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Distribution Transformer Industry:

The Challenge of

Dual Certification

Focus
Distribution Transformers

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Dear Friends,

In April issue I spoke about how trade wars portended a slowdown globally. Also how China was facing the lowest growth in decades in its effort to control the burgeoning debts. The world was staring at "synchronised slowbalisation"

There has been change of course in China since. It has chosen to reverse the slowdown - or at least arrest the same - by introducing a stimulus of proportions far bigger than expected. It has issued almost 180 bn USD local government bonds mainly to spend infra bonds. This has been supplemented by USD 300 billion cut in VAT so that reduced cost will enable companies to have more investible surplus. This is also aimed at private sector as distinct from state sector emphasis of earlier stimulus. In Europe and US there are mixed signs with plans to increase bank rates not in the agenda for the time being. In fact, around a year ago dominant concern was inflation control. In fact the noted journal "Economist" observed seven months ago that aggregated economies of Europe suffered from weak demand. It lamented that monetary policies didn't do more, sooner, to facilitate recovery. Concerns over debts and inflation was termed as misplaced.

The reference above is to put in perspective effect of hawkish monetary policies on MSME growth and jobs. While control on indiscriminate lending and effective steps for loan recoveries are laudable developments, credit control to check inflation has created problems for MSMEs in particular.

High interest rates when inflation is low would only unaffordably high "real interest rates".

There has been change in stance off late, but probably this too is the case where more could be done sooner. I want to be careful of any political undertones but certain facts can't be ignored. Monetary policies can't exist in isolation. There can't be a confrontation of the kind we have seen for supposed independence of an office without consensus of some kind. We can't have talk of fiscal prudence and supposed durability of 50 billion dollar scheme which is almost 2 percent of GDP coming from the source of same breath. This money would only come either from hefty increase in deficit or heftier increase in taxes.

In an atmosphere of cut and thrust of electioneering, it is a season of free- for - all accusations underpinned by nothing stronger than opinions and prejudices. To a rational mind with no prejudices and preferences, such money as talked about can't come from any recovery from supposed swindlers but only through a combination of increased deficit and higher taxes. Both are fraught with dangerous consequences.

However, I must hasten to add that in today's world of competitive and divisive politics, such political appeasement straddles across the political divide.

Harish Agarwal

Dear Members,

ELECRAMA fever will soon grip the country as we commence the space booking process this month for the 14th edition of the mega exhibition scheduled from 18-22 January 2020 at India Expo Mart, Greater Noida.

ELECRAMA has always been special for the electrical equipment industry in India since its inception in the year 1990. Starting from a small area in Godrej factory to the largest and most modern exhibition venue with gross area exceeding 110,000 sqm, what a momentous 30 years these have been!!

ELECRAMA has been built brick by brick and it has reached the stature of being the largest multi dimension show for Electrical Equipment Industry particularly the Transmission and Distribution segment.

IEEMA has constantly endeavoured to add value and evolved the show to meet the expectation of the industry in this fast changing environment. This constant adaptation ensures that exhibitors and visitors both are able to get value while investing time and resources.

The mega event is a platform to connect the world with Indian industry in respect of technology, new trends and innovation. It is also a stage where all global leaders can meet and share their ideas to develop cost effective solutions for the world.

Next year we are expecting 1250+ Exhibitors from India and overseas; 10+ country pavilions and exhibitors from 25 countries. We are also expecting around 3 lakh visitors footfalls from the length and breadth of India and also from over 50 foreign countries including from South Asia – Bangladesh/ Nepal, Sri Lanka, Afghanistan; South East Asia – Indonesia, Thailand; Malaysia; Myanmar; Vietnam; Cambodia, Laos, Philippines, Korea, Taiwan, Japan and Africa – South Africa and many countries of Sub Saharan Africa & CIS.

ELECRAMA has completed the transition from the traditional power transmission and distribution domain to cover the complete electricity ecosystem.

Co-located events such as **3rd World Utility Summit** – conference for the Utilities and by the Utilities – witnesses CEOs from leading Utilities of the world deliberate and share experience with Indian counterparts. **eTechnxt** brings future technologies in the domains of Renewables, Energy Storage and eMobility to the Indian audience.

Knowledge sharing is one of the primary objectives of ELECRAMA and forums such as CEO Summit (for CXOs); Engineer Infinite (for budding talent); Network to Networth (finance for the electrical industry) etc are other attractions.

Focused pavilions on Rail Electrification; Power PSUs; MSME; Industrial Transformation; Lighting and electrical equipment on low voltage side for realty and industry would make ELECRAMA a must visit for everyone.

It is matter of extreme pride for us that Ministry of Commerce, Govt of India supported **ChangeXChange** - Reverse Buyer Seller (RBSM) program at ELECRAMA is the biggest for any exhibition. We host 650+ hosted buyers from 80 countries. In the coming edition we are replicating the RBSM model and shall conduct Domestic Buyer Seller Meet (DBSM) to be hosted entirely by IEEMA and organise one to one meetings of the exhibitors with the Utilities, EPC, Contractors etc

There is a lot happening at ELECRAMA 2020.

We invite the industry both in India and overseas and our global counterparts to actively take part in this *Mahakumbh* of electricity..

Sunil Misra

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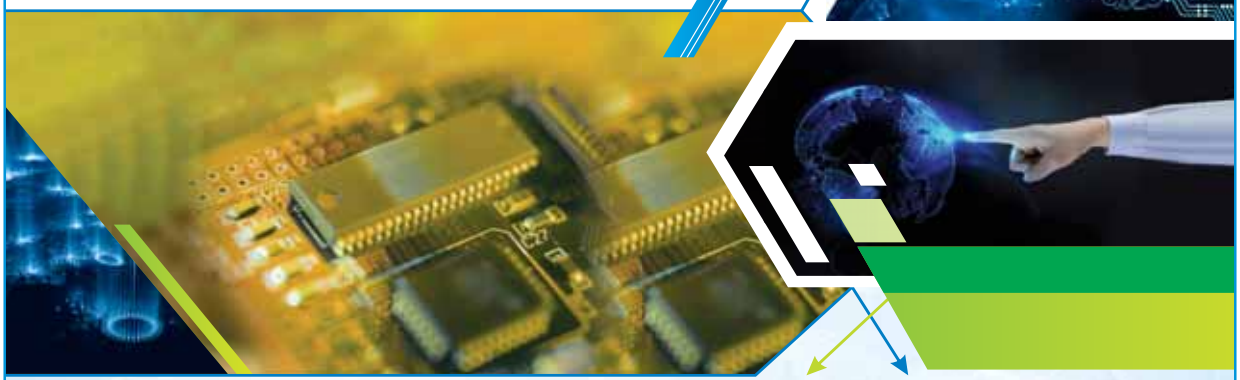

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The Distribution Transformer Manufacturers of the country who now have to obtain dual certification from BEE & BIS for energy efficient DTs under IS:1180 Part 1/2014 issued by the Government of India have been urging the government to consider mandatory certification from either BEE or BIS. IEEMA has also done representation in this regard to the government through its division as it is creating severe hardships for the manufacturers of Distribution Transformers, especially for the Small and Medium Enterprises. With the dual cost involved, compliance formalities, renewal, procedural delays, and manpower requirements, is acting as a deterrent for the manufacturers in doing their business with ease. The manufacturers are forced to comply with both the mandatory regulations.

Background

India is on the verge of becoming major power nation among developing economies. Electricity is a key constituent for the economic growth of the country and is directly linked to GDP of the country. There has been a surge in demand for power in India due to increase in capacity utilisation, industrialisation, urbanisation and population.

After the enactment of Energy conservation Act 2001, BEE was given the responsibility of efficient use of energy in variety of equipment particularly in the house hold appliances in a bid to save electricity as per saying that a unit of KWH saved is unit generated.

Consequently a notification dated February 2009 was issued by Ministry of Power specifying the energy consumption standard under S&L programme describing energy losses at 50% & 100 % loading of DTs up to 200 KVA rating units at 11KV level and labeled as star 1 to star 5 having progressively maximum to minimum losses respectively.

Recently BEE has issued an amendment to its February 2009 notification as per No. SO.4062 (E) dated 16th December 2016 effective from 1st January 2017 which has been recommended for extension by another 6 months wherein the losses of Distribution Transformers (DTs) has further been reduced thereby assigning its original star 4 (four) as star 1 (one) and star 5 (five) as Star 2 (two) with further new losses for Star 3, 4 & 5 worked out by extrapolating.

Industry Speaks

Mr Alok Agarwal, Chairman, IEEMA Distribution Transformer Division and Director, Uttam (Bharat) Electricals (P) Ltd. Is of the opinion that, “Mandatory BEE Certification for 16 KVA to 200 KVA three phase transformers was started when specific losses for distribution transformers were not mentioned in any standards. However with the introduction of mandatory BIS certification, where energy efficiency figures are specified for whole range of distribution transformers up to 2500 KVA transformers, the provisions of BEE have become redundant. However after introduction of mandatory BIS Certification. Instead of repealing the BEE requirement for distribution transformers, the scope of BEE certification is increased from 200 KVA to 2500 KVA.”

