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Electrical India

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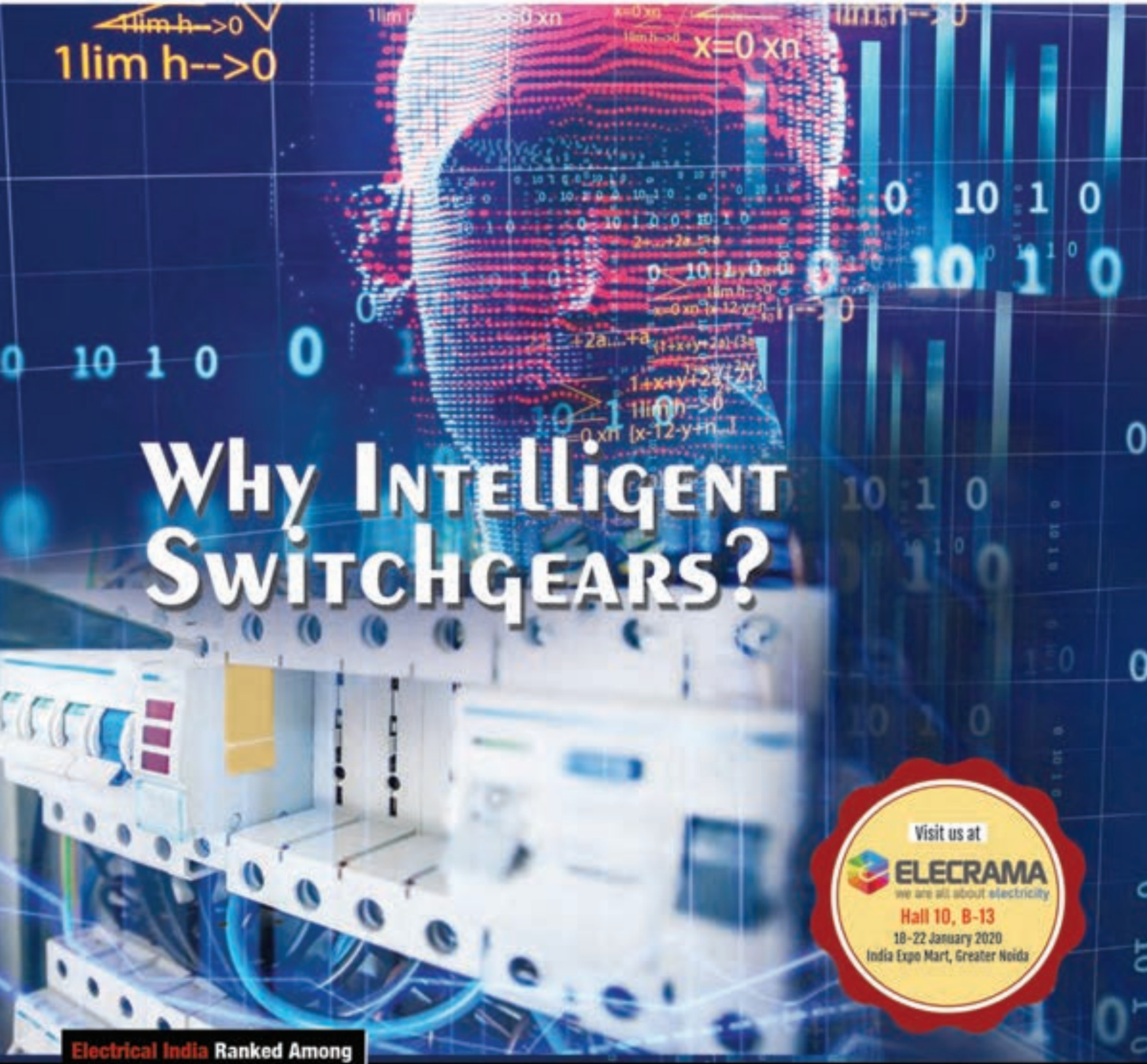
India's oldest magazine on power and electrical products industry

59th Year of Service to the Industry



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Publisher's letter

The global switchgear market size to exceed US$ 140 billion by 2024, predicts a latest study by Global Market Insights. Keeping pace with the global trends, the switchgear industry in India is also witnessing high demand in the wake of the robust development of infrastructure and construction activities across the country. According to a Research and Markets report, the Indian switchgear market is expected to grow at a CAGR of over 15 per cent through 2023.

Today, with the advent of IoT, switchgears are becoming increasingly intelligent and enabling better visibility, real-time information, and improved predictive diagnostics. This time, we present to you an exclusive analysis on what makes a switchgear intelligent and why it is essential to have intelligent switchgears.

On the renewable energy front, India Inc. has recently witnessed the gigantic congregation of global renewable energy players at the 2019 edition of Renewable Energy India Expo held in Greater Noida. We are delighted to present a detail review of the event in this issue.

Electrical India is about to enter into its glorious 60th year of publication. To mark this milestone, we are coming up with the Annual Issue in November. Based on the theme 'POWER 2020', the mega issue will cover almost all aspects of power and electrical industry featuring detail insights to keep our readers abreast of the latest industry trends. We invite your participation in this landmark issue.

For more details on this, please contact at miyer@charypublications.in

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EDITOR'S LETTER

INDIA INC. WELCOMES 'FESTIVE BONANZA'

September 20, 2019, would be remembered as a watershed moment in the history of Indian economy. This day signifies the relief of about Rs 1.45 lakh crore for the corporate taxpayers.

With the aim of boosting corporate profit growth and encouraging private investment cycle, the government slashed the corporate tax rate to 22 per cent from 30 per cent for existing companies, and to 15 per cent from 25 per cent for new manufacturing companies. Being termed as a mid-year bonanza, the lowered corporate tax rate is expected to give the much-needed stimulus to the economy.

Commenting on the announcements, CII President Vikram Kirloskar said that, cut in corporate tax from 30 per cent to 22 per cent without exemptions has been a long-standing demand of the industry and is an unprecedented and bold move by the government whereas FICCI President Sandip Somany observes that the announcements will give a major boost to the 'animal spirits' of corporate India and will reinvigorate the manufacturing sector that has been going through a difficult phase of late.

R K Chugh, President, IEEMA said, "The measures announced will bring Indian companies at par with other countries and would spur growth in exports through higher competitiveness."

Sumant Sinha, Chairman & MD, ReNew Power, said, "This is a step in the right direction and will bring our rates closer to that in most mature economies. Reasonable tax rates also go a long way in ensuring better compliance." ■

Subhajit Roy
Group Editor

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Electrical India

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Venkatesh Dwivedi, Director (Projects), Energy Efficiency Services Limited (EESL)

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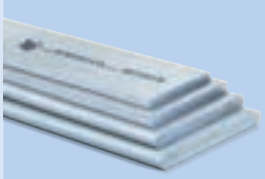

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Infrastructure solutions for 5 lakh smart meters for EESL

L&T's Smart World & Communication BU has been engaged by Energy Efficiency Services Limited (EESL) to roll out the largest Advanced Metering Infrastructure solutions implementation comprising over 5 million smart meters across Haryana, Uttar Pradesh and NDMC. The project aims to help discoms to improve their billing efficiency, energy savings and empower consumers to save and manage their energy consumption.

Together, L&T and EESL have already successfully implemented the AMI system for more than 500,000 smart meters including integration and commissioning of 50,000 smart meters for NDMC.

Saurabh Kumar, MD, EESL, said, "The smart meter project is primarily aimed at regulating power consumption pattern, promote online billing, infusing transparency, reducing line losses etc. "

R Srinivasan, Executive Vice President and Head of L&T - Smart World & Communication Business, said, "We are delighted that our solutions have been successfully implemented and are running efficiently to help authorities effectively manage the metering system. The AMI system is a gateway to new technology and some of the main advantages are accurate billing and real time monitoring of energy usage."

'Need to bring drastic reforms in power distribution'

IEEMA's Annual Convention 'Transformative Reforms' was inaugurated by Subhash Chandra Garg, Secretary, Ministry of Power. The Convention witnessed the presence of around 270 delegates from the electrical equipment industry. Garg stated, "There are transformational changes happening in the power sector but there is a need to bring in drastic reforms in the power distribution sector and the government is working on the revised version of the scheme, where it will also cater to separating carriage and content in the distribution sector. Electricity distribution is an area of concern. There have been various initiatives taken by the government, including the UDAY scheme to revive the distribution sector, but it has not proved to be effective. It is necessary that we take drastic reforms in the sector.

He further adds, "The aim of the UDAY scheme was to make sure that power is paid for. I am of the view

that is discoms are buying power, they should pay. Under the UDAY scheme, states have to bear the burden of the losses of discoms. If this time the power sector digs deep holes in the finances of the state, then Centre will have to take the burden as the discoms will not be able to do it. He also noted that the private sector will play a key role in the transformation journey of the Indian power industry.

The implementation of the various reform measures in India has given immense opportunities to the countries of the world to come and invest in India and promote bilateral trade, technology sharing and transfer and also joint membership.

Schneider Electric launches oil, gas & petrochemical sector dedicated EcoStruxure in India

Schneider Electric announced the launch of EcoStruxure Power and Process (EP&P) to drive efficiency and augment profitability in this crucial segment of the economy. The company has partnered with Microsoft to create commercial internet of things (IoT) solutions in the areas of energy management and automation, thus, bringing power and process systems together. Through this platform,

Anil Chaudhry, Zone President & Managing Director, Schneider Electric India, said, "Through our partnership with Microsoft, we aim to deliver real or tangible solutions and measurable business results for oil and gas players, improve efficiency, bring down cost of running operations and raise profitability."

Meetul Patel, COO, Microsoft India, said, "Microsoft's Azure platform provides Schneider Electric with advanced cloud and edge computing technologies to establish an intelligent network of IoT devices that can provide insights, drive innovative new solutions, and improve returns from investments."


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Smart Environmental Sensors by iRam Technologies

iRAM's Environment Monitoring System is designed to address the growing need for monitoring air quality across India. The portable IoT-based solution measures gases like CO, CO2, NO2, O3, SO2 along with Particle Matter, UV and noise levels through a remotely calibrated sensor. Apart from the pollutants, it also measures various other ambient parameters such as temperature, humidity, surrounding light and rainfall. This portable solution can be fully integrated into the smart pole. The live information can be captured and stored for future analysis by the authorities to create better policies for the environment.

The Monitoring System constitutes multiple sensors that continuously measure and transmit data to the Central Monitoring System (CMS). The sensors send data signals through a WAN network, which are also location marked and time-stamped. All the sensors are extremely durable and weather-proof, making it resistant to ambient conditions. The sensors are quick to respond to variable changes in the environment, are highly accurate as well as reliable, with low maintenance, and have a built-in battery backup that can last 24 hours. It automatically connects to the CMS and starts measuring. Each sensor samples the environment at configurable intervals and transmits the data to the controller.

NTPC signs MoU to build hydro projects of 520 MW in Himachal

NTPC signed a Memorandum of Understanding (MoU) with the Himachal Pradesh government to set up two hydro projects totalling 520 MW in the state. The MoU was signed by Prabodh Saxena, Principal Secretary (Energy), Himachal Pradesh and A K Gupta, Director (Commercial) NTPC in the presence of Jai Ram Thakur, Chief Minister Himachal Pradesh, Suresh Bhardwaj, Education Minister Himachal Pradesh, Shrikant Baldi, Chief Secretary Himachal Pradesh and other officials and dignitaries at the Power Conclave organised by the state government in Shimla.

Seli and Miyar HEPs are located in Chenab Basin at Lahaul & Spiti district. While Seli HEP (400 MW) is a Run of River Project with pondage scheme, Miyar HEP (120 MW) is a run of river project without pondage scheme, on Miyar tributary of Chenab River.

NTPC has presence in Himachal Pradesh with Koldam Hydro Power Station, the first hydro power project of NTPC, with an installed capacity of 800 MW. The power station is commercially operational since July 2015 and provides 28 per cent power to the state of Himachal Pradesh.

BHEL commissions 1320 MW supercritical power project in Odisha

Bharat Heavy Electricals Limited (BHEL) has successfully commissioned the 1320 MW IB Thermal Power Station (2x660MW). Located in Jharsuguda district of Odisha, the project is owned by Odisha Power Generation Corporation Limited (OPGC), a joint venture company of the Government of Odisha and AES, a US-based energy company. BHEL had previously set up two units of 210 MW at IB Thermal Power Station which have been in operation for more than 20 years.

BHEL has been a committed partner in the development of the state of Odisha, with BHEL-supplied sets contributing 100 per cent of the coal-based power stations installed by OPGC. A substantial portion of power generated from the project will be supplied to the Grid Corporation of Odisha (GRIDCO). BHEL's scope of work in the project encompassed design, engineering, manufacturing, supply, erection and commissioning of steam turbines, generators, boiler, associated auxiliaries and electricals, besides state-of-the-art Controls & Instrumentation (C&I) and electrostatic precipitators (ESPs).

The key equipment for the project has been manufactured by BHEL at its Haridwar, Trichy, Hyderabad, Ranipet, Bhopal and Bengaluru works, while the construction of the plant was undertaken by the company's Power Sector -Eastern Region, Kolkata.

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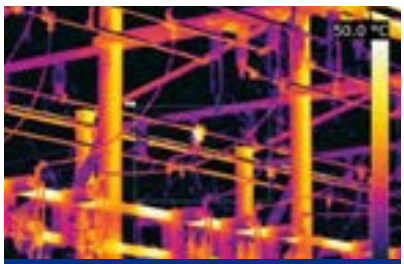
Transformer Thermal Image



Substation Thermal Image

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Tata Power commissioned 70kW solar rooftop in New Delhi

Tata Power Solar has commissioned 70kW solar rooftop installation at the eminent India International Centre. Tata Power Solar joined hands with India International Centre, one of the most premier cultural institutions of the country to promote green energy. The project entails energy efficiency of 90,000 kWhr annually along with reducing carbon emission by 63 tonnes. The uniqueness of this installation was that the engineering team had to cast the RCC beams to fit the ballast structure to the curved roof. "The association of Tata Power Solar and India International Centre showcases their commitment towards making the country a green energy leader," said N N Vohra, President, Indian International Centre.

Praveer Sinha, MD & CEO, Tata Power, said, "We are pleased to partner with India International Centre on installing the solar rooftop solution."

Ashish Khanna, MD & CEO, Tata Power Solar and President, Tata Power (Renewables), said, "After executing the world's largest rooftop in a single location, we feel pleased to be associated and support India International Centre in their endeavour of encouraging green and clean energy by installing 70kW solar rooftop. This is another milestone that encourages us in maintaining our number one solar rooftop position in the country."

SenseHawk monitors 2.5 mn solar panels

SenseHawk, an artificial intelligence driven data and analytics software company, recently set a world-first benchmark of assessing the health of 2.5 million solar modules in record time at one of the largest single location solar plants in the world, the Adani Kamuthi Solar Plant in Tamil Nadu.

Adani's Kamuthi solar plant, with a DC capacity of 780 MWs is amongst the largest in the world. It spans an area of 2,500 acres, equivalent to about 950 football fields, and contains 2.5 million solar modules that converts solar radiation into clean electricity.

Monitoring the health of each solar module and tracking module level defects in such a large plant is done using a technique called Thermography. This technique uses infrared photography to identify abnormally high temperatures within solar modules that indicates a potential defect. Using manual methods, it can take many months to conduct thermography for a plant of this size making it impractical to implement.

This is where SenseHawk's advanced solution comes in.

This was the second time that Kamuthi Solar Plant was scanned using SenseHawk's solution in a span of 18 months. Regular thermographic analyses using SenseHawk ThermTM has helped Adani Solar track module level defects and potential degradation issues accurately, thereby, increasing energy yield. Jayant Parimal, CEO, Adani Green Energy said, "As the leading Solar Power Developer in India, we are always pushing the boundaries in terms of using state of the art technologies like robotics and artificial intelligence for better asset management. SenseHawk is leveraging new age technologies for improved solar asset management, and we have been successfully working with them for the last two years with good results".

Luminous Power launches range of advanced solar inverters at REI Expo 2019

Luminous Power Technologies, one of the leading home electrical, power storage and renewable energy company in the country, launched an array of technologically advanced solar inverters like On Grid Inverter, Hybrid Inverter, Off-Grid Inverter at the Renewable Energy India Expo 2019. These solar solutions by Luminous intend to maximise consumers' savings by efficiently managing power at home. The new range of solar inverters are designed for high performance catered to diverse consumer needs.

These highly efficient solar inverters from Luminous Power Technologies deliver uninterrupted power supply for all electrical applications and are extremely safe and reliable. These inverters offer tailored solutions to consumers through their applications.

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Waaree expands its module manufacturing capacity to 2 GW

Waaree Energies, one of India's largest solar module manufacturer and a leader in the EPC segment, recently announced the expansion of their module manufacturing capacity to 2 GW from 1.5 GW. With the manufacturing facility based in Gujarat, the company has now upgraded the production capacity to 5.7 MW per day. The demand for solar energy has seen an uptake in the recent years with the current requirement holding strong at 25 GW. However, due to various policy driven and geo-political factors, the Indian solar manufacturing segment is equipped only to produce module equivalent to 3 GW. Waaree aims to bridge this demand – supply gap and inch towards a viable indigenous ecosystem.

Sunil Rathi, Director Sales & Marketing, Waaree Energies says, "Waaree Energies continues to be the premier solar power manufacturer helping in the solar transformation in India, and therefore, is always exploring new opportunities to boost its capabilities to make solar power accessible to all. We have already supplied over 2.5 GW of solar panels till date, and commissioned over 600 MW of solar EPC projects in India."

"With the recent expansion touching 2 GW, we foresee creating jobs in the surrounding villages, largely employing the blue-collar workforce", he added

Signify illuminates Qutub Minar with white LEDs

Signify, formerly known as Philips Lighting, announced that it has lit the iconic Qutub Minar in New Delhi, India using Color Kinetics Essential White lighting system. Signify provided 445 LED light points in warm white colour to create an impressive design emphasising the tower's architectural features. The new LED lighting also enables the tower to project itself as an urban icon in the heart of New Delhi's Mehrauli area, further enhancing the image of the city and encouraging night tourism.

The newly installed LED lights are not only energy efficient, but also more cost effective over the long run due to their lower power consumption and durability, when compared to conventional lighting. While some parts of the ancient monument were already illuminated before this project, the newly installed lighting will significantly spruce up the Minar complex, enabling visitors to have a detailed view of its opulent architecture, calligraphic verses, corbels, and intricate carvings even at night, whilst increasing footfalls at the monument as well. "We are proud to bring the magic of the minaret to life at night with our Color Kinetics LED lighting that highlights its architectural features and at the same time is cost effective and energy efficient," says Sumit Padmakar Joshi, Vice Chairman and Managing Director of Signify's operations in India.

JinkoSolar gets top-rated bankable PV module

JinkoSolar Holding, one of the largest and most innovative solar module manufacturers in the world, announced that it was one of only four PV module suppliers to receive a 'AA' bankability rating from PV-Tech and Solar Media. JinkoSolar is the only PV module supplier to have AA-Ratings for the past 12 consecutive quarters.

In its first-ever quarterly PV ModuleTech Bankability Ratings, PV Tech set out to create an independent, comprehensive and transparent ranking system to help investors, banks, project developers and EPCs differentiate between the hundreds of PV module suppliers.

The benchmark ratings, which incorporate the Altman Z score that was first developed over 50 years ago to help forecast the likelihood of manufacturing companies going bankrupt, aim to balance corporate solvency with module manufacturing capabilities in order to help end-users understand the overall risk and financial health of their suppliers.

Kangping Chen, CEO of JinkoSolar, commented, "As the need for cleaner alternative energy solutions becomes ever more important, and as our industry continues to grow, it is becoming increasingly difficult for customers to distinguish between supplier claims. We have also deliberately tried to balance profitability and the long-term sustainability of our business."

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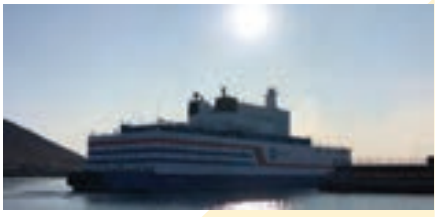
Coronal Energy rolls out QOS Energy's O&M monitoring platform

Coronal Energy, a leading North American IPP specialised in solar PV, has selected QOS Energy, an innovative independent software vendor specialising in data intelligence solutions as its primary monitoring and performance analytics software partner. Coronal will benefit from the Qantum platform's unique ability to aggregate data from all types of energy sources onto one single analytics platform to monitor its 353 MW solar portfolio.

Coronal Energy, powered by Panasonic, provides turnkey solar energy solutions tailored for diverse enterprise customers across North America. By aggregating all project data onto one platform, QOS Energy brings the twin benefits of improving the productivity, quality and the consistency of the asset management process. "Before consolidating our O&M management with QOS Energy, we used to rely on as much as five different monitoring platforms", explained Vania Mesrob, VP Asset Management of Coronal Energy. "That obviously generated a lot of unnecessary work for our performance team and created inconsistencies across our KPIs." "Since they manage a renewable energy portfolio, they can really extract the maximum value out of Qantum and ensure data quality and integrity," said Hugo Lapie, Director of Sales North America of QOS Energy.

Rosatom's first of a kind floating nuclear power unit arrives in Russia

The floating power unit Akademik Lomonosov has arrived at the port of its permanent location in Pevek, Chukotka, in Russia's Far East, where it is being docked to start operations by the end of this year. Once commissioned, it will become the world's first operational nuclear power plant based on small modular reactors (SMRs) technology and a working prototype for reliable source of low-carbon energy supply in remote areas.



Rosatom's CEO Alexey Likhachev said, "It maybe one small step for sustainable development in the Arctic, but it's a giant leap for the decarbonisation of remote off-grid areas, and a watershed in the development of small modular nuclear power plants in the world. The project has been welcomed by scientists, nuclear energy experts and environmentalists across the world. Agneta Rising, Director General of the World Nuclear Association, said, "To meet the nuclear industry's Harmony goal of supplying at least 25 per cent of the world's electricity by 2050, we will need to bring the benefits of nuclear energy to more people in a wider range of locations. The Akademik Lomonosov is the first of a new class of small, mobile and versatile nuclear power plant that will supply clean and reliable electricity, heat and water, helping meet the UN's sustainable development goals.

Siemens Gamesa expands its green guarantee line to €1.25 bn

Siemens Gamesa Renewable Energy (SGRE) continues to pass milestones in its commitment to sustainable development, having raised to €1.25 billion the amount of guarantees that qualify as green as they contribute to the United Nations Sustainable Development Goals (SDG).

In a deal arranged with BNP Paribas, the company converted a €240 million guarantee line into a green line and signed an additional line for €110 million. That €350 million is in addition to the €900 million in guarantees arranged with other banks.

Siemens Gamesa will use this line to fund its business of manufacturing and selling onshore and offshore wind turbines worldwide.

"This deal is a further step in our commitment to being one of the main drivers of sustainable development. In fact, our wind turbines produce clean energy for millions of homes and contribute to combating climate change, one of the main challenges that we face at present," said David Mesonero, CFO, Siemens Gamesa.

"BNP Paribas is fully aligned with Siemens Gamesa in pursuit of the common goal of a low-carbon economy," said Alberto Sarricolea, Head of Corporate Banking at BNP Paribas.

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Collaboration provides turnkey SRA to US market

A new and complete Solar Resource Assessment (SRA) solution has been introduced to the US market via a collaboration between ArcVera Renewables, NRG Systems (NRG), and Harness Energy. This end-to-end offering will provide solar project developers with the design, manufacture, shipping, installation, and operation of their solar measurement systems, including the delivery of independent campaign monitoring and finance-grade resource assessment reports.

Unlike existing solar resource offerings, the ArcVera-NRG-Harness collaboration promotes independence in the three main areas of a solar energy assessment – equipment procurement, installation and maintenance, and data analysis. NRG supplies its highly integrated and standardised solar met stations for a repeatable measurement result; Harness Energy provides the installation and ongoing operations; and ArcVera Renewables provides independent technical advisory services.

Taj Capozzola, Managing Director at Harness Energy, said, "ArcVera Renewables is deeply involved in the methodologies and technical rigor required to conduct high-quality met studies and prepare bankable reports. What's more, ArcVera directly performs the important work of daily data quality checking and reporting rather than outsourcing it to silent, third-party commercial partners."

Siemens partners with Chinese R&D Center to develop new technologies for EV batteries

Siemens Digital Industries Software has partnered with Tianmu Lake Institute of Advanced Energy Storage Technologies (TIES), a major Chinese energy storage research and development centre, to build an Advanced Battery Technology Innovation Centre. The Innovation Centre, to be located at the 500 million-yuan, 51,000 square meter TIES facility in Liyang, China, will be dedicated to transforming and upgrading the advanced battery industry, including nurturing advanced battery technology research and development, and the development.

The Innovation Centre will provide the advanced battery innovation chain and industry chain with comprehensive digital services, including design and simulation, test and analysis, pilot verification and engineering simulation. Meanwhile, the Innovation Centre will also provide manufacturing enterprises, both domestic and abroad, with high-quality professional digital transformation services, including digital construction and digital manufacturing construction consulting services for medium- and large-sized enterprises, implementation of complete solutions for digital enterprises. In doing so, this centre can enable advanced research in battery technology, drive collaboration throughout the supply chain, and allow partners to develop the leading-edge battery technologies required for enhanced range with future electric vehicles.

TKPIL brings innovative solutions to India

Technocrat Kohlhauer Infrastructure Pvt Ltd (TKIPL), born out of a strategic partnership between the 33 years old Mumbai-based Technocrats Security Systems Pvt Ltd (TSSPL), a pioneer in automation-powered safety and security solutions, and Kohlhauer Gmb, a German infrastructure technology giant, has been providing technologically empowered infrastructure solutions for modern Indian cities. Endorsing their path breaking innovation, TKIPL recently bagged a mandate from the Central Road Research Institute (CRRI) in association with CSIR for technology transfer and development of Noise Reducing Barriers across the country.

