 3,4,5 are TPX type core. As it is declared as Low leakage reactance type CT, Indirect test method followed.

Burden (VA) & Power factor	Type of error	Errorat percentage of rated current
		100
5.63 & UPF	% Current error	-0.005
	Phase displacement (min)	0.862

Table 6: Ratio Error and Phase Angle Error of Tpx Core

Current error and phase angle error at primary current was measured for 4th core, ratio of 3000/1 A and given in table 6. The secondary winding resistance at 75 deg. C was calculated, the difference of value to ambient was added with required burden resistance, Generally electronic current burden will be used as it requires smooth adjustment of burden values.

Transient error was calculated at 4th core 3000/1 A ratio with secondary limiting emf Eal : 589.1 V by Ktd:6 ; and Kssc: 11; Rb : 5 ohms and given in Table 7.

Secondary winding resistance corrected to 75 °C (Ω)	Exciting voltage- Eal (V)	Measured Exciting current- ial (mA)	Transient error (%)
3.9257	589.096	6.983	0.045

Table 7: Transient Error of Tpx Core

Test by Direct method will be challenging as it demands to have standard CT, required burden at Ktd times of short circuit current and achieving specified duty cycle. But it is required for High Leakage reactance type Current Transformer.

Conclusion

CPRI has the facility to conduct the test on Transient class Current Transformers. In India, Transient class Current Transformers are being used in very few places. Many of other countries like Australia, Brazil etc., using it. Transient class Current Transformers are very useful to have more reliability in network protection. ■

References

International Standard for Instrument Transformer- Additional Requirements of Current Transformers, IEC 61869-2:2012 and IEC 61869-1: 2023

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MINISTRY UPDATE

Budget Update

Find below Industry Relevant Highlights of the Interim Budget 2024-25

India's Interim Budget 2024, presented by Hon'ble Finance Minister Smt Nirmala Sitharaman, lays out the government's spending plans for the first half of the upcoming fiscal year. This summary delves into the key highlights across various sectors relevant to the electrical and electronic industry, offering insights for the readers of IEEMA Journal.

Strategy for 'Amrit Kaal'

Government will adopt economic policies that foster and sustain growth, facilitate inclusive and sustainable development, improve productivity, create opportunities for all, help them enhance their capabilities, and contribute to the generation of resources to power investments and fulfil aspirations.

Guided by the principle 'Reform, Perform, and Transform', the Government will take up next generation reforms, and build consensus with the states and stakeholders for effective implementation.

Government to ensure timely and adequate finances, relevant technologies and appropriate training for the MSMEs to grow and also compete globally. Orienting the regulatory environment to facilitate their growth will be an important element of this policy mix.

Government will facilitate sustaining high and more resource-efficient economic growth. This will work towards energy security in terms of availability, accessibility and affordability.

For meeting the investment needs our Government will prepare the financial sector in terms of size, capacity, skills and regulatory framework.

Aspirational Districts Programme

Government stands ready to assist the states in the faster development of aspirational districts and blocks, including the generation of ample economic opportunities.

Development of the East

Government will pay utmost attention to making the eastern region and its people a powerful driver of India's growth.

Rooftop Solarization and Muft Bijli

Through rooftop solarization, one crore households will be enabled to obtain up to 300 units of free electricity every month. The following benefits are expected:

Savings of up to fifteen to eighteen thousand rupees annually for households from free solar electricity and selling the surplus to the distribution companies.

Charging of Electric Vehicles

Entrepreneurship opportunities for a large number of vendors for supply and installation

Employment opportunities for the youth with technical skills in manufacturing, installation and maintenance

Research and Innovation

A corpus of INR 1 Lakh Cr will be established with a fifty-year interest-free loan. The corpus will provide long-term financing or refinancing with long tenors and low or nil interest rates. This will encourage the private sector to scale up research and innovation significantly in sunrise domains.

A new scheme will be launched for strengthening deep-tech technologies for defence purposes and expediting 'Atmanirbharta'.

Infrastructure

The outlay for the next year is being increased by 11.1% to eleven lakh, eleven thousand, one hundred and eleven crore rupees (INR 11,11,111 Cr). This would be 3.4% of the GDP.

Railways

Three major economic railway corridor programmes will be implemented. These are:

Energy, mineral and cement corridors

Port connectivity corridors

High-traffic density corridors

The projects have been identified under the PM Gati Shakti for enabling multi-modal connectivity. They will improve logistics efficiency and reduce costs.

Together with dedicated freight corridors, these three economic corridor programmes will accelerate our GDP growth and reduce logistic costs.

Forty thousand normal rail bogies will be converted to the Vande Bharat standards to enhance the safety, convenience and comfort of passengers.

Metro Rail and NaMo Bharat can be the catalyst for the required urban transformation. Expansion of these systems will be supported in large cities focusing on transit-oriented development.

Aviation

Number of airports has doubled to 149. The rollout of air connectivity to tier-two and tier-three cities under the UDAN 19 scheme has been widespread. Five hundred and seventeen new routes are carrying 1.3 Cr passengers.

Indian carriers have proactively placed orders for over 1000 new aircrafts.

Expansion of existing airports and development of new airports will continue expeditiously.

Green Energy

Towards meeting our commitment for 'net-zero' by 2070, the following measures will be taken.

Viability gap funding will be provided for harnessing offshore wind energy potential for an initial capacity of one giga-watt.

Coal gasification and liquefaction capacity of 100 MT will be set up by 2030. This will also help in reducing imports of natural gas, methanol, and ammonia.

Phased mandatory blending of Compressed Biogas (CBG) in Compressed Natural Gas (CNG) for transport and piped natural gas (PNG) for domestic purposes will be mandated.

Financial assistance will be provided for the procurement of biomass aggregation machinery to support collection.

Electric Vehicle

Government will expand and strengthen the e-vehicle ecosystem by supporting manufacturing and charging infrastructure.

Greater adoption of e-buses for public transport networks will be encouraged through payment security mechanisms.

Promoting Investments

The FDI inflow during 2014-23 was $596 Bn marking a golden era. That is twice the inflow during 2005-14.

For encouraging sustained foreign investment, we are negotiating bilateral investment treaties with our foreign partners, in the spirit of 'First Develop India'.

Reforms in the States for 'Viksit Bharat'

A provision of INR 75,000 Cr as a fifty-year interest free loan is proposed this year to support those milestone-linked reforms by the State Governments.

Societal Changes

The Government will form a high-powered committee for an extensive consideration of the challenges arising from fast population growth and demographic changes.

For the full speech, please refer: https://www.indiabudget.gov.in/doc/Budget_Speech.pdf

Cabinet approves Signing and Ratification of Bilateral Investment Treaty between India and United Arab Emirates

The Union Cabinet chaired by the Prime Minister, Shri Narendra Modi, today has given its approval for signing and ratification of Bilateral Investment Treaty between the Government of the Republic of India and the Government of the United Arab Emirates.

The Treaty is expected to improve the confidence of the investors, especially large investors, resulting in an increase in Foreign Investments and Overseas Direct Investment (ODI) opportunities and this may have a positive impact on employment generation.

The approval is expected to increase investments in India and is likely to help in realizing the goal of Atmanirbhar Bharat by encouraging domestic manufacturing, reducing import dependence, increasing exports etc.

12,146 public EV charging stations operational across the country

The Ministry of Heavy Industries (MHI) has been making consistent efforts for facilitating the promotion of electric vehicles in India. The FAME-II scheme inter-alia included financial support in the form of subsidy for setting up of Public Charging Infrastructure to instill confidence among the EV users.

Further, Ministry of Power has taken several initiatives to accelerate deployment of public Electric Vehicle (EV) charging infrastructure in the country. Details of the initiatives are as follows:

1. Guidelines & Standards for Charging Infrastructure for Electric vehicles issued in January, 2022 which has been amended on November, 2022 and April, 2023. The broad features of the above guidelines are as below:
   - i. Enabling owners of Electric Vehicles to charge their EVs at their residence/offices using their existing electricity connections.
   - ii Prescribing Revenue sharing model for provision of land at promotional rates for public charging stations.
   - iii. Providing electricity connection to Public Charging Station (PCS) within stipulated timelines.
   - iv. Prescribing single part EV tariff for public charging stations and shall not exceed Average Cost of Supply (ACoS) till 31.03.2025.
   - v. Specifies a ceiling of Rs 2.50 per unit and Rs 3.50 per unit of electricity used for slow AC charging of EVs at PCS during the solar and non-solar hours respectively. Additionally, a ceiling limit of Rs. 10/- per unit and Rs. 12/- per unit of electricity used for DC Fast charging of EVs at PCS during the solar and non-solar hours respectively has also been specified.
   - vi. Average cost of supply (ACoS) by DISCOMs to Public Charging Stations (PCSs) during solar hours shall have a rebate of 20% and a surcharge of 20% during all other times.
2. Green Energy Open Access Rules,2022 has been notified with the objective to further accelerate renewable energy adoption, ensuring access to affordable, reliable, sustainable and green energy for all.
3. Ministry of Power also Launched “GO ELECTRIC” Campaign in February, 2021, to create awareness on the benefits of Electric Vehicles (EV), EV Charging Infrastructure and electric cooking in India.

The details of charging stations commissioned under FAME India Scheme Phase-II, State-wise, as on 02.02.2024, are annexed as **ANNEXURE-I.**

As per the information received from Ministry of Power, **12,146** nos. of public EV charging stations are operational across the country, as on **02.02.2024**. The details of state wise operational public EV charging stations are at **ANNEXURE-II.**

As per the information received from NITI Aayog, charging infrastructure requirement depends upon the composition of Electric Vehicles, Running Patterns, Terrain & Geography, Urbanisation Pattern and the Technology of EVs and Charging Equipments. Since, all these factors are still evolving, there is no global

consensus on number of charging points required for a certain number of EVs. The requirement is considered dynamic and in the wide range of 1 Charging Point per 20 EVs to 1 Charging Point per 150 EVs, depending upon aforementioned factors.