He further adds, “This dual certification has created lot of paper work and cost for the industry without adding any benefit to either manufacturer or customer. The delay in certification is also leading to unnecessary delay in supplies. Since the scope of BIS certification is wider and includes testing and surveillance, the BEE certification should be dispensed with or alternatively the same be changed to voluntary instead of mandatory certification, wherein the supplier/ Customer may opt for BEE certification if they find it beneficial. Further it is emphasised that BIS is the supreme standardising body for any equipment manufactured in India and hence the role of BEE in standardisation process is superfluous after introduction of mandatory BIS on distribution transformers.”

“With the introduction of mandatory BIS/BEE certification the requirement of number of type test/ routine test to be conducted at BIS certified laboratory has increased significantly. Further due to change in guidelines by BIS the tests at independent labs are required for each and every rating and variety. Frequent changes in requirement of minimum energy efficiency levels by BEE have rendered old type tests invalid. This has led to huge financial burden on MSME units. The proposal of reducing charges by MSME Ministry or reduction in test requirements by simplifying guidelines by BIS will be a welcome step and will help the DT industry which has very large base of MSME units.”

Mr Ajay Kumar Sanghi, Vice Chairman, IEEMA Distribution Transformer Division and Director Shri Krshna Sudarshan Urja Pvt Ltd says**,** “The Dual Certification is an anomaly which has to be removed. Both BIS and BEE are certifying on the basis of Standards promulgated by BIS vide IS1180:2014. Therefore the Mandatory Certification by BIS should continue, whereas the Certification by BEE should be made optional. It is also pertinent to note that bulk of the sales, comprising over 95% of Transformers sold in India, are purchased by Utilities who are having domain knowledge and are repeat buyers and have established procurement practices. Therefore no value is derived by the Purchaser from BEE Labelling, which might be the case in Consumer products such as Fridge, AC, Lights.”

Mr Harish Agarwal, President, IEEMA and CEO Supreme & Co Pvt Ltd opines, “It is matter of grave concern for manufacturers particularly SME manufacturers. Essentially for the same product you need to get certification done from two of the government agencies. It is hard to think how other stakeholders will trust their certificates if as an evolved agency is trusting the certificate of another independent agency. Each having a huge cost involved. Such duplication of work involving loss of time and huge amount of money makes mockery of government. There has been a tireless efforts to ease the conduct of business and promote innovation. After the introduction of BIS, BEE should have been made irrelevant.”

Mr RK Chugh, Vice President, IEEMA informs, “For Distribution Transformers, both BIS and BEE certification is required leading to unnecessary time and cost to MSME sector . Dichotomy exists because BIS & BEE come under different ministries . There is need for alignment between them to arrive at a consensus on the requirements & the certification process . Ideally , BIS should be the only certification agency for products as per IS & Energy Efficiency star rating .

Distribution Transformer Division has finalised another representation on the subject, which is being submitted to DIPP. Earlier , the issue was raised in our visit to Shri Sudhir Garg, Joint Secretary, Ministry of Micro, Small and Medium Enterprises, Government of India, on 4th April 2019. He understood the topic & proposed to convene a joint meeting with representatives from BEE & BIS to sort out the matter . We requested to be part of this meeting which he consented to . Shri Garg has also been invited for an interactive session with IEEMA members in our New Delhi office , when the matter would be represented again.

Earlier, the issue was also discussed during an interactive meeting with senior officials of Bureau of Indian Standards (BIS) at the CII Capital Goods Committee meeting in March 2019 . We suggested to BIS that they should internally ensure that their test results are duly accepted by BEE & they don't insist on a different round of certification . BIS officials had taken note of the difficulties and informed that they would help towards resolution of this matter .Infact , we are inviting BIS officials also in the MSME meet being organised in our New Delhi office when this issue would be highlighted again."

Mr A Shanmuga Velayuthan, Managing Director, I.P.L Products says, "These two agencies are Dual Ministry BEE – MOP & BIS – Ministry of Consumer Affairs & Department of Heavy Industries. Both agencies has short of manpower. Both agencies charges for the certification and there is no policing. It is suggested to have a single agency combining both who can give certification and reporting it."

Mr Mayur Karmarkar, Regional Director Sustainable Energy, International Copper Alliance says**, "** I believe that this is not any certification but in a typical industrial policy language, it is a 'product registration'. Both BEE & BIS mandatory schemes are as per two different regulations & purpose. As BEE is regulating 'energy performance' and BIS is regulating 'Quality' and both the agencies are under different ministries, they are maintaining different registers; hence manufacturers' need to apply separately. To simplify the product registration process, BEE & BIS should jointly agree to accept the same test certificates along with their application.

Mr Nagarjuna Babu Nannapaneni, Advisor, Shri Sai Electricals Ltd, informs, "In the present scenario the BEE is accepting the reports submitted to BIS as far the labelling is concerned. There is no specific testing for standalone neither to BEE nor to BIS as both the certifications were made mandatory for transformers covered under IS 1180 (Part-1):2014. It is obvious that any one certification can be waived or otherwise waive off either the BIS marking fee or the BEE star labelling fee. Incidentally the BEE star labelling fee is Rs. 100 per unit irrespective of the rating whereas the BIS marking fee is Rs. 3/- per kVA. Which means above 35kVA the BIS fee works out to be more substantial. For example, if a 2500kVA level 3 transformer as per IS 1180 :2014 has to be marked as per BIS the marking fee is Rs. 7500 whereas the 2 Star labelling fee of BEE is only Rs. 100. In the competitive market the manufacturer's loose orders just for meagre Rs 500 yet times and hence an addition cost on account of BIS marking further becomes an issue. There have been quite a few debates on the BIS / BEE issues, however no decisions were ever taken thus far either by BIS or by MoP or by DHI. If in case the labelling fee or the marking fee could not be waived off, let there be a common fee of Rs. 100/- per unit irrespective of the rating and the same can be equally distributed by both the institutions. After all are these money making institutions?"

Mr Vipul Ray, Vice President, IEEMA and Managing Director, ELMEX Controls says, "Anything that leads to increased cost and burdens the industry with duplication of effort is ultimately a loss to the nation. In an era where the government is pushing for digitisation and ease of doing business this requirement is counterproductive. As per my understanding the requirement for BIS certification takes care of equipment efficiency and hence having a separate BEE certification is not called for moreover all the utilities have prescribed terms and condition for transformer losses which automatically mandates efficient working. I believe that the authorities should re-look at this requirement so as to encourage ease of doing business and help the many small and medium enterprises who are in the business of manufacturing Distribution Transformers."

Mr Neeraj Khare, Managing Director – Adishaktyai India, says**, "**The Bureau of Indian Standards (BIS) is the national Standards Body of India, which is into the formulation, recognition and promotion of the Indian Standards, which helps the industry in upgrading the quality of their products and services. The mission of Bureau of Energy Efficiency (BEE) is to assist in developing policies and strategies with a thrust on self-regulation and market principles with the primary objective of reducing energy intensity of the Indian economy within the overall framework of the Energy Conservation Act, 2001. From the activities of both BIS and BEE, it is clear that, instead of both, any one of them should be made certifying agency for energy efficient DTs under IS:1180 Part 1-2014. Dual certification from both BIS and BEE will not going to achieve anything extra. Certification from any one of the govt. agency, will reduce the work, ease business, save time and expenditure of both manufacturers and one of the Govt. Agencies."

The items covered under BEE are mainly house hold and other equipments which are available in open market where the consumers have informed choice regarding energy efficiency on the basis of BEE star label, however distribution transformer is the only item covered under BEE scheme which is not available in

open market and is purchased by Discom though detailed specifications drawn under IS 1180 and are already aware about the energy efficiency.

The matter is detrimental towards the policy of Ease of Doing Business and Make in India. Alternatively, for ease of operation, instead of BEE star label certification, BEE should limit itself in announcing the minimum energy efficiency norms to be followed by giving sufficient lead time in consultation with BIS and other stake holders.

IEEMA is again in the process of making representation to the government in this regard to request for an early resolution of the issue in order to ensure ease of doing business for the manufacturing industry.

Other issues faced by DT Industry

Frequent Changes in the guidelines, specifications w.r.t mandatory certification of Distribution Transformers

Mr Alok Agarwal is of the opinion that, "Distribution transformers are normally purchased by Electrical Utilities against a technical specification through tendering system with a long delivery schedule, the whole process of specification finalisation, tendering, order placement and deliveries takes around 1-2 years. The frequent and sudden changes without giving any prior timeline or changeover time disrupts the whole process of purchase and supply of distribution transformers. It is strongly suggested that any changes in the energy efficiency level / guidelines/ procedures should be made only with wider consultations with stake holders and proper change over time should be given. The time line of gradual changes in energy efficiency figures, if required, should be published and a minimum 5 year period should be kept before any change is specified to align with validity of type test report as specified by BIS.