With the rise of smart cities and IoT devices, infrastructure solutions need to be relevant, intelligent, innovative and thoughtful, to solve real-life urban challenges. Under the directors Nitin Munot, Reinhard Kohlhauer, and Rolf Willm, Technocrats Kohlhauer Infrastructure Pvt Ltd (TKIPL) has been working to create an intelligent public environment through innovation.

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Flora Haixia Zhao joins Sterlite Power as an Independent Director


Flora Haixia Zhao

Sterlite Power announced the appointment of Flora Haixia Zhao as an independent director of the company. Zhao is a respected leader in the global energy sector, and has held leadership positions in companies such as BP and AES. She will advise the board and leadership team on matters related to strategy and global expansion.

Pratik Agarwal, Group CEO, Sterlite Power, said, "We are delighted to have someone of Flora Zhao's calibre and experience join our board. Her wealth of experience in the energy and infrastructure sector will be of immense value in guiding our strategic decisions and global expansion."

Flora Haixia Zhao, Independent Director, Sterlite Power, added, "I am excited to join the Board of Sterlite Power, and look forward to working with the leadership team."

Zhao holds Bachelor of Engineering (BE) degree from Zhejiang University, China and MS from University of Maryland, USA.

R K Chugh takes over as President, IEEMA for 2019-20


R K Chugh

Indian Electrical & Electronics Manufacturers' Association (IEEMA) - the apex association of the Indian electrical equipment manufacturing industry, has announced that R K Chugh has taken over the post of President, IEEMA for 2019-20.

Talking about the priority areas to focus on in his new role as President IEEMA, Chugh says, "At the present juncture, when state of economy in India and globally is not all that good, it presents to us challenges as well as opportunities to address the same. All of us individually and collectively can make a big difference towards bringing about a turnaround in our own areas of work, thereby, contributing to a substantial change at macro level. Increase in productivity together with creation of more jobs in our set ups should be a priority to increase consumption level in the country."

Sunil Misra, Director General, IEEMA said, "We are glad to have Chugh lead and guide the Association. His outstanding professional credentials and extensive international experience make him exceptionally well placed to provide leadership to IEEMA at this important juncture. He is very well known in the industry for his work with Utilities & across Electrical Equipment spectrum and people management."

Jennifer Scanlon to become President & CEO of UL

The UL Board of Directors has appointed Jennifer Scanlon as president and CEO of UL and a member of the UL Board of Directors, effective September 30, 2019. Scanlon most recently served as President, CEO and a director of USG Corporation, a 116-year-old innovative building products manufacturer and one of UL's oldest clients. Over her 16-year career at USG, Scanlon led the company through some of its most significant strategic moves, including establishing the global joint venture, USG Boral Building Products, and divesting L&W Supply. In 2018, she negotiated the sale of USG to Knauf for USD 7 billion, which represented a 76 per cent premium to the Company's stock price compared to when Scanlon was named CEO. The transaction closed April 24, 2019. She is the first woman to serve as president and CEO of UL.


Jennifer Scanlon

James Shannon, Chair of the UL Board of Directors and of the Underwriters Laboratories Board of Trustees, said, "Jenny brings exceptional integrity, experience, talent and technology expertise to UL. A Chicago-area native, Jenny also has a global perspective that is certain to benefit UL having previously led USG's 8,000 employees around the world."

"It is an honour to be joining UL as technological advances continue to drive dramatic changes in UL's clients' operations," said Scanlon.

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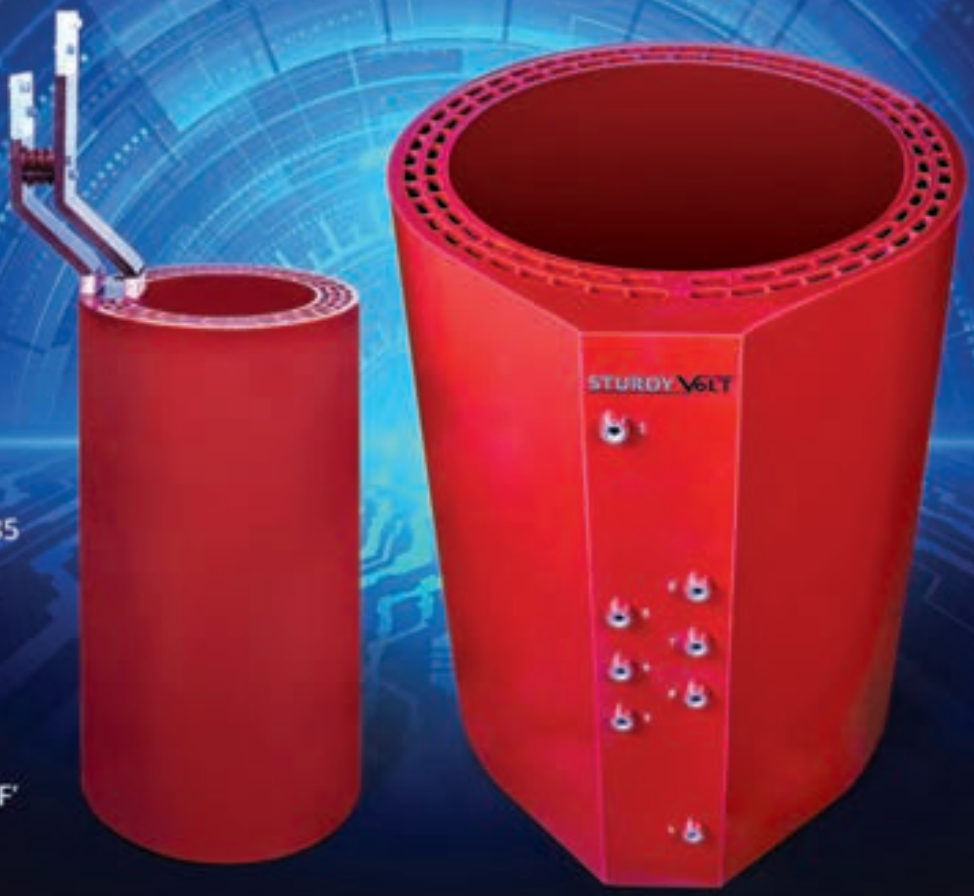

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Adani Solar top PVEL performer for a second consecutive year

Mundra Solar PV Limited (Adani Solar) received the Top Performer title for the second consecutive year for its high-efficiency products by PVEL – the world's largest resource of independent energy experts. PVEL published its fifth annual PV Module Reliability Scorecard report, the most comprehensive publicly available comparison of PV module reliability test results. Results of the 2019 PV Module Product Qualification Program has rated Adani Solar for its high-efficiency products that passed rigorous tests for quality checks. For 2019, the global solar installations are expected to cross the 120 GW mark. Growth in increased installations is driven by higher efficiency PV modules with new materials projecting higher returns and lower LCOE (Levelised Cost of Energy). The new high-efficiency PV modules such as PERC and PERT Technologies do not come with significant track records and hence, a reliability and durability testing demonstrating the lifetime warranty of the modules and its technology is vital. The annual PV Module Reliability Scorecard reports the results of PVEL's PV Module Product Qualification Program (PQP). Adani Solar has a capacity of 1.2 GW with a mix of Multi, Mono-PERC, Bifacial PV Modules and has its factory located in Mundra SEZ, Gujarat, India. It is noteworthy that Adani Solar is the only Indian BNEF Tier-1 Manufacturer with an in-house cell and module capacity with a top performer award at PVEL PQP Program. Ramesh Nair, Chief Executive Officer of Mundra Solar PV (Adani Solar) commented, "PVEL's PV Module Reliability Scorecard is an invaluable tool that developers and lender's engineers use to ensure that projects are built with reliable and durable products that would perform as expected. We at Adani Solar will continue to allocate more resources towards innovating new and high-efficiency solar technologies and their application to the market. We will continue to provide the most reliable and high-efficiency products through stringent test procedures for material selection and continual in-house reliability tests, which have also enabled us to create benchmarks for ourselves."

BHEL wins highest number of National Safety Awards

Among a host of public and private sector companies in the country, Bharat Heavy Electricals Limited (BHEL) has won the highest number nine of ‚National Safety Awards' for outstanding achievements in terms of the longest accident-free period and lowest accident frequency rate at its works. The awards were received by Dr Nalin Shinghal, Chairman and Managing Director, BHEL from Santosh Kumar Gangwar, Minister of State (Independent Charge) for Labour & Employment at a function held in New Delhi. Significantly, BHEL has been winning these prestigious national awards, instituted by the Ministry of Labour & Employment, Government of India consistently, since their inception.

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DG Market size to exceed $20bn by 2025

Growing demand for continuous power on account of unreliable supply of electricity will drive the global diesel gensets market growth.

According to the latest study by Global Market Insights, diesel generators market is set surpass USD 20 billion by 2025.

Growing demand for continuous power on account of unreliable supply of electricity will drive the global diesel gensets market growth. These units find applications across multiple industries including pharmaceutical, manufacturing, healthcare, data centers and transportation and communication amongst others. In addition, significant investments across the mining, construction and oil & gas sector will further strengthen the product adoption over the forecast timeline.

The North America diesel gensets industry share is anticipated to witness growth over 4 per cent by 2025. Rising intensity of harsh weather across the region on account of climate change will positively enhance the product penetration. Furthermore, the increasing digitalisation has resulted in the expansion and development of existing and new data centers which will further drive the industry outlook.

Diesel generators (>750kVA) market is anticipated to witness growth of over 5 per cent by 2025. Quick start-up times and optimum reliability are some of the eminent features favouring the installation of these generator sets. Ongoing expansion of commercial businesses along with surging investments toward the data center business by prominent technology companies including Google, IBM, Amazon and Apple will enhance product adoption. The growing demand to effectively manage the high-volume data creation and intensifying data protection laws are some of the key underlying factors favouring the installation of these units.

Introduction of various government funded ventures on account of supporting the significant infrastructure

expansion and industrialisation will enhance the product installation.

Europe diesel generators market is set to witness growth on account of rising infrastructural investments, increasing construction activities and low diesel prices. Rising concentration of SEZs and retail complexes will boost the product deployment as a source for backup power. Positive outlook toward investments across the industrial sector will further proliferate the business landscape. 375-750 kVA diesel generators market is expected to witness significant upsurge with growing penetration of manufacturing bases in developing nations. Industries are deploying DG sets for peak and standby applications to avoid any production losses and maintain economic balance in trade. The Middle East diesel generators market is set to witness gains with ongoing expansion of the regional industrial and commercial infrastructure. In addition, the surging tourism industry across the region has resulted in the high demand for the expansion and development of existing and new establishments owing to the rising demand for world class tourism infrastructure. This has provided the manufacturers with growth opportunities and enhance their market penetration. EI

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With the devices getting smarter, user interfaces getting IoT enabled, the surge in intelligent switchgear is the next big trend.

WHY Intelligent Switchgears?

- Subhajit Roy, Group Editor

Switchgear is an integral component in the electrical power system. A switchgear comprises devices such as disconnect switches, fuses, circuit breakers and relays that are used to control, protect and isolate an electrical equipment to enable continuous and reliable supply of electricity. Switchgear is also used to de-energise the circuits for repair, maintenance and testing purposes.

Based on the load bearing capacity, the market for switchgear in India is categorised into three segments – low voltage (LV), medium voltage (MV) and high voltage (HV). The LV switchgear segment includes switchgear rated up to 1 kV, MV switchgear segment

consists of switchgear rated up to 33 kV whereas the HV switchgear segment includes devices rated at 66 kV and above.

According to a latest study by Global Market Insights, Inc, the global switchgear market size is projected to exceed US$ 140 billion by 2024 on account of rising investment towards the infrastructure development across developing economies.

Switchgear is the second biggest segment in the Indian electrical equipment industry. The Indian switchgear market is expected to grow at a CAGR of over 15 per cent through 2023 thanks to rising development across residential, commercial and industrial end-use sectors, reported ResearchAndMarkets.

Moreover, rapid expansion of transmission and distribution networks together with increasing electricity consumption due to rising per capita income is further fuelling growth in Indian switchgear market. As per IEEMA, the present size of the LV switchgear industry including domestic modular switches is estimated at around Rs. 11,050 crore.

What makes switchgear intelligent

Like every other industry, power sector too is going through a sea change. Internet of Things (IoT) is transforming the power sector and revolutionising nearly every part of this industry from generation, transmission to distribution, changing how energy companies and consumers interact. Today, powered by connected and software enabled solutions, the switchgears are turning inherently intelligent, allowing for predictive maintenance. Thus, the failures and downtime are minimised.

An intelligent switchgear can overcome the disadvantages of common electric switchgear by utilising efficient internal computer technology to perform functions as system diagnosis, electric fire prediction prevention and electric power demand prediction.

SHRINIVAS CHEBBI, PRESIDENT – POWER PRODUCTS, SCHNEIDER ELECTRIC-INDIA

"A smart and intelligent switchgear is a term given to programmable power distribution solutions that are equipped with self-monitoring features. The technology plays a major part in making such products intuitive and user-friendly. Such intelligent devices when combined with IoT form a base for enhanced protection, control and monitoring," describes Shrinivas Chebbi, President – Power Products, Schneider Electric India while commenting on what makes switchgear intelligent.

Sameer Saxena, Director Marketing, Legrand (Group) India, says, "Intelligent switchgears are able to garner scenarios and conditions-based responses like: to automate non-critical load shedding to better manage electricity usage and reduce costs, zone selectivity to reduce the stress on electrical distribution equipment during short-circuit or ground-fault conditions, and raise pre-trip alarms. These switchgears are embedded with intelligent electronic devices and are pre-programmed for remote monitoring and communication of key electrical parameters."

Why it is essential to have intelligent switchgears

According to Mr Chebbi, an intelligent switchgear can overcome the disadvantages of common electric switchgear by utilising efficient internal computer technology to perform functions as system diagnosis, electric fire prediction prevention and electric power demand prediction. They also help in detecting electric sparks that can cause electrical fires and predict monthly power demand in a load network. They can also recognise patterns and predict failures on advance, thereby reducing downtime and saving costs.

Mr Saxena states that intelligent switchgears will have a great impact on electrical distribution and will be the next disruptive force. The switchgear industry will witness the impact in two ways:

- Entire manufacturing process and its device becoming increasingly intelligent. Digital manufacturing helps to enhance efficiency, fight scale advantage of some other manufacturing countries,

minimise manufacturing defect and shorten production time.

- Installing digital switchgear will contribute greatly to increasing operational efficiency. It will also help in self-monitoring and diagnostic of the switchgear by way of which the reliability can be enhanced.

Today switchgear maintains a history of various fault conditions and triggers to alarms for parameters critical to high system and switchgear reliability. This not only provides an avenue to optimise the system but also helps to take actions that enhance the uptime and reliability of the switchgear installed. This will enable companies to achieve improved efficiency and cost outcomes, opines Mr Saxena. He said, "Data will be accessible in real-time, enabling the ability to resolve critical issues and increase competency."

How to make an aging electrical switchgear smarter

Aging equipment exist in many industries and facilities. Through modernisation, the existing equipment can be brought into the digital world and offer full benefits of a smart switchgear. According to Mr Chebbi, this conversion can be completed at a fraction of the costs compared to complete replacement with new equipment.

There are many devices and solutions that can easily be integrated into the existing electrical equipment and deliver smart systems capabilities. Some of the examples are as follows:

- **Upgrading of breakers:** Replacing existing circuit breakers that offer trip units with modern day communication capable and other power monitoring capabilities allow the breakers to be integrated into an existing or new smart system network.
- **Installing thermal sensors:** By integrating thermal sensors in the equipment, temperatures of bus connections and cable connections can be monitored remotely allowing customers the capability to plan ahead for any maintenance required and avoid any possibly arc flash issues due to degradation of the material.
- **Installing partial discharge monitoring:** Partial discharge or degradation of insulation material in medium voltage equipment is one of the leading issues contributing too many arc flash incidents. Having the capability to remotely monitor this helps ensure that equipment is properly maintained and upgraded at appropriate times.
- **Installing humidity monitoring:** Humidity monitoring sensors that allow communication to any existing management system can easily be installed to any existing electrical switchgear line-up.
- **Relay upgrades:** With smart relays auto transfer systems can be easily monitored and controlled from a remote site, limiting exposure to facility maintenance employees to possible arc flash incident energy by having to take measurements in front the switchgear.
- **Upgrade existing buildings** to comply with new safety expectations and regulations especially when the fire data in buildings and national human loss data due to fire is driving a serious demand to upgrade existing switch gear of old buildings etc

Intelligent switchgears will have a great impact on electrical distribution and will be the next disruptive force.

SAMEER SAXENA, DIRECTOR MARKETING, LEGRAND (GROUP) INDIA

Emerging trend in increased usage of intelligent switchgear

Mr Saxena acknowledges that the future of switchgear is intelligent. He said, "Over the past few years, several technological solutions have emerged that have contributed significantly to enhancing the operational efficiency of utilities and to scaling down costs, making projects more viable."

With the devices getting smarter, user interfaces getting IoT enabled, the surge in intelligent switchgear is the next big trend. There is a need for centralised control enabled by intelligent switchgear for smart cities. There may be a time when all switchgears will be connected to IoT and communication capable. EI

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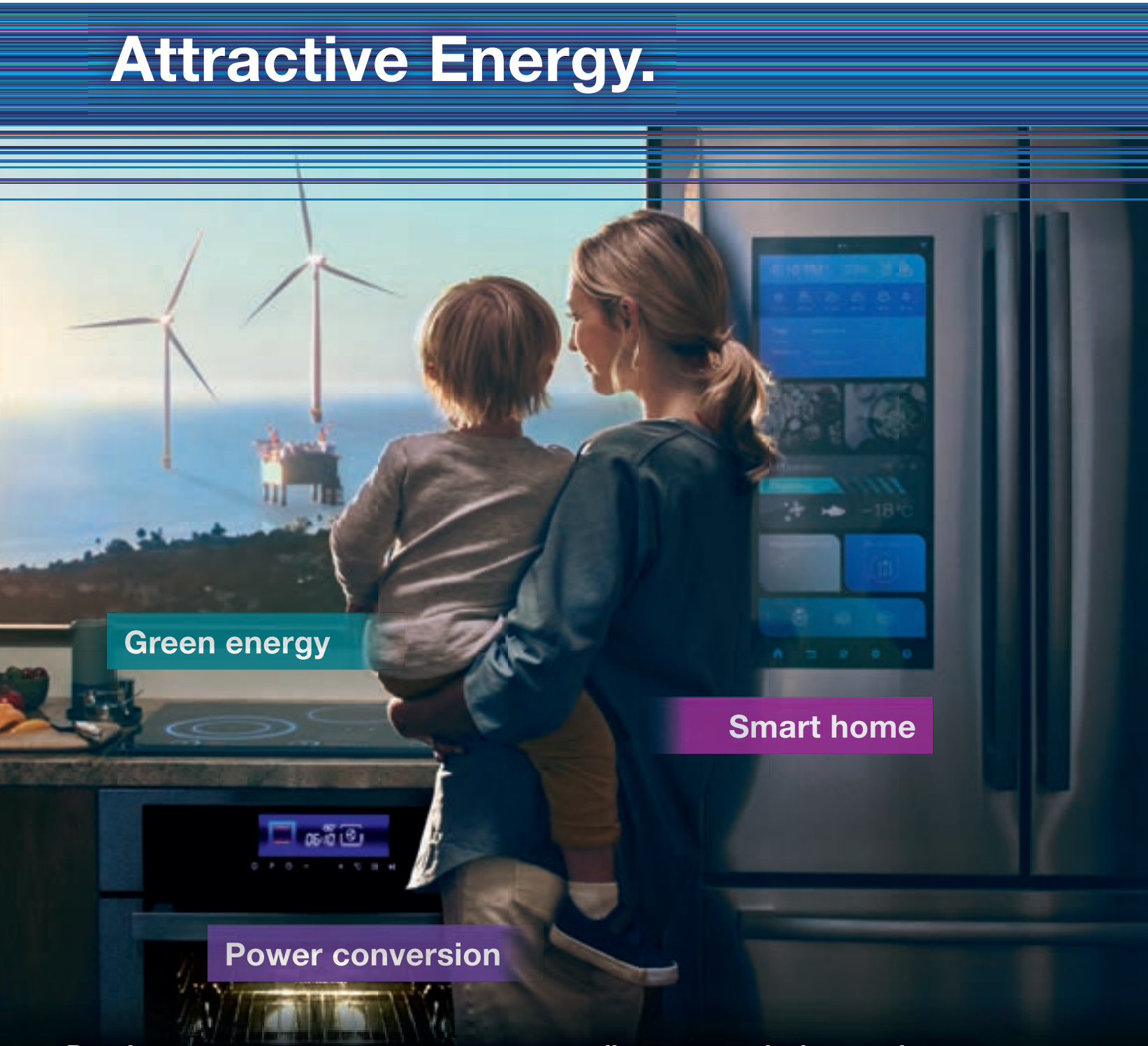

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LOAD BREAK SWITCH: EVALUATION OF BREAKING & MAKING CAPABILITIES

Among several switching devices largely used in medium voltage distribution systems, which change the grid configuration, isolates faulty parts from the grid, etc. Load break switch is a remarkable one. For the reason to analyse the interrupting capabilities, load break switch rated up to 52kV has to undergo various test duties according to IEC 62271-103. This article focuses on the parameters involved in evaluation of its behaviour during make-break tests.

Ascending changes in the way we generate, transmit and use of electricity in developed economy or highly industrialised society, prioritised the maintenance of continuity of supply to consumers. With the goal to be integrated in smart cities, the safety of electrical equipment by fast disconnection of the power supply in case of fault events like leakage current, electrical arc, over current or overvoltage is taken care through switchgear such as disconnecting switches, circuit breakers, etc. For the systems up to 33kV, the more costly circuit breakers are getting replaced with load break switches. A load break switch is a type of switching device used for voltages in the range of 12 to 36 kV and must have the following capabilities:

- Interruption of current equal to its continuous current rating at the system voltage and the power factor of the normal load
- Designed to possess enough insulation to isolate the circuit in closed position.
- Interrupting small capacitive and inductive currents which is essential for disconnecting the unloaded overhead lines, transformers, cables, etc.
- Carrying the maximum fault current for the duration required by the interrupting device to clear the fault.
- Making on the terminal fault at rated voltage.

The basic functional difference between Load break switch and circuit breaker is that the former cannot interrupt the short circuit currents. The following figure 1 shows the how the load break switches are employed in a substation.

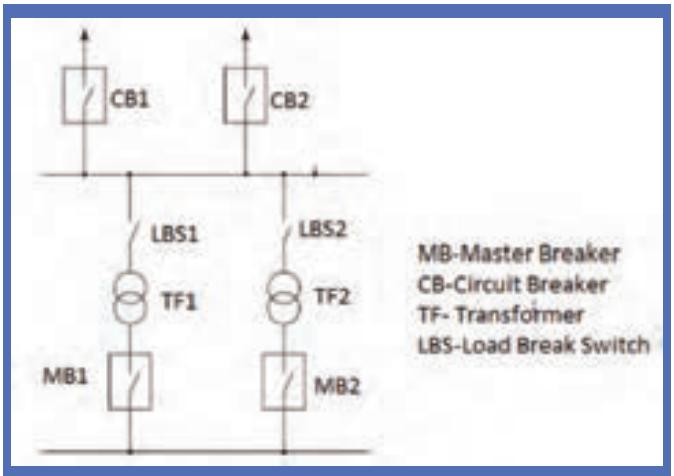


Figure 1: Line diagram for Load break switch at substation

Load Break Switch

The AC high voltage load break switch is used in indoor or outdoor medium voltage systems at rated frequency 50/60 Hz. The load break switch is generally composed of disconnect blade, arc extinguishing chamber and operating mechanism. The arc extinguishing chamber will be made of insulating material with merits of high dielectric performance, and arc-endurances.

Generally, two types of load break switches (LBS) have been developed namely air-blast and SF6.In air-blast type, the interrupter heads same as those of used for isolation purpose in air-blast circuit breakers are employed for making and breaking currents. In SF6 type LBS, the gas serves as insulating and arc quenching medium.

The three-phase load break switch is installed on one sectional galvanized steel base, joint together with one drive axis to ensure closing and opening of three poles synchronously. The switch opens or closes under rated load current, without requiring any secondary protection device.

Load break switch switches the current by mechanically moving their contacts with an appropriate speed in order to make (close) or break (open) the current. It is exposed to mechanical, thermal and dielectric stresses during switching operation. Hence, for investigating and in detail exploring the interrupting capabilities of load break switch, they need to undergo various test duties according to IEC 62271-103. The essential parameters that are taken into consideration for analysing the behaviour of the load break switch during breaking tests are the current levels and the transient recovery voltage (TRV). The following figure 2 shows the load break switch tested at CPRI, Bhopal.

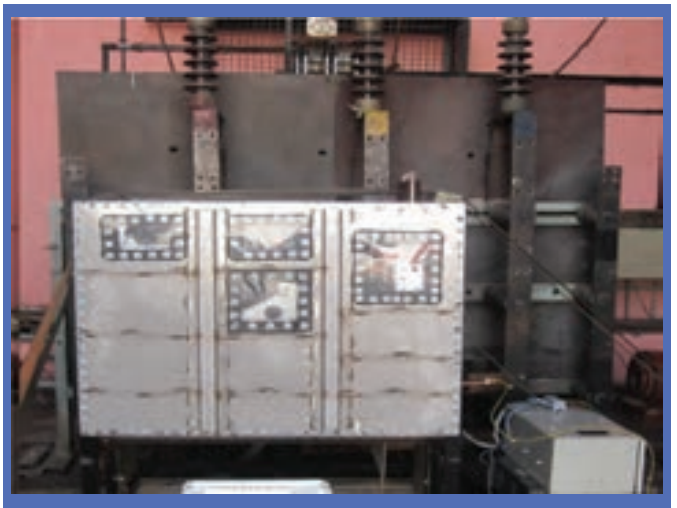


Figure 2 Load break switch of 12kV, 630A, SF6 gas insulated type Ring Main Unit tested at CPRI

Role of CPRI

CPRI is a pioneer testing organisation in India with six decades expertise in the short circuit and dielectric testing, short circuit design data reviews, quality control checks and stage inspection of various power system equipment. CPRI is continuously engaged in testing of various types of switchgear equipment from last six decades and issuing test certificates and test reports as per national and international standards.