ANNEXURE-I

The details of charging stations commissioned under FAME India Scheme Phase-II, State-wise, as on 02.02.2024

Sr. No.	State / Union Territory	No. of EV Charging Station
1	Delhi	21
2	Gujarat	53
3	Haryana	2
4	Karnataka	1
5	Kerala	30
6	Maharashtra	13
7	Meghalaya	1
8	Tamil Nadu	13
9	Uttar Pradesh	11
10	West Bengal	3
	Total	148

ANNEXURE-II

State wise operational public EV charging stations as on 02.02.2024

Sr. No.	State Name	No. of Operational PCS
1	Andaman & Nicobar	3
2	Andhra Pradesh	327
3	Arunachal Pradesh	9
4	Assam	86
5	Bihar	124
6	Chandigarh	12
7	Chhattisgarh	149
8	D&D and DNH	1
9	Delhi	1886
10	Goa	113
11	Gujarat	476
12	Haryana	377
13	Himachal Pradesh	44
14	Jammu & Kashmir	47
15	**Jharkhand**	**135**
16	Karnataka	1041
17	Kerala	852
18	Lakshadweep	1
19	Madhya Pradesh	341
20	Maharashtra	3079
21	Manipur	17
22	Meghalaya	21
23	Nagaland	6
24	Odisha	198
25	Pondicherry	23
26	Punjab	158
27	Rajasthan	500
28	Sikkim	2
29	Tamil Nadu	643
30	Telangana	481
31	Tripura	18
32	Uttar Pradesh	582
33	Uttarakhand	76
34	West Bengal	318
Total PCS		**12,146**

This information was given by the Minister of State for Heavy Industries, Shri Krishan Pal Gurjar, in a written reply in Lok Sabha today 06 FEB 2024, said PIB Delhi.

Parivesh 2.0 portal to be default platform for all environment clearances

The Ministry of Environment, Forest and Climate Change (MoEFCC) is set to transition all pending proposals awaiting environment and forest clearances to its newly upgraded Parivesh 2.0 portal, making it the primary online platform for such processes. The government introduced Parivesh 2.0 (Pro-Active and Responsive Facilitation by Interactive and Virtuous Environmental Single-window Hub) to enhance transparency in these procedures.

This updated version incorporates various features, including the mapping of employees to project proposals, integrated GIS clearance, and the integration of a payment gateway, among other enhancements. The decision to migrate all proposals to the new portal follows the technical limitations of the previous Parivesh 1.0, which resulted in over 12,000 proposals seeking forest clearance under the Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980, being stalled.

Govt. of India working in mission mode to develop robust quality ecosystem in India

DPIIT introduces Quality Control Orders for critical products impacting consumer safety like Electrical Accessories, Laboratory Glassware, Hinges, Copper Products and Door Fittings

The Government of India has been working in mission mode to develop a robust quality ecosystem in India, the hallmark being the accent on superior and safety compliant products to take the economy to higher echelons of growth and development. As part of this endeavor, Quality Control Orders (QCOs) are being rapidly introduced by the Department for Promotion of Industry and Internal Trade (DPIIT) for critical products impacting consumer safety like Electrical Accessories, Laboratory Glassware, Hinges, Copper Products and Door Fittings. These QCOs have the right ingredients for strengthening the quality standards of 'Made in India' products, without compromising on the range of goods being made available to the Indian consumer. This focused approach for restricting the circulation of sub-standard products shall be a crucial driver for establishing India as a manufacturing powerhouse synonymous with best-in-class quality products.

With a view to establish India as a global leader in providing superior quality and safety compliant products, a plethora of reforms have been undertaken for ensuring that the 'Made in India' brand resonates with internationally recognized brands that offer premium quality. The guiding force behind this reform centric approach is the vision of the Prime Minister, Shri Narendra Modi, that "If there's a "Made in India" product on any table in the world, the world should have confidence that there is nothing better than this. This will be ultimate. Be it our produce, our services, our words, our institutions, or our decision-making processes, everything will be supreme. Only then can we carry forward the essence of excellence."

With the advent of technology, customers are becoming increasingly particular about safety standard related aspects such as the performance parameters, durability, and dependency of the goods. It has become a common practice to check product quality reviews before making a purchase. Maintaining a balance between product quality, price, and innovation in terms of manufacturing strategy is, therefore, of great essence.

To enforce strong quality standards for enhancing consumer product safety, there is unprecedented policy focus on implementation of Quality Control Orders (QCOs) which is in line with the provisions of the Technical Barriers to Trade (TBT) Agreement of the World Trade Organisation (WTO). The Agreement recognizes that countries can take necessary quality control measures to maintain the quality of its exports, protect human, animal or plant life and safeguard the environment.

Implementation of QCOs will help India acquire a greater share of the global manufacturing market while enforcing strong quality standards to enhance consumer product safety, prevent circulation of sub-standard products in the Indian market, attract investments and prevent loss of life or any accidents. The imposition of QCOs shall help detect any kind of product defect and malfunction in the initial stage which will be beneficial for both the manufacturers and consumers by way of rationalized costs.

The Bureau of Indian Standards (BIS) which serves as the National Standard Body of India, is harmonized to a great extent with the relevant International Standards as laid down by the International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC). It is involved in standardization, marking and quality certification of goods and conformity assessment with the underlying objective of providing safe, reliable, and quality goods.

While the Standards issued by the BIS for any product or process are for voluntary compliance, those notified by the Central Government through issuance of Technical Regulations (TR) primarily through Quality Control Order (QCO) under Scheme-I and Compulsory Registration Order (CRO) under Scheme-II are mandatory in nature.

Factoring in the importance of inculcating the safety aspect, DPIIT has focused on developing a robust quality ecosystem for products under its purview to provide good quality products and promoting exports of Indian products. This has led to the issuance of more than 60 new QCOs covering approximately 300 product standards, which have not only ensured that reliable products are being made available to the consumers but also improved the manufacturing quality standards, thereby enhancing brand and value of 'Made in India' products.

While implementation of QCOs is being introduced for various product categories, there is increased focus on products, the violation of standards for which, can pose threat to safety of consumers by causing severe harms and injuries as they are widely present in households. Therefore, QCOs have been recently notified for 'Steel Wires/ Strands, Nylon Wire Ropes and Wire Mesh', 'Hinges', 'Safes, Safe Deposits Locker Cabinets and Key locks', 'Laboratory Glassware' and 'Electrical Accessories', among many others. All of the aforementioned products have great usage and applicability in everyday activities, highlighting the criticality of having well-defined standards for them to avoid any unforeseen incidents.

The implementation of QCOs is an extensive exercise which encompasses DPIIT's continuous engagement with relevant stakeholders for identification of products for which QCOs could be issued. Post the identification, BIS is consulted on various aspects including, Indian Standards, Suitable Conformity Assessment Scheme, availability of BIS test labs or BIS recognized Test Labs and Product Manual. This is followed by the preparation of draft QCO, on which consultations are held with the industry and relevant stakeholders.

Post the incorporation of comments from the industry, the draft QCOs are approved by the Union Minister of Commerce and Industry followed by legal vetting by Department of Legislative Affairs. Subsequently, the QCOs are uploaded on the World Trade Organisation (WTO) website for 60 days, inviting comments from WTO member countries. These comments from member countries are examined and reviewed, after which the final approval is sought from the relevant Central Government authority for notifying the QCO. To facilitate smooth implementation of QCOs for Micro and Small Industries several carveouts and relaxations are envisaged in terms of relaxation of timelines.

QCOs are implemented by BIS through Grant of License and/or Certificate of Conformity. With the notification of QCO, manufacturing, storing and sale of non-BIS certified products are prohibited. The violation of the provision of the BIS Act can attract a penalty up to 2 years of imprisonment or with fine of at least Rs 2 lakh for the first offence which increases to Rs 5 lakh minimum for the second and subsequent offences.

In the spirit of strong industry-government partnership for developing a robust quality ecosystem in India, DPIIT conducts regular consultations with industry members, sectoral associations, and relevant stakeholders to ensure that the QCOs being issued are attuned with their needs and requirements. Further, after the notification, several initiatives are undertaken about the newly implemented QCOs to develop awareness and sense of ownership in industry at a pan-India level. These extensive consultations ensure that the views, feedback, and technical inputs are taken into consideration of the authorities for smooth implementation.

The safety and well-being of the consumers is of paramount importance for which continued efforts shall be made to introduce QCOs for products. Adherence to safety standards will play a pivotal role in controlling the production and distribution of substandard products which will be a major step in enhancing the value of 'Made in India' products. The key for India is to create awareness among the manufacturers and service providers across the supply chain about quality. As there is reimagined focus on quality to avoid accidents, QCOs have become an integral element to foster consumer trust.

Going forward, QCOs shall therefore, play a pivotal role in enhancing the credibility and value of Indian products while promoting homegrown brands and minimizing inefficiency of any nature. It is indeed imperative to balance between 'Zero Defect' that is delivering at par with the global standards and 'Zero Effect' that is ensuring that there are no negative environmental implications or compromise on sustainability.

As emphasized by the Prime Minister, it is the opportune moment to work with the ethos of 'Zero Effect, Zero Defect' and with 'Vocal for Local' reverberating in every household, it is time to ensure that our products meet global standards, especially in terms of safety. The initiative on QCOs shall help develop world-class products of superior quality in India, thereby fulfilling the Prime Minister's vision of creating an 'Aatmanirbhar Bharat'.

NTPC and Oil India Limited's Numaligarh Refinery Limited to build strategic partnership in Green Chemicals and Green Projects

NTPC Limited, India's largest integrated power utility, has signed a non-binding MoU with Numaligarh Refinery Limited (NRL), for partnership opportunities in the proposed bamboo-based Bio-Refinery at NTPC Bongaigaon and other green projects. NRL is a subsidiary of Oil India Limited, which is engaged in the business of refining and marketing of petroleum products.

Through this MoU, the two Central Public Sector Enterprises intend to enhance their footprint in green chemicals and foray into sustainable solutions to advance the efforts towards achieving the nation's Net-Zero targets and be partners in the development of North Eastern Region.

The MoU was signed on 30th January, 2024, in the presence of CMD NTPC, Shri Gurdeep Singh; CMD OIL & Chairman NRL Dr Ranjit Rath; and MD NRL, Shri Bhaskar Jyoti Phukan.

NTPC is committed to achieve 60 GW of Renewable Energy capacity by 2032 and be a major player in Green Hydrogen and Energy Storage domain. The company is taking up several initiatives towards decarbonization such as Green Hydrogen, Biofuels, Carbon Capture & Hydrogen Mobility.

PM Inaugurates India Energy Week 2024

The Prime Minister, Shri Narendra Modi inaugurated India Energy Week 2024 in Goa today. India Energy Week 2024 is India's largest and only all-encompassing energy exhibition and conference, bringing together the entire energy value chain to catalyze India's energy transition goals. The Prime Minister also held a roundtable with Global oil & gas CEOs and experts.