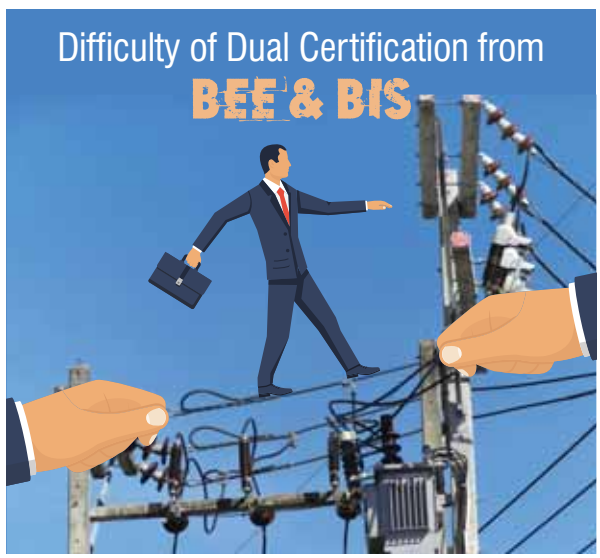
Mr Ajay Kumar Sanghi informs, "Whereas change is inevitable, it has to be orderly. The frequent and sudden changes, which are also mandatory, cause big upheavals for Manufacturers and Users. There should be a 2 year COOLING PERIOD for new policies, specifications, guidelines. This is as per Global practices."

Mr Mayur Karmarkar shares, "While I agree that this product was out of any regulatory regime till 2010. In last 8 years there was BEE mandate, QC order for CRGO & now distribution transformers. Erstwhile, I an unregulated market the country has seen highest failure rate, loss performances of public utility distribution transformers were higher than contract values & highest usage of 'bad quality raw material'. Also there was huge potential of energy saving in distribution transformer."

Mr A Shanmuga Velayuthan, says, "Technology up gradation is necessary and we are not against it. But at the same time all stake holders to be consulted, also sufficient time to be given to develop the Infrastructure & Manpower. Further availability of raw material to assessed before the implementation**."**

Mr Nagarjuna Babu says, "Apparently there is a lot of confusion in this. The scope of IS 1180 (Part-1):2014 has been amended to cover both Indoor and Outdoor type miner oil immersed transformers up to and including 2500kVA 33kV class vide Amendment No 1 of August 2016. At present vide a draft version of Quality Control Order 2018 under scrutiny of the Ministry of Heavy industry and the Department of Heavy Industry is contemplating on separate certification and marking license for the Indoor and Outdoor (for Outdoor already in place and for indoor effective 1st January 2019 as thought over but yet to be implemented). As per the "Guidelines for certification of Outdoor Type Distribution Transformer as per IS 1180 (Part-1) : 2014" CMD-3/16: IS 1180 dated 28.06.2016 –"Clause No.: I.1.c: For Sealed and Non-sealed construction, separate samples are not required to be drawn for Independent testing. If sealed sample is already drawn, non-sealed variety can be included in the scope of licence after its conformity to pressure test requirements as per IS 1180 (Part-1): 2014 and vice-versa. This testing may be done in factory or independent testing. Inspection charges as applicable shall be collected for factory testing".

We understand from the aforesaid clause that if the manufacturer has submitted the complete type test report of Non-sealed type verity (say 200kVA) to BIS and also submitted the pressure test report of sealed type of the same rating with same core-coil assembly or vice-versa then now they can manufacture and supply the transformers of 200kVA in both verity (sealed and non-sealed type) with the ISI marking.



During surveillance inspections, if the BIS inspector want to see the type test report of sealed type transformer then the manufacturer can show the complete type test report of non-sealed type transformer and pressure test report of sealed type transformer of the same ratings for verification and the same will be accepted by BIS inspector or not. It is not clear.

The systems shall have to be simple and must be to encourage the industry. On the contrary the frequent changes are creating more confusion only.

There are few more queries to be resolved:

- Can the transformer manufacturers dispatch the transformers to customer after the license validation date while they have paid marking fee to BIS one-week prior the license validation date and they did not receive any endorsement letter from BIS?
- Can the manufacturers manufacture and supply the transformers with level-1 losses for 22 & 33kV class?
- As per BEE notification, it is not talking about the losses of 22 & 33kV and banned the level-1. What do the manufacturers understand that level-1 is banned for 11kV only?
- Please clarify.
- As per clause no. 6.6 of IS 1180 (Part-1), the vector group is Dyn11 only and this clause is not talking about other vector group while the clause no. 7.6 of IS 1180 (Part-1) is talking about two types of vector group i.e. Dyn11 & Dyn1. If the customer required different vector group apart from the aforementioned vector groups (Dyn11 & Dyn1) for a similar transformer rating as mentioned in IS 1180 then this transformer will not be as per IS 1180 (Part-1):2014. Is it correct?
- Can the manufacturers treat this transformer as special purpose transformer as per IS 2026?

Difficult commercial terms and conditions in tenders restricting manufacturer's participation in utility tenders

Mr Alok Agarwal opines, "The restrictive practices like heavy EMD, PBG extended guarantee period, strict qualification requirement, requirement of type test on tendered design etc. are making it very difficult for MSME manufacturer to participate in the tenders of Utilities. With the introduction of mandatory BIS where the technical requirements have been standardised, a need is felt that for standardisation of commercial terms and conditions as per norms laid down by GeM, the e marketing portal of Government which may create a unified market all over India and will benefit the purchaser also immensely in reduced cost and timely deliveries."

Mr Sanghi shares, "Whilst the Utilities would like to encourage the development of vendors and to increase competition, they are in a bind because of the large percentage of Failures. These Failures are LARGELY ATTRIBUTABLE TO IMPROPER USAGE. The effort to reduce failures has led to restrictive practices such as long warranty periods, expensive type testing and heavy Bank Guarantees. The extended Warranty Period leads to further improper usage, as well as complacency amongst the Field Staff about the high failures. It spoils the situation further. There is a strong case for reduction in Warranty Periods so as to bring focus on the actual problem areas."

Mr A Shanmuga Velayuthan articulates, "Third party like Banks are gaining the benefit by performance bank guarantee (PBG). Asking for long term guarantees without proper maintenance of Transformers. Failure reasons are not analysed, manufacturers are asked to replace the transformers irrespective of nature of failures. Payment is not made even after 6 months which makes it unviable for SME's. Utilities are not abiding the MSME Act."

Random sampling of Distribution Transformer by State Utilities

Mr Alok Agarwal says, "We appreciate the right of the utilities to carry out random sample checking of the supplied transformers but the same should be done immediately on receipt of supply and not after installation or prolonged storage. The process of sampling, test to be carried out and penalties to be imposed in case of deficiency in the material should also be clearly spelt out.

Mr Ajay Kumar Sanghi apprises, "There could be issues with respect to storage and transportation and some manufacturers may be justifiably upset at being targeted. The larger issue of creating a culture of accountability has to address the IMPROPER USAGE at the Discom end. The search for scapegoats in the Manufacturing space is misdirected."

Mr A Shanmuga Velayuthan informs, "It is not serving any purpose. Few testing labs are enriched with huge testing charges. Random is selected by Engineers of Utilities. It is suggested Utility can set up 4 or 5 test labs at different locations geographically covering the areas at cost around Rs.20L per Lab. The inspection agency of Utility to inspect the Transformers at manufacturing centres & seal it. The purchasing authority to give the dispatch advise to different store. At the receiving end, all the Transformers should be again tested by Engineers of Utility on rotation to maintain the quality of the product."

Shalini Singh, IEEMA

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- RS485 Port, 5KV Isolated with MODBUS RTU Protocol and POWER MASTER Software (Optional)
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- Auto / Manual Scroll Display
- CE Compliance with EN61010-1, EN61326-1

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- Versatile Handy Instrument Kit
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- Graphic Phasor Diagram
- Display 50 Harmonics With Wave Form
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- KW, KVA, KVAR, PF, KWH, KVARH, PFH, MD (KW, KVA)
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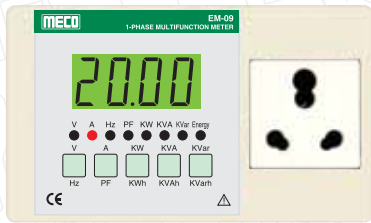
- 512K Memory with Easy to Download Software
- Optical Isolated RS232C - USB Interface Cable
- Facility to retrieve Snapshot of Power & Harmonic on Meter
- Built in Timer & Calander for Data Logging
- Option to select Clamp On CT Ranges : 1/10/100A AC or 10/100/1000A AC or Flexible CT of 120/1200A AC or 300/3000A AC

1 PHASE MULTIFUNCTION METERS

EM-08S



EM-09

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- LCD Display with Backlight (Green & White)
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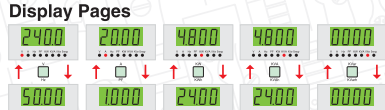

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Efficient Dielectric Fluid Technology for Fire Safe and Environment Friendly Distribution Transformer

Distribution Transformers play a very important and vital role in delivering electricity to the last mile. It can be rightly said that the Distribution industry is bringing light in the life of the people. The distribution transformers insulated and cooled with mineral oils remain, still today, the most widespread and effective solution for converting electrical energy. Mineral oils (MO) are used for their excellent dielectric and thermal properties, but have a low fire points and biodegradability and these factors may negatively contribute in cases of fire and toxic release with contamination of soil and surface water and groundwater. For these reasons, innovative insulating fluids, such as natural esters have been suggested worldwide.