To prove the satisfactory performance of the load break switch, various test duties have been carried out as specified in the international standards. Several

load break switches of rated voltage upto 12kV, and of current rating 200A, 400A, 630A, etc of various manufacturers have been tested at CPRI, Bhopal.

Test Duties

The following table 1 indicates the various test duties that a load break switch has to be undergone according to IEC 62271-103 to verify the breaking and making capabilities.

Make-break operating cycles shall be carried out for test duties TDload, TDloop, TDcc, TDlc, TDef1 and TDef2. The opening operation shall follow the closing operation with a time delay between the two operations at least sufficient for any transient currents to subside.

Table 1: Test duties for make-break tests

Test duty		Test Voltage	Test Current	Number of cycles of operations		
Description	TD			Class E1	Class E2	Class E3
Mainly active load current	TD_{load2} TD_{load1}	U_r	I_{load}	10	30	100
			$0,05xI_{load}$	20	20	20
Closed-loop distribution circuit current	TD_{loop}	$0,20xU_r$	I_{loop}	10	20	20
Cable-charging current	TD_{cc2} TD_{load1}	U_r	I_{cc}	10[a]	10[a]	10[a]
			$0,1\text{-}0,4xI_{cc}$	10[a]	10[a]	10[a]
Line-charging current	TD_{lc}	U_r	I_{lc}	10[a]	10[a]	10[a]
Short-circuit making current	TD_{ma}	U_r	I_{ma}	2 making operations	3 making operations	5 making operations
Earth fault current	TD_{ef1}	U_r	I_{ef1}	10	10	10
Cable and line-charging current under earth	TD_{ef2}	U_r	I_{ef2}	10	10	10

[a] In the case of the switch is defined as a class C2 switch and if one restrike occurs during the test series, 6.101.8 is applicable

Table 2: Tolerances to be maintained during Test duties for make-break tests

Make-break tests	Test quantity	Specified value	Tolerance
Frequency	Test frequency	Rated frequency	±8%
Test voltage for breaking tests	Test voltage for breaking tests	As specified in table 1	0 to +10%
Breaking current	DC component at instant of interruption		≤20%
	AC component of test current in any phase		±10%
Mainly active load current test	Power factor of supply circuit	≤0.2	
	Impedance of supply	0.15 of total impedance of test circuit	0.12 to 0.18
	Power factor of load	0.7	0.65 to 0.75
	Test voltage	Rated voltage	0 to +10%
	I_{load2}	Rated active load breaking current, I_{load}	0 to +10%
	I_{load1}	$0.05^* I_{load}$	-10 to +10%
Closed loop switching tests (Distribution line switching tests (TD_{loop}))	Power factor	≤0.3	
	Closed loop current	Rated closed loop breaking current I_{loop}	0 to +10%
Capacitive current switching tests	Cable charging current I_{cc2}	Rated cable charging current, I_{cc}	0 to +10%
	Cable charging current I_{cc1}	$(0.1 \text{ to } 0.4)^* I_{cc}$	
	Line charging current I_{lc}	Rated line charging current	0 to +10%
Short circuit making tests	Test voltage	Rated voltage	0 to +10%
	making current I_{ma}	Rated short circuit making current	0 to +5%

Mainly active load circuit (test duty TDload)

The rated mainly active load-breaking current is the maximum mainly active load current that the switch shall be capable of breaking at its rated voltage. The current to be interrupted shall be symmetrical, but at the instant of interruption the value of the dc-component of the breaking current is considered negligible as it is equal to or less than 20 per cent as stated in table 2. When Iload flows through load break switch, the current carrying parts of the device will be subjected to thermal and mechanical stresses. When this current is interrupted by the switch, fast rising voltage appears across its contacts called as transient recovery voltage. This test duty is conducted so as to analyse the load-breaking capability of the switch and withstand capability of the peak of transient recovery voltage after the current interruption. The circuit needed for this test duty on load break switch is shown in figure 3.

The parameters and their tolerances that are used for conducting this test duty are listed out in table

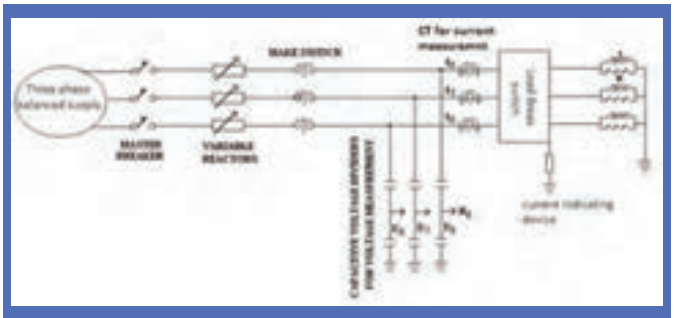


Figure 3: Test circuit for mainly active load current test duty

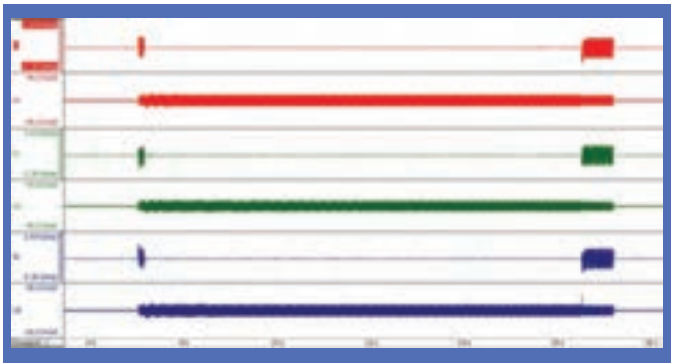
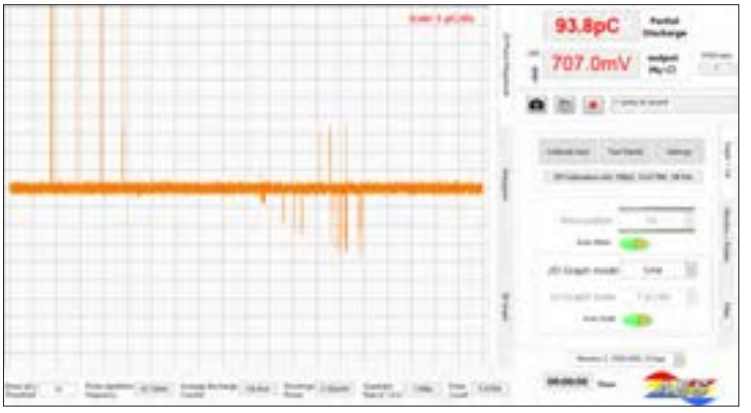


Figure 4: Break-make operation on 12kV, 630A Load break switch during mainly active load current test duty TDload2

Continued on page 36

Partial Discharge Measurement System



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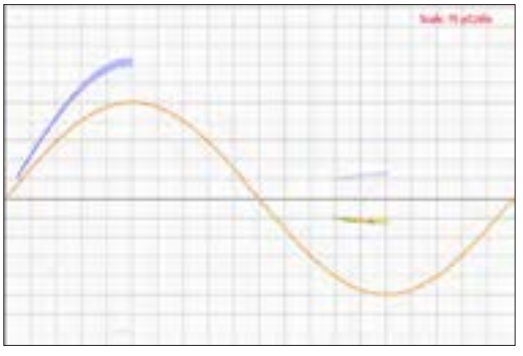

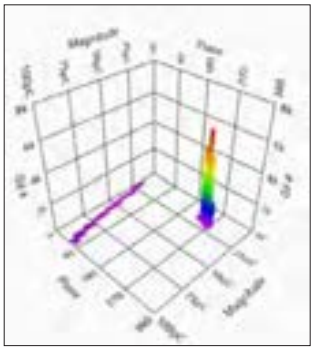

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Continued from page 34

1 and 2. The following figure 4 indicates a recording of break-make operation on 12kV,630A Load break switch during mainly active load current test duty TDload2.

Closed loop switching tests

Closed loop breaking capacity is breaking capacity when opening a closed-loop distribution line circuit, or a power transformer in parallel with one or more power transformers (as shown in line diagram of figure 1), i.e., a circuit in which both sides of the switch remain energised after breaking. So, to analyse this breaking capability, TDloop test duty is conducted on the Load break switch with the parameters and tolerances as listed in table 1 and 2.

Capacitive current switching tests

When an unloaded transmission line, cables, etc are suddenly opened, interruption of capacitive currents causes excessive voltage surges which will stress the insulation medium of the switching device. So, when load break switch interrupts line charging capacitive current, to analyse its interrupting capability line charging current test duty (TDlc) and to analyse breaking of cable charging current capability, cable charging current test duties (TDcc1 and TDcc2) is conducted. The parameters and their tolerances that are used for this conducting this test, are listed out in table 1 and 2.

Short-circuit making tests

The load break switch sometimes, closes on to an existing fault. In such cases, maximum peak of first major current loop of the current in a pole of a switch during the transient period following the initiation of current during a making operation will be observed. The load break switch must be able to close without hesitation as contacts touch and must be able to withstand the high mechanical forces during such closure.

Short-circuit making tests shall be performed on a switch which has been subjected to at least 10 make-break operating cycles at 100 per cent mainly active load as required for test duty TDload.

For class E1 switches, the tests shall be performed with a sequence of two C operations with a no-load O in between, i.e. C – O (no-load) – C.

For class E2 switches, the test sequence is 2C – x – 1C.

For class E3 switches, the test sequence is 2C – x – 1C – y – 2C, where x represents arbitrary switching tests, or even no-load tests.

The switch shall be able to make the current with pre-arcing occurring at any point on the voltage wave. Two extreme cases are specified as follows:

- Making at the peak of the voltage wave, leading to a symmetrical short-circuit current and the longest pre-arcing time;
- Closing at the zero of the voltage wave, without pre-arcing, leading to a fully asymmetrical short-circuit current. During the short-circuit making tests series, both requirements a) and b) shall be met once for class E1 switches, once for class E2 switches and twice for class E3 switches.

The circuit needed for this test duty on load break switch is shown in figure 5. The parameters and their tolerances that are used for this conducting this test, are listed out in table 1 and 2.

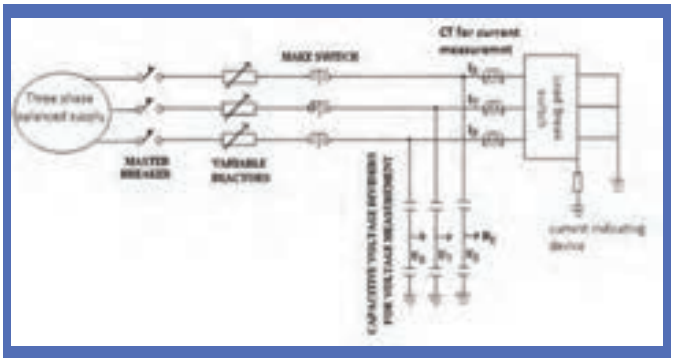

Figure 5: Test circuit for short circuit making test duty

The following figure 6 indicates a recording of make operation on 12kV, 630A Load break switch during short circuit making test duty for a making current of 25kA.

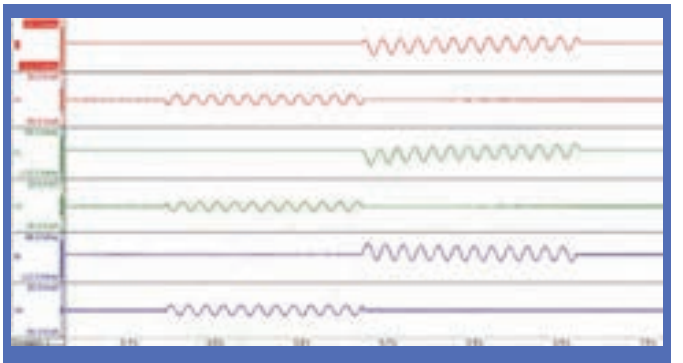

Figure 6: make operation on 12kV, 630A Load break switch during short circuit making capacity test duty.

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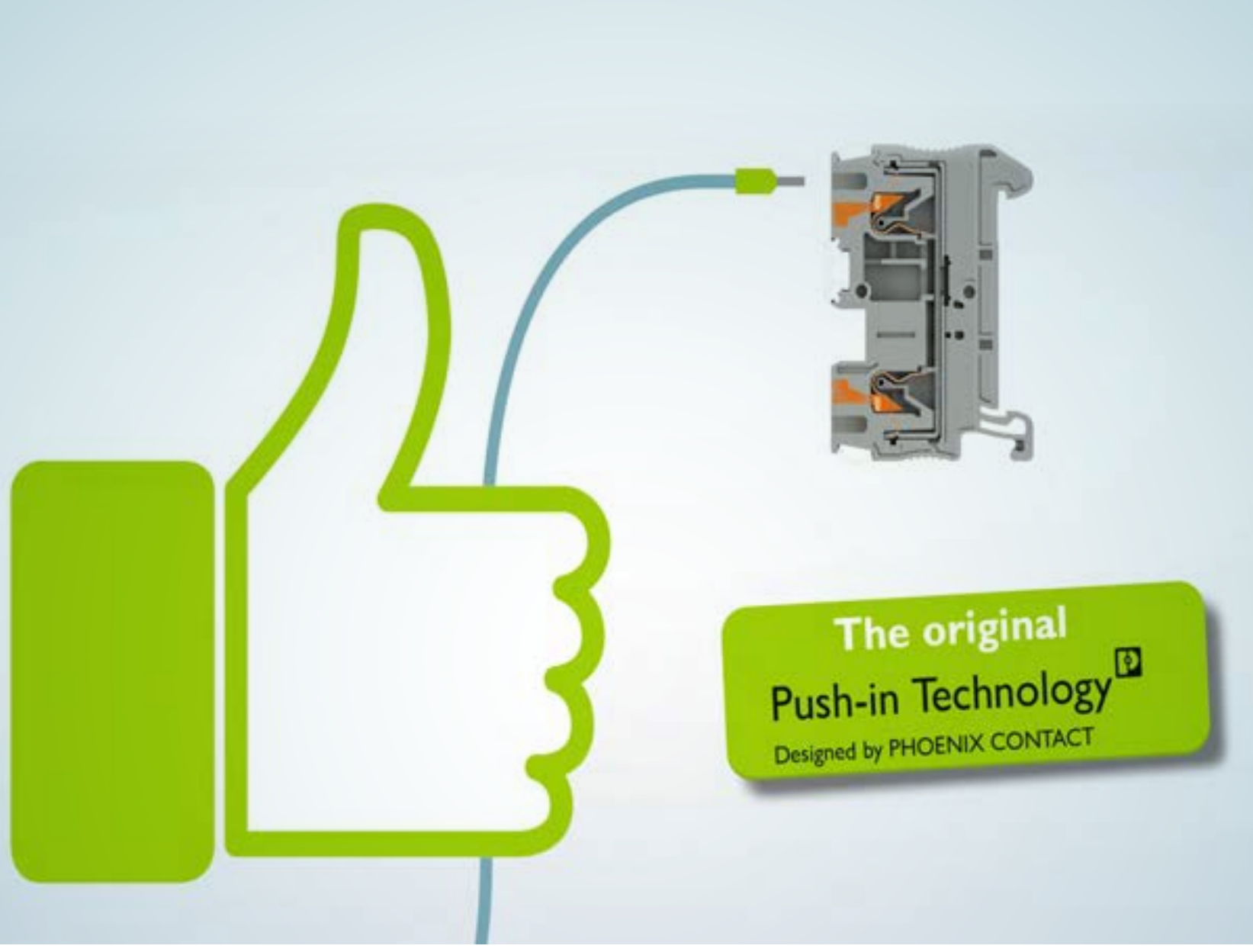

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Continued from page 36

Behaviour of switch during breaking tests

- The switch shall perform successfully without evidence of mechanical or electrical distress.
- There shall be no flame or material ejected from the switch, that may be harmful to operating personnel.
- For capacitive current breaking tests, re-strikes are permitted during switching for class C1 switches.
- For class C2, if one single re-strike occurs along an entire specific series of capacitive switching, for example test duties TDcc1 and TDcc2 for cable charging current, the number of operations as indicated shall be doubled for this test series. The additional operations shall be performed on the same switch and without any maintenance or reconditioning in between. The requirements for class C2 are still fulfilled, if no further re-strike occurs. A re-ignition followed by interruption at a later current zero shall be treated as a breaking operation with long arcing time.
- There shall be no significant leakage current to the earthed structure or screens, such as to endanger an operator or damage insulation materials.
- There shall be no outward emission of flame or metallic particles from the switch during operation such as might impair the insulation level of the switch.
- NSDD (Non-sustained disruptive discharge) may occur during the recovery voltage period following a breaking operation. However, their occurrence is not a sign of distress of the switching device under test. Therefore, their number is of no significance to interpreting the performance of the switch under test.

Condition of switch after breaking tests and short-circuit making tests

- After performing the specified breaking tests on one sample and after test duty TDma, the mechanical function and the insulators of the switch shall be in practically the same condition as before the tests.
- The requirement of being capable of carrying its rated normal current is considered met if one of the following criteria is satisfied:
  - Visual inspection of the main contacts shows evidence of their good condition; or if impracticable or unsatisfying,
  - The resistance measured, as close as possible to the main contacts, does not exhibit an increase of more than 20 per cent compared with resistance measured before the test. Before measurement of contact resistance, a maximum of 10 no-load operations may be done, or if the condition of b) is not satisfied
- A test under rated thermal maximum current demonstrates that no thermal runaway occurs, by monitoring the temperature at the points where resistance measurement were made until stabilization, and that the limits of temperature and temperature rise are not exceeded. During this test, no other temperature measurement is made inside of the switching device. If the stabilisation cannot be obtained, or the temperature and temperature rise are exceeding the limits, then the condition check has failed and the switch is considered to have failed the test duty as well.

Conclusion

In the testing laboratory, the source has to supply high fault current and fast rising TRVs to evaluate the load break switch performance. The guidelines for setting the fault current magnitude and Transient Recovery Voltage parameters are given in IEC standard 62271-103. These parameters represent the most onerous system conditions.

The medium voltage switchgear manufacturers in and around central part of our country and other places utilise CPRI, Bhopal laboratory for circuit breaker certification and development. This facility is a boon for developing not only load break switch and other switchgear equipment like fuses, disconnectors, earth switches, circuit breakers and lightning arresters etc.

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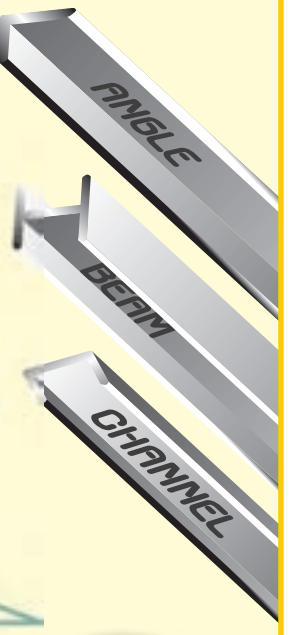

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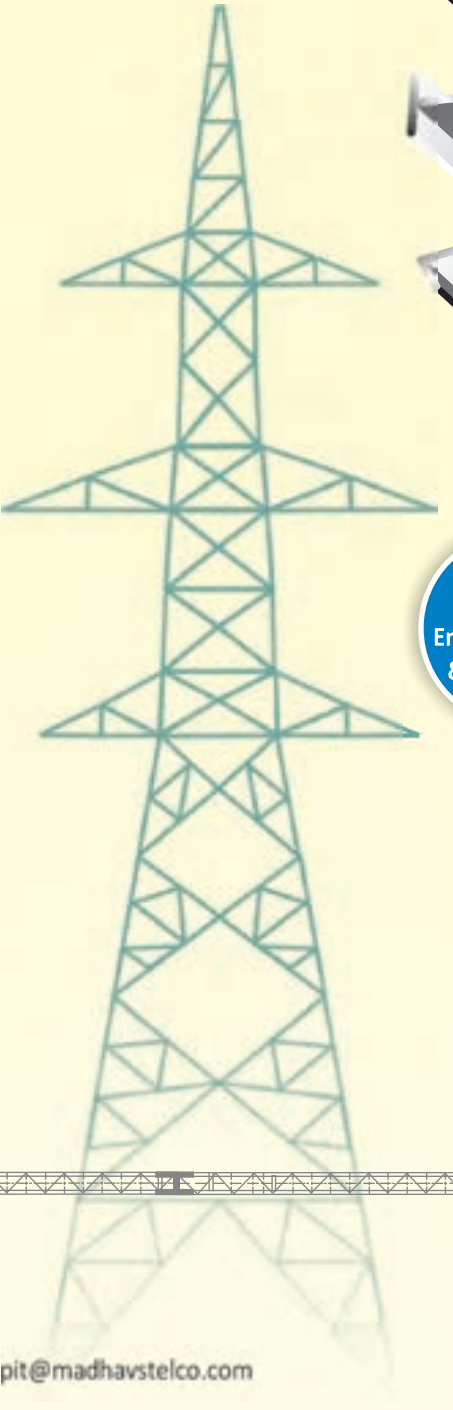

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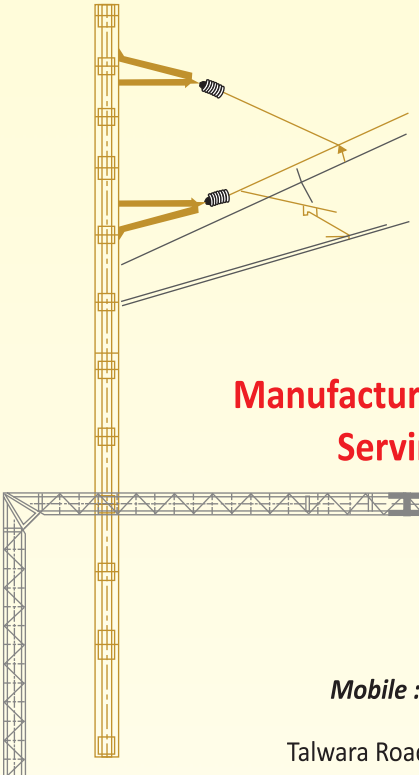

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MOTOR
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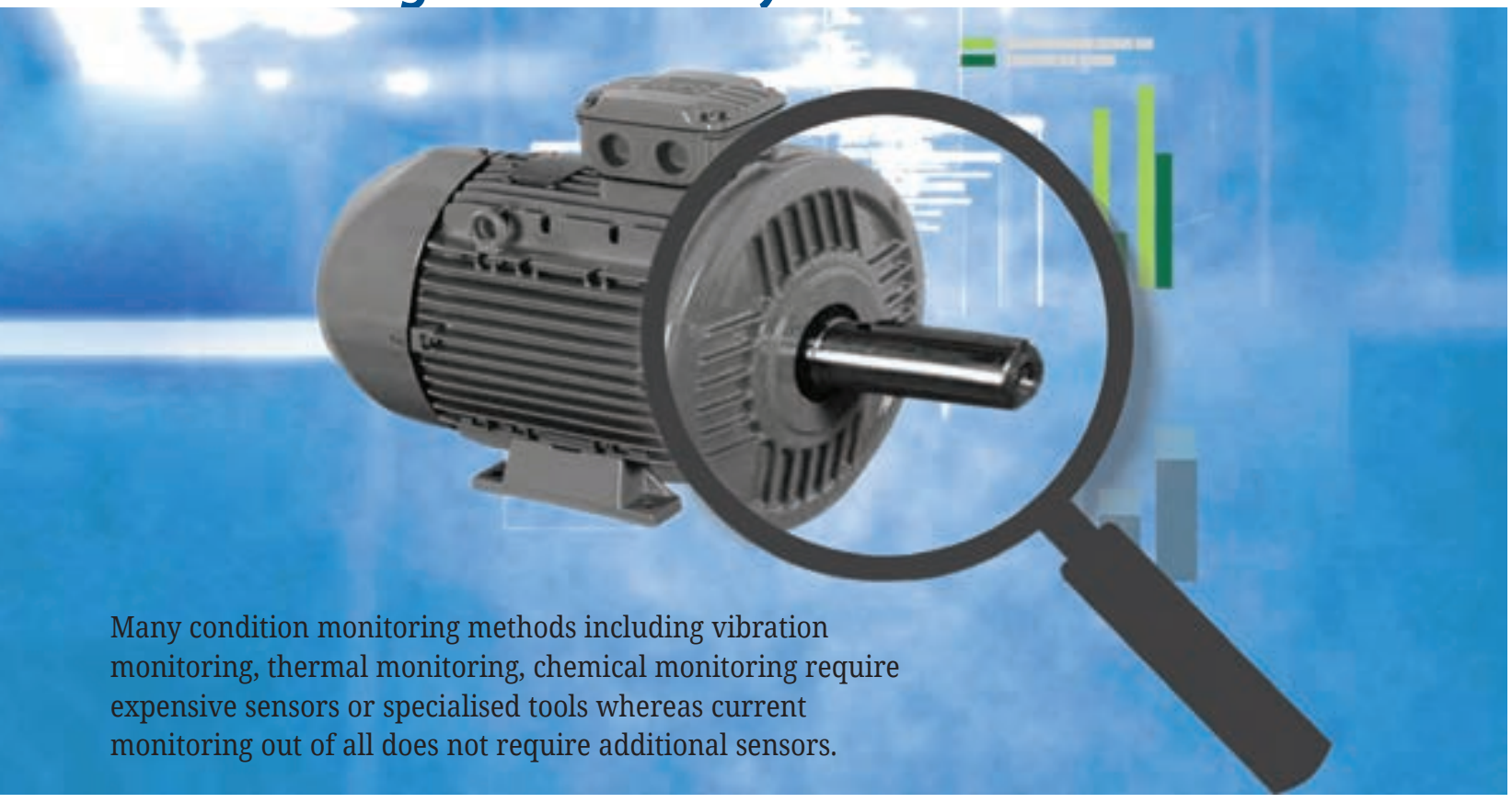

Many condition monitoring methods including vibration monitoring, thermal monitoring, chemical monitoring require expensive sensors or specialised tools whereas current monitoring out of all does not require additional sensors.