Addressing the gathering, the Prime Minister welcomed everyone to the second edition of India Energy Week. Expressing delight that the event is taking place in the energetic state of Goa, the Prime Minister said that it is known for its spirit of hospitality and the natural beauty and culture of the place leaves a profound impact on tourists from around the world. "Goa is touching new heights of development", the Prime Minister said, underlining that it is the perfect destination for a discussion on a sustainable future and sensitivity towards the environment. He expressed confidence that the foreign guests who have gathered in Goa for India Energy Week 2024 will take along a lifetime memory of the state.

"The India Energy Week event is not just India's event but a reflection of 'India with the world and India for the world' sentiment"

Noting that India Energy Week 2024 is taking place at a significant time period when India's GDP rate crossed 7.5 percent in the first six months of the financial year, the Prime Minister said that the growth rate is higher than the global growth estimate making India the fastest growing economy in the world. He also mentioned the International Monetary Fund's prediction of similar growth trends in the future. "Economic experts around the world believe that India will soon become the 3rd largest economy in the world", Shri Modi said and emphasized the expanding scope of the energy sector in India's growth story.

"We are giving momentum to rural economy through 'Waste to Wealth Management"

The Prime Minister noted that India is the world's third largest energy, oil and LPG consumer. Furthermore, he said India is the fourth largest LNG importer and refiner along with the fourth largest automobile market. He also underlined rising demand of EV in the country. He also talked about the estimates of doubling of the nation's energy demand by 2045. The Prime Minister elaborated India's plan to meet this growing demand. Highlighting

the efforts to ensure affordable fuel, the Prime Minister said that despite adverse global factors, India is among the few nations where petrol prices have come down and 100 per cent electricity coverage was achieved by electrifying crores of houses. "India is not just meeting its needs but is also determining the global direction", the Prime Minister added.

Explaining the unprecedented infrastructure push, the Prime Minister mentioned 11 lakh crore rupees that the recent Budget pledged for infrastructure, a big part of which will go to the energy sector. This amount will create assets in railways, roadways, waterways, airways or housing which will need energy leading to India's efforts to expand its energy capacity. He noted rising production of domestic gas due to the government's reforms and the country is making efforts to take the percentage of gas in the primary energy mix from 6 to 15 percent. This will see an investment of about 67 billion dollars in the next 5-6 years, he informed.

Throwing light on the circular economy and concept of reuse being a part of India's ancient traditions, the Prime Minister noted that the same is applicable for the energy sector. He said that this belief is symbolized by the Global BioFuel Alliance which brings together governments, organizations and industries from across the world on a single platform. Initiated during the G20 Summit held in India, the Prime Minister highlighted the holistic support received by the Alliance and informed about 22 nations and 12 international organizations coming onboard to encourage the use of biofuels in the world, while also creating economic opportunities worth $500 billion.

Highlighting India's progress in the biofuel sector, Shri Modi informed about India's rising adoption rate. He said that ethanol blending witnessed a significant rise

from 1.5 percent in 2014 to 12 percent in 2023 leading to a reduction in carbon emissions by about 42 million metric tons. “Government has set a target of 20 percent ethanol blending in petrol by 2025”, he said. Recalling the initiation of 20 percent ethanol blending in more than 80 retail outlets during India Energy Week last year, PM Modi informed that the number of outlets has now increased to 9,000.

Outlining the government’s commitment to transforming rural economies through the Waste to Wealth Management model, the Prime Minister highlighted the government’s efforts towards sustainable development, Prime Minister Modi announced “we are working towards the installation of 5000 Compressed Biogas Plants in India.” Addressing global environmental concerns, Prime Minister Modi remarked, “despite being home to 17% of the world’s population, India’s Carbon Emission Share is only 4%.” He added, “We are committed to further improving our Energy Mix by focusing on the development of environmentally sensitive energy sources.” The Prime Minister reiterated India’s goal to achieve Net Zero Emissions by 2070.

Prime Minister Modi noted, “Today, India ranks fourth in the world in Renewable Energy Installed Capacity.” 40 percent of India’s installed capacity comes from non-fossil fuels. Highlighting the nation’s progress in solar energy, Prime Minister Modi stated, “In the past decade, India’s Solar Energy Installed Capacity has grown by more than 20 times.” He added, “The campaign to connect with Solar Energy is gaining momentum in India.”

Prime Minister Modi noted that the launch of a major mission aimed at installing Solar Rooftop Panels in one crore homes across India, will not only make one crore families self-reliant in the energy sector but also establish mechanisms to deliver excess electricity generated directly to the grid. Prime Minister Modi emphasized the transformative impact of these initiatives. “There is a great potential for investment in the entire Solar Value Chain”, he added.

Touching upon India’s stride in the green hydrogen sector, the Prime Minister highlighted the National Green Hydrogen Mission which will pave the way for India becoming a center of hydrogen production and export. He expressed confidence that India’s green energy sector can make both investors and industries a sure shot winner.

The India Energy Week event reflects India’s commitment to global cooperation in the energy sector. Prime Minister Modi remarked, “The India Energy Week event is not just India’s event but a reflection of ‘India with the world and India for the world’ sentiment.”

He encouraged collaboration and knowledge sharing in sustainable energy development, stating, “Let us learn from each other, collaborate on cutting-edge technologies, and explore avenues for sustainable energy development.”

In conclusion, Prime Minister Modi expressed optimism about building a prosperous future that prioritizes environmental conservation. He stated, “Together, we can build a future that is prosperous and environmentally sustainable.”

Governor of Goa, Shri P S Sreedharan Pillai, Chief Minister of Goa, Shri Pramod Sawant, Union Minister for Petroleum and Natural Gas, Shri Hardeep Singh Puri and Union Minister of State for Petroleum, Oil and Natural Gas, Shri Rameswar Teli were present on the occasion among others.

Background

IEW INDIA ENERGY WEEK
6-9 February 2024 | Goa | India

Achieving Aatmanirbharta in energy requirements has been a key focus area of the Prime Minister. In yet another step in this direction, India Energy Week 2024 is being held from 6 – 9 February in Goa and is India’s largest and only all-encompassing energy exhibition and conference, bringing together the entire energy value chain, and will serve as a catalyst for India’s energy transition goals. The Prime Minister also held a roundtable with Global oil & gas CEOs and experts.

Encouraging and fostering startups and integrating them into the energy value chain will be an important focus for India Energy Week 2024. It is expected to witness the participation of around 17 Energy ministers from different countries, 35,000+ attendees and more than 900 exhibitors. It will have six dedicated country pavilions - Canada, Germany, Netherlands, Russia, the UK and the USA. A special Make in India Pavilion is also being organized to showcase innovative solutions which Indian MSMEs are spearheading in the energy sector.

Images link: Press Information Bureau (pib.gov.in)

Draft Revised Guidelines for Retirement & Up-rating / De-rating of Generating Unit(s)

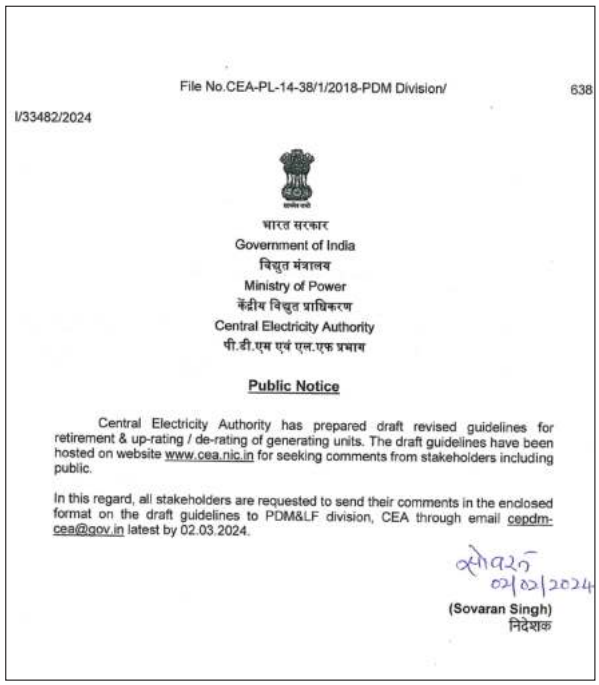
1. Background

Improving efficiency of thermal power stations is one of the effective method to reduce CO2 emissions, which is being achieved by various schemes introduced by the Government of India such as adopting super critical/ultra-super critical technology for coal-based generation. Also efficiency improvement measures through Renovation and Modernization (R&M) of old and inefficient units is being undertaken and units in which R&M is not possible are being considered for retirement.

The Central Electricity Authority (CEA) is discharging the work entrusted for Retirement and De-rating / Up-rating of generating units in the Country and also to prepare guidelines thereof. The Standing Committee under the chairmanship of Member (Planning), CEA examines the proposals received from the generating companies/utilities for Retirement or Up-rating or De-rating, as the case may be, of generating units and give its recommendation for the Retirement/ Up-rating/ De-rating of Generating Units.

2. Scope and Applicability:

The revised guidelines shall be applicable to the conventional sources of electricity generation i.e. Coal/ Lignite, Diesel, Gas based power plants and Large Hydroelectric plants (above 25 MW).



File No.CEA-PL-14-38/1/2018-PDM Division/ 638
I/33482/2024

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
केंद्रीय विद्युत प्राधिकरण
Central Electricity Authority
पी.डी.एम एवं एल.एफ प्रभाग

Public Notice

Central Electricity Authority has prepared draft revised guidelines for retirement & up-rating / de-rating of generating units. The draft guidelines have been hosted on website www.cea.nic.in for seeking comments from stakeholders including public.

In this regard, all stakeholders are requested to send their comments in the enclosed format on the draft guidelines to PDM&LF division, CEA through email cepdm-cea@gov.in latest by 02.03.2024.

सोवरन
02/02/2024
(Sovaran Singh)
निदेशक

3. Guidelines:

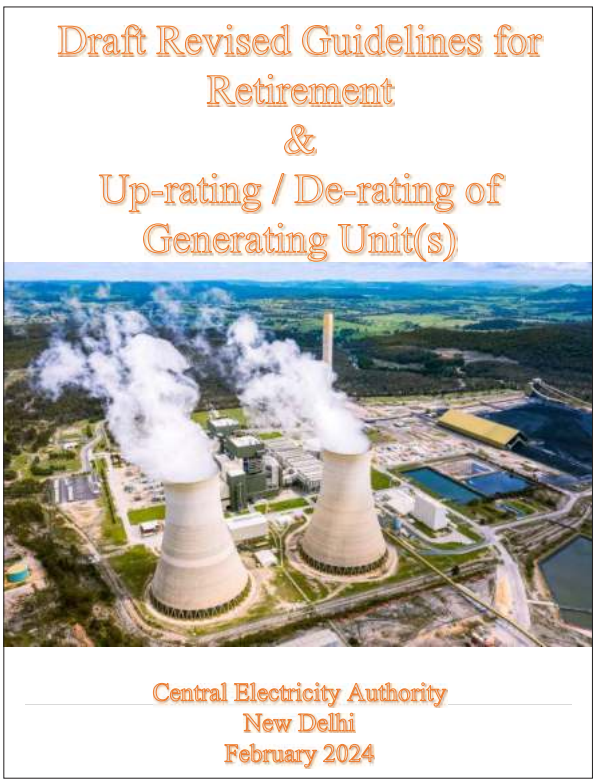
3.1 Retirement of Generating Unit(s):

(a) Case I: When generating company / Utility has decided to retire its generating unit(s) on its own

(i) If the generating company / utility has decided to retire its generating unit (s), the generating company / utility shall request CEA to incorporate the same in the database of installed generating capacity of the country along with the a certified copy of the Resolution of Board of Directors in which the decision has been taken to retire the generating unit (s).