Now a Days, major operational challenges are being faced by utilities in Distribution Range:-

- The distribution industry is an extremely robust industry in terms of operation and maintenance. Once installed and energized, chances are that a distribution transformer might never be considered for preventive maintenance until it fails. Most of the distribution utilities across India are govt owned, barring a few which are privately owned. The fleet of distribution transformers across all these utilities is massive and its almost an impossible task to monitor the transformers. With a rapid growth in population, the demand is ever increasing and its getting more difficult to manage the same for the utilities.
- With the increase in demand, the load on the DTs is also increasing majorly. Transformers are running with a continuous overload in order to cater the demands and hence a lot of failures are being recorded. With mineral oil, the ability of the transformer to take extra load is not present.
- Also along with this, mineral oil being a fluid with low fire point, the risk of fire is immense.

Natural Ester is very suitable to this type of application. DTs filled with natural ester are capable to continuous overload up to 20% and hence prove to be instrumental in avoiding catastrophic failures of the transformers. Along with fire safety, the system attains a reliable supply of power to the consumers.

Today the capabilities of natural esters are nearly unlimited, as are the reasons why transformer operators decide to choose these fluids. They are used in almost any application and any location. Their benefits are just as numerous. Natural esters have been used extensively in distribution transformers, and there are currently more than two million transformers using natural ester in service worldwide.

By leveraging the higher thermal capabilities of natural ester in addition to the fire safety, we can solve the crucial problems being faced by the distribution industry.

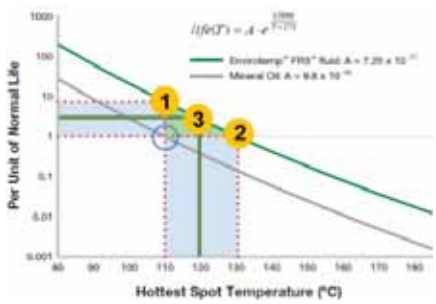


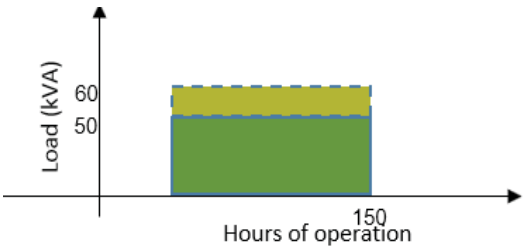
Figure. 1. High temperature curve

From Figure 1,we can explain,

Increase load capacity

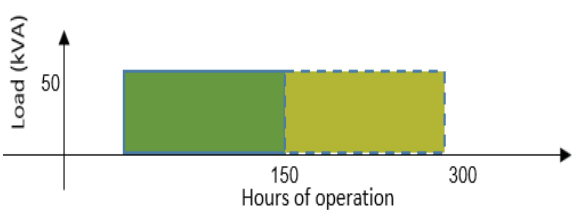
Transformers filled with natural ester are capable of taking additional load of up to 20% as compared to mineral oil filled transformers.

This is a very critical advantage keeping in mind the ever growing demand in the distribution sector and the lack of space to cater it. Transformers filled with natural ester help in catering this demand growth in a very economical way. IS 2026 part 14 annexure also supports all such claims.



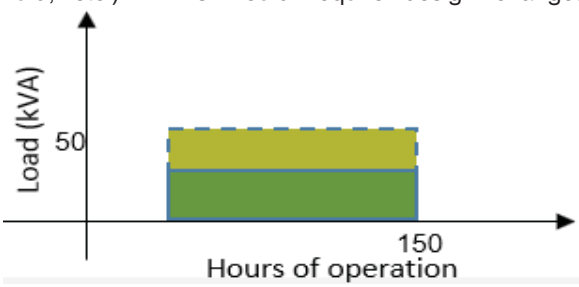
Life extension

By protecting the insulation life of the paper, you could then likely extend the life of the transformer (depending on the transformer loading profile). This allows to use the same kVA, but get more useful life out of the existing asset. Thus, lowering your total cost of ownership. This does not require any design changes to your existing specifications.



Smaller transformer

This third option enables a transformer to be built with a smaller footprint, yet have maintain the original capacity needed. Often times, this allows an initial cost savings as well given you likely will use less raw materials (copper, paper, steel, fluid, etc.). This would require design changes.



Fire safety: The fire point is the most important property for determining fire safety of a transformer fluid. When a liquid-filled transformer operates at full (100%) load in a 40°C temperature ambient, the oil temperature is approximately 100°C which is close to flash point of Mineral Oil. In case of failure of electrical protection devices, heating from an internal arcing fault or chronic overloading can increase the fluid temperature and put conventional mineral oil at risk of ignition. The higher fire point of K-class fluids makes them almost impossible to ignite under realistic transformer conditions of operation.

In the more than 40 years of use of silicone, high molecular weight hydrocarbons, natural ester, or synthetic ester liquids, no transformer fire has been reported which is also addressed in IEC 60695. Specifically, natural ester has the best-in-class fire point (natural ester FR3 fluid with 360°C versus synthetic ester with 316°C) as shown in Figure 1. In small and large scale tests, the fire resistance properties of natural ester have been shown to be superior to those of other K-class fluids. Also, natural ester has a flawless fire safety record in over two million transformers and 23 years of use.

As the ageing performance of esters outweigh those of mineral oil, transformers may be operated at higher temperatures than conventionally filled units. This is also proposed by IEC 60076-14 & India standard IS 2026 part 14, where over temperatures and hot spot temperatures for winding designs using thermally upgraded paper are considered already.

The revolutionary idea began simply enough: Create a more reliable, safer, better-performing dielectric fluid that keeps the power flowing and the lights turning on all over the globe. Lofty goals to be sure. Or were they? Enter natural ester dielectric fluid to literally change the industry by providing utilities increased grid reliability, overload capacity, improved fire safety and real environmental benefits that mineral oil can't match. natural ester (NE) fluid extends the insulation life five to eight times longer, has two times greater fire point, and also allows up to 20% more overload capacity than that of mineral oil. For utilities, this means the elimination of costly fire mitigation and deluge systems, reduced routine maintenance costs, reduced clearance to buildings, and extended asset life. Even a possible decrease in insurance liability premiums. All this with a total transformer cost comparable to or lower than mineral oil-filled transformers. And, since its launch, there have been absolutely zero fires reported with transformers filled with NE fluid. Being carbon neutral, ultimately biodegradable, non-toxic and non-hazardous in soil and water, Envirotemp FR3 fluid delivers an improved environmental footprint, keeping lake trout safe everywhere.

As compare to Dry type transformer , natural Filled transformer had Improved fire safety, Contamination resistance, Longer life, Higher load capacity, Full diagnostic capability, Higher BIL, Lower noise. For optimal outcome, it is the ideal technology solution

through an ecofriendly safe and cost-benefit analysis.

Global Experiences

Lowest Cost per kVA

One Brazilian project currently uses transformers designed to take full advantage of the natural ester/ thermally upgraded paper insulation system. An 88 kVA, 85K rise natural ester transformer was designed to replace a 45 kVA standard design using the same transformer tank. The capacity increased 95%, yet the 88 kVA unit weighs 85 kg less than the original, reducing the effort needed for installation and maintenance as well as requiring less mounting hardware.

Compared to a standard 75 kVA transformer using 102L of mineral oil, the 88 kVA natural ester transformer using 81L of natural ester fluid has lower no-load losses. In addition, the cost per kVA was reduced by one third to €23,25/kVA from €36,75/kVA for the standard 45 kVA transformer.

Figure. 2 shows the new natural ester production transformers. Approximately 2100 transformers of this design having more than 50 million hours of operation are currently installed on the distribution network, with failure rates lower than the standard transformers now in use. The utility plans to energize an additional 900 units in 2011.

Figure 2: Example of the 88 kVA, 85 K rise natural ester transformer (11400 or 13800 – 127/220 V) currently in production: (a) external and (b) internal.