Induction motors are widely used in industrial drives because they are rugged, reliable and economical. They became an industry workhorse and play a pivotal role in industry for conversion of electrical energy into mechanical energy. Online fault diagnostics of these machines are very important to ensure safe operation, timely maintenance, increased operation reliability. There are many published techniques and commercially available tools to monitor induction motors to ensure a high degree of reliability. In spite of these tools, many companies are still faced with unexpected system failures and reduced motor lifetime. There are many condition monitoring methods including vibration monitoring, thermal monitoring, chemical monitoring, but all these monitoring methods require expensive sensors or specialised tools whereas current monitoring out of all does not require additional sensors.

Basics of Motor Current Signature Analysis

Motor Current Signature Analysis (MCSA) is a technique used to determine the operating condition of induction motors without interrupting production. Motor current signature analysis is that it is sensing an electrical signal that contains current components. MCSA

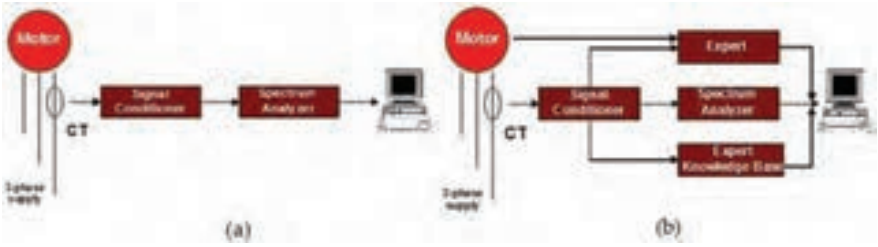

Figure (a) & (b) Basic System for MCSA

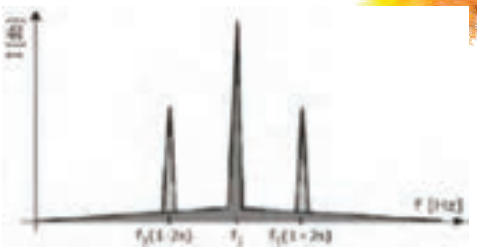
Figure (c) Idealised current spectrum

detect the faults at an early stage and avoid the damage and complete failure of the motor. Proper analysis of MCSA results assists in identifying:

1. Rotor bar damage
2. Misalignment/ unbalance
3. Foundation looseness
4. Static eccentricity
5. Dynamic eccentricity
6. Stator mechanical /electrical faults
7. Defective bearings
8. Coupling health, including direct, belted and geared systems
9. Load issues

The current signal is acquired from one phase of the motor supply (at motor terminal box, or at local electric panel) without interruption of the machine operation. In MCSA, the current signal is processed to obtain the frequency spectrum usually referred to as current signature. The MCSA uses this current spectrum of the machine for locating fault frequencies. When fault present, the frequency spectrum of the current becomes different from healthy motor.

The signal processing techniques are used for condition monitoring and fault detection of induction motor. The signal processing techniques have advantages that these are not computationally expensive, and these are simple to implement. By using MCSA , accurate analysis of fault is possible. An idealized current spectrum is shown in Fig (C).

Usually a decibel (dB) versus frequency spectrum is used in order to give a wide dynamic range and to detect the exclusive current signature patterns that are characteristic of different faults. The most common faults are bearing faults, stator faults, rotor faults and eccentricity or any combination of these faults. When analyzed statistically, about 40 per cent of the faults correspond to bearing faults, 30-40 per cent to stator faults, 10 per cent to rotors faults, while remaining 10 per cent belong to a variety of other faults. Frequencies induced by each fault depend on the particular characteristic data of the motor (like synchronous speed, slip frequency and pole-pass frequency) as well as operating conditions.

Types of Faults Detected using MCSA

Bearing Faults

Rolling element bearings generally consist of two rings, an inner and an outer, between which a set of balls or rollers rotate in raceways. Under normal operating conditions of balanced load and good alignment, fatigue failure begins with small fissure, located between the surface of the raceway and the rolling elements, which gradually propagate to the surface generating detectable vibrations and increasing noise levels. Motor bearings faults are more difficult to detect than rotor cage problems. Misalignments are common result of defective bearing installation. MCSA can detect bearing faults by detection of frequency components f 0 and f 1 that are for most bearings with between six and twelve balls , determined by following equations (a) and (b) respectively.

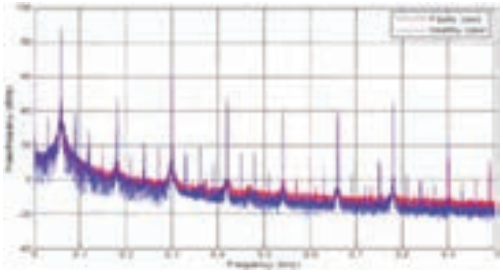
Figure 1: Current spectrum for bearing at faulty and healthy conditions

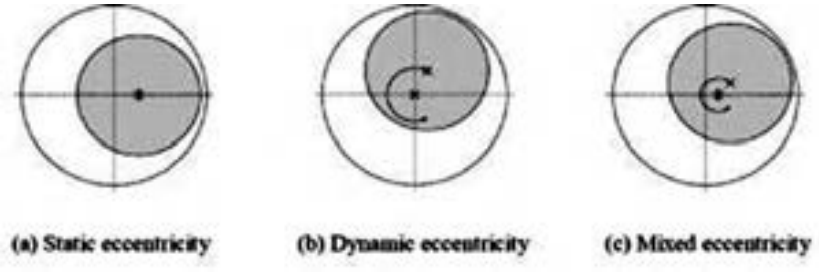

Figure 2: Schematic representation of Static, Dynamic and Mixed eccentricity

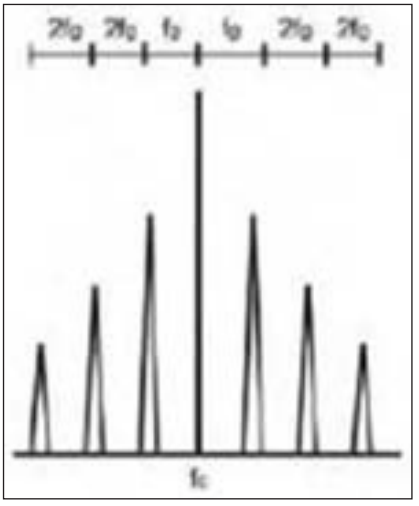

Figure 3: Air Gap-Static eccentricity

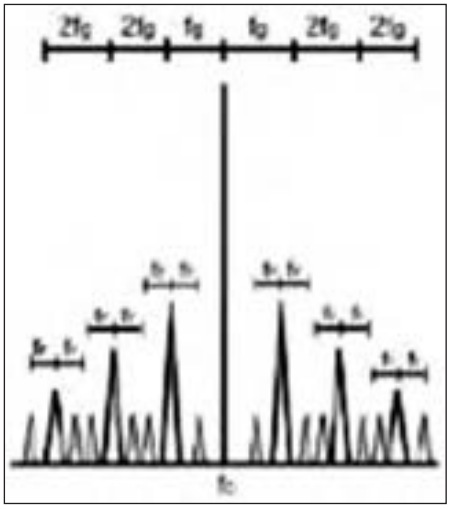

Figure 4: Air Gap-Dynamic eccentricity

f0 = 0.4 frm (a)
f1 = 0.6 frm (b) where ,
f0 is lower frequency,
f1 is upper frequency,
n is the number of balls in the bearings frm is the rotor's mechanical frequency

Air-Gap Eccentricity

Air-gap eccentricity leads to an air-gap length that is no longer constant with respect to the stator circumference angle and/or time. Air-gap eccentricity represents a condition when air gap distance between the rotor and the stator is not uniform. In general, three types of air-gap eccentricity can be distinguished as shown in fig:2

a. Static eccentricity: The rotor geometrical and rotational centers are identical, but different from the stator center. The point of minimal air-gap length is stationary with respect to the stator. In case of static eccentricity, the position of minimal radial air gap is fixed.

b. Dynamic eccentricity: The rotor geometrical center differs from the rotational center. The rotational center is identical with the stator geometrical center. The point of minimal air-gap length is moving with respect to the stator. in case of dynamic eccentricity position of minimal air gap follows turning of the rotor.

c. Mixed eccentricity: The two effects are combined. The rotor geometrical and rotational center as well as the stator geometrical center is different.

Air gap eccentricity may result from the assembly and manufacturing processes. For example, static eccentricity is caused by manufacturing tolerances between the center of the stator bore and bearing centers.

$$f_{ec} = f_g\left\{(R \pm n_d)\left(\frac{1-s}{p}\right) \pm n_{ws}\right\}$$

fec is eccenticity frequency
fg is electrical supply (grid) frequency
R is the number of rotor bars
s = slip
p = pole-pairs *nd* = ±1
nws = 1, 3, 5, 7 …

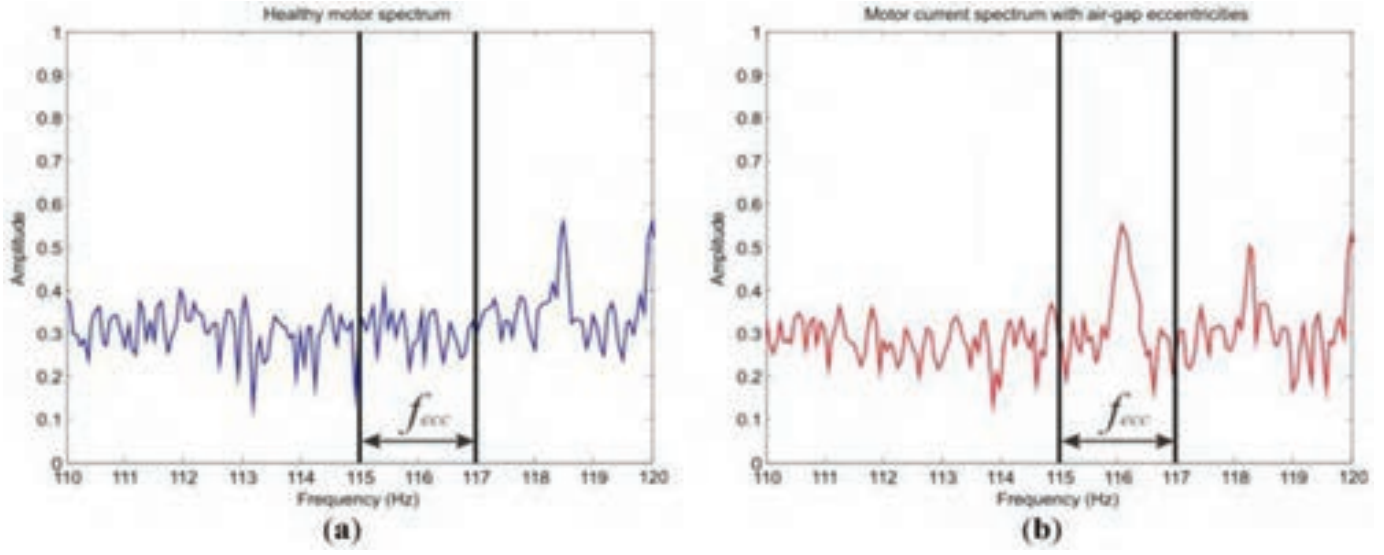

Figure 5: Motor Current Spectrum (a) Healthy Motor & (b) Motor with Air-gap Eccentricity

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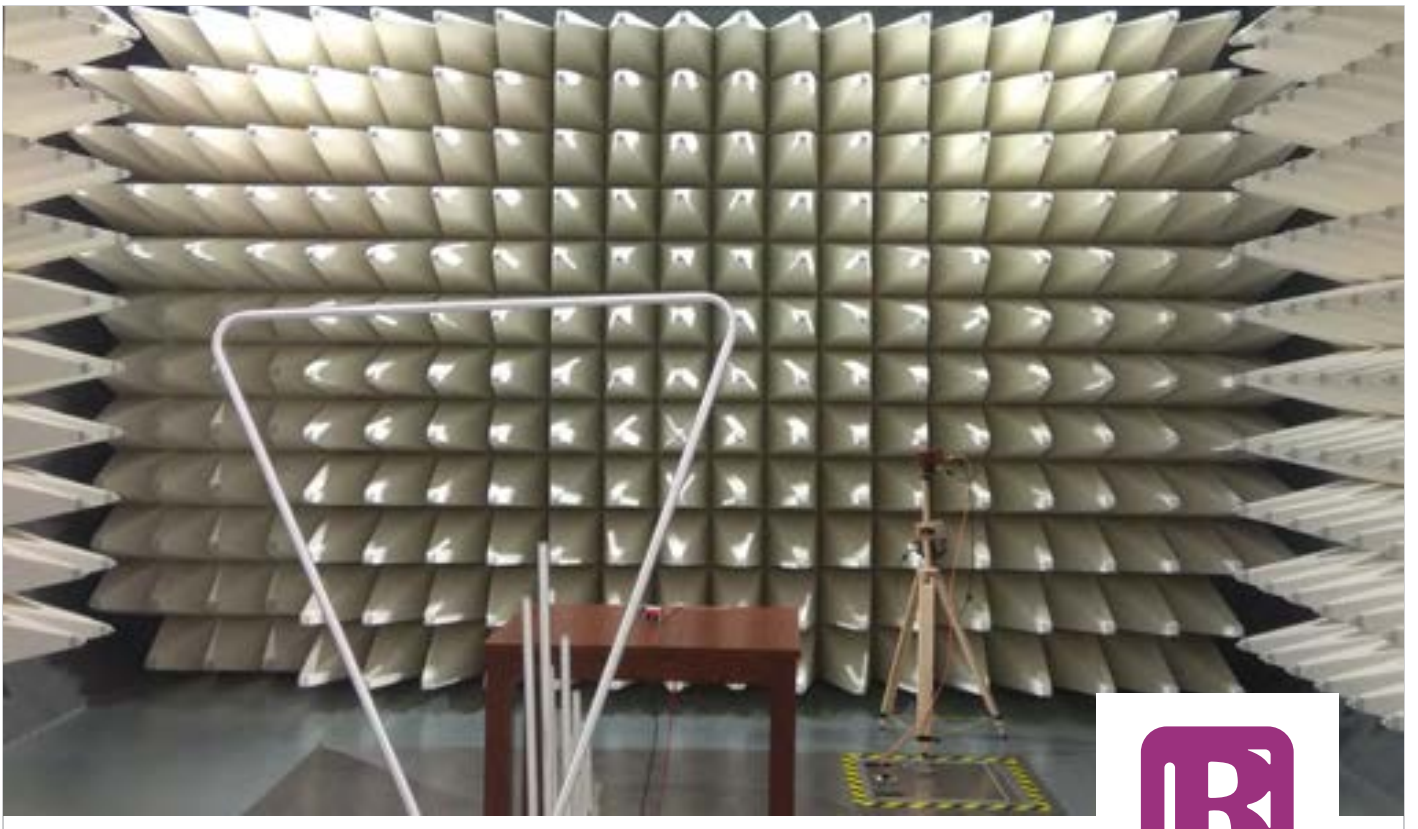

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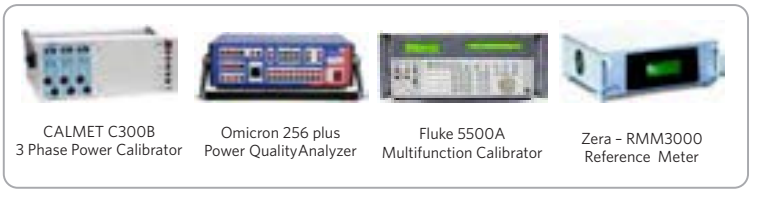

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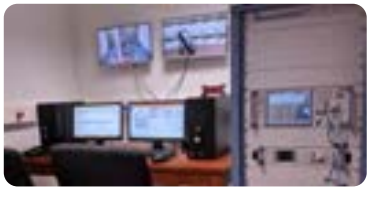

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Continued from page 42

The slip is determined from

$$s = \frac{N_s - N_r}{N_r}$$

where,

s is per unit slip

Nr is rotor speed

Ns is synchronous speed

Central frequency fc on Figures 3 and 4 is determined by where *R* is the number of rotor bars.

$$f_c = Rf_g$$

When dynamic eccentricity is present, frequency components from static eccentricity are further modulated with the rotational frequency fr, as shown in Figure 4.

Broken Rotor Bars

Broken rotor bars can be a serious problem with certain induction motors due to arduous duty cycles. Although broken rotor bars do not initially cause an induction motor to fail, there can be serious secondary effects. The fault mechanism can result in broken parts of the bar hitting the end winding or stator core of a high voltage motor at a high velocity. This can cause serious mechanical damage to the insulation and a consequential winding failure may follow, resulting in a costly repair and lost production. Broken rotor bars or end rings can be caused by the following:

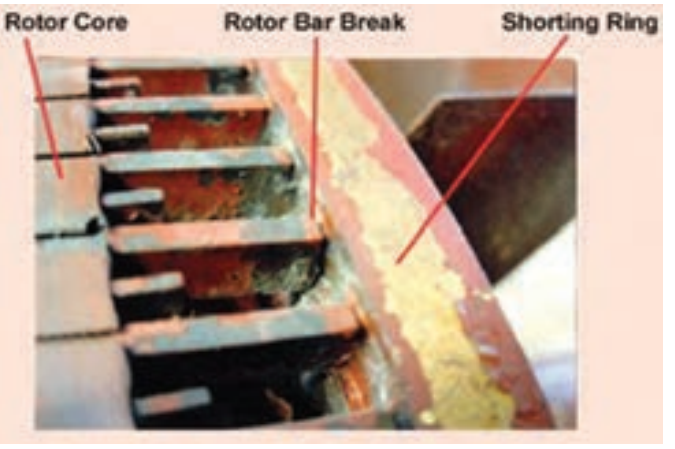
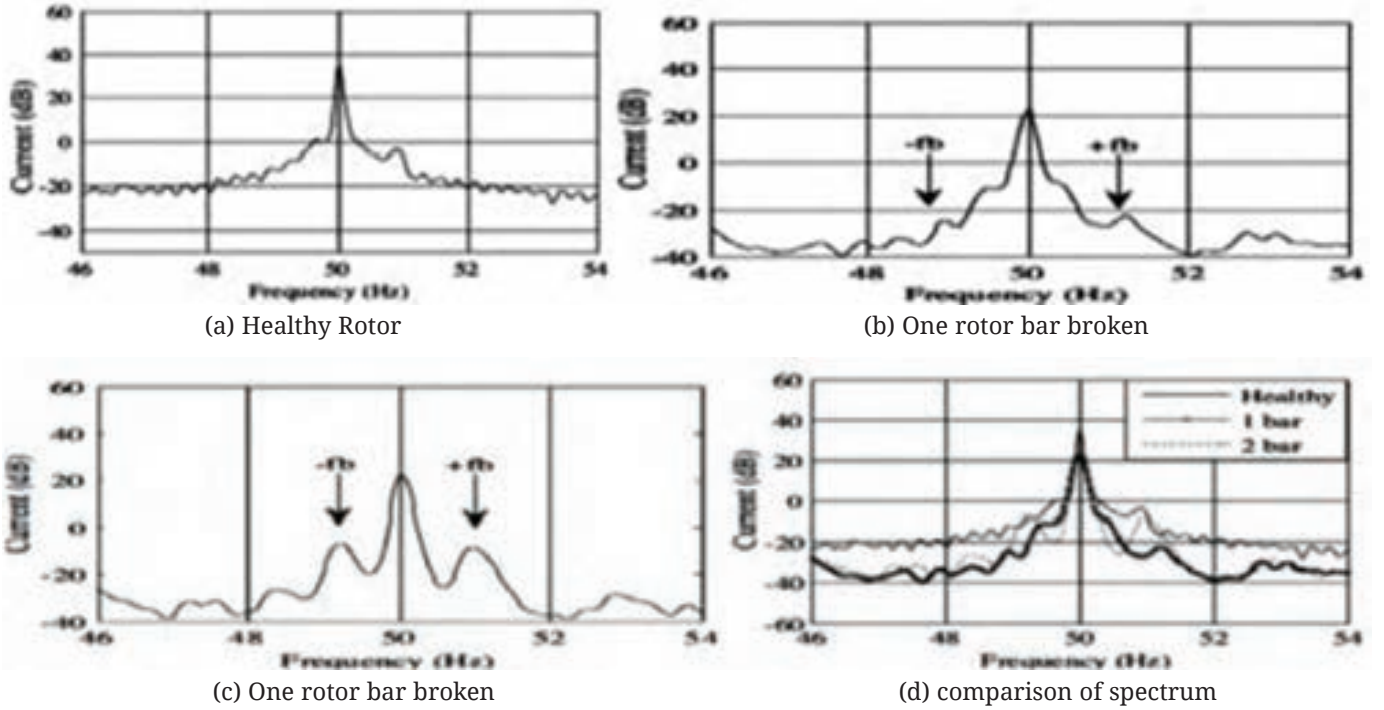


Figure 6: Motor with broken rotor bars

- Direct-on-line starting duty cycles for which the rotor cage winding was not designed to withstand causes high thermal and mechanical stresses.
- Pulsating mechanical loads such as reciprocating compressors or coal crushers (etc.) can subject the rotor cage to high mechanical stresses.
- Imperfections in the manufacturing process of the rotor cage.

Detection of Broken Rotor Bars

The location of the frequency components of the current due to broken rotor bars in the frequency spectrum is given by the formula:



(a) Healthy Rotor

(b) One rotor bar broken

(c) One rotor bar broken

(d) comparison of spectrum

Figure 7: Current Signatures for broken rotor bars

Continued on page 46

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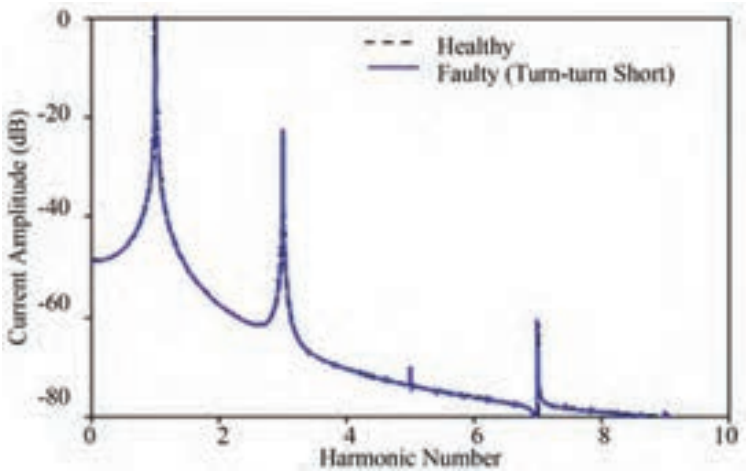

Figure 8: Healthy & faulty current spectrum for turn to turn short for single phase

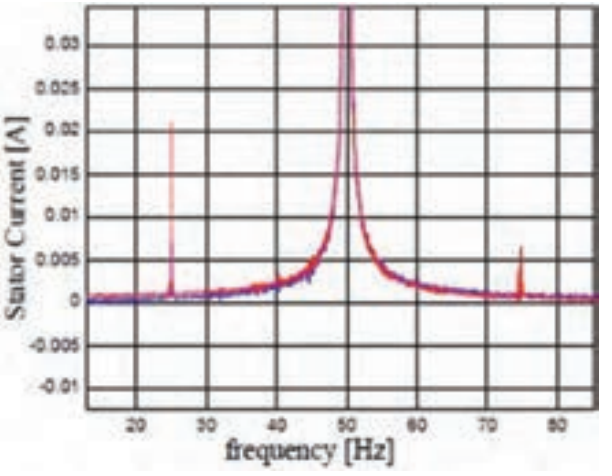

Figure 9

fb = f1(1±2s) Hz

where:

fb = frequency components of the current due to broken rotor bars, also known as sidebands

f1 = power supply frequency (Hz)

s = operating slip (per unit)

Figure 7 illustrates the current spectrum for broken rotor bar

Shorted Stator winding turns

Stator inter-turn fault is one of the most common faults occurring in the induction motor, not predicting it before it becomes severe, may lead to breakdown and loss of production. The stator current can be continuously monitored in order to predict any fault brewing in the stator windings

The example in fig 8 shows a comparison between the spectrum of frequencies in a motor in normal conditions, and the spectrum of the same motor with one of its coils in short circuit. (The current in the loop in short circuit was limited to the same value as the nominal motor current). The main advantage of MCSA is to detect faults at an early stage. Most of stator faults start with inter-turn short circuits and then develop into open or short circuits depending on motor operation. Under inter-turn short circuit, the stator winding is unbalanced and draws unbalanced three phase currents. For stator faults, it is enough to detect peaks at higher than the twice of the supply frequency. Fig 9 shows the presence of harmonics in the motor current in case of short – circuited stator windings. For no load, the harmonics due to the faults occur at 25 Hz and 75 Hz.

Conclusions

Motor Current Signature Analysis is an electric machinery monitoring technology. It provides a highly sensitive, selective, and cost-effective means for online monitoring of a wide variety of heavy industrial machinery. It has been used as a test method to improve the motor bearing wear assessment for inaccessible motors during plant operation. This technique can be fairly simple, or complicated, depending on the system available for data collection and evaluation. MCSA technology can be used in conjunction with other technologies like Fast Fourier Transform (FFT), Fuzzy Logic, Park's Vector, Wavelet Analysis etc in order to provide a complete overview of the motor circuit. The result of using MCSA as part of motor diagnostics program is a complete view of motor system health. Developing motor faults have its counterparts in waveform and harmonic content of the motor supply current. MCSA can be applied everywhere in industry where induction motors are used enabling non-intrusive on-line (even remote) analysis of motor supply current and detects faults while motor is still operational and without interrupting its service. It can be efficiently applied to detection and the localization for variety of motor faults. As such, it is important contribution to tools for condition monitoring of induction motors.