(ii) The Standing Committee shall examine the proposals for Retirement of generating unit (s) as per the extant relevant provisions in the policies / rules / regulations / guidelines / directions of the Central Government.

(iii) In case, the decision of the generating companies / utilities with regard to the retirements of the generating unit (s) is against any of the provisions in the policies / rules / regulations / guidelines / directions of the Central Government, then the Standing Committee may not



agree with the decision of the generating companies / utilities and convey its decision to the generating companies / utilities / State Governments accordingly.

(iv) In case, the standing committee decides to retire the generating unit (s) then, the database of installed capacity of CEA is updated and stakeholders are informed, accordingly.

(v) The decisions of the Standing Committee mentioned at para (iii) and (iv) above, shall be subject to the approval of the Chairperson, CEA.

(vi) The proposal shall be examined within one month subject to the submission of all relevant data / required information by the generating company / utility to CEA.

(b) Case II: When generating company / Utility seeks advice of CEA for retirement of its generating Unit(s)

(i) The section 73 of the Electricity Act 2003, provides for the functions and duties of CEA. The clause (m) of section 73 of the Electricity Act 2003, provides as under: "(m) advise any State Government, licensees or the generating companies on such matters which shall enable them to operate and maintain the electricity system under their ownership or control in an improved manner and where necessary, in co-ordination with any other Government, licensee or the generating company owning or having the control of another electricity system" Accordingly, CEA may advise any State Governments, licensees or generating companies (including private companies).

(ii) If a generating company / utility wants to seek advice of CEA for retirement of their generating unit (s), the generating company / utility shall submit a proposal to the Chairperson, CEA along with the requisite data / information for generating unit(s) and their associated transmission system in the prescribed format attached at Annexure-I of these guidelines.

(iii) The proposal of retirement of generating unit(s) shall be put up to the Standing Committee. The proposal shall be examined by the Standing Committee through various Divisions in CEA as per the relevant policies / regulations / guidelines / standards etc.

(iv) After completing the examination of the proposal and interaction with the generating company, including any field/site visits, final decision of the Standing Committee shall be put up to Chairperson, CEA for approval. After the approval, Stakeholders would be informed, accordingly.

(v) The proposal shall be examined within three months subject to the submission of all relevant data / required information by the generating company / utility to CEA.

(vi) In case, there is an adverse impact on the grid security due to retirement of the generating unit (s), the remedial measures shall be suggested by the Standing Committee to mitigate the adverse impact on the grid.

3.2 De-rating or Up-rating of Generating Unit(s):

(a) Case I: When generating company / utility has decided to de-rate or up-rate generating unit(s) by its own:

(i) In case, the generating company / utility has decided to de-rate or up-rate the generating unit(s), as the case may be, shall request CEA to incorporate the same in the database of installed generating capacity of the country along with the following documents:

(a) A certified copy of the Resolution of Board of Directors in which the decision has been taken to de-rate / up-rate the generating unit (s),

(b) In case of uprating of thermal generating unit (s), utility shall provide a Certificate from RLDC/ SLDC to the effect that the generating unit (s) has been operated for the continuous trial run for a period of 24 hours at its up-rated capacity.

(c) In case of uprating of hydro generating unit, utility shall furnish a Certificate from RLDC/SLDC to the effect that the generating unit (s) has been operated for the continuous trial run for a period of 12 hours at its up-rated capacity. However, if it is not possible to demonstrate the up-rated capacity due to insufficient reservoir or pond level or insufficient inflow, the generating unit (s) may be up-rated subject to the condition

that the same shall be demonstrated by the generating unit immediately when sufficient water is available after it's up-rating.

(ii) The Standing Committee shall examine the proposal received from generating company and if any other data/ information is required, then the same shall be conveyed to the generating company.

(iii) The proposal of de-rating or up-rating of generating unit(s) shall be put up to the Standing Committee. The proposal shall be examined by the Standing Committee through various Divisions in CEA as per the relevant policies / regulations / guidelines / standards etc.

(iv) After completing the examination of the proposal and interaction with the generating company, including any field/site visits, final decision of the Standing Committee shall be put up to Chairperson, CEA for approval. After the approval, Stakeholders would be informed, accordingly.

(v) The proposal of de-rating or up-rating of generating unit(s) shall be examined within one month subject to the submission of all relevant data / information by the generating company / utility to CEA.

(b) Case II: When generating company / Utility seeks advice of CEA for De-rating/Up-rating of Unit(s)

(i) The section 73 of the Electricity Act 2003, provides for the functions and duties of CEA. The clause (m) of section 73 of the Electricity Act 2003, provides as under: "(m) advise any State Government, licensees or the generating companies on such matters which shall enable them to operate and maintain the electricity system under their ownership or control in an improved manner and where necessary, in co-ordination with any other Government, licensee or the generating company owning or having the control of another electricity system" Accordingly, CEA may advise any State Governments, licensees or generating companies (including private companies).

(ii) If a generating company / utility wants to seek advice of CEA for de-rating / up-rating of generating unit(s), the generating company / utility shall submit a proposal to the Chairperson, CEA along with the requisite data / information for generating unit(s) and their associated transmission system in the prescribed format attached at Annexure-I of these guidelines.

(iii) The proposal for de-rating / up-rating of generating unit(s) shall be put up to the Standing Committee. The proposal shall be examined by the Standing Committee through various Divisions in CEA as per the relevant policies / regulations / guidelines / standards etc.

(iv) After completing the examination of the proposal and interaction with the generating company, including any field/site visits, final decision of the Standing Committee shall be put up to Chairperson, CEA for approval. After the approval, Stakeholders would be informed, accordingly.

(v) The proposal shall be examined within three months subject to the submission of all relevant data / information by the generating company / utility to CEA.

(vi) In case, there is an adverse impact on the grid security due to de-rating / up-rating of generating unit(s), the remedial measures shall be suggested by the Standing Committee to mitigate the adverse impact on the grid.

3.3 General Guidelines applicable for Retirement or Up-rating or De-rating of Generating Unit(s), as the case may be:

(i) The proposal of uprating / de-rating of generating units due to reasons such as Renovation & Modernization, design modification, environmental constraints and other relevant technical/economic issues etc. may also be considered for further processing by Standing Committee, if it is required so.

(ii) In case of de-rating of a generating unit (s), the de-rated generating unit shall not be allowed to up-rate till next 5 years from the date of de-rating of the unit.

(iii) As per CEA advisory dated 20.01.2023 regarding R&M and retirement of thermal power stations, it is advised not to retire any thermal units till the year 2030.

(iv) Registration ID of the generating unit intended to be retired or up-rated or de-rated of the CEA's e-gen portal is must before sending the request / proposal to CEA for retirement or uprating or de-rating.

(v) The methodology of examination for retirement / de-rating / up-rating of generating unit(s) is enclosed at Annexure-II of these guidelines and shall be followed in examination of all cases either retirement or up-rating or de-rating. (vi) CEA may seek additional information data (if any) needed for retirement / de-rating / up-rating of generating unit(s).

(vii) If needed, the officers of CEA may undertake site visit of the generating unit(s) being considered for retirement / de-rating / up-rating of generating unit(s).

(viii) The final decision on retirement / de-rating / up-rating of generating unit(s) shall be approved by the Chairperson, CEA on recommendation of the Standing Committee.

(ix) The advice of CEA on retirement / de-rating / up-rating of generating unit(s) being recommendatory in nature, and therefore, is not binding on the generating company, which may take its own decision as deemed appropriate, keeping in view the security of grid.

(x) Formats for submitting input data by generating company for retirement / de-rating / up-rating of generating unit(s) may be revised by the Standing Committee, as and when required, to reduce the time taken in the processing of the proposals for ease of doing business.

(xi) The Power Data Management and Load Forecasting Division (PDM&LF) of CEA shall be the Nodal Division for processing of the proposals for retirement / de-rating / up-rating of generating unit(s).

(xii) The final decision of the CEA with regard to retirement / de-rating / up-rating of generating unit(s) shall be issued by Secretary, CEA, to concerned generating company / utility and shall also be intimated to all stakeholders. (xiii) The generating unit(s) shall comply with all applicable Rules, Regulations, and Technical Standards for their retirement / up-rating / de-rating.

(xiv) The up-rating / de-rating of Hydro units shall meet the safety norms as mandated under section 8(2) (b) of the Electricity Act 2003 which provides that "the proposed scheme meets the norms regarding dam design and safety." ■

Advertorial

Meco "Vehicle Battery System Meter With Printer" Model Vbsm6246p

MECO Model VBSM6246P Vehicle Battery System Meter with Printer for testing of 12V and 24V Lead-acid storage vehicle batteries during the process of Vehicle Start Up, Charging and Electrical Loading. This meter is designed to be used with only 4 buttons on it which makes it easier to operate. It provides the result to the user on large LCD screen with backlight, also hints by sound while testing and generate thermally printed report of battery State of Health for future reference and records. This meter is provided with easy operation i.e. "▲▼" button are used to change mode, test function and ENTER for selection and ESC to return.

FEATURES:

This meter has 4 test methods as follow:

Function 1: Battery Status Test like CCA, Internal Resistance and DC Voltage)

Function 2: Engine Activation Load Test

Function 3: Max. Load Test

Function 4: Charging System Test

Thermally Printed report of Battery State Of Health Diagnose Battery Health as per CCA / IEC / EN / DIN standards

Featured with Loose Lead Detection, Reverse Polarity Protection and Over Load Protection for operators' safety with Safety standard CAT III 600V.

This tester is the best tool for battery sales, vehicle repair and condition check of all kinds of lead-acid batteries.