Brazilian Sustainability: All materials used in the production of these transformers are produced and available for sale in Brazil, reducing transportation costs and supporting the local economy. This includes growing and crushing the seeds, refining the oil, and manufacturing the natural ester fluid. The biodegradability and non-toxic nature of vegetable oil help avoid problems of environmental contamination and minimize harm to flora and fauna. Spent natural ester fluid can be easily disposed of or recycled as biodiesel fuel. The production of natural ester fluid is essentially carbon neutral.

Recent Development in India

On the above known significant properties of natural ester, with joint effort of Cargill, CAHORS designs immersed hermetical seal transformers that are compatible with natural esters. This transformer installed as Milan laboratories ltd by replacing their old convention transformer with new design transformer with high reliability. Requirement was for dry type transformer it could not have been accommodated in same size.

Specification

Standard of reference:	IS 1180, IS 2026, IEC 60076-14
Transformer Sr. Number:	200AP1804I
Transformer Reference:	01361DBTIR03
Rated Power:	1000KVA
Overloaded Power:	**1250KVA (125% Overloading)**
Rated HV Voltage:	22000V
Test HV Voltage:	**19800 V (Lower Tap)**
Rated LV Voltage:	433 V
Rated HV Current:	36.45 A
Overloaded HV Current:	32.80 A
Test HV Current:	**36.45 A (Overloaded Current of Lower Tap)**
Rated LV Current:	1333.41A
Overloaded LV Current:	1666.76A
Total losses at 100% Loading:	7824.4W (at Rated Power & Rated Tap)
Total losses at 50% Loading:	2884.2W (at Rated Power & Rated Tap)
Total Test losses at 100% Loading:	**12251.7 W (at Overloaded Power & Lower Tap)**
Insulation Paper:	Thermally Upgraded Paper
Insulation Fluid:	Natural Ester FR3 Oil
Oil Standard Reference:	IEC 62770, IS 16659
Manufacturing Month & Year	October 2018
Testing Date:	09.10.2018
Customer Name :	**MILAN LABORATORIES LTD., KALAMBOLI**

(b)

Figure 3. Replaced conventional transformer showing in fig. 3(a) by CAHORS make 1000 KVA 22 kV Natural Ester Fire Retardant (FR3) oil filled hermetically sealed Transformer with 125% Extended Loading capacity. Fig 3(b).

During the conventional transformer operation, three mechanisms influence the cellulose ageing process (depolymerization):

a) Thermal ageing – At temperatures of about 105 °C the glucose rings will start splitting (depolymerization). Typical ageing products are free glucose, water, carbon monoxide and carbon dioxide.

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b) Oxidative ageing – Oxygen leads to a further polymerization, even already at normal operation temperatures of less than 105 °C. Investigations have shown that the ageing rate is tripled when oxygen is present.

c) Hydrolytic ageing – Water is the cause as well as the product of cellulose ageing and splits the oxygen bridges between the glucose rings.

By the application of the natural ester filled hermetically sealed transformer design two out of three described ageing processes are eliminated. [6]. The transformer tanks are hermetically sealed to protect the insulation liquid against atmospheric oxygen and therefore offer optimal conditions to reduce insulation ageing and to minimize maintenance rate.

natural ester insulating fluid reduces the thermal ageing process of the windings compared to common paper insulation, as the ageing is only relevant for the remaining conventional insulation.

It helps to reduce transformer installation size while increasing fire safety and loadability.

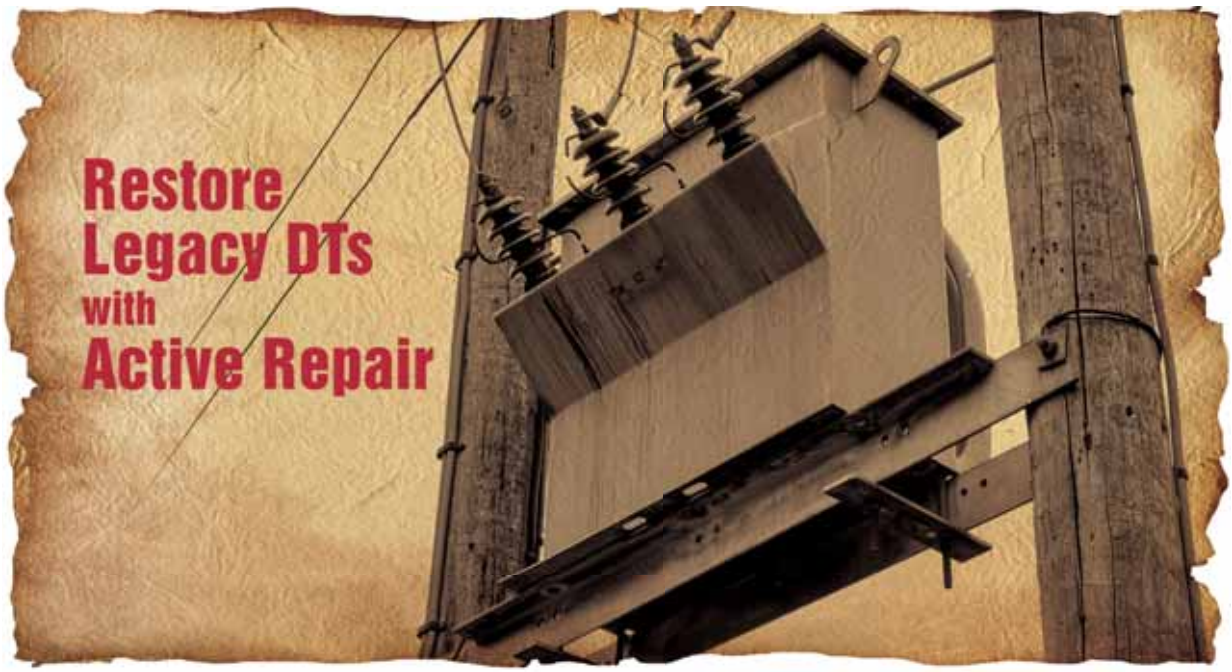
With this successful development 1000 KVA, 22KV Cahors started approaching higher rated natural ester filled distribution transformer rating i.e 3000KVA , 33KV which resulting in power capacity of 3600KVA 33KV class with the help of natural ester. It is under type test and will be installed shortly

Conclusions

Higher temperature materials have been utilized in niche transformer markets for many years. Natural ester technology is fast becoming more applicable and affordable in the mainstream as material capabilities are better understood. Transformer insulation systems comprised of paper insulation/natural ester dielectric coolant operated at 130°C hottest spot temperature age at the same rate as paper insulation/mineral oil systems operated at 110°C hottest spot temperature. Designing with the updated standards enables a revised set of rules that minimizes the insulation system as the limiting factor.

The outcome of applying this technology is smaller, more cost effective transformers possessing enhanced fire safety performance, based upon a renewable, recyclable, and non-toxic fluid having a carbon neutral footprint. ■

Rajaram Shinde
Global Technology Adviser, Cargill.
Alexandre Ramat, Cahors.



India has already emerged as a major power nation among the developing economies. Electricity is a key element for the economic growth of the country and is directly linked to the quality of life and GDP of the country. There has been a rush in demand for power in India due to increase action in industrialisation, urbanisation, and capacity utilisation. Even though technology makes our lives easier, it comes with its own set of complications. Still, it is often the case that these complications are probed seriously only when an alarm goes off. While many initiatives are being taken in the power sector to guarantee reliable power supply, it is of extreme importance that Distribution Transformers, which form the heart of an electrical network, function reliably and efficiently.

Now, imagine a human body. As it ages the organs start wearing out. The heart starts to give out, decreasing the life expectancy of an individual. But, once he/she goes through a cardiac transplant, he/she can live an extended life of, say, another 15-20 years. Similarly, the life expectancy of a Distribution Transformer (DT) can be increased through Active Repair. A new life can be pumped in an old DT that might have gone through the stress and strain of its journey from shop floor to pole serving millions.

DTs are key assets for any distribution network. Their dependable and competent operation is important for strong economic standing of the DISCOMs. Many DISCOMs follow DT energy audit, but that concentrates on aggregate technical and commercial (AT&C) losses external to the DT and often weighed down heavily by metering, billing and collection inefficiencies. Such areas are more of management issue rather than technical issues.

In India, power distribution companies (DISCOMs) have high 24.96% Aggregate Technical & Commercial (AT&C) losses, with a high 22% T&D loss. Of these, the Technical losses are expected to be around 9-12%[1]. These losses are quite high as compared to other countries and continue demanding financial aid for survival of the DISCOMs in public space. DT forms one of the major and high capex assets for DISCOMs.

As per the CEA statistics, there are some 70 lakhs DTs in India of different capacities and some 6-8 lakhs DTs breakdown every year[2]. This high breakdown rate is the result of weak asset management practices as well as low quality of repairs and maintenance of DTs. Sometimes the weakness does have genesis at lowest cost procurement policies being followed in public procurement overlooking life cycle cost principle or more relevant carbon footprint imprint by each of such inefficient DTs.