Ankush N Bahale

Deputy Executive Engineer in Maharashtra State Power Generation Company Ltd (MAHAGENCO)

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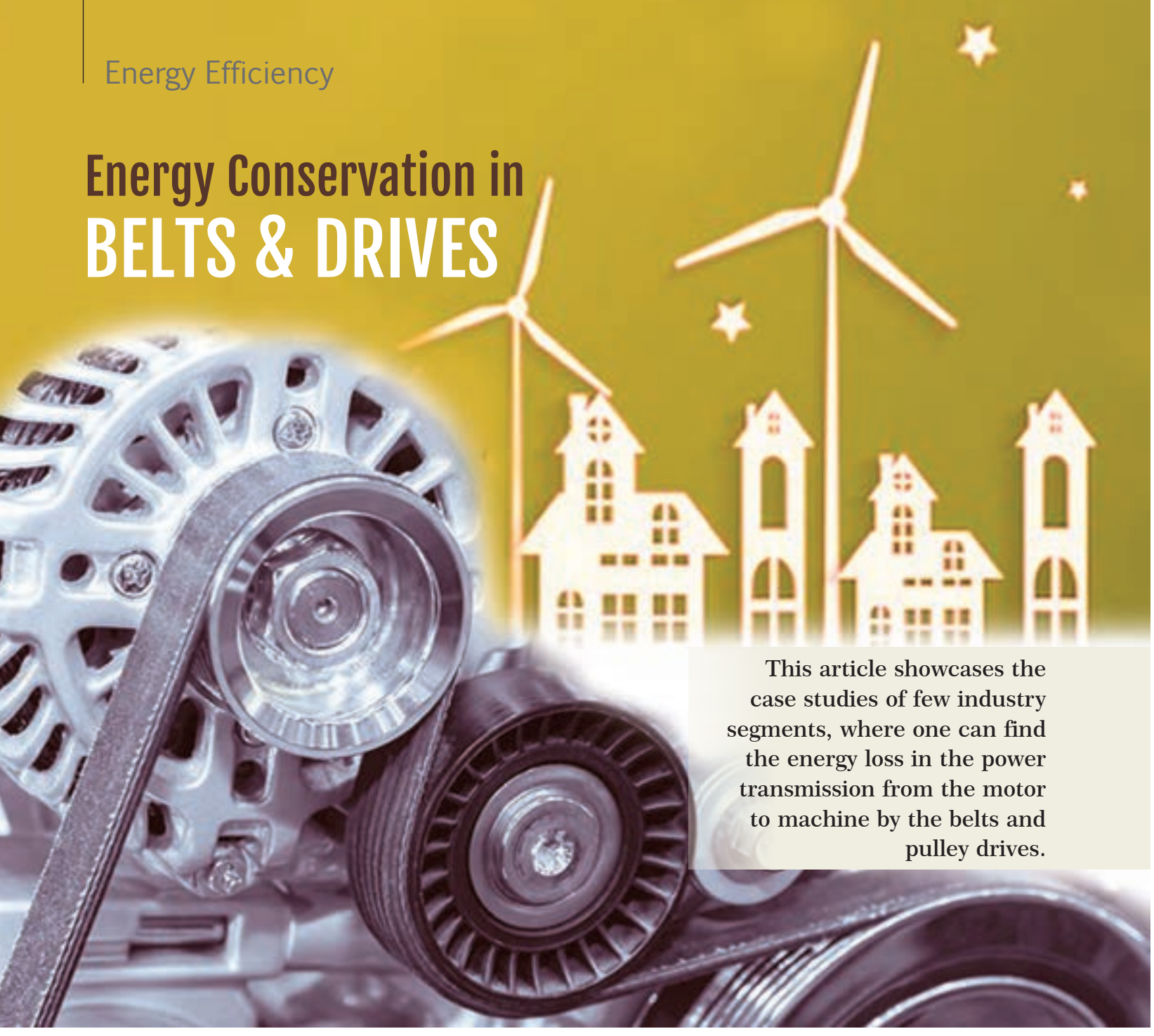
Energy Conservation in BELTS & DRIVES



This article showcases the case studies of few industry segments, where one can find the energy loss in the power transmission from the motor to machine by the belts and pulley drives.

The industry is facing energy losses in each of its machine in the motor-to-machine power transmission. This is happening due to oversized pulleys meant for V belts, existed in the decades-old running machine. Now, since the energy efficiency route is taking over the energy conservation route, it is time to think of reducing the weight of rotating component and increase the size of conducting component in a system. While talking of energy conservation in the industry now, material conservation is the first thing to tried by the OEM in its new and old products supplied long years back; and to be

tried by the user industry to achieve energy conservation in its decade-old running machines, as they are paying excess energy bills.

Any industry segment will have this system of motor-coupled-to-machine by belts in majority of its machines. Here, the machine OEMs in each segment do take extra care of its product safety first and then only focused its running cost. That is why the government suggested going for 5-Star rated products with the slogan 'More the Stars, More the Energy savings in that product'. This article showcases the case studies of few industry segments, where one can find the energy loss in the power transmission from the motor to machine by the belts and pulley drives. Especially, the pulley drives are not replaced by the industry for its total machine life. These dished out pulleys increase the energy loss in power transmission. Also pulley needs to be undersized to match to the new compact and power saving belts and here raw cogged belts now.

These heavy weight pulleys consume 10 per cent more power when transferring from the motor to machine in some of our case studies and this is an eye-opener. The loss percentage may vary, but it needs to be focused now, immediately. So, the user industry is suggested to revisit today to study energy breakup analysis of his motor–to-machine power transmission, generically, and horizontally deploy this instantly applicable exercise to all his other machines.

Instead of investing on industry's proposed swap from his decade old standard motor to the latest IE3 motor now, first one must try to find the ways to reduce energy demanded by the machine and links from the motor end. And by implementing this immediately, the user can reduce energy loss from today and this paves way for more productivity from each of its machines at less power consumption, and the simple payback period is in the order of few weeks to months now. After energy demand reduction achieved first in the motor only, then the user has to replace with the optimum-sized IE3 motor.

Existing Energy Losses Existed in Old Pulley Drives

The symptoms of energy losses can be seen in belts due to the looseness, worn-out belts, that is visibly observed, but what is not noticed, is that the worn-out pulley which is ignored by the user. Because he assumes that the pulley is part of the equipment meant to serve for the lifetime of the machine. The existing running pulley grooves look with glossy finish in most of grooves. They need to have rough surface with matt finish. Rough surfaced grooves only can grip the belt better and they were over-designed till date. Grooves inside pulley have been dished out of differential driving of belts over grooves. Over five years of 24x7 hours of usage, that pulley had gripped many old and new belts, hence this pulley is a consumable based on its condition.

The user has to have a mindset to change his pulley costing few thousand rupees after few years. This is the need of the hour now because, when switching over to REC belts from V belts, the pulley can be undersized in size and weight due to reduction in groove numbers says three grooves in new pulley instead of six grooves in the old multi-groove pulley.

Energy Efficiency Improved Due to REC Belts & Pulleys Now

Thanks to old energy efficient concepts in belts and the industry conveniently switched over to raw edged cogged REC belts in the past decade. We suggest swapping for cogged belts now, due to the additional factors of correction power rating, speed ratio, belt length correction factor, and arc of contact correction factor. These factors aid in optimising the pulley drive for cogged belts. This REC belt swap is taken because of its superiority over V belts as mentioned under:

- The cogged belts by design, is having 30 per cent power carrying capacity for the same classical V belt weight now.
- The cogged belts run cooler, run say, 50 per cent more longer hours, and occupy less space in pulley.
- The narrow and cogged belts operate higher speed ratios using smaller diameter pulleys.
- Hence, this needs the existing pulley to be replaced with say 20 per cent around, less-dimensioned pulley.
- Being cogged on the pulley side the belt has a better grip with the pulley, to sustain the RPM drop better.
- Better grip and higher coefficient of friction reduces slippage to near negligible and improves its efficiency.
- Cogs on the inner surface of the belt increase air flow and facilitate cool running.

For any industry application of motor to machine belt transmission, here, one can find the motor OEM sizes his motor to suit the machine demanded load. The machine OEM

manufactures his efficient machine taking utmost care to reduce his manufacturing cost and as well he sees to it, that his machine consumes optimum energy as running cost.

Here, for the sake of not losing RPM, we are implementing the timing belt and matched pulley. This increases the power of transmission here. Take ambient at 40C, if the belts are hotter by 20C above the ambient, say at 60C and above, then the belt life reduces by 50 per cent that is noticeable. This hotter belt in turn reduces the pulley life and dishes out pulley more, but not noticed by us. Soft belt also by continuous rubbing the hard pulley, can elongate the pulley inside dimensions.

While discussing about the motor to machine transmission, the machine OEM wants to play it safe to go in for stronger belt (at least for him, his belt must not fail during his warranty period prematurely). So, to accommodate his strong belt, he plans for stronger pulley to withstand the belt, and the tangential stress from the motor to machine. By this, he makes his pulley size that of a flywheel and that acts as heavy tare load to the motor, consuming more of Tare KW, during idle loading.

The industry conveniently ignored the swap of old to new pulley as that involved more of additional labour in erection and alignment of new pulley in place of old pulley. Here, the industry needs to understand only one concept that energy saving is fully possible and achievable in a healthy power transmission system by fine tuning and optimisation. If the same system is unhealthy by way of old oversized worn-out pulleys, then this will result in mismatch of new belts in old pulleys and energy savings is achieved meager, compared to better energy savings achievable.

Replacing Existing Worn-out Oversized Pulley

V belts are designed for motor at full load rating and in 7 out of 10 cases, over belting is designed. The motor and blower pulley are heavy mass when designed and this adds more to Tare-load consumption of motor, belt and pulley upto the load, thus, increasing unproductive load on the motor power. Because of overweighing belting, the pulley sizes, belt width and the number of belts go up to increase power demand to motor. The motor is always not running to the designed full power ratings. It is ideal to use the actual running KW as the motor load now applied to the belt as the transmission power.

One has changed his or her motor starting from Harsh DOL, Star Delta starting to smooth VFD starting now and so now his belt and pulley also need to undersized to withstand only slow and soft ramp of VFD starting current. The origin of inefficiency is due to the overdesign of belt and pulley drive transmission starts from the OEM at the design maximum only.

The industry needs to be aware that pulley (also due to this cyclic belt movement under harsh conditions) needs to be replaced around five years duration based on the loading nature and thermal imager inputs on pulley. Now, we always demand the industry after our energy audit to replace belts and pulleys, and optimise power in their pulley. After thermal imaging and measuring the slippage losses, we the Energy Auditors now suggest to the user to replace both belts and pulley from V belt to cogged belt now. Citing the above factors, let the user first resize the pulley, discuss with the belt and machine OEM to achieve the same RPM or the desired RPM after reduced slip, possible now due to this cogged belt.

Conclusion

Material conservation is the first thing to be tried by the OEM to achieve energy conservation in their products. Motor OEM is reducing the overall weight, but improves the material composition and in its MOC (Material of Construction). In the load ends like pump or fan or compressor, the OEMs are innovating to reduce the weight of rotating wetted parts inside the housing. So here too, the user industry is suggested to follow, what the OEM is doing now to improve their machine efficiency.

It is necessary for OEM to revisit to the power transmission areas in decades-old machines and analyse what is the cup-to-lip energy losses happening in between due to the rotation of the heavy bulk weight of the pulleys especially now, since he is replacing the belts only routinely till date. He needs to consult belt and pulley specialist or the machine OEM today and ask him what can be done now to reduce the energy losses in there. EI

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— Supporting —

Capacitors
Beyond Fundamentals

The article focuses on basics and some other new aspects in capacitor for various applications which needs to be relooked in to engineering education.

The capacitor, similar to the rechargeable batteries, has the ability to store the energy in the form of an electrical charge producing a potential difference across its plates. The basic capacitor consists of two or more metal plates separated by various insulating material such as mica, waxed paper, plastic film or some form of a liquid gel as used in electrolytic capacitors or air could be the other option. The insulating material layer between a capacitor plates is known as dielectric.

Inductor, capacitor and resistors

Table 1: Dielectric materials and their important parameters.

Dielectric Material	Dielectric Voltage (v/mm)	Dielectric constant (K)
Polymer based films	4000-7500	2-8
Alumin oxide	10000	8
Tantalum pentoxide	20000	28
Ceramic	1000	Up to 50000

i.e. Trimurti's of electrical and electronics engineering are not given equal focus in research and academics. As a result, most of the application finds use of resistor or inductor as its base. Capacitor is most neglected of all three. Most of the working engineers are not aware of desirable values of time constants or capacitance or internal resistance of capacitor in specific application. Role of capacitor in AC and DC circuits is not clear to them. Concept of pulse current and pulse power is always confused. In academics, one can only find a chapter on electrostatics covering capacitor partly at first year level. In-fact, electrostatics is not explored by our scientist and engineers as much as electromagnetic. Capacitor primarily uses dielectric materials and it is neither covered in material science nor is covered in polymer engineering. There are very few universities/ institutes across the globe which are offering special course on capacitor technology. If mathematics is important in engineering then so is the case with material science. Material science subject needs to be introduced in every year at UG level. Instead of keeping material science as generalised subject, it needs to keep as material science for specific component/ technology.

In DC system, capacitor is an energy storage device. Same is the case with battery and fuel cells. On energy and power scale they are different from each other. There are many applications where one can see or read that battery and fuel cells are giving stored electricity for some system for its operation. However, capacitor is not giving energy for doing some useful work which can be seen. Battery and fuel cell energy can be directly used as electrical energy and can be converted in other form like mechanical, sound, heat etc. In case of capacitor, it does not happen that way. Then the question arises, how do one say that it is energy storage device and what is then it's role. Basically, capacitor storage energy for electronic circuits as a functional requirement of same. Amount of energy it stores is very small and it can be used only by electronic circuits. In AC system, energy storage and release is at very high rate and usually at high voltage. In such applications, phase shifting and frequency dependency plays a key role. Capacitors used in AC and DC systems have different structure, materials and manufacturing method.

Materials & Manufacturing

The small grain size of nanomaterials has significant effect due to drastic change in the physical properties of the materials used for components. The dielectric property for nanomaterials is very attractive for its applications in capacitor, sensors and memory devices. The dielectric property of nanomaterials exhibits unusual property which will give rise to develop new materials for capacitors. The frequency behaviour of dielectric materials gives the valuable information about the conduction phenomena of nanostructures materials. The dielectric properties in nanomaterials have some odd aspects especially for metal nanoparticles in which the cappants are insulating and the core is metallic. However, when they form complex system of nanoparticles, then their insulating and conducing properties gets reversed due to reduced particle size of the order of 1 nm, due to quantum size effect. Dielectric strength of a material is the ability to the material to act as an insulator. Dielectric strength is a measure of the electrical strength of a material as an insulator. The dielectric constant is the ratio of the permittivity of a substance to the permittivity of free space. Table 1 shows conventional dielectric materials with their dielectric voltage and dielectric constant. There is need to introduce nanomaterials as insulating materials in academics covering all basic properties of new insulating materials. Insulating material properties need to be co-related to technical specifications of capacitors. Fundamental research in materials for capacitor can lead to improvement in parameters

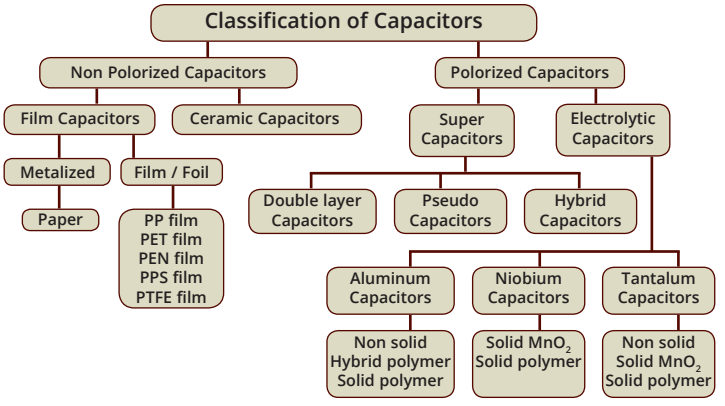

Figure 1: Classification of capacitor

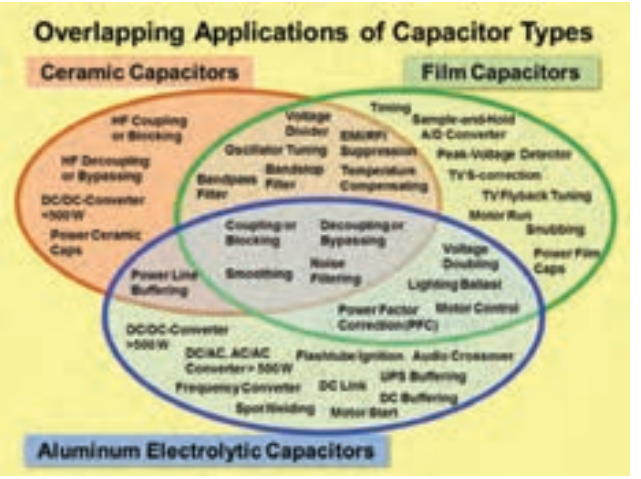

Figure 2: Various applications of capacitors

(increase in operating voltage, reduction in ESR etc.) of capacitor and will increase its application range.

Capacitors are not manufactured (in true sense) in India but they are just assembled from imported components. Manufacturing includes preparing raw material and processing it to get complete product. Making impurity free materials is a persistent problem which Indian industries are facing. Most of the main parts of capacitors are imported in India. Process of assembling capacitors has not changed over decades. New and advanced methods need to be adopted. Use of IoT in industry 4.0 environment is likely to increase quality of capacitor and it will reduce the price. Use of IoT in capacitor manufacturing and applications needs sensing lot of data from capacitor. Capacitance value, internal resistance, capacitor voltage, capacitor charging and discharging currents, number of charge/ discharge cycles, rusting, dimensional changes, temperature needs to be sensed for better manufacturing adopting predictive maintenance of this device. Over time, the performance of unmaintained capacitors can deteriorate, reducing power system's power factor, leading to power factor loss. In DC applications, if capacitor is not maintained properly, it can lead to malfunctioning of the system and can result in huge financial loss. Adoption of flexible manufacturing concept can increase profit and range of the capacitor manufacturers. Many aspects related to materials and manufacturing are missing in engineering syllabus. New approach of research in this area need to be adopted as fast as possible.

Table 2: Capacitor types, usages and parameters

Type of Capacitor	Capacitance Range	Voltage Range	Typical Usage	Main Properties
Electric Double Layer (Supercapacitor)	20nF to 3000F	2.1 -5.5V	Memory backup, Automobiles	High series resistance
Niobium	4.7μF- 1nF	2.5-10V	Power supply filters	Low ESR
Tantalum	0.1μF- 2.2 F	2-63 V	Power supply filters	Low inductance
Electrolytic Aluminium	0.1μF-1F	2-700 V	Power supply filters	Polarised, Short life
Mica	2.2 pF-47nF	500 V	RF apps	Excellent at HF
Paper	470pF- 470nF	250 V- 1KV	Mains, low frequency apps	High dielectric constant
Ceramic Multilayer	0.1pF-820nF	4V-3KV	General Purpose	Small, low cost
Plastic film	10pF-164μF	10V- 3KV	General Purpose	High quality, small

Continued on page 56

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Capacitors & Applications

Figure 1 shows the classification of capacitor. All capacitors have their own capacitance, internal resistance values and suitability for particular application. Fundamental of each of these capacitors need to be covered at UG level in depth.

Capacitor is energy storage device which can store energy in the form of electrical charges and release it as and when required by the circuit. It is extensively used in electronic circuits to perform variety of tasks, such as smoothing, filtering, bypassing etc as shown in Fig 2. One type of capacitor is never suitable for all applications. Ceramic capacitors are generally better than other types and therefore are used in many applications. Some of the typical capacitor applications in electrical and electronic systems are:

DC blocking capacitor: In this application capacitor blocks the passage of DC current (after completely charged) and yet allows the AC to pass at certain portion of a circuit.

Filter Capacitor: Capacitors are the most important component of filters. There are several types of filters that are used in electronic circuits. Since the reactance of the capacitor is inversely proportional to the frequency, therefore it can be used to increase or decrease the impedance of the circuit at certain frequencies and therefore does the function of signal filtering.

Capacitor as power source: Capacitors used as a charging unit and energy stored is used for ignition and triggering.

Pass capacitor: The reactance of capacitor is frequency dependant and hence in certain application it is used in parallel with other components to bypass it at a specific frequency.

Coupling capacitor: In electronics circuit it is common to use capacitor to pass signal from one stage to other.

Decoupling capacitor: In high speed electronic logic, switching causes sinking of current. It results in disturbance in the logic values due of change in voltage level. Decoupling capacitor is connected close to the output of IC and provide the needed extra current and thus minimises the disturbances to the logic signal.

Snubber capacitor: In relays and power electronic switching devices high inductance loads could induce voltage in the contacts and may damage the device. Snubber capacitor is used to limit the high voltage transient in such circuits.

There are other applications such as signal processing and tuned circuits. Table 2 shows capacitor types and their applications. Academics need to cover capacitor parameters such as dielectric constant, capacitance, time constant, ESR, EPR and then which values are suitable in various applications. Scaling these applications in AC and DC systems against these parameters can give good insight to engineers and researchers.

SDM & Stray Capacitance

Dielectric constant values of various materials need to be included in academics. Today, low and high value dielectric constant material capacitors use is not known properly. In some applications capacitor with very high dielectric constant is desirable. Evidence is provided that a class of materials with dielectric constants greater than 100K, herein called Super Dielectric Materials (SDM), can be generated readily from common, inexpensive materials. Specifically, it is demonstrated that high surface area alumina powders, loaded to the incipient wetness point with a solution of boric acid dissolved in water offers remarkable increase over the best dielectric constants previously measured. It is postulated that any porous, electrically insulating material (e.g. high surface area powders of silica or titania), filled with a liquid containing a high concentration of ionic species will potentially be an SDM. Lot of research work is being done in the area of SMD and it needs to be converted in to the product. Capacitors created with the first generated SDM dielectrics (alumina with boric acid solution), herein called New Paradigm Super (NPS) capacitors display typical electrostatic capacitive behaviour, such as increasing capacitance with decreasing thickness, and can be cycled. However, operating voltage is limited to about 0.8 V. Potentially NPS capacitor stacks can surpass supercapacitors in volumetric energy density.

Concept of wanted capacitance and unwanted capacitance is completely missing from academics. Stray capacitance is unavoidable capacitance existing between live parts and equipment case or surroundings, or between live parts of different polarities. Capacitance always exists between two

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conducting paths or components, simply by virtue of their being separated by some kind of electrical insulating materials. For example, capacitance exists between two wires or between wire and surroundings (including earth). Stray capacitance is neither designed nor desirable. Its frequency dependence makes it more complex to understand. Stray capacitance affects electrical machines such as transformer, semiconductor devices like BJT/ CMOS/OPAMP, Sensors like thin film piezo-electric and embedded system. There are many systems which experience bad effect of stray capacitance and hence it should be properly and collectively included in UG syllabus.

Conclusion

Capacitor is one of the most extensively used components in all electrical and electronic circuits. Current engineering syllabus covers only fundamental aspect of it. Many important issues of it are covered in distributed manner in various subjects. Material properties, type of capacitor it forms and use of it, needs to be co-related to give better understanding of this device. Some aspects such as advances in materials and manufacturing need of material parameters co-relation to applications, development of SDM and importance of stray capacitance is presented briefly in this article. There are many techno commercial aspects which can be included in engineering syllabus. Indian capacitor industries need to put money in research and development. Due to computer sector lucrative jobs, there is tremendous shortage of skilled manpower at production and research work level. In this scenario, industries should collaborate with public and private sector research labs/ institutes. Industry sponsored materials and equipment with research lab sponsored manpower model should be adopted. Use of locally available material can be key for addressing commercial issues.

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With rapid industrialisation, turbines and generators are integral to deliver uninterrupted power supply. Here's a brief overview of this important sector.

TURBINES & GENERATORS
MARKET TRENDS

Turbines and generators both are used in producing electric power, but turbine converts different available energy forms into rotation while generator converts rotation into electricity. Different types of turbines are used depending on type of energy they use and are used to power generators. Turbines are also used for other purposes such as powering ships and airplanes, but generator only produces electricity. Turbines and generators are also built completely differently. Common thing about both is they both rotate.

Turbine generators are used to generate electricity. Different types of turbines are used according to the energy used to power turbine. An aircraft uses jet fuel to power its turbine while a wind turbine uses wind energy. A gas turbine uses natural gas while a steam turbine runs on steam from boilers.

The turbine then runs the generator using the connected turbine shaft. When a generator rotates, coils of wire move through magnetic field, and electricity is produced in wires. This electric current runs through transmission lines to homes here power is utilised.

Recent Trends

Recent times have seen an increasing trend in power generation market that will likely shape it for many years to come. Natural gas and steam turbines seem to replace coal and oil, which is clearly on

Continued on page 62

Control cabinet sockets for worldwide use

The new EO sockets with different plug shapes are designed for international use in control cabinet and systems manufacturing. Additional functions such as LED displays, switches, fuses or circuit breakers expand the application possibilities.

Wide product range with over 150 variants for all regional variants for worldwide use it is Space-saving and double-slotted variants with Integrated Contact Protection via shutter Flexible installation, it can be DIN rail mounting and direct mounting on the service interface.

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decline path. Different turbine designs and generator configurations are trending these days.

Modular Turbine Designs are simply aiming to reduce the timeline used to construct a power plant. This reduces the cost of gas turbines and help some power plants to increase electricity production and gain market share. Even modular and compact generators are driven by these turbines

The increasing usage of gas instead of oil to run turbines and generators helps in various ways. Firstly, gas is more efficient and less expensive. The gas generators are environment-friendly compared to diesel generators. This makes power generation less expensive and its supply at low cost to the consumers.

Bi-fuel technology is recently trending for portable generator but it also provides significant fuel saving and environmental benefits when incorporated on larger generators.