INDEX TO ADVERTISERS

Product Launches @ Buildelec Intellect Distribuelec 2024

Find below a basic profile and listing of products that were launched by eight companies at BUILDELEC INTELLECT DISTRIBUELEC 2024

C & S ELECTRIC

Arc Pro

Arc Pro (Arc Protection relay) monitors the arc phenomenon in the circuit and takes measures instantaneously when the arc is found in the system to protect the LV/MV electrical equipment and personnel. The purpose of the protection relay is to detect arc, ideally during its initial stage and to either eliminate or significantly reduce damage to personnel and/or equipment. We are offering the Live demonstration of the same in our Panels.

C&S Electric make Arc Protection relays trigger Instant tripping with trip time ≤2 msec which is the fastest among the available solutions at present. This is C&S indigenous design that comes with LCD display, Fault logs storing facility and keypad for settings of product.

Track Busway Modular Technology

Track Busway being a modular hot swappable technology majorly used in data centers for server room power distribution to racks. It ranges from 250A -1000A catering all colo, edge to hyperscaler data centers. It improves uptime facility & gives no downtime, more flexible & unique solution. Advantages include, Hot Swappable; No Downtime; Easy to Modify; BMS Integrated; Online Plug & Play.

RCBO

RCBO helps with protection against overload, short circuit and Earth Leakage. The range offered is up to 6A~ 63A, 2P & 4P.

Smart Switches

A range of Wi-Fi enabled Smart Touch switches for modern homes and retrofit solutions for existing conventional homes to convert them in smart homes. The smart solutions are aimed to give home automation solutions to customers.

The Wi-Fi enabled technology helps customers to operate from remote locations. The retrofit solutions are readymade solutions for converting conventional installation into smart installations.

ELMEASURE

EG100

IoT enabled Micro-processor based Intelligent Circuit breaker Module

EG100 Intelligent Protection Unit—an innovation for circuit breakers, offering comprehensive protection features. Effortlessly upgrade standard breakers to smart solutions with real-time monitoring via Elmeasure IoT Cloud. Enjoy a complimentary 12-month subscription for enhanced protection. Safeguard your system, promote health, and reduce maintenance time with EG100.

The product offers comprehensive protection in that EG100 offers under-voltage, over-voltage, phase sequence, overload, single phasing, short circuit, and earth fault protection. It has intelligent upgrade wherein transforms standard circuit breakers into intelligent ones, adding an extra layer of protection. It also has Real-time Monitoring where the monitor breaker status, voltage, current, power, and energy in real-time through Elmeasure IoT Cloud. We offer a 12-Month IoT Cloud Subscription where you can enjoy

a complimentary 12-month subscription for enhanced protection and proactive maintenance. There is also System Optimization: Safeguard your electrical circuit, promote system health, and reduce maintenance time. It has operational efficiency to enhance overall system performance with proactive monitoring and timely insights. It is our innovation to stay ahead with cutting-edge technology for improved electrical infrastructure management.

STROME ENERGIE

SVC

Passive Solution to Control Leading reactive Power

Perfectly Controlling Leading Power Factor Through Shunt Reactors

Smart APFC Panels

APFC Panels with single phase capacitors for phase wise compensation. Achieving accurate power factor with compensating per phase requirements is a key advantage.

MEGGER

MS5000

Smart Grid Sensor is an online wireless system for overhead medium voltage distribution and sub-transmission lines that complements distribution management systems (DMS) and provides online information about faults, weak spots, and grid operations. Reduces the duration and frequency of outages and thus helps to improve SAIDI and SAIFI. Real-time data tracking with theft details. Specialised algorithm to detect high impedance and broken conductor faults. Analyse and classify fault information and periodic measurements in the grid level. Advantage includes fast and easy installation for independent operation with built in cellular base station.

Megger STX40

Megger STX40: World's most advanced complete toolbox for power cable fault location and only Fully Automatic system in the range.

Advantages include Integrated Powerful TDR, Integrated Insulation tester; True Inductive Arc Reflection Multi-trace; High Frequency Burner for fault conditioning; Sheath Testing and fault pinpointing facility; Current Impulse and Decay Method; Outdoor application - Trolley mounted, IP protection, Portable.

MOTWANE

MTAND

This set includes Bridge Model: MTAND & HV Supply model: HLS12A, Laptop based & necessary cables & very flexible, user friendly Visual C++ windows-based Software. The use of Laptop & Windows based software makes the system more flexible easy to handle & accurate Data can be stored, Retrieved and analysed at site.

Temp correction for the tan delta of object is automatically done as per IEC.

Coloured Screen analysis & graphical plotting of Tan Vs Voltage, Tan d Vs Time Complied IEC 61010, ASTM D999, EMI/EMC-EN-61326, IEC61000-4-3.

Suitable for measuring C & Tan for generators, transformers, bushings, circuit breakers, cables, motors at various test voltages up to 12KV.

Product strengths include automatic measurement of capacitance & Tan as per the test plan by auto-

balancing, No need of manual balancing. Automatic voltage setting through software. Indication of Leakage current. Data logging with graph of voltage vs Tan to know the tand gradient & data analysis for comparison with old results / manufacturer's data. As per IEC Temperature correction for Tan @ 200 C. Executes all the test modes/voltage automatically once fed. On site printout. Automatic interference suppression suitable for extraneous conditions in 400KV switchyard under heavy induction. More than 10000 Results Data-storage and built in Temperature and Humidity sensor.

Very Low Frequency HV Generator – MTVLF

The MTVLF Series combines modern advanced digital variable frequency technology and microcomputer control together, therefore, it can realize the fully automatic voltage boost, stepdown, measurement and protection as well as the manual intervention in the process of automatic voltage boost. The full electronic design ensures the small size and light weight. The big LCD screen ensures the clear and visual display and can display the output wave form. The printer outputs test reports.

Displaying information of output current voltage and waveform with high accuracy.

Overvoltage protection: if the set limit is exceeded the device will automatically shut down in less than 20 ms. Overvoltage protection: if the current setpoint is exceeded on low voltage side, the device will automatically shut down in less than 20ms. Protective resistor in the design of the high voltage output of the voltage amplifier, which eliminates the need for an external protective resistor.

Motwane Transformer Testing Bench – MTRF

The Transformer Test Bench is a comprehensive system designed for evaluating the performance and integrity of transformers, ensuring their reliability in power distribution systems. This advanced testing setup incorporates essential tools such as the Insulation Resistance Tester (5KPI), Transformer Turns Ratio Meter (XTRM), Transformer Winding Resistance Meter (XWRM), and Tan Delta Tester (MTAND), collectively offering a thorough assessment of transformer health.

The Insulation Resistance Tester, with a capability of measuring up to 5 kilovolts. The Transformer Turns Ratio Meter is employed to determine the turns ratio between the primary and secondary windings. The Transformer Winding Resistance Meter facilitates the assessment of winding resistance, a critical parameter for detecting issues like loose connections or damaged windings. The Tan Delta Tester evaluates the dielectric losses within the transformer insulation. By measuring the tangent of the loss angle, this test identifies any degradation in the insulating materials, allowing for timely maintenance or replacement.

The product has many advantages like HVT, Variable Output Voltage AC (0-12 kV); Trip Current - 100 mA; Zero Start Interlock; Timer to set duration of test; Audio/ Visual Indications; XWRM-3; Test Voltage: 10V, 40V, 100V; Measure Turns Ratio, Voltage Ratio & Ratio Error; Measure Phase Deviation & Excitation Current; Auto Detection of Transformer Vector Group; XWRM, and many others.

Transformer Test System Specification Details - M Trans 1.0 / 2.0

M TRANS 1.0 / 2.0 is an automated van system for performing various tests on power transformer like ratio test, winding resistance test, insulation test, capacitance tan delta test, high voltage withstands test AC and DC both and many more like line impedance test for cable, oil dielectric strength test for Transformer oil, also using CT PT tester to perform various tests on instrument transformers. Also useful for finding cable faults using very low frequency HV generator. All the equipment's are operated using our advanced 'MOTWARE' software, so it saves user time as getting all tests done in one Van following all required standards.

SONEL

Multi-Function Meter of Electrical System Parameters

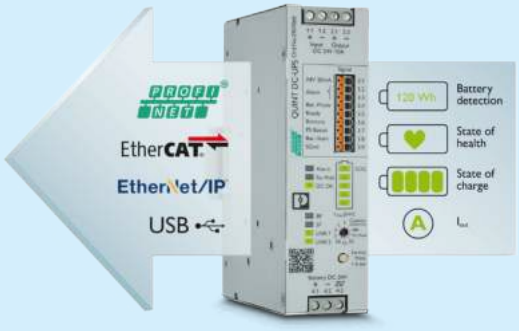
NEC 2023 & CEA recommend that, to execute basic safety tests to maintain your protective devices efficiently.

Imagine having a single instrument at your disposal that seamlessly combines multiple functions, streamlining your testing processes and simplifying your work. The Sonel MPI 540 does precisely that. It is not just a Multimeter or a loop impedance tester; it is an all-in-one solution that can handle various testing tasks with unparalleled accuracy and efficiency.

Application of MPI 540-PV include Electrical Installation Testing; Troubleshooting; Routine Maintenance; Compliance Testing and Safety Verification. Advantages include 1) Multi-Function Tester with Class S Power Quality Analyser; used for the Solar PV module Testing; EV Charging station testing and many others.

PHOENIX

QUINT 4th Generation UPS



IQ Technology: intelligent battery management system (BMS) Energy monitoring which Monitors output and battery voltages and associated currents. PC mode that has a reliable shutdown of the IPC in the event of a mains failure without data loss, and auto start of the IPC when the power returns. Cold restart function in which the UPS startup even without mains power.

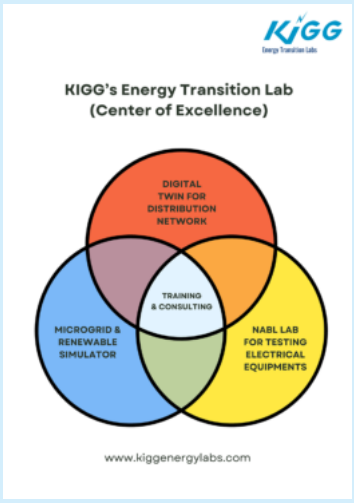
ImpulseCheck - Assistance System for Surge Protection

ImpulseCheck provides continuous monitoring of surge protection devices, serving as the world's first intelligent assistance system for such equipment. This module, connected via cloud, enables measurement of the surge protection device state of health (SoH) by detecting surge currents and transient over voltages on active conductors. The data is then stamped and transferred to PROFICLOUD for analysis.