Transformer losses are of two types, namely the No-load losses and the Load losses. No-load losses are mainly contributed by the core due to - bad quality of core (including improper thickness and coating of the core); consecutive dilapidation from loss of core material during repairs; decrease in the number of turns during repairs. The Load losses happen in the windings and it increases with the loading of the DT. The Load losses are caused due to – substituting the original coils with derated (smaller size) coils during repairs; replacement of original electrolytic grade coils with commercial grade coils and using coils with higher than standard current density.

One major challenge with DTs is innate intricacy in the measurement of the Technical losses while the

DT is functional on the network. Generally, DTs have secondary side meters for energy auditing. For measurement of Technical losses, it will require to have metering also on the primary high side of the DT, which consecutively will necessitate mounting new CTs and PTs, and that will be a considerable investment at each DT level. Then again, there can be a custom-built setup mounted on a mobile van, and this can be used to measure Technical losses in a DT. This will, however, require taking blackout time at each DT level, and cause its own realistic challenges.

Most DISCOMs follow an inert approach of attending to a DT only when it fails. And even then, the highpoint is to get the DT functional and back into the network, rather than losses measurements and active reduction of the same. The current repair contract and defined service level agreements (SLAs) too do not encourage loss reduction by incentives for loss reduction during repair. Also, the DT repair technicians /SME units are not very well-informed on DT design optimisation for loss reduction, and often fail to follow best practices. The equipment used for losses measurement or estimation is also not well kept and updated for accurateness.

With the above realities and challenges, a pilot execution on Active Repair of DT was conducted with the following objectives:

- There is high technical loss deviation in old legacy DTs, compared to the manufacturing specifications or guaranteed technical particulars (GTP)
- Active Repair can achieve sizeable technical loss reduction achieving close to (or even better than) manufacturing specs as per latest IS Standard
- Active Repair with winding compensation only, including change of winding materials, allow a scalable repair technique to improve efficiency level
- Active Repair is techno-commercially viable to the DISCOMs. They can selectively undertake Active Repair only for high loss legacy DTs to derive a shorter payback period.

Active Repair of DTs is a method that primarily focuses on technical loss reduction in DTs through winding compensation as well as any change in winding material when the core is in an acceptable condition. The core is left untouched as different makes of DTs will entail different laminates design and cuts and that is not an easy and replicable repair method. Active Repair can be carried on both the failing and functional legacy DTs, though as a rule it shall be selectively applied to high loss DTs.

Given below is a case study for undertaking Active Repair on a sample DT in Maharashtra

A 100 kVA failed DT was requested from a DISCOM. DT selection for high losses was done based on DT chronological and inventory data, including key parameters like DT make, No-load loss, Full load loss, ageing and number of repairs already made.

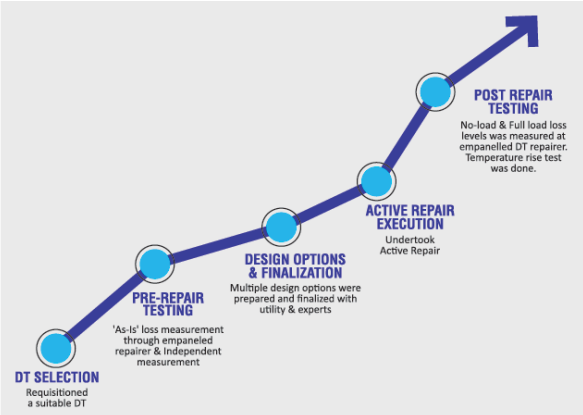
The selected sample DT was tested at the repairer's lab to perform routine and type tests, including temperature rise test, to verify its condition and measure the 'As-is' No-load and Full-load losses as per IS 2026. As the 100 kVA was a failed DT, its No-load loss was measured by supplying rated voltage at LV winding and keeping the HV winding open as per IS 2026. Its Full-load loss was calculated based on an empirical formula. The test was carried out by independent local technical institute with calibrated meters.

The 'As-is' loss level measurements for the failed 100 kVA Aluminum DT were conducted. It was found that the 'As-is' No-load loss was 65% higher while the Full-load loss was 3% higher from the manufacturing specification values, which were as per old 1-star BEE rating. Post Active Repair the No-load loss was reduced to 13% and Full-load loss to -3% from the manufacturing specification values.

Founded on the baseline measurements different design options for the DT was worked out. The designs were prepared with both the LV & HV windings being replaced with the copper windings with an increased number of turns and optimally using the window space. Subsequently, in consultation with design experts and DISCOM team, the final design for Active Repair was chosen and the following sequence of activities under Active Repair was agreed to:

- Unstacking of core laminations and restacking them securely to reduce air gap between laminations
- Placing the LV and HV windings as per design specifications and re-assembling
- Moving to oven drying for eliminating moisture
- Placing final assembly back in the tank and closing

A step-by-step approach was adopted during the Active Repair execution for DT sample to ensure checks and validation at each level as shown below.



After Active Repair execution of the DT, it was tested for post-repair loss levels by performing routine and type tests as per IS 2026. Below are the Active Repair design interventions and pre-repair and post-repair results for the 100 kVA failed DT.

Key Design Parameters	Utility Spec	Baseline (As-is)	Actual Post-repair Results
Capacity (kVA)	100	100	100*
Flux Density (Tesla)	1.55	1.55	1.35
LV Winding Material	-	DPC Al	DPC Copper
LV Winding No. of turns, ID(mm), OD(mm)	-	75, 123, 159	86, 123, 156
HV Winding Material,	-	DPC Al	DPC Copper
HV Winding No. of turns, ID(mm), OD(mm)		3300, 179, 260	3784, 176, 241
No-Load Loss (W)	260	426	295
Full-Load Loss (W) @ 134A rated current	1760	1815	1654
Impedance (%)	4.90 - 5.10	4.50	5.19
Total Winding Weight (kgs)	-	57	174

Table 1. Design and Results for Active Repair with reference to the baseline measurements and utility specs

Then, the post-repair heat-run test was taken and the temperature rise of the winding and the top oil were found within the permissible limits as defined in IS 2026.

	Permissible Limits	Results Obtained
Winding Temperature Rise	55^{0}C	45.4^{0}C
Top Oil Temperature Rise	50^0 C	38^{0}C

Table 2. Post-repair heat run test results

Finally, the cost-benefit analysis was carried out based on the factual data points obtained from the supporting DISCOM. The DT loading was understood to be 70% with an average cost of supply of 6.03 Rs./kWh and 10% annual inflation. Active Repair defers a sum total savings of 1838 kWh/year compared to baseline losses, and a simple yet efficient payback is observed. The payback period further improves with an increase in DT loading or the cost of supply.

As it was a failed DT, its kVA capacity was assumed to be the same as the nameplate rating of 100 kVA. However, based on the post-repair temperature rise test, it was observed that the kVA capacity was enhanced by 9% after the Active Repair, which can allow the DT to take up more load with higher reliability. Additionally, this refurbished and upgraded DT can give full new life cycle similar to any new DT.

The Active Repair case demonstrated momentous divergence of No-load and Full-load losses from the specification values, and that Active Repair offers a business case for considerable loss reduction. Leveraging the breakdown repair window opportunity for legacy DTs, Active Repair can be applied to selective high losses DTs that can yield an attractive payback period. Additional benefits of Active Repair come in the form of increased kVA capacity, higher reliability (i.e. reduced failure rate) and increased asset life. Active Repair provides an alternative solution to bring energy efficiency in the DTs at reduced costs compared to new replacements. A mixed approach of applying Active Repairs on selective old high loss DTs and doing replacement of very high losses and dilapidated DTs can keep overall cost balance and hence low impact on electricity tariffs to the end customers.

Repairers will be important stakeholders to shape and scale-up Active Repair and its benefits to the DISCOMs. DISCOMs can design new performance tied DT repair contract to incentivize repairers to undertake Active Repair on right select batch. Such managed services contract across the life cycle of the DTs can potentially create better economy-of-scale and also economy-of-scope for the provider, and better-integrated value proposition to DISCOMs.

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Currently, the pilot DT is in service for the last two years and has been performing much better than general expectations like sustaining the ambient temperature as high as 47.14 degrees in the month of May 2018. This Active Repaired DT has served as a living example of new energy efficiency enhancement solutions for such legacy DTs. Adoption of such methods may help in achieving and maintaining optimum energy procurement and utilisation, throughout the organisation which may help in minimising energy costs and mitigating environmental effects. This DT is monitored for energy use through a cloud based system showing aggregate data into one, centralised view. It provides access to both real-time and historical energy use along with analytics to help one understand trends.

In the end, as power distribution systems continue to grow in size and complexity, Active Repair with only winding compensation provides an opportunity for significant technical loss reduction at reduced costs over replacement with new DT. DISCOMs can develop new business models and contracting for DT repairing that promote performance tied SLAs, including technical loss reduction and perhaps some blend of

managed services around DTs for efficient life cycle asset management.