Innovations

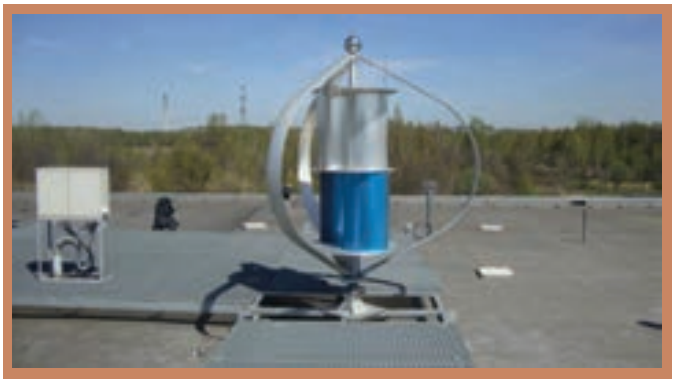
Innovations in electrical sector is gaining momentum and various measures are been taken to make least possible pollution and still get most efficient output from turbines and generators. Environment friendly measures are taken into account to make the future a better place to live and so innovation in industry is a need of hour.

Companies like Solar Aero are ergonomically designing turbines with no blade for low maintenance cost to bring down wind power price down to coal-fired rates. These are fuller turbine which uses thin metal disks to turn a generator.

Fuller Turbine [photo:solarpedia.com]

To get more output power from a generator, the jet-engine concept is being implemented to make turbines that give four times more power. Using these we can produce more power with less input compared to conventional turbine.

Maglev Turbines are the best alternative for conventional turbines since frictional loses are least and they give efficient power output. These frictionless units can harness slower moving turbines to capture more electricity.



Maglev Turbine [photo:solar.excluss.com]

Air-Water-Gravity generator is the future of hydropower plants. The AWG is a large, hollow cylinder filled with air and harboured to seafloor at varying depts. An electrical generator sits inside the cylinder and piston movement generates electricity.

Miniature hydroelectric generators are being researched to produce power at small level and runs household devices. These may be the future mini hydropower plants installed in all of ours houses.

Opportunities & Challenges

Research on various technologies to improve the design of turbine and generators have been done. But the obstacle arises when implementation of such technologies is to be done. Therefore, various opportunities lie in front of an engineer to solve these challenges and implement the results of a research.

Another challenge is the forecasting of electrical energy. It can never be predicted for long term; therefore, various opportunities lie in this area to assess the impact of implementation.

Power electronics implementation with electric turbines and generators can also give a prominent source to get more efficient and reliable power. Research in these areas and proper implementation can further help in covering the increasing demands of power supply.

Cooling of large electrical turbine and generator system is a major issued faced by the engineers these days. So there lies an opportunity to design a proper cooling and lubricating system that can diminish losses and helps in curbing the heating problems.

Over 200 million people in India has no access to electricity. However, many of the power generators are idling for lack of electricity demand. The challenge is to supply this idle power to those in need or to implement portable generators near to those who have no access to electricity.

Future Outlook

Globally, generators are benefitting with increasing concerns about energy security, which in turn has led prospective generator end-user seek ways for operating more efficiently and safely. In emerging nations worldwide, regular power outages have hindered smooth business operations and implementation of generators has become the key for these entities for functioning throughout a power outage.

According to Fact.MR's report on Generator Market for forecast period 2017-2016, Asia-Pacific is expected to remain the fastest expanding market for generator. Rapid industrial expansions in countries like China and India witness huge demand of generators due to unstable power supply.

In terms of usage, revenues from stationary generators will remain quite larger than front their portable counterparts. Even sales of larger rated generators remain dominant in the market due to industrial expansion.

Report also says that sales of generators in residential segment will showcase the fastest growth through 2026. With growing emphasis on green technology, diesel generators will show decline in their demand.

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EESL steering India's energy efficiency drive

Venkatesh Dwivedi, Director (Projects), Energy Efficiency Services Limited (EESL) gives update on EESL's initiatives for achieving energy efficiency through its programs for LED lighting, proposed roll-out of electric vehicles (EVs) and charging infrastructure, procurement of smart meters performance, and outlook for the sector in an email interaction with **Electrical India**.

What is your opinion the current state of the power sector?

Power sector in India is undergoing a transformation with access to electricity being provided to all households. However, the financial health of the Distribution Companies (DISCOMs) continue to be a cause for concern with the main reason being the high AT&C losses.

The Government of India is working towards addressing two key challenges before the sector. Billing efficiency – the Ministry of Power has issued ministerial guidance to all the states, which stipulates that the entire metering of over 38 crore consumers' needs to be shifted to smart meters on a pre-paid mode. This move has the potential to transform the financial condition of the sector.

Agriculture subsidies – Leveraging the potential of solar energy, schemes like KUSUM can incentivise solar agriculture pumps installation in a manner that it is scalable and has incentives for DISCOMs, farmers and investors alike.

Can you please shed light on impact of EESL's programs for LED lighting?

In one line we can summarise and say that the programmes like Unnat Jyoti by Affordable LEDs for All (UJALA) programme and Street Lighting National Programme (SLNP) have not just transformed the industry but also transformed consumer behaviour, in their acceptance to energy efficient technologies.

EESL adopted an innovative mass procurement strategy, which lowered the manufacturing cost of the LED bulbs. The benefit of this price reduction has been passed on to the consumers. Consumers benefited with reduced bill through usage of LED bulbs, DISCOMs and ULBs benefited with increased savings. Most importantly, the nation benefited with significant reduction in CO2 emission. UJALA has led to an estimated GHG emission reduction of 36.91 million tonnes CO2 per year and SLNP has led to an estimated GHG emission reduction of 4.23 million tonnes CO2 per year.

We are now replicating the revolution brought in by the LED

"EESL programmes have cumulatively saved over 50 billion kWh of energy and have helped obviate 10,000 MW of peak demand. These programmes have reduced India's CO2 emissions by over 40 million tonnes annually."

programmes to our other programmes like smart meters, e-mobility, trigeneration, rural LED lighting and decentralised solar plants.

What is the role of EESL in proposed roll-out of electric vehicles (EVs) and charging infrastructure? According to you, what are some of the key challenges that need to be overcome?

The government has taken the leadership in driving India's transition to e-mobility. Significant progress has been made with the evolving policy landscape which has brought in the much-needed clarity for the industry. However, there is a need for greater public consciousness on the value propositions of EVs. It is important to build a robust e-mobility ecosystem in the country by incorporating innovative business models.

Our e-mobility vision entails procuring and deploying electric vehicles in government offices across India. Towards, EESL has completed the procurement of 10,000 e-cars. Besides this, we are also exploring synergies with various urban local bodies to develop a robust public charging infrastructure for EVs, so that customers don't have to commute long distances for their next car battery fuel-up. After New Delhi, we have joined hands with various municipal bodies such as Ahmedabad, Jaipur and Chennai to set up public charging infrastructure, deploy EVs on contract basis and facilitate their e-mobility transition. Gradually, we will put up public charging stations across 11 cities.

Furthermore, the Government of India is working towards large-scale commercialisation of indigenous battery technologies to achieve economies of scale for lithium battery manufacturing in India. Such initiatives will benefit both the battery manufacturing industry and the automobile industry.

The intersection of proactive policy, an agile mobility ecosystem, and compelling consumer use cases will drive India's successful transition to e-mobility.

What kind of response have you experienced for smart meter procurement drive? What are the future plans?

The response from the states and industry has been encouraging. EESL has awarded the LoA for procurement of 1 crore smart meters and system integrators and has floated another tender for 50 lakh smart meters. Till date, 3 lakh smart meters have been installed in the state of Andhra Pradesh, Uttar Pradesh, Haryana, Bihar and NDMC-Delhi. Under EESL's Smart Meter National Programme, NDMC has become the first municipal body to have all their consumers with access to smart meters without any upfront investment from NDMC.

What is the overall energy saving achieved as the result of efforts of EESL initiatives?

EESL programmes have cumulatively saved over 50 billion kWh of energy and have helped obviate 10,000 MW of peak demand. These programmes have reduced India's CO2 emissions by over 40 million tonnes annually.

EESL aims for measurable progress in the global movement towards achieving energy sustainability and strengthening India's energy security.

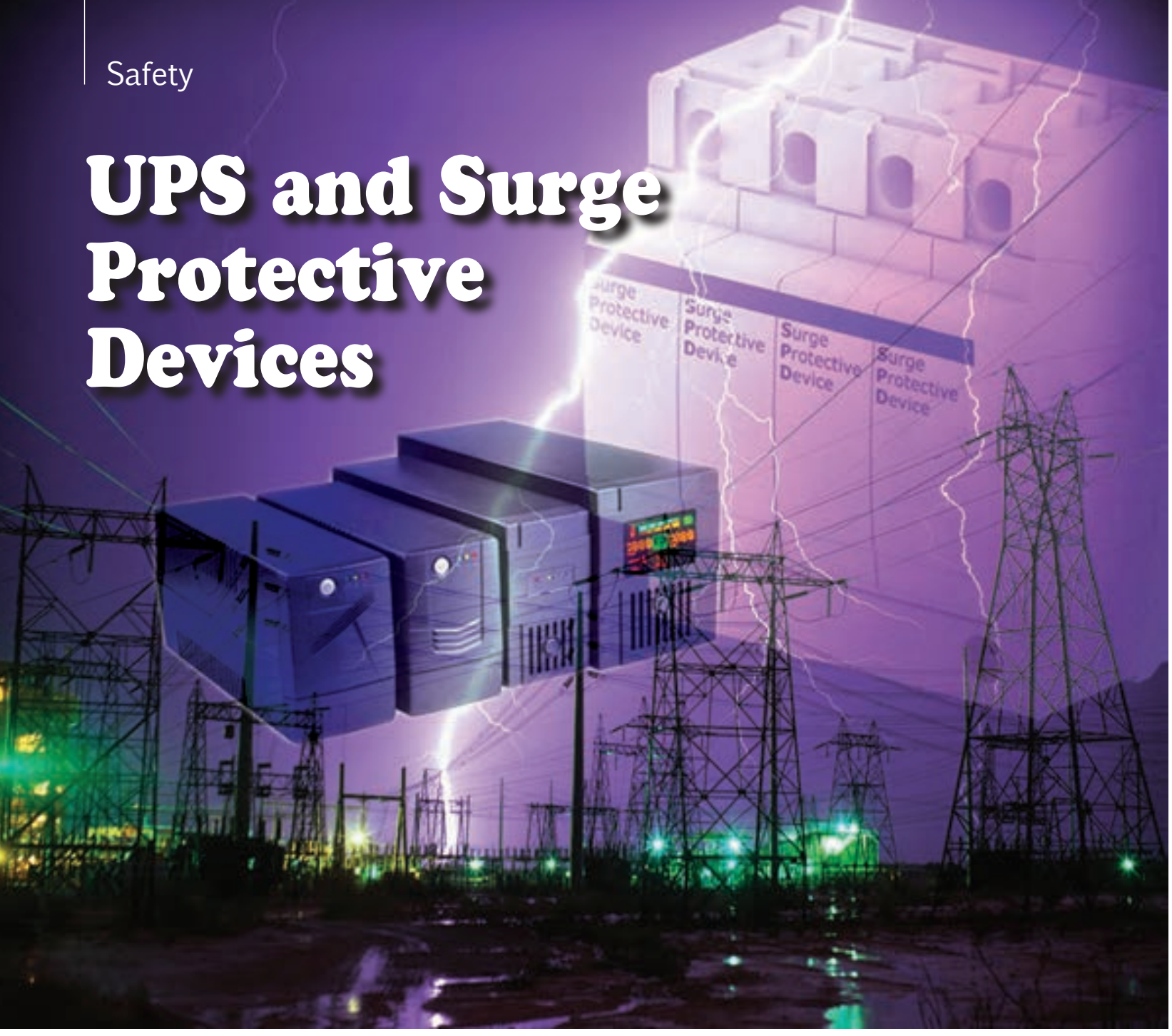
What is EESL's outlook for the power sector for the near future?

As mentioned earlier, power sector in India is undergoing a transformation with access to electricity being provided to all households, enabling 24X7 power to all. This is being further augmented with infusion of renewable energy.

As India's renewable capacity increases, the need for a robust ancillary service ecosystem will become more pronounced than ever. To support the renewable target of 175 GW, we will witness a lot of progress in developing commensurate ancillary services such as energy storage systems.

With the push by Government of India towards implementation of smart meters in the next few years, the DISCOMs will experience the benefit of the technology, leading to marked improvement in their financial health. Furthermore, this will direct the consumer behaviour towards efficient usage.

UPS and Surge Protective Devices



Combining high-quality protective devices with innovative arrester technology, surge protective devices ensure a high degree of system availability and safety in all areas of electrical engineering.

The number of electrical devices damaged or destroyed by surge voltages is increasing year by year. This can prove expensive in terms of repairs and downtimes. In an industrial environment, the hazards are not only restricted to systems and devices. Depending on their level, the effect of surges reaching electronic equipment ranges from operational malfunction to complete failure. At some level, the surge may only cause temporary upset with no permanent hardware effect, but at higher levels, it may cause failures of critical components.

- **Interference voltages:** Switching operations triggered mechanically or electronically generate pulse-like and high-frequency interference voltages. These voltages spread in an unimpeded manner across the cable network. All the devices within this cable network are affected. Data errors, uncontrolled functions, and system crashes can result with electronic and data processing devices at particular risk.
- **Lightning discharge:** Lightning strikes are originated by the electric charges accumulated in the clouds: the strike is the actual electric breakdown between the cloud and ground. The discharge drives a surge current of various kA, this current being driven similarly to that from a current source. The resulting waveform is typically an impulse, with a front as short as a microsecond (time to peak: 0.1 μs < T < 20 μs), lasting a few to various microseconds (tail duration < 300 μs), involving frequencies of hundreds of kHz (10 kHz to 1 MHz). Lightning surges are a major issue, and may be causing faults or failures throughout the power system. In fact, the most stressful transients in a power system are due to lightning strikes to the transmission lines, and associated flashover. Particularly, lightning is considered the greatest single cause of line outages. It is above all lightning strikes i.e lightning electromagnetic pulse that has the greatest potential for damage among all the causes of occurrence. They cause transient overvoltages that can extend across great distances and are often associated with high-amplitude surge currents. Even the indirect effects of a lightning strike can lead to a surge voltage of several kilovolts and result in a surge current of tens of thousands of amperes. In spite of the very brief duration, such an event can lead to total failure or even the destruction of the entire system.

- **Switching operations:** Switching operations i.e. switching electromagnetic pulse can generate induced surge voltages that spread to supply lines. In the case of large switch-on currents or short circuits, very high currents can flow within a few milliseconds. These short-term current changes can lead to transient overvoltages.
- **Electrostatic discharge:** Electrostatic discharge occurs if exposed conductive parts with different electrostatic potential approach each other and result in a charge exchange. A sudden charge exchange leads to a brief surge voltage. This presents a hazard, especially, for sensitive electronic components.

Regardless of what causes a surge voltage the consequences are the same- device destruction, system downtimes and total failure of controllers. Device failure or defects caused by surge voltages are more frequent than expected. Many a time, the consequences of a failure are generally much more serious such as downtimes or data loss. The failure of a device or a machine that is used in a professional environment often leads to costs that are many times higher than repairing the defective device.

Effective surge protection starts with assessing the potential risk and identifying all the devices within the item to be protected. The resulting protection concept takes into account all the interfaces of the power supply unit as well as those for data and telecommunications. This is the only way to comprehensively and effectively protect all the terminal devices, for example, within a data network, production plant or building installation. Combining high-quality protective devices with innovative arrester technology, surge protective devices ensure a high degree of system availability and safety in all areas of electrical engineering.

Lightning can strike more than once, and surges don't always come from outside. Surge events, short-term transients in voltage threatening critical downstream equipment happen for many reasons. The most common source, though, is internal devices powering on and off: motors, transformers, photocopiers, fluorescent lighting ballasts, light dimmers, variable frequency drives and more. They can also be generated externally by events like lightning, grid switching or electrical equipment in adjacent buildings. While seemingly surge events can wreak serious havoc on unprotected and inadequately protected facilities. They can disrupt or destroy sensitive microprocessor-based devices like computers, programmable logic controls, etc., resulting in premature aging of equipment, process interruptions and catastrophic failures. This change requires surge protection to be installed on all emergency electrical equipment to improve the reliability of emergency power systems. In power converters, fast-fronted transients may force a change of state of power semiconductor switches. Particularly, Silicon Controlled Rectifiers or thyristors can be spuriously fired with high dv/dt surges. Similarly, it is also possible to switch on an Insulated Gate Bipolar Transistor with high dv/dt surges.

Uninterruptible Power Supplies (UPS) provide power conditioning and backup power for critical and sensitive equipment, the typical example being Information Technology (IT) equipment in data centers. Various UPS topologies provide different level of power quality to the critical load. However, all UPS topologies feature unprotected paths that may expose the load to transient overvoltage i.e. fast disturbance, either in the form of impulse or ringwave, resulting in significant overvoltage, from the incoming utility. In this context, double-conversion topology provides the best protection, and it is often the preferred choice for

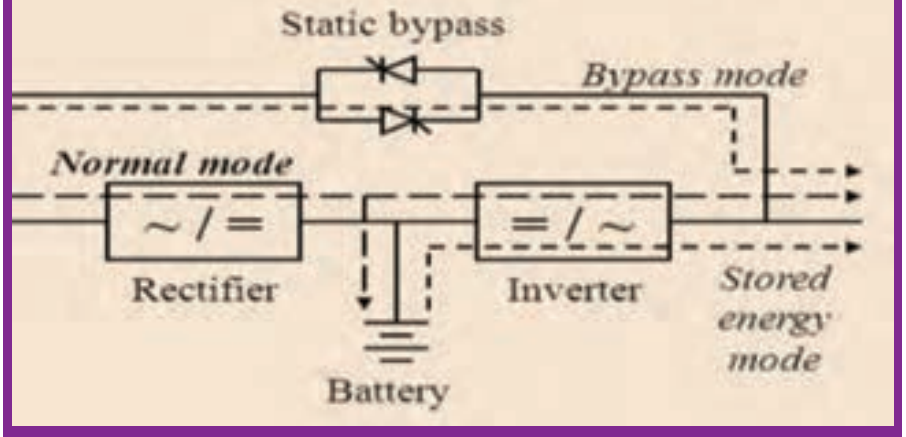


Figure 1: Block diagram for a double-conversion UPS

larger UPS installations. Various double-conversion UPS can operate in a high-efficiency mode, typically referred to as 'ECO' mode, where the load is normally fed by the bypass path. However, market adoption of 'ECO' like operating modes has been poor, following the concern that bypass operation may expose the load to the utility power disturbances, and particularly, transient overvoltage. IEC standard 62040-3 specifies three main types of UPS i.e. passive stand-by, line-interactive and double-conversion.

Passive Stand-By: It is the simplest topology for UPS systems, widely used in low-power applications, upto 2 kVA e.g. protection of a single workstation. The UPS normally operates offline, with the load being fed directly from the utility line. In normal conditions, the inverter is off while the charger is re-charging the batteries. In case of a power failure, the UPS switches to inverter dragging power from the battery stored-energy mode. This topology provides no line conditioning when operating on mains, although it may include an input filter, filtering utility noise and surge circuitry, providing limited surge and spike protection.

Line-Interactive: This topology is popular for applications upto 5 kVA. Similarly, to the stand-by UPS, a line-interactive unit can power the load directly from the utility. However, this topology features a parallel converter that may provide power conditioning by interacting with the utility, additionally; the converter re-charges the battery in normal mode. In case of a power failure, the utility is isolated via the static switch and the converter operates as an inverter feeding the load from the batteries, stored energy mode. This topology typically includes some sort of surge protection e.g. transient clamping components.

Double-Conversion: This topology is the preferred choice for larger installations for UPSs larger than 5 kVA. In normal mode, figure 1, the load is fed via the rectifier-inverter path. The inverter produces a regulated AC output, with voltage and frequency controlled at all times

independently from the quality of the AC input. In case of a power outage, the inverter drags power from the batteries. This UPS topology provides the best protection for the critical load. Particularly, transformer-based units prevent the propagation of any disturbance from the input to the output bus.

In normal operation, the load is fed through the rectifier or inverter path. The rectifier converts the AC input into a regulated DC voltage, providing a DC feed to the inverter while recharging the batteries. Then, the inverter converts the DC voltage into a fully regulated AC output. In case of a power outage, the inverter is fed by the batteries (stored energy operation). Additionally, double-conversion UPS often feature a bypass path, with a static switch connecting AC input and output, allowing bypass operation, load fed directly by the AC input utility. However, this mode is mainly used for emergency operation or during maintenance.

Following the AC-DC-AC conversion, output voltage and frequency are controlled at all times, and they are independent from the quality of the AC input supply. Therefore, this UPS topology provides top protection for the critical load. Particularly, transformer-based units also provide input to output galvanic isolation during double-conversion operation, preventing the propagation of any disturbance from the AC input to the output AC bus.

While providing optimum protection, double-conversion UPS offers limited efficiency. In fact, best-in-class efficiency for transformer-based double-conversion UPS is around 94 per cent. In order to overcome this limitation, some double-conversion UPS feature a high-efficiency ECO mode, where the load is fed directly by the input utility via the bypass path, as long as utility remains within given tolerances. The inverter is maintained in a stand-by state, ready to take on the load whenever the bypass utility experiences a disturbance. This operating mode greatly reduces losses, with resulting efficiency exceeding 98 per cent.

Advanced ECO Mode operation is particularly critical, as the load is normally fed directly by the input utility. This may prompt concerns than bypass operation may expose the load to the utility power disturbances, and particularly, lightning surges. However, basic surge protection and transient filtering may be implemented on the UPS. Here, the rectifier section typically includes an input filter. While this filter is mainly aimed to improve the rectifier input characteristics in terms of harmonics, it also constitutes a filter that may effectively attenuate transient overvoltage. In this operating mode, load-sharing between parallel units is not actively controlled. To limit the load unbalance due to cable length differences, an inductor is added to the bypass line, resulting in series with the load. Additionally, the inverter output filter is energised by back-feed from the bypass utility via the UPS output, resulting in parallel with the load. Therefore, Advanced ECO Mode operation combines a bypass inductor placed in series with the load, with the inverter filter capacitors placed in parallel with the load. Now, the combination of a series inductor and parallel capacitor provides some protection against surges, ideally complementing external surge protection devices. As a matter of fact, the bypass inductor in conjunction with the inverter output capacitors constitutes an L-C filter, for which the resonant frequency is given by: $fr = 1/2\pi\sqrt{LC}$. It is clear that the selection of inductor and capacitors is driven by their main function and not by the desired filtering frequency. However, in most application the resonant frequency would fall in the 1-2 kHz range.

All UPS topologies may expose the load to transient overvoltage from the incoming utility. In fact, stand-by and line-interactive UPS feed the load directly with the input utility, and this is also the case for double-conversion systems during bypass operation. For this reason, the IEEE 'Emerald Book' recommends Surge Protection Devices (SPD) to be installed at the UPS input.

Typically, surge protection includes some clamping devices, such as metal oxide varistors (MOV). However, these devices tend to exhibit significant leakage current at low voltages. This characteristic drives the device selection depending on the continuous operating voltage to which they are exposed, resulting in a clamping voltage that may exceed 200 per cent of the nominal utility voltage. This protection may result insufficient for IT equipment.

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MAINTENANCE OF TRANSFORMER

A few tips which can be useful in maintenance of power and distribution transformers.

Since transformer is very important capital equipment for an industry, therefore its proper maintenance is very important to allow the transformer for working with its full efficiency. Here are few tips which can be useful in maintenance of power and distribution transformers.

Maintenance Procedure

Safety Precautions

Under any circumstances, work on the transformer should never be done unless it is disconnected from all external electrical circuits and all windings have been properly earthed.

Naked lights and flames should be kept well away from the transformer while working.

Oil

Transformer oil is subjected to deterioration or contamination in storage as well as in service. Accordingly, a periodic treatment to maintain it in fit condition is required, and eventually, it may have to be replaced by new oil. Reason for oil deterioration and recommendations for various tests are covered in IS:1866 and is 335. The few tips given below may serve as ready reference.

- The oil level should be checked at regular intervals and any leakage of oil investigated.
- All leaks should be repaired as soon as possible to avoid possible trouble due to low oil level.
- Samples of the oil should be taken at regular period and tested for

BDV according to IS-335, BDV of oil should not be less than 60KVrms. This test should be carried out six times on the filled sample. The average value of the six results should be used.

- For large transformers, it may be mentioned that the dielectric strength does not give a right indication of the condition of the oil. In this condition additional test should also be carried out.
- For large transformers, it is recommended that the oil be kept under observation for acidity. If the acidity is increasing rapidly, transformer cover should be removed for checking purpose of the interior of the tank and of the core and windings. Oil should be treated or discarded, if the sludge or corrosion is there.

When transformer is opened or the IR values are low, it shall be filtered for 2 passes and sealed after topping up. Then the transformer is cooled down to ambient temperature, the oil level shall be reduced to normal fill level.

Bushings

Clean the porcelain bushing and examine them for cracks. Small chips may be ignored but any serious damage will require new porcelain which must be obtained from the manufacturer. It is recommended that some stock should be kept.

External Connections

All connections should be tight. If they appear blackened, undo the connections and clean down to bright metal with emery paper.

Conservator and Oil Level Gauge

Conservators are so arranged that the lower part acts as a sump in which any impurities entering the conservator will collect. A valve is fitted at the lowest point of the conservator for draining and sampling. The inside of the conservator should be cleaned with oil every two to three years.

The oil level indicator should be kept clean. The oil level is visible through a transparent material. In case of breakage immediate replacement is mandatory. When conservator is removed for cleaning, the oil gauge should be inspected and cleaned.

Breather

Silica gel breathers are fitted with a sight glass so that the colour of the crystals' visibility is clear. The colour changes from blue to pink as the crystals absorb moisture. When the crystals get saturated with moisture, they become pink and should therefore be reactivated by heating. Oil shall be available in oil cell.

Gaskets

Gaskets sometimes shrink during service. It is, therefore, necessary to check the tightness of all bolts used for gasketed joints. The bolts should be tightened evenly round the joints to avoid uneven pressure. Leaking gaskets should be replaced as soon as the circumstances permit.