ImpulseCheck, the world's first intelligent assistance system for surge protection devices, facilitates the measurement of the state of health (SoH) for connected protective devices via cloud connection. Additionally, it offers innovative digital services.

KIGGS

'Energy transition lab / Centre of Excellence'



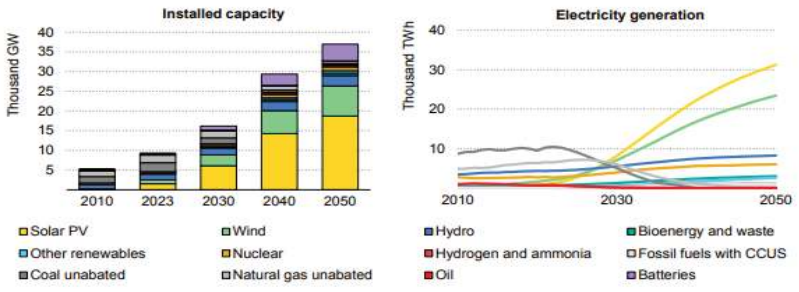
KIGG›s Center of Excellence is the world›s first energy transition lab with a real-time digital twin of the entire distribution grid, avant-garde simulators, an NABL lab where various companies can get their products certified and receive hands-on training for the future generation of engineers. Check out the website: www.kiggenergylabs.com.

Advantages include real time digital twin of the entire distribution grid which allows the user to make more accurate decisions. This is extremely useful for power utilities, private franchises, renewable energy farms, educational institutes, energy auditors, regulatory authorities, financial organizations and industries.

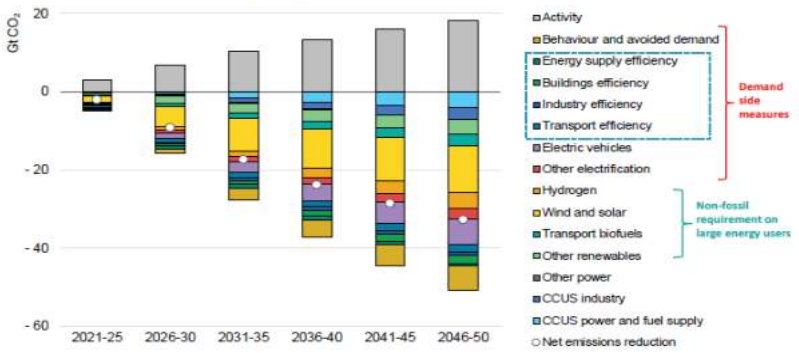
GLOBAL SCENARIO

GLOBAL - ENERGY EFFICIENCY SCENARIO

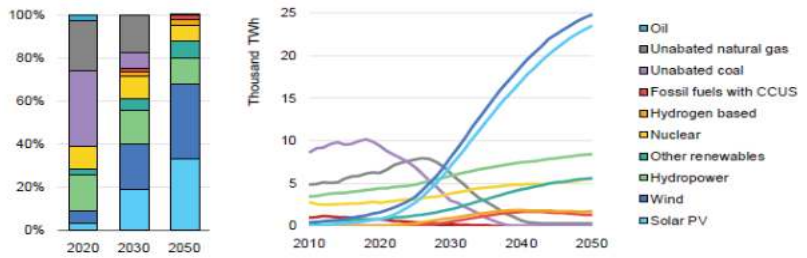
Total installed capacity and electricity generation by source in the Net Zero by 2050 Scenario, 2010-2050



Demand side measures play a significant role in the IEA Net Zero Scenario, 2021-2050



Changes in world electricity sources, IEA Net Zero Scenario, 2010-2050



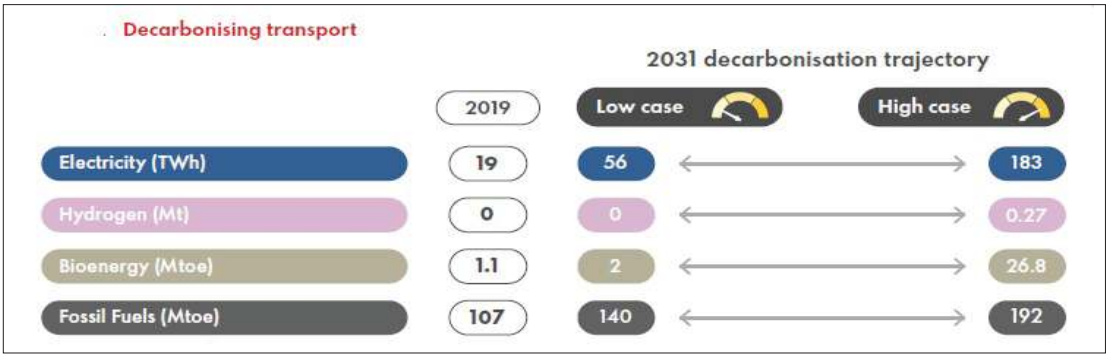
Evolution of energy efficiency policies to support fuel switching and demand response

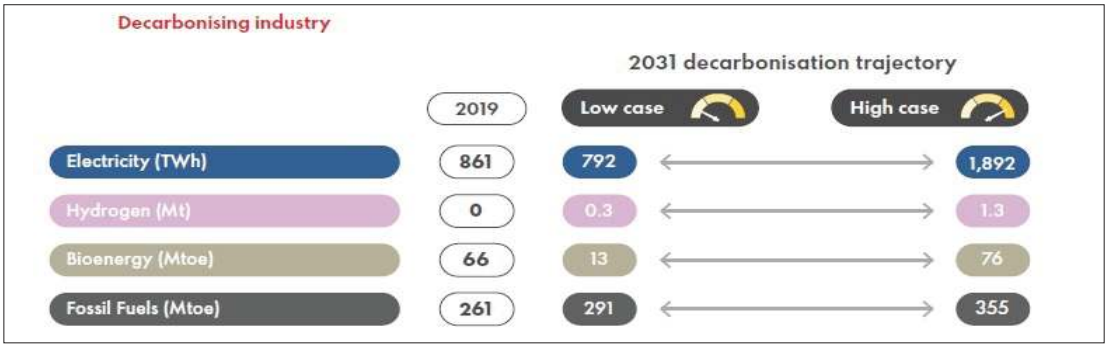
	Regulation	Incentives	Information
Buildings	**Building codes** ↳ Solar PV ↳ Demand response ↳ Smart EV charging **MEPS for appliances** ↳ Demand response	**Energy Efficiency Obligations** ↳ Carbon-based obligations ↳ Peak demand targets	**Energy Performance Certificates** ↳ Fuel to GHG
Transport	**Fuel economy standards** ↳ Fuel to GHG ↳ ICE phase-out ↳ EV bonus ↳ EV to Grid bonus	**Demand incentive schemes** ↳ Subsidies directed to EVs ↳ EV charger subsidies	**Energy label** ↳ Fuel to GHG ↳ EV to Grid bonus
Industry	**Industry agreements** ↳ Energy to GHG ↳ Electrification (e.g., heat pumps) ↳ DR requirements	**Subsidies, grants** ↳ Carbon-reduction based	**Energy and carbon reporting** ↳ Adding GHG reporting ↳ DR reporting

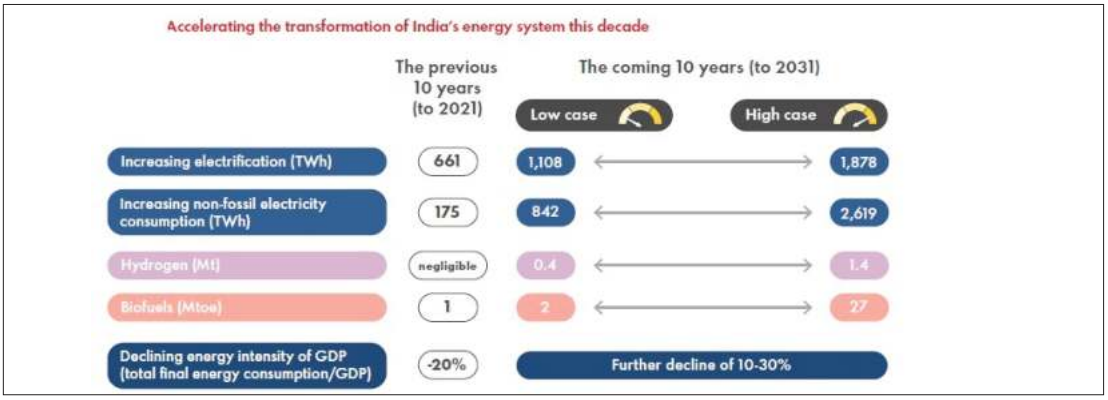
Source: IEA 2023

INDIAN SCENARIO

INDIAN ENERGY SCENARIO







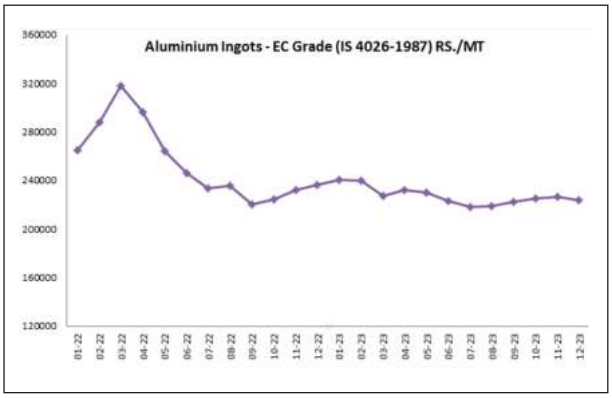
Source: Teri, Shell

BASIC PRICES & INDICES

BASIC PRICES AND INDEX NUMBERS

	Unit	as on 01.12.23
IRON, STEEL & STEEL PRODUCTS		
BLOOMS (SBLR) 150mmX150mm	TLT	47536.00
BILLETS (SBIR) 100MM	TLT	49212.00
CRNGO Electrical Steel Sheets M-45,C-6 (Ex-Rsp)	RM	109.91
CRGO Electrical Steel Lamination		**578213.00**
NON-FERROUS METALS		
Electrolytic High Grade Zinc	TLA&H	248600.00
Lead (99.97%)	CABLE	208100.00
Copper Wire Bars	SWGR	741318.00
Copper Wire Rods	CABLE	758026.00
Aluminium Ingots - EC Grade (IS 4026-1987)	TLA&H	223583.00
Aluminuium Properzi Rods - EC Grade (IS5484 1978)	CABLE	231666.00
Aluminium Busbar (IS 5082 1998)	SWGR	296000.00
OTHER RAW MATERIALS		
Epoxy Resin CT - 5900	SWGR	736.00
Phenolic Moulding Powder	SWGR	107.00
PVC Compound - Grade CW- 22	CABLE	151825.00
PVC Compound Grade HR - 11	CABLE	152825.00
Transformer Oil Base Stock (TOBS)	TOBS	100500.00
OTHER IEEMA INDEX NUMBERS		
IN-BUSDUCTS (BASE July 2000=100) FOR THE MONTH October 2023		334.66
IN - WT (BASE JUNE 2000=100)		354.95
Wholesale price index number for 'Insulators' (Base 2011-12 = 100) for the month October 2023		127.00
Wholesale price index number for 'Manufacture of Basic Metals (Base 2011-12 = 100) for the month October 2023		142.20
Wholesale price index number for' Fuel & Power (Base 2011-12 = 100) for the month October 2023		155.50
All India Average Consumer Price Index Number For Industrial Workers (Base 2016=100) October 2023		138.40
# Estimated, NA: Not available		