(Endnotes)

1 Government of India, Ministry of Power, Central Electricity Authority, New Delhi- Power Sector, April 2017

2 "Reduction of losses" by Electrical India, July 5, 2016 ■

Manas Kundu

Director (Energy Solutions), International Copper Alliance India (ICAI)

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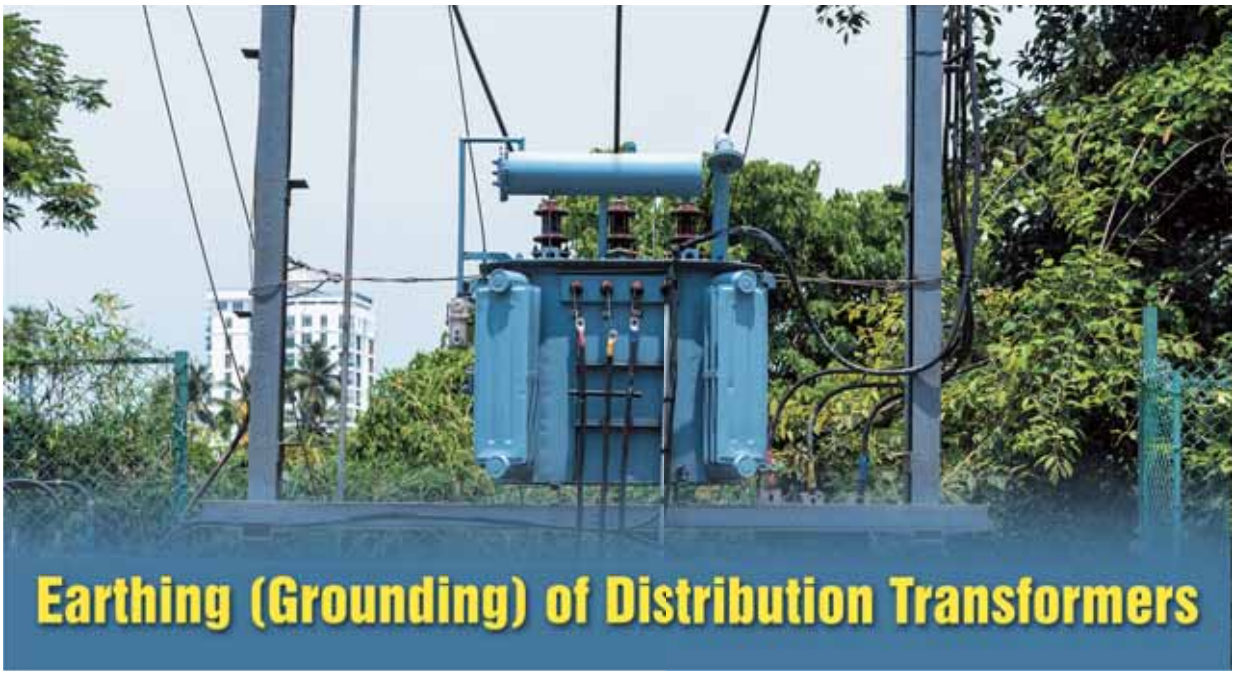

The transformer, being a key element in the transmission and distribution of electrical energy, improving its reliability is of utmost importance. System abnormalities, loading, switching and ambient condition normally contributes towards accelerated aging and sudden failure. It is important to provide adequate grounding which helps in mitigation of fire hazards and accidents.

This paper provides an overview of neutral and body earthing of DT & discusses the importance of grounding of DT.

Fig 1: Distribution Transformer

Introduction

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

The main objective of grounding electrical systems is to provide a suitably low resistance path for the discharge of fault current which ultimately provide safety to working personnel and costly installed equipments in the substation. The flow of heavy fault current results in rise of potential in the substation area and with respect to remote ground. There is need to ensure that the ground potential rise, and touch and step voltages are within permissible limits. Distribution Transformer and its role in distribution system are shown in figure 1 and 2 respectively.

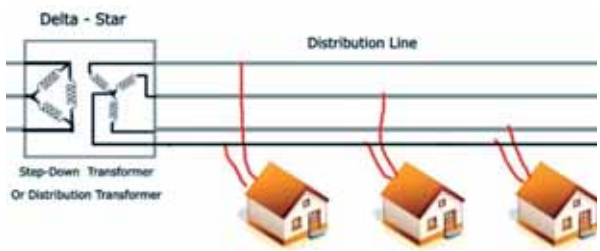

Fig 2: Role Of Distribution Transformer

Types of Earthing for Electrical Network

The earthing can be classified into two types:

1. Neutral (System) Earthing

2. Equipment Earthing

Neutral (System) Earthing

In neutral earthing, the neutral of the system is directly connected to earth with the help of some metallic conducting wire. The neutral earthing is also called

the system earthing. Such type of earthing is mostly provided to the system which has star winding. For example, the neutral earthing is provided in the generator, transformer etc . (Refer figure 3)

Fig 3: earthing of distribution transformer

Basic Objective Of System Earthing

- Earthing of system is designed primarily to **preserve the security of the system by ensuring that the potential on each conductor is restricted to** such a value as is consistent with the level of insulation applied.
- From the point of view of safety, it is equally important that earthing should **ensure efficient and fast operation of protective gear** in the case of earth faults.
- The system **earth-resistance should be such tha**t, when any fault occurs against which earthing is designed to give protection, **the protective gear will operate to make the faulty main or plant harmless**. In most cases, such operation involves isolation of the faulty main or plant, for example, by circuit-breakers or fuses.

Equipment Earthing

Such type of earthing is provided to the electrical equipment. The non-current carrying part of the equipment like their metallic frame is connected to the earth by the help of the conducting wire. If any fault occurs in the apparatus, the short-circuit current to pass the earth by the help of wire. Thus, protect the system from damage.

Purpose of equipment earthing

The basic objectives of equipment grounding are:

1) to ensure freedom from dangerous electric **shock voltages exposure** to persons in the area;

2) to provide current carrying capability, both in magnitude and duration, adequate to accept the ground fault current permitted by the over current protective system without creating **a fire or explosive hazard** to building or contents; and

3) to contribute to **better performance** of the electrical system.

Further, let us try to understand the above concepts as follow :

A) ***Voltage Exposure*** — When there is unintentional contact between an energized electric conductor and the metal frame or structure that encloses it or is adjacent, the frame or structure tends to become energized to the same voltage level as exists on the energized conductor. To avoid this appearance of this dangerous, exposed shock hazard voltage, the equipment grounding conductor must present a low impedance path from the stricken frame to the zero potential ground junction. The impedance should also be sufficiently low enough to accept the full magnitude of the line-to-ground fault current without creating an impedance voltage drop large enough to be dangerous.

B) ***Avoidance of Thermal Distress*** — The earthing conductor must also function to conduct the full ground fault current (**both magnitude and duration)** without excessively raising the temperature of the earthing conductor or causing the expulsion of arcs and sparks that could initiate a fire or explosion (Refer fig 4). The total impedance of the fault circuit including the grounding conductor should also permit the required current amplitude to cause operation of the protective system.

C) ***Preservation of System Performance*** — The earthing conductor must return the ground fault current on a circuit without introducing enough additional impedance to an extent that would impair the operating performance of the over current protective device, that is, a higher than necessary ground-circuit impedance would be acceptable if there is no impairment of the performance characteristics of the protective system.

Fig 4: distribution transformers on fire

Ungrounded and Grounded Neutral System

Generally **earthing of neutral point** of the **transformer and the generator** is called the **system earthing**. Now, if the **neutral point** for any system is connected to the **earth** then it will be called **grounded system**.

But when the neutral for any system is not connected with the earth then it will be called **ungrounded system as shown in figure 5**. Connecting the neutral point to the earth through a resistance means resistance earthing and **reactance earthing** means connecting the neutral point to the earth through a resistance. When the neutral point connected to the earth directly it will call solidly grounded as shown in figure 6.

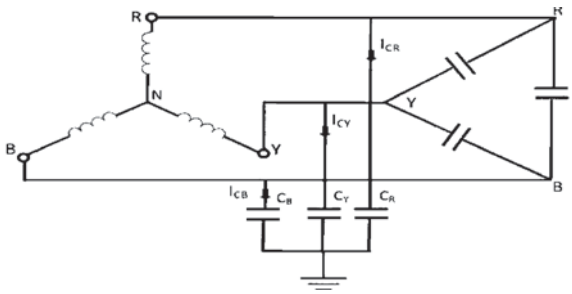

Fig 5 ungrounded neutral system

Disadvantage of Ungrounded Neutral Earthing System

1. **System Voltage Increase:** When the earth fault occurs in line then the potential of the faulty phase becomes equal to ground potential. However, the voltages of the two remaining healthy phases rise from their normal phase voltages to full line value. This may result in insulation breakdown.
2. **Protection Complicacy:** In this system earth fault is not easy to sense and troubleshoot will become complicated.
3. **Arcing Ground:** Sudden temporary fault can caused by failing of a branch creates an arc between the overload line and the ground. Arc extinguished and can re strike in a repeated regular manner. This is called arcing ground.
4. **Static Induced Voltage:** Over voltage due to the static induced charges are not conducted to the earth.