Buchholz Relay

Routine operation and mechanical inspection tests should be carried out at one- and two-yearly intervals respectively. During operation if gas is found to be collecting and giving alarm, the gas should be tested and analysed to find out the nature of fault. Sometimes, it may be noticed that the gas collecting is only air. The reasons for this may be that the oil is releasing any absorbed air due to change in temperature. The absorbed air is released in initial stages only when no vacuum is applied during filling of oil. The internal faults can be identified to a great extent by a chemical analysis of gas. Buchholz relay also give alarm / trip due to the oil level falling below the Buchholz level.

Explosion Vent

The diaphragm which is fitted at the exposed end of the vent should be inspected at frequent intervals and replaced, if damaged. Failure to replace the diaphragm quickly may allow the ingress of moisture, which will contaminate the oil. If the diaphragm has broken because of a fault in the transformer, an inspection shall be carried out to determine the nature and cause of the fault.

Temperature Indicators

During yearly maintenance inspection, the level of oil in the pockets holding thermometer bulbs should be checked and the oil filled. The capillary tubing should be fastened down again if it has become loose. Dial glasses should be kept clear and if broken, replaced as soon as possible to prevent damage to the instrument.

Physical Inspection

The transformer tank cover and other parts should be inspected periodically for oil leakage, peeling of paint, or rust. Rusted portions should be properly cleaned and repainted. Oil leakage should be immediately attended to clamping bolts on gasketed joints should be tightened if required, damaged gaskets replaced. Leaks through welded joints should be stopped by welding again (this should be done without any oil in the transformer tank and radiators).

(Courtesy: Sai Electricals)

Figure 4 - The 3-in-1 solution offers all functions of simple circuit breaker test set, source and micro-ohmmeter in one device.

Achieving maximum efficiency during testing

This article describes the different testing challenges per asset and shows the possibility how to achieve a higher efficiency using an optimised testing approach.

When it comes to testing assets in substations and performing comprehensive condition assessments, efficiency is king. To be able to come to informed conclusions about the correct operation and condition of the asset, whilst also keeping outage time to a minimum, all relevant test data must be collected within the shortest possible time and with the least amount of effort. The safety of the test engineer, the equipment, and the immediate surroundings must be guaranteed at all times.

The actual testing does not begin and end when entering and leaving the substation. To save time on site, the asset to be tested and all tests required should ideally be specified in advance. Afterwards, the collected data must be managed and evaluated, and test reports created.

Conventional testing solutions are increasingly reaching their technical limits and are only fulfilling growing requirements in terms of effort and test duration. Thus, it was time to rethink the current state of technology and develop new approaches in order to optimise testing.

The greatest added value comes into effect as follows: If you use testing solutions that are optimised in terms of effort and time, and if several test teams simultaneously test different substation assets, the total time for which the assets must be disconnected from the network is minimised. Figure 1 shows the average test duration and time-savings per asset using optimised test solutions.

This article describes the individual challenges during testing of power and instrument transformers, as well as circuit breakers, and points out the requirements for optimised testing solutions derived from them.

Challenges during power transformer testing

Power transformers are one of the key components in electrical transmission and distribution networks. Due to the increasing age of the transformers and changed load conditions in the network, regular diagnostic testing and condition assessments are becoming increasingly important in order to be able to make the right maintenance decisions.

The design of power transformers is complex, and accordingly, testing the wide range of transformer parameters is a time-consuming and costly task. In order to perform different diagnostic tests, several test devices and considerable rewiring are often required. Testing individual phases and tap changer positions further increases the work involved, as well as the required outage time.

On average, an entire working day needs to be scheduled for the full range of routine tests. Power transformer testing is, therefore, the most time-consuming type of asset testing in the entire substation.

Three-phase testing makes the difference

A true three-phase, multifunctional test system can offer numerous advantages, which all lead to reduced effort and shorter testing times. Due to the multifunctionality of the system, the most common standard electrical tests can be carried out using more or less the same test set-up, such as measuring transformer turns ratio, winding resistance, dynamic resistance, short-circuit impedance, as well as frequency response of

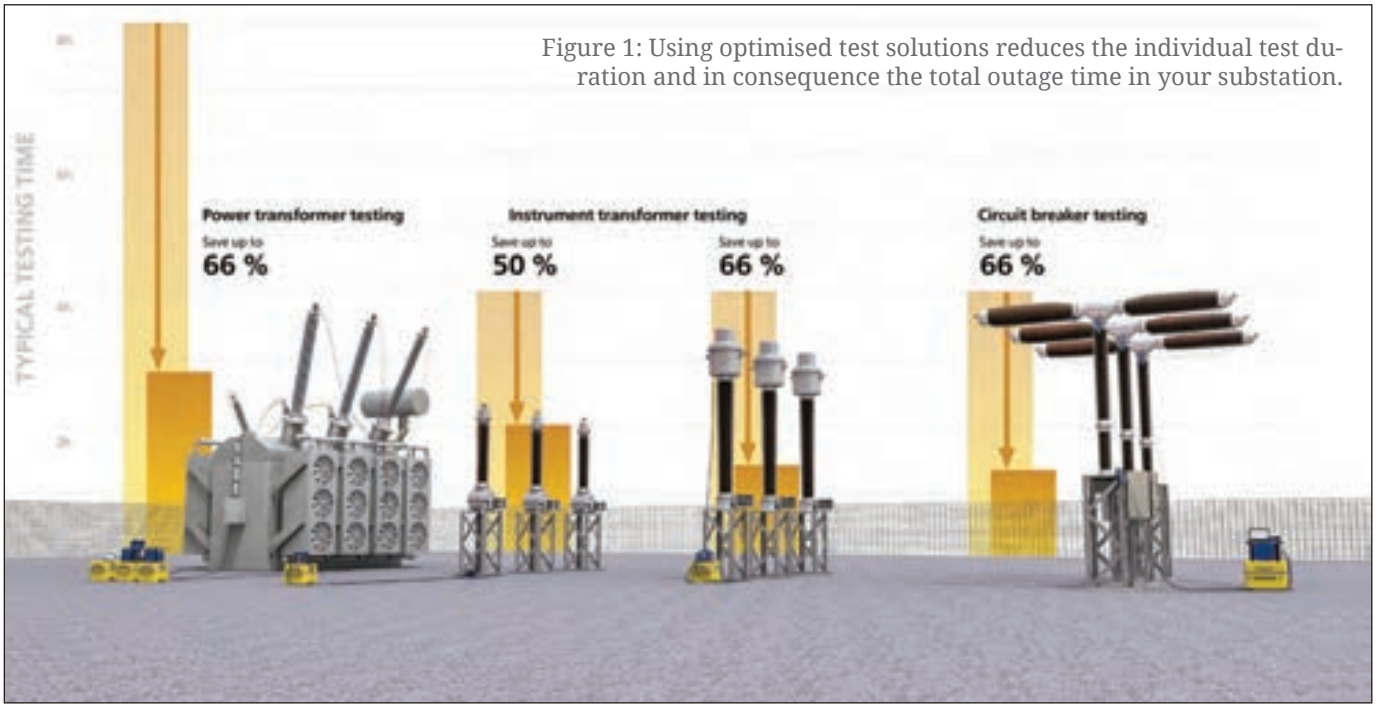

Figure 1: Using optimised test solutions reduces the individual test duration and in consequence the total outage time in your substation.

stray losses. Intelligent algorithms further ensure fully automated, simultaneous test execution across all three phases. This reduces the testing time to less than a third of the time required when compared to using conventional single-phase testing solutions involving multiple rewiring.

Modern test systems reduce the number of required leads and offer a simple and intuitive approach for setting up the test, which minimises the likelihood of errors. Specially developed 4-wire cables serve both signal injection and measurement and have to be connected to the high-voltage and the low-voltage side of the power transformer. All inputs and outputs can be automatically controlled without rewiring. To switch automatically between the individual taps of the tap changer, an additional third cable can be connected. This can also be used to record the motor current and voltage of the tap changer.

Table 1 – Example for common electrical tests on a 132 kV / 12 kV power transformer, the given time does not include the required time for setting up the tests or rewiring between tests

Test	Required Time (minutes)	Required Re-Connection
Transformer turns ratio (TTR) (per tap position)	7 min.	Same connection
Primary DC winding resistance (per tap position)	30 min.	Same connection
Tap changer / OLTC analysis (DRM) (per tap position)	Included with winding resistance test	Same connection
Secondary DC winding resistance	2 min.	Same connection
Demagnetization of transformer core	2 min.	Same connection
Magnetic core balance	5 min.	Same connection
Short circuit impedance / leakage reactance measurement (@ 3 tap positions)	5 min.	Short secondary terminals
Winding insulation capacitance and tan delta (DF/PF)	7 min.	Re-connection required
Bushing insulation capacitance and tan delta (DF/PF)	7 min.	Re-connection required
Report generation	1 min.	-
Total Time for Tests	66 min.	-

Figure 2 - Using a three-phase test system can significantly reduce the effort for rewiring between the individual power transformer tests.

Table 1 shows an example for a typical power transformer test procedure using an optimised three-phase test system and describes the required time and re-wiring effort. The test object was a 132 kV/ 12 kV two-winding power transformer with 25 on-load tap changer positions on the primary winding. The individual and total testing times only represent the time required to run the tests and do not include any time required to remove bus-bar connections, or set-up and change connections between tests.

Challenges during instrument transformer testing

Instrument transformers, such as current and voltage transformers, connect the primary and secondary system and play an important role in the reliability of the energy supply. Regular testing and calibration of these assets guarantee correct operation in normal conditions and in the event of a malfunction of an instrument transformer for protection purposes.

Conventional solutions require complex on-site testing or the complete dismantling and transport of the instrument transformer to a test laboratory. Depending on the testing method and the scope of required tests, high test currents and voltages are needed. These require bulky equipment or make dedicated applications, such as on-site testing of the transient behaviour of protection current transformers (types TP, TPX, TPY, TPZ), impossible.

In order to meet the relevant standards, all of the cores, windings, and specified operating points, must be checked. The amount of different instrument transformer types and designs requires considerable work in terms of test preparation and execution, for example, for specifying the asset or rewiring. The test duration itself can take up to several hours, for example, if different measuring points have to be tested at different currents, respectively voltages and burden ranges.

Model-based testing as a guarantee of precision and mobility

In order to master these challenges as efficiently as possible, and to reduce the weight of the test

equipment required, an indirect, model-based testing method has been developed. Based mostly on the secondary side measurements, the internal parameters of the instrument transformers are determined. Then, based on these specific parameters, all performance characteristics of the instrument transformer are calculated with very high accuracy.

This approach has been implemented in the form of dedicated test systems for both current and voltage transformers. Both testing solutions can be used to determine all parameters within minutes, including the accuracy and class assessment under different load, current, and voltage conditions.

A switching matrix reduces the required wiring effort to a minimum and makes testing of tapped current transformers and multi-winding voltage transformers efficient.

Table 2 shows a case study for the accuracy assessment of a metering current transformer while Table 3, in turn, details the accuracy assessment of an inductive voltage transformer - both using a model-based test system. Here too, the individual and total testing times only represent the time required to run the tests.

Table 2 – Example for accuracy assessment of a metering current transformer, the given time does not include the required time for setting up the system, respectively the leads, or rewiring between tests

Test	Required Time (minutes)	Required Re-Connection
Ratio and phase accuracy of CT (including polarity check, winding resistance, ratio, phase, and excitation curve)	Typically < 1 min	Connect to CT, automatic sequence with same connection
Class assessment	< 10 s (directly after measurement available)	–
Report generation	Automatically, directly after measurement	–
Total Time for Tests	1 min.	–

Table 3 – Example for accuracy assessment of an inductive voltage transformer, the given time does not include the required time for setting up the system, respectively the leads, or rewiring between tests

Test	Required Time (minutes)	Required Re-Connection
Ratio and phase accuracy of VT (including polarity check, winding resistance, ratio, phase, and excitation curve)	Typically < 15 min	Connect to VT, automatic sequence including 1 x rewiring
Class assessment	< 10 s (directly after measurement available)	–
Report generation	Automatically, directly after measurement	–
Total Time for Tests	15 min.	

Challenges during circuit breaker testing

Circuit breakers protect the transmission and distribution systems against damages through reliable separation of the electrical circuits in the event of a malfunction, for example, stopping a high fault current flow during the event of a line-to-ground short circuit in the transmission line.

Figure 3 – The model-based approach enables automatic assessment of the instrument transformer within seconds.

Any malfunction of a circuit breaker can lead to failures with far-reaching material losses and economic consequences. Due to their design, a broad spectrum of mechanical and electrical faults can occur in circuit breakers. For this reason, a number of diagnostic tests must be carried out, which until now required multiple test devices and led to time-consuming wiring and testing effort.

Another important aspect is the power supply during testing. Normally, the substation battery is used to

supply power for this test. However, this can lead to volatile test voltage and, thus, to reduced reliability of the test results.

A 3-in-1 solution instead of 3 individual devices

A 3-in-1 test system makes a crucial difference through combining a micro-ohmmeter, timing analyser, and a coil and motor supply in a single device.

It follows the same principle as the devices for the previously mentioned applications. A number of parameters such as switching times, static and dynamic contact resistance, sequence of operations, coil and motor current, and testing of the under-voltage and response time can all be recorded using just one test set-up. This new approach and modular connection technology simplify circuit breaker testing and reduces the testing time to a third of that which needs to be scheduled for conventional solutions.

The integrated power supply also guarantees safe and independent operation, as well as reliable and reproducible measurement results. The ability to test circuit breakers while they are grounded on both sides also means increased safety for all on-site personnel.

Table 4 - Example for a typical test sequence on a 132-kV gas-insulated switchgear; the given time does not include the required time for setting up the tests or rewiring between tests

Test	Required Time (minutes)	Required Re-Connection
Static contact resistance Dynamic contact resistance (all 3-phases)	10 min.	Circuit breaker (CB) closed, one side grounded
Timing tests including coil analysis, motion analysis (sequence C, O, CO, OC, O–CO, synchronism)	5 min.	Change voltage sensing, CB both sides grounded
Minimum pickup test (for trip and closed coil)	2 min.	Same connection, both sides grounded
Undervoltage condition test (Timing at for example 80 % of nominal voltage)	2 min.	Same connection, both sides grounded
Motor current analysis	1 min.	Same connection, both sides grounded
Report generation	1 min.	–
Total Time for Tests	21 min.	One Test Setup Only!

Table 4 shows an exemplary test procedure for a 132-kV gas-insulated switchgear (GIS) on all three phases. The test procedure comprises testing of open coil, closed coil and of the two auxiliary contacts. The given testing times only represent the time required to run the tests.

Challenges during test and asset data management

As mentioned earlier, the comprehensive management of substation assets also requires reliable handling of the data to be managed. In particular, merging the mass of data, as well as the further analysis and evaluation, is an extremely complex manual task, with an increased margin for errors. This also applies when summarising the results obtained and during the creation of the test report.

The use of different testing solutions from various manufacturers entails further challenges relating to data exchange and data integration. Users are often confronted with incompatibilities in terms of file formats, or interface problems with proprietary ERP systems, or systems for maintenance planning and asset management.

Combined software for test execution, condition assessment, and data management

A comprehensive software solution can master many of these challenges. Users only need to train themselves on one type of testing software, which can be used to operate several test systems and perform diagnostic tests on various substation assets. As well as the reduced effort for induction and training, the effort for maintenance measures, such as regular software updates, is also significantly reduced – a step in the right direction for greater efficiency.

The use of combined software further ensures the compatibility of the data obtained. Integrated import functions enable the import of measurement data which has been created with test devices from third parties or by oil laboratories, for example, during dissolved gas analysis.

Therefore, all asset and measurement data can be collected and managed in a central location or shared database. The data can also be recorded throughout the entire lifecycle of an asset, which enables trending analysis. All of this also has a positive impact on test reporting, as the desired information can be selected from the data in a targeted manner and compiled thoroughly. Flexible import and export interfaces ensure simple data exchange with other software systems and integration into a larger software ecosystem.

Software-based testing also has additional benefits, as a clever mix of automation and user guidance can offer a high degree of support, security, high-quality measurement results, and time savings. Corresponding automatic functions can accelerate complex steps such as specifying assets or making test execution as efficient as possible through automatic test algorithms. The validity of the obtained test results can be checked directly on site or evaluated automatically in accordance with applicable standards. Tailored user guidance also ensures quality and reliability when performing tests and of the data obtained.

Summary

The article describes the increasing challenges faced during substation asset testing. It further shows the changing requirements for state-of-the-art test solutions to allow the most efficient way of testing in order to counteract these challenges.

Thereby, state-of-the-art test solutions not only require optimised hardware, but also tailored software which does not just cover the pure test execution on site. It can also make the entire testing process, including preparation, and follow-up tasks such as assessment and reporting, as efficient as possible.

However, the added value of these new opportunities can only be gained through intelligent use. If, for example, several test teams with optimised testing solutions are working simultaneously on different assets, the maximum amount of data can be recorded in the shortest possible time, making the most efficient use of the outage time within a substation.

Christian Enk,

Area Sales Manager, Regional Application Specialist and Regional Training Manager at OMICRON

Martin Pfanner,

Product Manager for test software and data management for primary assets at OMICRON

A NUDGE TOWARDS TRANSFORMATION

Renewable Energy India Expo (REI) 2019

With a broadened scope of thought, and with an eye on the energy sector – the REI Expo 2019 nudges the renewable sector towards growth, while industry representatives speak on innovation, technological advancement while voicing the need for policy.

- Ranjana Konatt, Editor (Brand Positioning)

The 13th Edition of the Renewable Energy India (REI) 2019 Expo proved to be a worthy platform for both National and International stakeholders to exhibit their proficiency and technological advancement within the scope of energy management. The Expo was held from September 18th to the 20th at the India Expo Centre, Greater Noida and the three-day mega-event saw over 750 exhibitors. Over the years, REI Expo has been looked-up to as having a strong reputation as Asia's largest and most comprehensive expo within the field of renewables and technology. This year, leading associations participated - to name a few: the Indian Bio Gas Association; the Indo German Energy Forum; Solar Business Club; All India Solar Industries; APVIA; Indo German Chamber of Commerce; Skill Council for Green Jobs; and the National Solar Energy Federation of India.

Commencing with an opening ceremony, the first day was graced by key dignitaries, to name a few - Justin Wu, Head - APAC, Bloomberg New Energy Finance; Somesh Kumar, EY India Power & Utilities Leader; Ajay Mishra, Special Chief Secretary, Energy Department, Government of Telangana; Manu Srivastava, Principal Secretary, New & Renewable Energy Department, Government of Madhya Pradesh; Yogesh Mudras, Managing Director, Informa Markets in India; and

Rajneesh Khattar, Group Director, Informa Markets in India.

The event hosted discussions where industry leaders engaged in riveting conversations. Manas Trivedi, Senior Manager, Exicom Tele-Systems Limited, spoke on the current scenario; future trends in technology concerning the performance and cost -related aspects within the value chain in India. He said: "The government has been very clear concerning promoting electric mobility." Elaborating, he said that at a macro level, it is essential for companies and the industry to have a voice without being oblivious to what's happening globally. "It is essential to take global cues and apply it to India," he said. On the other hand, Rashi Gupta, Founder Director, Vision Mechatronics, offered a different perspective. She said: "India is a unique country, no solutions developed abroad apply to us." Making a very strong yet relevant statement, she said: "Our conditions are nothing like how it is abroad and we work on a different scale and the industry needs technology that is customised." While she was assertive, she did also say that India is a price conscious market.

Allied Moulded is a US-based company which is over 55 years old. We are set up in the US and have been in India for the past seven to eight years. During the event we have special focus on our Fiberglass Reinforced Polyester (FRP) enclosures and non-metal enclosures for solar systems. We have fibre re-enforced polymers that are most suitable for outdoor environments. Having an Expo for the solar industry is effective. Our enclosures are high-quality and are certified even for exposure to UV rays, and we stand guarantee for all our products.

Ananthakrishna GR,
GM, SALES AND MARKETING,
ALLIED MOULDED ENCLOSURE PRODUCTS INDIA PVT LTD

Vikram Solar is one of India's leading module manufacturers and solar EPC solutions providers. At REI 2019, we launched a new line of high-efficiency MBB half-cell modules. This module series is an upgrade of Vikram Solar's existing 5 BB half-cell module and a new addition to the company's product portfolio. The modules will house 144 half-cells and would have maximum power up to 415 Wp in monocrystalline technology. This new series would be available in the market from January 2020 and would offer increased light harvesting by reducing the inactive area of solar cells and internal resistance to yield higher field performance."

Amit Gupta,
DIRECTOR, LEGAL & CORPORATE AFFAIRS, VIKRAM SOLAR

We are one of the leading manufacturers in India. One particular technology within the solar segment is the glass-to-glass module. The dual glass module offers a module conversion efficiency of up to 17.16%. Last year, we began doing EPC and this year we are entering into IPP – hence we will also be an integrated solutions provider. In addition, Polycrystalline Solar Panels are in high-demand but we also see Monocrystalline panels picking up. We hope for support from the state government as government policies have a major role in the market.

Bharat Bhut,
DIRECTOR,
GOLDI SOLAR PVT LTD

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Meteo Control has recently established its presence in India with an office in Ahmedabad. As a company, we provide service and support to our customers. We are showcasing our monitoring, control and other solutions for power plants, i.e. monitoring, forecasting and related services. As the market is growing, people are moving towards the use of new products. Today, the industry is focused on price rather than giving technology preference. Moreover, people are also focused on short-term rather than long-term goals that hinders the adoption of new technology.

Ashutosh Yadav,
HEAD, B.D. (INDIA),
METEO CONTROL INDIA

We are a string inverter manufacturing company. We have big inverters that find application in the solar sector. Our experience at the REI Expo has been good. A new product launch that we are showcasing here at the expo is the Fronius Tauro – a robust commercial inverter built for maximised profit. The inverter allows flexible system planning, minimises the balance of the system (BOS), it also helps reduce costs even during extreme conditions. The innovative double wall construction and active cooling technology allows the Fronius Tauro to be placed in direct sunlight while still ensuring continuous yield.

Ashok T,
HEAD - SOLAR BU, INDIA,
FRONIUS

Our company was established in Taiwan in the year 1997. This is the first time we are exhibiting here at the REI Expo in Delhi – and now we plan to work pan India. We have the on-grid solar inverters and also do OEM work for clients. The market demand for solar-powered products is increasing and we see a steady 30-40% increase each year. We have our sales and distribution in three to four countries, and we see our sale numbers growing day by day. Our applications are in the commercial and domestic sector and today, especially we see the solar industries being deeply influenced by government policies.

Bharat Patel,
SOLAR INVERTER AND
ACCESSORIES, MJ INTERNATIONAL

We are a German company; this is our second time at the REI Expo. The solar sector in India has begun to show promise and Axis Storage is a premium product by AXITEC. The facet that makes us different is that with our products, our client gets a 15-year manufacturer warranty and a 85% linear output warranty after the 25th year. We deal in solar panels for residential, commercial and the agricultural sector. The overall market demand or our products is good and because quality customers are available in the market, we understand about quality, and the challenges within the sector.

Nisha Goswami,
SALES, AXITEC

We are a well-established company that has been functioning for over 30-years, and we have offices in over 26 locations. We provide inspection, certification and testing in India. Chennai is the place from where we handle our renewable sector. Within the scope of renewables, we provide services right from the planning stage, right to the time when the transactions are executed. We address issues concerning feasibility during the construction stage of a project.

Tushar Chaudhary,
ASSISTANT MANAGER - BUSINESS DEVELOPMENT, RENEWABLES, TUV INDIA

As a company we are showcasing our solar battery, and panel solutions. We are presently also providing training to 30,000 electricians on how to install and work with these products and also to ensure that they are certified solar installers. We have multiple projects wherein our panels and batteries are used. As a company we take up an approach that involves direct client education.

Sachin Bhalla,
VP MARKETING, LUMINOUS POWER TECHNOLOGIES

Our experience at the REI Expo has been getting better every year. This is a place where representatives from the solar industry come together to discuss and learn from one another. We at Sileaf Technologies are manufacturers of DC water pumps. We focus on DC water pumps as they are our flagship products. Our pumps are 0.5 to 5HP and have a BLDC motor with a true MPPT controller. The pumps have a head range of 10 to 150M and give an output that is 25% higher as compared to AC pumps. All our products are manufactured in India and we are one of the few companies who have been successful in using the motor for our pumping activities.

Sunil Joshi,
BUSINESS HEAD - PRODUCTS, SILEAF

REC is a Norwegian company and we started in 1996. We are a fully-integrated player within the solar segment. One particular kind of technology is heterojunction technology – the concept is not new but we are taking the existing technology and introducing half-cut cells. The monocrystalline-based heterojunction (HJ) cell will use Meyer Burgers 'SmartWire' (SWCT) cell connection technology.

Rohit Kumar,
HEAD OF THE INDIAN SUBCONTINENT, RENEWABLE ENERGY CORPORATION - REC INDIA

At REI, we are showcasing our robotic dry-cleaning systems being used for cleaning panels. Our system does not use any kind of water and is fully-automated. With the modules we can see that these are self-charging batteries, hence there is no human effort. We have already installed the robot at a few sites in India. Having this kind of a system will reduce human effort and will help clean the panels regularly, improving the efficiency of the system. The next five years is all about the O&M sectors.

Aayushman Goyal,
SR. MANAGER - NEW PRODUCT DEVELOPMENT, GANGES INTERNATIONALE

We began doing business in the solar sectors three years back and have recently upgraded our line-up of products. We have a Three-Phase and Single-Phase net meters. The meters include a single metering unit for bi-directional energy measurement with separate registration for import and export. Also, we have AC combiner boxes, cables, lighting arrestors all as a part of our upcoming projects. In comparison to last year, we have seen a lot of change – people are gradually moving to EV charging and are entering into the rooftop segment.