QE/PVC/39



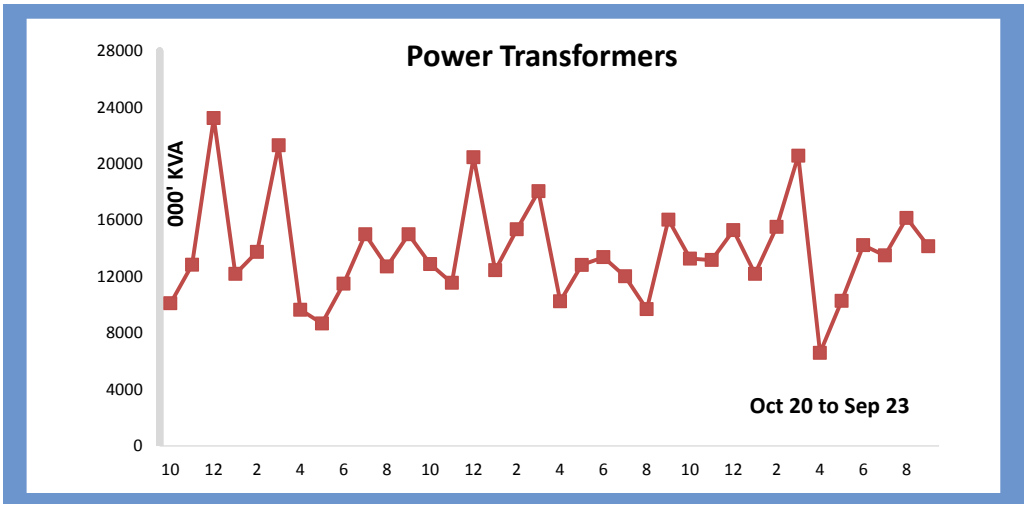
The basic prices and indices are calculated on the basis of raw material prices, exclusive of excise/C.V. duty wherever manufactures are eligible to obtain MODVAT benefit.

These basic prices and indices are for operation of IEEMA's Price Variation Clauses for various products. Basic Price Variation Clauses, explanation of nomenclature can be obtained from IEEMA office.

Every care has been taken to ensure correctness of reported prices and indices. However, no responsibility is assured for correctness. Authenticated prices and indices are separately circulated by IEEMA every month. We recommend using authenticated prices and indices only for claiming price variation.

Source : IEEMA

PRODUCTION STATISTICS



Name of Product	Accounting Unit	Production		
		For the Month	From Oct 22	Highest Annual
		September-23	to Sep 23	Production
Electric Motors				
AC Motors - LT	000' KW	1512	18241	17744
AC Motors - HT	000' KW	356	4850	5273
DC Motors	000' KW	30	355	618
Switchgears				
Contactors	000' Nos.	1445	15469	15211
Motor Starters	000' Nos.	185	2110	2427
SDF	000' Nos.	50	687	752
Circuit Breakers DIN Rail Mounted	000' Poles	17758	213947	213362
Circuit Breakers - LT	Nos.	450726	5326316	4850300
Circuit Breakers - HT	Nos.	5976	70875	77659
Custom Built Product	Rs. Lakhs	28359	294793	452536
HRC Fuses & Overload Relays	000' Nos.	1273	16933	17246
Power Cables	**KM**	84730	873226	855297
Power Capacitors - LT & HT *	000' KVAR	5589	57693	57368
Transformers *				
Distribution Transformers	000' KVA	4386	45843	58341
Power Transformers	000' KVA	14153	164693	234922
Instrument Transformers *				
Current Transformers	000' Nos.	106	1206	1042
Voltage Transformers	Nos.	21925	207771	177288
Energy Meters *	000' Nos.	2777	28871	25973
Transmission Line Towers *	000' MT	80	912	1250

* Weighted Production

Source : IEEMA

NA – Not Available

IMPACT NEWS

Local 2 Global

BREAKING NEWS!

ELECRAMA 2025 Launch Ceremony

Minister RK Singh graces the world's largest electrical show ELECRAMA 2025's launch party

The Honourable Minister of Power and New and Renewable Energy Shri RK Singh officially announced the dates of ELECRAMA 2025 in a grand launch ceremony held on February 27, at the Ballroom of Delhi's plush five-star Hotel Lalit.

Reigning industry leaders, top industrialists, business tycoons, global magnets from India's power sector were preset at the magnificent launch ceremony. At the event earlier participants shared their experiences about the event and narrated how ELECRAMA boosted their business. Some professional shared elaborate presentations about the success story of this unique electrical industry event. Dignitaries shared their views about the industry sharing their outlook about the sector's future and the direction of the industry's developmental goals.

All in all it was a grand celebratory evening, spent with the crème de la crème anticipating the arrival of ELECRAMA 2025.

NATIONAL NEWS

Parivesh 2.0 Portal To Be Default Platform For All Environment Clearances

The Ministry of Environment, Forest and Climate Change (MoEFCC) is planning to make its new and upgraded Parivesh 2.0 portal the default online platform for all proposals awaiting environment and forest clearances. The government introduced Parivesh 2.0 (Pro-Active and Responsive Facilitation by Interactive and Virtuous Environmental Single-window Hub) to enhance transparency.

This updated version includes features such as mapping employees to project proposals, integrated GIS clearance, and the introduction of a payment gateway, among other modifications. The move to shift all proposals to the new portal comes as over 12,000 proposals seeking forest clearance under the Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980, were stuck in limbo due to technical limitations of the Parivesh 1.0.

According to the fresh guidelines issued by the MoEFCC, the current platform (Parivesh 1.0) can be utilised for processing proposals during the specified 150-day duration. However, after this period, all proposals would be automatically migrated to Parivesh 2.0 for further processing. The guidelines signed on January 25 said the applications on Parivesh 1.0 that haven't shown progress in the past 90 days will be deemed inactive and rejected.

"In such proposals, if the user agency desires to pursue their proposals for prior approval under the Adhiniyam (rule), fresh applications shall be submitted on Parivesh 2.0," the guidelines said.

The fresh guidelines gave relief to the proposals already under process on Parivesh 1.0. Such proposals can be completed there, but they must adhere to the updated procedures of Adhiniyam. Moreover, applications that receive forest clearance on Parivesh 1.0 will be migrated to Parivesh 2.0 for compliance tracking.

Welcoming the upgrade, an environmental law expert said the government should not hide details of the projects on Parivesh 2.0.

"As long as all the information is kept in public purview, any upgrade is welcome. The government shouldn't use the new platform to hide something," the expert said.

The government faced criticism from environmental experts and activists in 2022 when it stopped updating details on environmental impact assessments, forest clearances, wildlife clearances, and coastal regulation zone clearances. The MoEFCC decided to provide such information only upon request under the Right to Information (RTI) Act on the new website. However, the MoEFCC provides minutes of meetings of expert appraisal and forest advisory committees, information on environment and forest clearances, coastal regulation zone proposal details and clearances, and minutes of the regional empowered committee.

The migration aims to increase the speed and transparency of environmental clearance," a source at the MoEFCC said.

Parivesh is a web-based workflow application designed for the online submission and monitoring of proposals seeking Environmental (EC), Forest (FC), Wildlife (WL), and Coastal Regulation Zone (CRZ) clearances. The portal operates on a role-based system, facilitating a streamlined process for proponents. Its primary objective is to serve as a "single window" solution, employing process automation and leveraging technologies like GIS and Advanced Data Analytics. This approach aims to ensure expeditious, transparent, and effective decision-making while maintaining stringent environmental safeguards.

Privesh 1.0 was instrumental in reducing the time in these clearances. The average time taken for the grant of EC and CRZ clearance at the central level was reduced significantly from more than 150 days in 2019 and 102 days in 2020 to less than 70 days in 2022, according to the MoEFCC. Similarly, the average time taken for a grant of 'in-principle' FC approval was also reduced to 180 days in FY22 against 188 days in the previous financial year.

DATA:

Total number of clearances (EC, FC, WL and CRZ) granted on Parivesh since inception

Year: Number of clearances granted

The government launched Parivesh 1.0 in August 2018 at the Central level and in August 2019 at the State level. From 2018 to 2022, a total of 33,533 projects were given clearances (EC, FC, WL, and CRZ), according to MoEFCC data tabled in Parliament in March 2023.

2018: 577

2019: 3,498
2020: 8,169
2021: 8,793
2022: 12,496
Total: 33,533

Source: MoEFCC, Lok Sabha answers

Induction of Electric Vehicles In Indian Army

Indian Army has proposed to introduce phased induction of a limited number of Electric Vehicles in 'Peace Stations' across the country. The aim and objectives are to adapt to latest technological advancements, give impetus to green energy and reduce dependency on fossil fuels. The Indian Army is inducting the following Electric Vehicles at peace stations:

- Light Vehicles (Electric)
- Buses (Electric)
- Motor Cycles (Electric)

This information was given by Raksha Rajya Mantri Shri Ajay Bhatt in a written reply to Shri Maddila Gurumoorthy and Shri Kuruva Gorantla Madhav in the Lok Sabha on Feb 2, 2024.

ENERGY

NewScientist: Nuclear Fusion Reaction Releases Almost Twice The Energy Put In

Scientists have confirmed that **a fusion reaction in 2022 reached a historic milestone** by unleashing more energy than was put into it – and subsequent trials have produced even better results, they say. The findings, now published in a series of papers, give encouragement that fusion reactors will one day create clean, plentiful energy.

Today's nuclear power plants rely on **fission reactions,** where atoms are smashed apart to release energy and smaller particles. **Fusion** works in reverse, squeezing smaller particles together into larger atoms; the same process powers our sun.