Neelaksh Pathak,
BUSINESS DEVELOPMENT, SOLAR, HPL ELECTRIC & POWER LTD

Corros Metals Pvt Ltd was established in the year 2007, and is located in Pune, Maharashtra. We are the manufacturers of galvanised structural steel materials and we manufacture all kinds of model mounting structures – especially for solar utility-scale power units. Some of our products within the solar application segment include – solar mounting structures, utility scale module mounting structures, single and dual axis tracking structures, solar pumps mounting structures, and rooftop solar structures. Apart from the utility-scale, we also cater to rooftop structures that range from 1KW to 500KW. We produce and manufacture all our products in-house. We have cold forming lines, state-of-the-art fabrication facilities, plasma cutting facilities and also a hot-dip galvanising unit.

Kuldeep Walujkar,
DIRECTOR, CORROS METALS PVT LTD

Vitronic is a company based in Germany, we are a privately-owned company with around one thousand staff. To be specific, we are involved with the production of photovoltaic solutions where we focus on eliminating a manual vision inspection. Optical quality inspection is critical for high-quality and uniquely classified products in photovoltaics production. With 30 years of experience in industrial automation and almost 10 years in photovoltaics production as well as more than 1000 successful system implementations at 70 plus end customers, Vitronic has developed the VINSPEC Solar product line to provide a customised inspection solution for every relevant production step.

Richard Moreth,
HEAD OF PV SALES, VITRONIC

LS Power Control Pvt Ltd works in the sector of electrical equipment and manufacturing and has been functioning for the past 40 years. We have a complete range of electrical panels and provide end-to-end solar power solutions. Our motto is to augment the power production through solar energy and as a company we are presently developing a PAN India network for EPC services. We have a dealer network in Haryana and Uttar Pradesh. Our services are: EPC, project planning, trading of solar modules, feasibility report, energy audits, installation and commissioning, and operation & maintenances. A key stressor within the industry today is cost to which there are various processes associated with costs. Overall, the market demand for solar applications are stable.

Bimlesh Kr. Singh,
AGM, SALES AND MARKETING (TECHNICAL),
LS POWER CONTROL PVT LTD

Good Opportunity for Cable & Wire Industry

Cable & Wire Fair, which has undisputedly become India's leading trade fair for the wire and cable industry will be held from November 6 to 8 in New Delhi.

The most illustrious wire and cable manufacturers, wire and cable machinery manufacturers and suppliers of materials for the wire and cable industry take pride in exhibiting their products and services at Cable & Wire Fair, which has undisputedly become India's leading trade fair for the wire and cable industry.

Cable & Wire Fair 2017, which saw 10,800 visitors, 164 exhibitors, over 300 conference delegates and representations from 19 countries, had spectacular success in providing the participating wire and cable companies with a platform for advertising and networking.

Like the Cable & Wire Fair held in 2017, this year's fair aims to give players from various segments of the wire and cable industry a good opportunity to network and to exhibit their products. It will make real business happen – something that will eventually push up economic growth. Approximately 200 exhibitors from around 25 countries will showcase their products and services at this important event. Valuable knowledge and information will be shared at the event's collocated conference and CEO conclave.

Pragati Maidan, Delhi, provides the venue for this year's Cable & Wire Fair. Delhi is India's top venue for prestigious events, mainly because it is the country's capital territory and all policy initiatives are launched here.

Growth Drivers

According to Institute for Energy Economics and Financial Analysis (IEEFA), India's gross domestic product (GDP) will double over the next 10 years, growing at a rate of 7 per cent per annum. Over this period, the demand for electricity is expected to nearly double. This growth rate augurs well for the development of the wire and cable industry in India, which has already crossed Rs 60,000 crore.

The wire and cable market in India, which comprises nearly 40 per cent of the electrical industry, is growing at a CAGR of 15 per cent – thanks to the growth of the power and infrastructure sectors. The recent policy and regulatory initiatives and government schemes like Ujwal Discom Assurance Yojana (UDAY), Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Integrated

Power Development Scheme (IPDS) and Pradhan Mantri Sahaj Bijli Har Ghar Yojana have given the market a major boost. It may be mentioned that under DDUGJY, the government has envisaged the electrification of all villages. With the outlay of Rs. 2.6 lakh crore announced by the government for the five-year period ending FY2022, the Transmission and Distribution sector is all set to remain in focus for quite some time. The government's target of generation of 100 GW of solar energy by 2022 and measures like excise duty exemption for Ferro Silicon Magnesium used for manufacturing components of wind-operated electric power generators have also increased the demand for electrical wires and cables.

In addition, the government's 'Smart City' project is expected to promote large-scale growth in infrastructure, telecom, power generation, T&D, engineering and automotive sectors. In addition, electric vehicles (EV) are expected to drive growth for cables and wires firms in a big way. There will be an increased demand for wires and cables when the acceptability of EV picks up. Some amount of wire will also be required to set up EV charging infrastructure.

The wire and cable industry expects a spurt in manufacturing activity and capacity expansion in sectors like steel, cement, pharma, etc.

Cable & Wire 2019 will give exhibitors an excellent opportunity to showcase their offerings and a platform for establishing a mutually beneficial relationship with other business people and potential clients.

Kyoritsu's 2210R Flexible Clamp Meter

Kyoritsu's 2210R Flexible Clamp Meter is used to measure the current in A, mA of 5ϕ mm cable size to 150ϕ mm. Apart from being used as energy-measuring devices for open space area it will use as well as for crowded space too. Wide current measuring ranges from 30-3000A with 120-hour battery backup.

Kyoritsu's 2210R key features are:

- Flexible and light weight clamp sensor
- Wide reading range up to 3000A
- True RMS
- MIN MAX function
- Backlight LCD display
- IEC 61010-1 (CAT IV 600V / CAT III 1000V)
- 5000A AC for 10 seconds over load protection

Kyoritsu products are readily available in India and have complete service and calibration support setup too.

Kyoritsu, Japan has frontline global presence in electrical test & measurement equipment since 1940, with specialised expertise in low voltage test & measurement. In India, the company has been present for many decades already, offering world class products optimised for Indian needs at just right prices. Many of these products have for long been the choice equipment of every Indian electrical installation professional.

For more info: info.ei@kew-india.co.in

ERDA gives glimpse of transformers through workshop

A one-day workshop on 'Transformer Design, Applications and Life Extension', jointly organised by ERDA, IEEE-PES and IEEMA with GETCO as knowledge partner, was held in Vadodara recently.

The programme was inaugurated by the Chief Guest K M Bhuva, Director Technical, GUVNL and by the Chairman, Organising Committee B B Chauhan, Managing Director GETCO. Welcome address was delivered by Hitesh Karandikar, Director – ERDA followed by an address from Rakesh Patel, Chair IEEE-PES, Gujarat Chapter.

The Chief Guest and Chairman, Organising Committee emphasised the importance of transformer in the electrical power system and the requirement of a better designed and properly maintained transformer for better reliability and longevity of the transformers used by the users.

Vipul Ray, Vice President, IEEMA and MD, Elmex Controls proposed vote of thanks. The technical presentations were divided into five sessions. The workshop topics were Design Aspects of Transformer by Ronnie Minhaz, IEEE-PES; Health Index of Transformer by Dr Satish Chetwani, Assistant Director and Head of R&D, ERDA; Inverter Duty Transformers for Solar Application by Prasenjit Paul Global Technical Manager (R&D), Scheider Electric; IEEE Specification by Ronnie Minhaz and Life Extension of Transformer by P Ramachandran, Senior Advisor, ABB. The main objective of this workshop is to discuss the transformer design aspects, specifications, special applications and life enhancement technologies, among the designers, manufactures, utilities, consultants, academia and R&D institutes professionals.

Glimpses of workshop on Transformer Design, Applications and Life Extension

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Whisper quiet, modular cleanroom solutions from igus for the smallest of installation spaces

The world's first e-skin soft and e-skin flat ensure particle-free cable routing in compact and flat installation spaces

With the e-skin flat and the e-skin soft, igus offers two new space-saving energy supply systems for the cleanroom. The modular energy chains operate quietly and are easy to fill. In a second expansion stage of the e-skin flat, the individual chambers are openable thanks to the zipper system.

For guiding cables securely and abrasion-free in cleanrooms, igus has e-skin in its product range. The energy chain for cleanroom applications has now been equipped with a softer material especially for compact installation spaces. The safe and particle-free guidance of cables can be undertaken at a low clearance height with the new e-skin soft. For very tight installation spaces, igus has also developed the e-skin flat. The new low-profile energy supply has a chamber design and is easy to fill and maintain. Both energy chains were convincing in the sound test with their very quiet operation.

In the production of microchips, OLEDs, LCDs, implants, and semiconductors or in the pharmaceutical industry, there are very high demands in a pure manufacturing environment. Because every type of contamination has a direct effect on the product and can lead to serious damage for the manufacturer. Therefore, the conditions on the used machine elements as well as on energy supply systems are particularly high. As a result, igus presented the easily openable e-skin, an enclosed corrugated tube, four years ago. It has the seal of approval Fraunhofer Tested Device of the ISO class 1 and in 2018 received the 2nd prize of the Fraunhofer clean technology award "Clean! 2018". The reasons for this approval were: the e-skin is made of tribologically optimised, abrasion-resistant plastic, has a modular structure, and can be filled quickly. To make the e-skin suitable for use in compact rooms, it has now been fitted with a new soft material. The new e-skin soft can also be used in small installation spaces on short unsupported lengths. For very flat installation spaces, igus offers a new solution with a chamber design: the e-skin flat. Both energy chains were convincing in the noise test in the movement. The e-skin soft had a value of 32.4 dBA and the e-skin flat, 29 dBA. This means that the new

energy supply systems for cleanrooms are significantly quieter than alternative solutions on the market.

e-skin soft: modular and fast to fill

The new e-skin soft is based entirely on the modular principle of the proven e-skin. The separable upper and lower shells of the energy chain can be easily put together by a "zipper" to a fully enclosed tube, which is highly dustproof and water-resistant. This guarantees both cleanroom compatibility, quick filling and maintenance of the cables.

Safe energy supply for flat installation spaces in cleanrooms

igus has now developed the e-skin flat especially for very tight installation spaces, for example in semiconductor manufacturing. The new energy supply consists of a profile with three cable chambers, which are extruded from high-performance plastics. Therefore, it is very flat and allows a very small bend radius and a low clearance height. The profiles can be connected to wider systems. In contrast to alternative solutions, the cables in the e-skin flat are not shrink-wrapped but are inserted into the chambers. In the event of a need for maintenance, the cables can simply be pulled in without having to install a new energy supply system. The user reduces the costs and improves his technology. In a second expansion stage, the individual chambers are openable from the outside thanks to a zipper system, so that maintenance can be speeded up further. Another advantage: with the new energy supply systems, e-skin flat and e-skin soft, igus offers two cost-effective solutions available directly from stock.

Immediate ready-to-connect system with guaranteed service life

Upon request, the customer can receive the new energy chains for the cleanroom immediately as a ready-to-connect complete system with chainflex cables. The user has the option to use more than 918 highly flexible cables with IPA class 1, which are specifically developed for use in the energy chain. All cables were tested under real conditions in the company's own 3,800 square metre laboratory. This makes igus the only provider in the world to offer a 36-month guarantee on its range of cables.

For more details, visit www.igus.in

Ktec gets NABL accreditation for Transformer Oil Testing

Ktec Oil Laboratories, a division of Event Electric Pvt Ltd, one of the leaders in transformer oil testing has been accredited from National Accreditation Board for Testing and Calibration Laboratories (NABL) for Testing of Transformer Oil.

Routine testing of transformer oil on a regular schedule is highly required. Uninterrupted power supply is the biggest goal for every power transmission and distribution company. Anything going wrong anywhere with any transformer, a huge area will be affected. The contaminated oil can lead to tripping of transformer or failure of transformer or in worst case bursting of transformer. Therefore, it becomes very much important to monitor the transformer health regularly.

Dissolved Gas Analysis test performed on transformers oil and insulating oil is highly reliable and proven technique to detect internal fault. Furan analysis on transformer oil indicates degree of degradation of transformer paper insulation. So, it is important analysis in deciding when to discard a transformer unit or retain.

Ktec's lab is fully equipped with fully-automatic instruments to perform various transformer oil tests

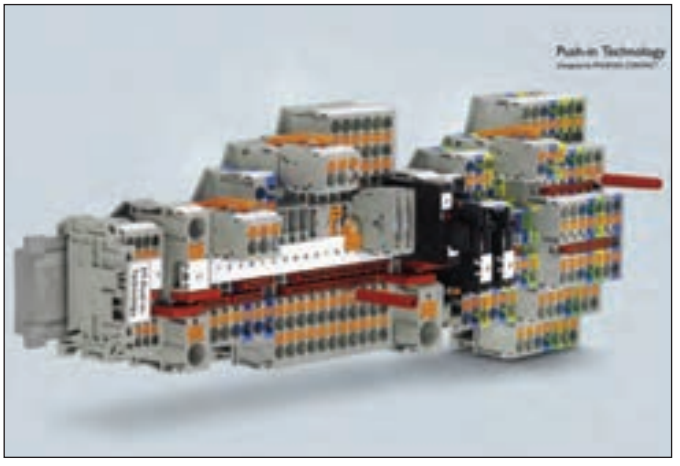
including – DGA, BDV, Tan Delta Test, Specific Resistivity test, Density, Pour Pont, Furan Content, Interfacial Tension, Kinematic Viscosity at 27C, water content test, flash point, sludge/sediment and appearance. Also, the company has secured orders from prestigious clients like Indian Railways, IOCL, HPCL, BPCL, NHPC, Aditya Birla Group, Lafarge Cement, Naini Tissue Limited, Ultratech Cement, and TVS Tyres.

For more details, email at info@ktec.co.in or contact on +91-9911580807

Push-in Connection Technology

The original Push-in Technology designed by Phoenix Contact

Push-in, the connection technology of the future: This requires many years of experience in development, and Phoenix Contact know-how. Benefit from the advantages of easy, consistent wiring realised through the company's wide range of push-in products from the terminal block to the controller.



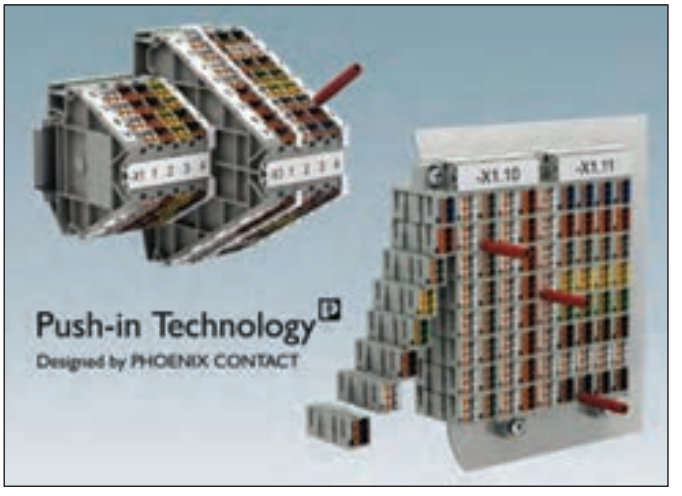
With the new terminal principle, flexible cables with ferrules starting at 0.14 sq.mm. to 185 sq.mm. can be connected. The integrated actuation lever allows to release conductors or to connect small conductor cross sections from 0.14 mm^2 with any type of tool - easily and without direct contact with live parts.

The PT connection technology has been tested and approved for a range of approvals. These include, for example, vibration resistance according to railway standard EN 50155 and shock and corrosion resistance according to current shipbuilding registers. It is also certified for process engineering in areas with increased safety.

Advantages

Many years of experience in Push-in connection technology, and 1.5 billion wired contacts stand for maximum quality and safety

- Wide range of products enables the wiring of entire applications
- Easy and tool-free wiring, thanks to insertion force reduction by up to 50 per cent

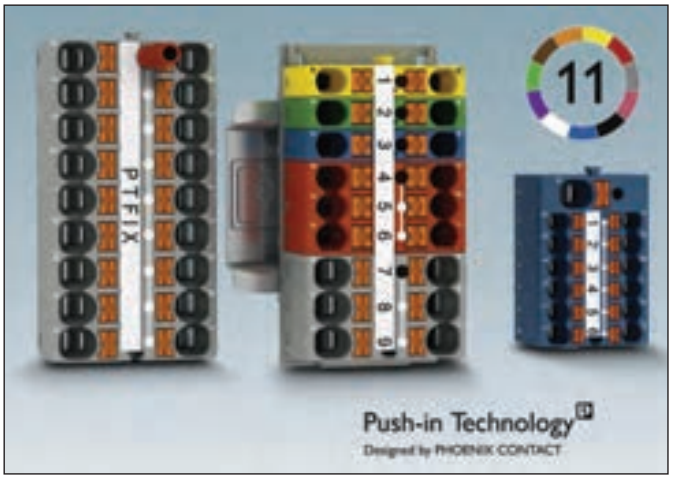


- Automated wiring: made possible by Push-in connection technology
- Reduced costs and installation times due to easy and fast wiring

  Release connected conductors using any type of tool – easily and without direct contact with live parts
- Safe wiring and operation, thanks to the color-coded push button.

New Products

Compact potential collective terminals with screw and Push-in connection



- Distribution blocks with Push-in connection – PTFIX
- PTPOWER High current terminal block
- Marshalling terminal block.

For further details, email to adverts@phoenixcontact.co.in.

testo 868 – Thermal Imager

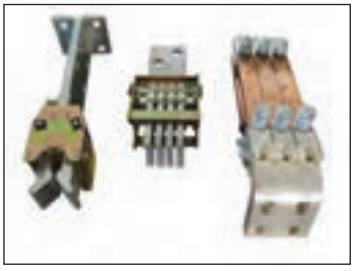
The testo 868 thermal imager is characterised by its professional measuring performance and its easy handling. It has the best thermal image quality in its class, an integrated digital camera and impressive smart functions. The case supplied with the thermal imager means it can be conveniently transported, so it is always there for you when needed.

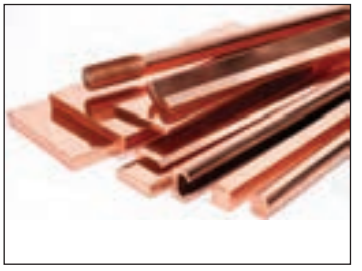
Features

- Very good image quality: IR resolution of 160 x 120 pixels, via integrated testo Super Resolution Technology 320 x 240 pixels
- Large temperature measuring ranges from (-) 30C to (+) 650C.
- Smart and networked: the free testo Thermography App enables you to write and send reports on site, as well as saving them online, and lots more.
- Integrated digital camera.

For more details, visit www.testo.com or mail on info@testo.in

Citizen Metalloys: Committed to Customer Delight & Satisfaction





Citizen Metalloys Ltd is one of the leading manufacturers of copper, working towards being in market as leaders for manufacturing of copper components, fabricated bus bars, copper profiles, sections and many more items for electrical transmission and distribution, and power generation sectors.

The company's products are certified with ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018 quality certified and compliant with the Environmental Law and Occupational Health & Safety Laws of India. Having government recognised Star export house, Citizen Metalloys exports its products regularly to more than 40 countries.

Located at Chhatral of Gandhinagar district in Gujarat, the company has a production capacity with a facility of production of over 4,000 tonnes.

Citizen Metalloys produces various grades i.e. ETP Grade high conductivity copper, oxygen free copper flats, bus bars, and rods which are available to customers in wide spectrum of sizes. They also manufacture a range of phosphorised nuggets, balls and anodes used for electroplating.

Citizen Metalloys also offers earthing materials i.e. pure copper tapes, solid copper earthing rods, plates and lattice which are available in durable quality for earthing solutions.

They are also appreciated for manufacturing premium quality copper washers and nails. The laminated flexible connectors and braided flexible connectors along with flexible insulated bus bars are recognised for efficiently minimalising contact damage.

Citizen believes in providing customised services to its clients, so that the end products can readily be used. Customer delight and satisfaction is their primary goal. For that they are committed towards leveraging the latest technology in keeping up with the times.

For more details, visit www.citizenmetalloys.com

FLIR CM94: 2000 A AC/DC Utility Clamp Meter

The CM94 clamp meter from FLIR is designed to tackle high-current measurements in demanding utility and industrial job sites. Its oversized, 55 mm jaw can securely clamp around conductor wires and busbars for accurate readings up to 2000 A AC and DC. Designed with a CAT IV-1000 V safety rating, the CM94 is ready to work on relays, distribution panels, and switchgear as well as service conductors, feeders, and production power lines. VFD mode allows you to tackle noisy signal environments to ensure correct measurements when working on large motors and motor controls. Utilities and industrial electrical technicians demand the best, and FLIR delivers with the rugged and dependable CM94 clamp meter.

Features

- Right tool for high-current jobs with improved safety built-in.
- It is a full-featured clamp meter saves time and helps to troubleshoot effectively.
- FLIR CM94 features an oversized jaw to clamp around large conductors or multiple conductors.

For more information, mail at flirindia@flir.com.hk or call on +91-11-45603555 or visit www.flir.in

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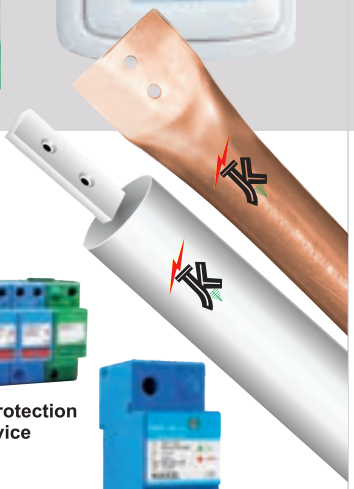
Insulation Monitoring Device



Surge Protection Device

Surge Arrester TYPE 2 / CLASS II

Lightning Current & Surge Arrester TYPE 1+2 / CLASS I+II

Certifications

NABL RoHS compliant RoHS

APS

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LPI®

LIGHTNING PROTECTION INTERNATIONAL PTY LTD

Guardian Plus

Protection Solutions for HV Power Facilities

AUSTRALIAN MADE

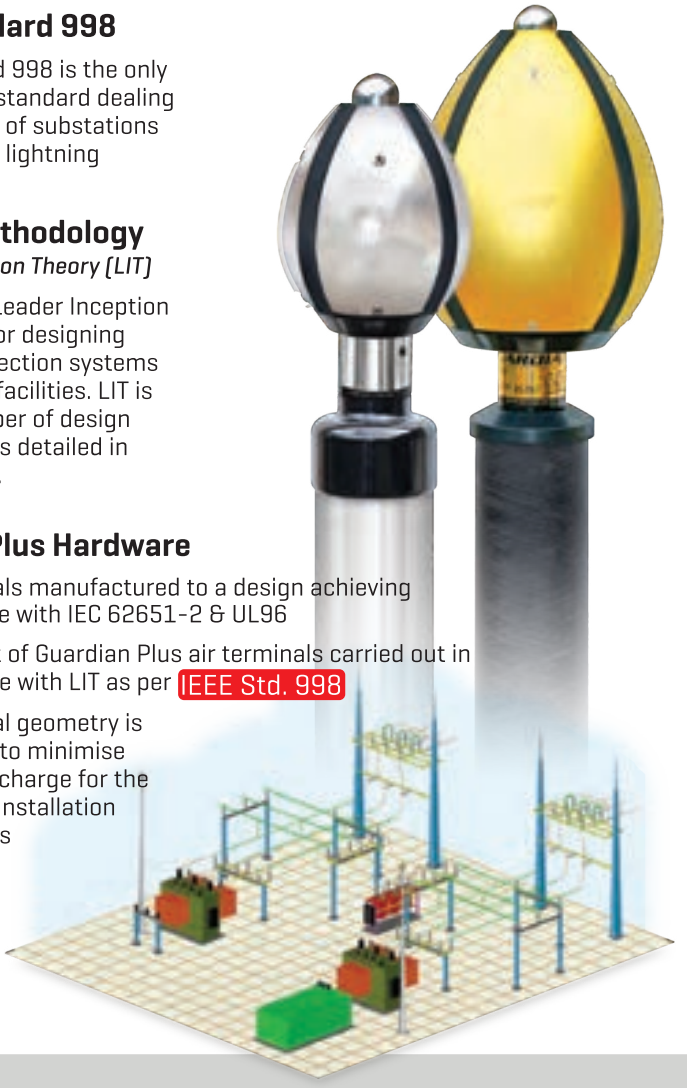
IEEE Standard 998

IEEE Standard 998 is the only international standard dealing with shielding of substations against direct lightning strikes.

Design Methodology

Leader Inception Theory (LIT)

LPI uses the Leader Inception Theory (LIT) for designing lightning protection systems for HV power facilities. LIT is one of a number of design methodologies detailed in IEEE Std. 998.



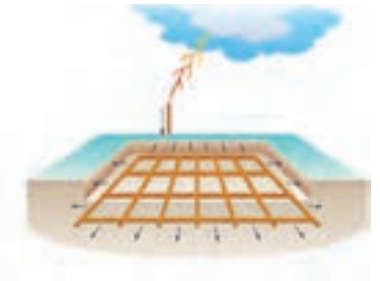
Guardian Plus Hardware

- Air terminals manufactured to a design achieving compliance with IEC 62651-2 & UL96
- Placement of Guardian Plus air terminals carried out in accordance with LIT as per IEEE Std. 998
- Air terminal geometry is optimised to minimise corona discharge for the particular installation parameters

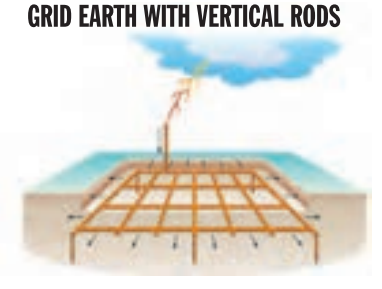
Comprehensive Lightning, Surge Protection

GRID EARTH

Specially Design for substation based on IEEE standard.



GRID EARTH WITH VERTICAL RODS



Cornelius Plath
Product Manager

Transformer Testing made quicker and easier than ever before … …

… was our vision for our new powerful and lightweight test set.
TESTRANO 600 is the world's first portable, three-phase test system which supports all of the common electrical tests done on power transformers.

With just one setup for multiple tests, **TESTRANO 600** significantly reduces the wiring effort and testing time. Its specially designed power amplifiers ensure a new level of accuracy. And the multi-touch color display enables smart and comfortable operation.

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