Fusion can create more energy with none of the **radioactive** waste involved in fission, but finding a way to contain and control this process, let alone extract energy from it, has eluded scientists and engineers for decades.

Experiments to do this using capsules of deuterium and tritium fuel bombarded with **lasers** – a process called inertial confinement fusion (ICF) – began at the Lawrence Livermore National Laboratory (LLNL) in California in 2011. The energy released was initially only a tiny fraction of the laser energy put in, but it gradually increased until an experiment on 5 December 2022 finally passed the crucial milestone of breaking even. That reaction put out 1.5 times the laser energy required to kickstart it.

In one paper, the lab's National Ignition Facility (NIF) claims that trial runs since then have yielded even greater ratios, peaking at 1.9 times the energy input on 4 September 2023.

Richard Town at LLNL says the team's checks and double-checks since the 2022 result have proved that it "wasn't a flash in the pan", and he believes there is still room for improvement.

Even with the hardware currently installed at NIF, Town says it is likely that yields could be improved, but if the lasers can be upgraded – which would take years – things could be pushed even further. "A bigger hammer always helps," he says. "If we can get a bigger hammer, I think we could get to target gains of about roughly 10."

But Town points out that NIF was never built to be a prototype reactor and isn't optimised for boosting yields. Its main job is to provide critical research for the US nuclear weapons programme.

Part of this work involves exposing electronics and payloads from nuclear bombs to the neutron bombardment that takes place when ICF reactions occur, to check that they will function in the event of all-out nuclear war. The danger of an electronics failure was highlighted during a test in 2021 when NIF fired and wiped out all lights across the site, plunging researchers into darkness. "Those lights were not hardened, but you can sort of imagine a military component that has to survive a much higher dosage," says Town.

This mission means some research from the project remains classified; even the concept of ICF was a classified secret into the 1990s, says Town.

The announcement that ICF had reached the break-even point in 2022 provided hope that fusion power was drawing closer, and this will be bolstered by news that further progress has been made. But there are caveats.

Firstly, the energy output falls far short of what would be needed for a commercial reactor, barely creating enough to heat a bath. Worse than that, the ratio is calculated using the lasers' output, but to create that 2.1 megajoules of energy, **the lasers draw 500 trillion watts**, which is more power than the output of the entire US national grid. So these experiments break even in a very narrow sense of the term.

Martin Freer at the University of Birmingham, UK, says these results are certainly not an indication that practical fusion reactors can now be built. "There's still science to be done," he says. "It's not like we know the answers to all of this and we don't need researchers any more."

Freer says that as scientific experiments progress, they throw up engineering challenges to create better materials and processes, which will allow better experiments and more progress. “There is a chance that we will have fusion,” he says. “But the challenges that we have are pretty steep, scientifically.”

Aneeqa Khan at the University of Manchester, UK, agrees that recent progress in fusion research is positive, but stresses that it will be decades before commercial power plants are operational – and even that will hinge on global collaboration and a concerted effort to train more people in the field. She warns against interpreting progress in fusion research as a possible solution to tackle our reliance on energy from fossil fuels.

“Fusion is already too late to deal with the climate crisis. We are already facing the devastation from climate change on a global scale,” says Khan. “In the short term, we need to use existing low-carbon technologies such as fission and renewables, while investing in fusion for the long term, to be part of a diverse low-carbon energy mix. We need to be throwing everything we have at the climate crisis.”

POWER ELCTRONICS

IIT-Guwahati-Led Research Develops Cost-Effective, Semiconductors For High-Power Applications

A cost-effective method to grow a special semiconductor with the potential to significantly enhance the efficiency of power electronics used in high-power applications even at very high temperatures has been developed in a collaborative effort led by researchers of Indian Institute of Technology (IIT), Guwahati, the statement said. A team of IIT-Guwahati came together with researchers of IIT-Mandi and Institute of Sensor and Actuator Systems, Technical University Wien, to develop this special semiconductor which can be used in high-power applications like electric vehicles, high-voltage transmission, traction and industry automation.

The research team has developed an innovative and cost-effective technology to grow ultrawide bandgap semiconducting material named gallium oxide. This is achieved through a customised low-pressure chemical vapour deposition (LPCVD) system. Emphasising on the need of this research, Ankush Bag, assistant professor, Department of Electronics and Electrical Engineering and Centre for Nanotechnology, IIT-Guwahati, said, “Power semiconductor devices are the heart of every power electronic system and function primarily as efficient switches, toggling ON and OFF to condition incoming power from grid to be used by end-user. For emerging high-power applications, there is a demand for compound semiconductor materials with an ultra-wide bandgap”.

Power electronic systems play a vital role to manage and control the flow of electricity. They are crucial for converting electrical energy from both renewable including solar and wind, and non-renewable sources including thermal power plants, into a form compatible with end-user applications in terms of voltage, current and frequency.

However, there will always be some losses incurred when the electrical energy passes through a typical power electronic system. Researchers globally have been working on improving the efficiency of power electronic systems using materials like Gallium Nitride (GaN) and Silicon Carbide (SiC) but these have limitations, especially in terms of cost, for high-power applications.

“The main challenge was to make thin and smooth films out of the material. We have successfully developed a superior quality ultra-wide bandgap compound semiconductors and fabricated two terminal devices. The applications of this technology extend to electric vehicles, high voltage transmission, traction systems, and industrial automation,” Bag added.

He said a key challenge was creating a Gallium oxide thin film on a sapphire substrate, deviating from the common use of Gallium oxide substrates. This shift enhances cost-effectiveness and thermal performance, addressing issues related to the expense and poor thermal conductivity of Gallium oxide substrates, the assistant professor added.

The findings of the study have been published in multiple research papers in ‘Journal of IEEE Transactions on Electron Devices’ and ‘Thin Solid Films’. Besides Bag, the co-authors include Satinder K Sharma and Arnab Mondal from the School of Computing and Electrical Engineering, IIT Mandi, and Manoj K Yadav from Institute of Sensor and Actuator Systems, TU Wien, Vienna, Austria.

The research has received funding from the Science and Engineering Research Board (SERB), Department of Science and Technology, according to the statement.

Colours of the Budget !

By Kamakshi Fernandes

It's that time of the year when nature renews itself, birds build nests, trees dress up in vivid hues of yellow-orange-red. 'Tis that time of the year when the budget has just been announced and people are looking at their pockets in wonder, if they have developed invisible holes, or if the cloth of the pocket has shrivelled, or weather their hands have developed paranoia of paucity. Alas! This financial year's Interim Budget held no respite for the poor taxpayer!

Every request for lowering taxes by industries being forthrightly disregarded by the ''Money-Lady'' of India, the common man is feeling like his life is dull, colourless and in darkness.

The light of the sun only shone brightly on solar panels and on the cute looking trio of Ramlallas! So, with positive reforms solely on solar panels and sunlight, what would be the best solution to bring about colour in the 'monotone'ous lives of the 'tax-respite-deprived' junta of modern, yet erstwhile Bharat?

We at IEEMA Journal have listed funny suggestions to humour Smt. Nirmala Seetharaman, our finance minister with some shocks and sparks!

- **Diamonds are forever:** When light passes through a diamond, it transforms into a spectrum of rainbow colours. So, along with a solar panel, if the FM gave away free diamonds, (as diamonds are a girls' best friend), one crore homes would have colourful rainbows for light at home!
- **Tax Air Pollution:** Air pollution should be made a taxable offence. The municipality of every city that has a deplorable AQI should be taxed and fined as each and everyone living in that city is responsible for the deplorable state of the city's air. If you inhabit the place, you better be responsible for its AQI!
- The main culprits of air pollution are kids who binge eat and some adults too. Then there are those who sweat incessantly and use perfumes to camouflage it. These antisocial elements are to be levied with heavy taxes for causing great inconvenience to people in public places.
- **Tax Noise Pollution:** There is a tsunami of noise. Everybody on media, off media, on reels, off reels, on phones, in trains, in busses, at homes from the kitchen, inside washrooms, while cooking, bathing, meditating, in the middle of a song need to talk or give an account or an instruction. Who is listening… we wonder to so much of talk?

  We have AI as a companion who replies to everything on a speaker, provided we give verbal instruction to machines. Smart homes, smart cars, smart gadgets for a smart and talkative life.

  Please note we have not yet considered the usual car honking, sound amplifiers without frequency mapping or channels, loud speakers used on roads at public places like hospitals, schools at odd hours of the day and night need to be taxed. Also note that we have not considered the profound sufferings of all meek listeners of ''loud speakers''.
- **Tax Artificial Intelligence:** All that's free has a hidden cost and freely available artificial intelligence is robbing India's youth of using their minds or their skills. There is no motivation nor effort needed to learn anything as every new thing is smart and intelligent, but our children are taught to become dumb and dumber.
- **Other Taxable Itinerary:** December and November rain should be taxed for it spoils crop. Every hospital that has an increasing number of patients should be taxed. Time-wasters can be taxed; for example, holding meaningless meetings could be a taxable offence.
- **in Kind:** It is time to introduce the concept of charging taxes 'in kind'.
- Pet owners to be taxed. Owning the life of an animal should be made taxable because pet owners own the pet's freedom of movement, freedom of social interaction with family members and same species, travel restrictions (for fishes esp.), food choice restrictions, total sexual impotency, psychological alienation etc. We have not considered how pet owners deface public roads with pet litter etc.
- Every hospital, doctor, nurse, vaid, healer, to be levied with compulsory listening to the world's best classical music, with free chocolates, meals and massages.
- Mumbai's BMC workers need exceptional taxation methodology. Anyone who sees a Municipality worker sweeping the road, must join him or pay a fine. BMC workers should be punished with free psychiatric counselling, de-addiction retreats and their children given free education till the PG level. All BMC Staff uniforms be should designed in vivid colours by India's top fashion designer like Sabhyasachi Ray or a global icon like Versace … and why not, BrihanMumbai Corporation is India's richest municipality with the highest 'budget'!

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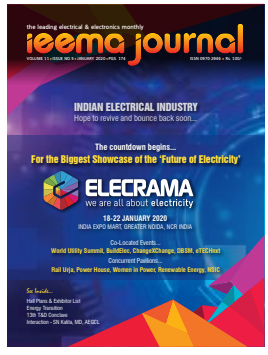

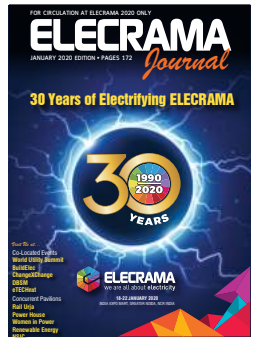

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