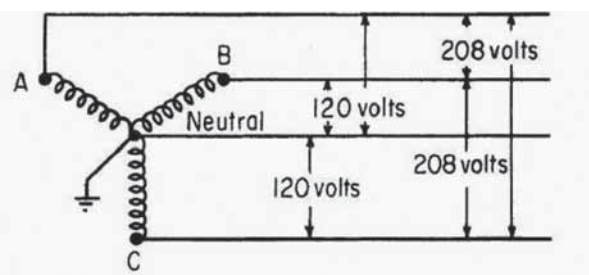

Fig 6 : Grounded Neutral System

Advantage of Grounded Neutral Earthing System

1. **The System Voltage Will not Increase in Case of Ground Fault:** When the healthy line of a grounded system i.e earthed the voltage of the healthy line will not increase w.r .t earth as in the case of ungrounded earthing system.
2. **Arcing Grounds are Eliminated:** If the neutral point of the system is earthed then the distribute capacitive current from the lines to earth will neutralized by the current from the neutral point to earth and the arcing grounds will eliminated.
3. It will be a **stable neutral point**.
4. Life of the **insulation** will increase.
5. It will give general **safety** to personnel and the equipments due to operation of the **fuses**/ circuit breakers.
6. Over voltage due to sudden lightning will discharged to the earth.
7. Earth fault relaying will relatively simple.

Concept of Step and Touch Potential During Fault in System

Step Potential : Step potential is the step voltage between the feet of a person standing near an energized grounded object. It is equal to the difference in voltage, given by the voltage distribution curve, between two points at different distances from the electrode (Refer figure 7). A person could be at risk of injury during a fault simply by standing near the grounding point. (Refer figure 8)

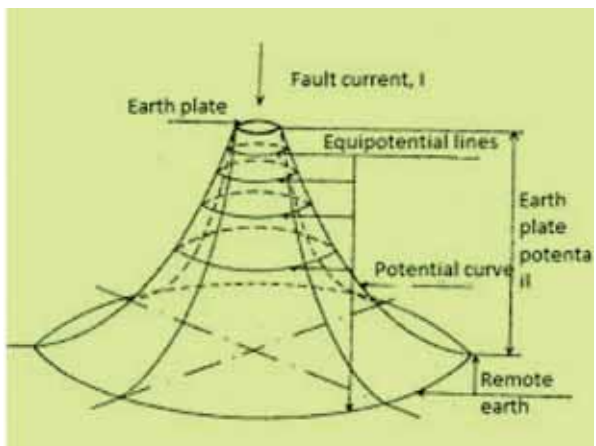

Fig 7 voltage distribution around earth electrode

Touch Potential : Touch potential is the touch voltage between the energized object and the feet of a person in contact with the object. It is equal to the difference in voltage between the object and a point some distance away. The touch potential or touch voltage could be nearly the full voltage across the grounded object if that object is grounded at a point remote from the place where

the person is in contact with it[1,3,4]. (Refer figure 8)

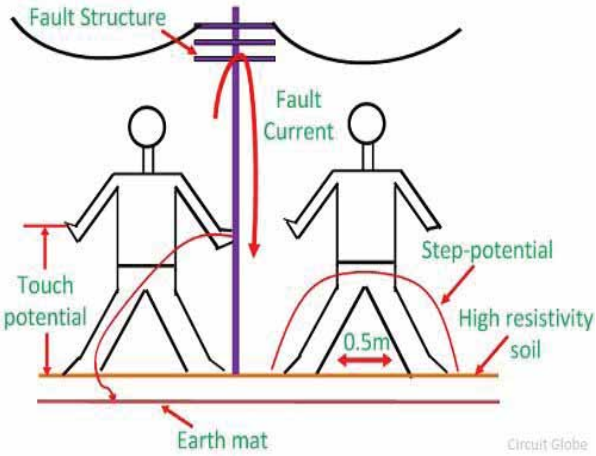

Fig 8 : Illustrations Of Step & Touch Potential

The more current that is pumped into the ground, the greater the hazard. Fault clearing time is an important factor to consider as well. The more time it takes the electric utility company to clear the fault, the more likely it is for a given level of current to cause the human heart to fibrillate.

A few engineers believe that Fibrillation Current for Step Potentials must be far greater than Touch Potentials, as current will not pass through any vital organs in the former case. This is not always true as personnel that receive a shock due to Step Potentials may fall to the ground, only to be hit again, before they can get up, when the automatic re-closers activate.

Mitigation of Step and Touch Potential Hazard

Mitigating Step and Touch Potential hazards is usually accomplished through one or more of the following three main techniques:

1 Reduction in the Resistance to Ground of the grounding system

2 Proper placement of ground conductors

3 The addition of resistive surface layers

Understanding the proper application of these techniques is the key to reducing and eliminating any Ground Potential Rise hazards.

Reducing resistance to ground (RTG) of the site is often the best way to reduce the negative effects of any Ground Potential Rise event, where practical. The Ground Potential Rise is the product of the fault current flowing into the grounding system times the resistance to ground of the grounding system.

It is important that all metallic objects in a GPR environment be bonded to the ground system to eliminate any difference in potentials. It is also important that the resistivity of the soil as a function of depth be considered in computed touch and step voltages and in determining at what depth to place conductors.

Another technique used in mitigating Step and Touch Potential hazards is the addition of more resistive surface layers. Often a layer of crushed rock is added to a tower or substation to provide a layer of insulation between personnel and the earth. This layer reduces the amount of current that can flow through a given person and into the earth.

Weed control is another important factor, as plants become energized during a fault and can conduct hazardous voltages into a person. Asphalt is an excellent alternative, as it is far more resistive than crushed rock, and weed growth is not a problem. The addition of resistive surface layers always improves personnel safety during a GPR event.

Conclusion

When a fault occurs in the distribution system, the current will enter the earth. This heavy fault current will develop hazard potential around earth electrode due to distribution of varying resistivity in the soil near earth electrode. The voltage drop in the soil surrounding the grounding system can present hazards i.e. Step and touch voltage for personnel standing in the vicinity of the grounding system.

Adequate designing of grounding system will help in mitigating or eliminating fire and accident hazard.

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Industrialized nations throughout the world have added solar power capacity into their grids to supplement and provide an alternative to conventional energy sources. Long distance transmission networks allows for remote locations of solar farms to displace fossil fuel consumption. The majority of solar power is generated via photovoltaic (PV) systems which utilize multiple ground mounted solar panels that convert sunlight directly into electric power.

Transformers are critical components in solar energy production and distribution. Historically, transformers have "stepped-up" or "stepped-down" energy from non-renewable sources. There are different types of solar transformers including distribution, station, sub-station, pad mounted and grounding. All solar transformers have specialized needs that impact costs.

For example, solar power applications experience steady state loading during inverter operation. When the sun's out, there's a dampened reaction process and more constant loading on the transformer.

Inverter duty transformers with two inverter windings to four inverter windings now a days. Inverter transformers with many innovations in order to reduce the cost of solar plants. The four inverter windings (2 CCA in one tank) transformers have made it feasible to reduce HV side switchgear. Large size inverter duty transformer help developers and EPC contractors to complete their project comparatively in less time plus the cable work also reduces leading to project cost savings. It is imperative to go for larger size transformers to save time and of course the economy of the project also gets addressed at the same time. Nowadays developers are going for 33 kV or 11 kV, 4 MVA to 12.5 MVA multi winding (3 winding or 5 Winding (2 CCA in one tank) inverter duty transformers

Multiple Windings on Primary Side

Special multiple windings [3, 4, 5, etc.) design on primary side of the transformer enables to connect multiple inverters to the grid with minor number of transformers in total. The precise requirements vary from device to device and from site to site. That's why each transformer will be almost as unique as a fingerprint when it comes to voltage, power, climate efficiency, network topology, permissible noise level, and other factors. Earth Shield is provided between the HV & LV windings to reduce the harmonics & path to ground any residual resonance.

Compact Design

Sizing of a transformer is a crucial factor when planning a Solar PV Power Plant, as too large rated power can lead to instabilities and economic disadvantages and at the same time too small rated transformer power might not exploit the whole capability of the plant erected. Special multiple windings design of the transformer enables to connect multiple inverters to the grid with minor number of transformers in total.

Salient Features:

- Galvanically isolated inverter winding for each inverter
- Inverter windings are capable of withstanding voltages with rate of rise (dV/dt) up to 500V/μs to ground

- Inverter windings are specifically designed to withstand voltages excursions that arise due to pulsed mode inverter operation
- Electrostatic shield between LV & HV winding
- Winding Material: Copper or Aluminum. Major requirement is copper winding
- Connection could be star/delta. In case of star winding neutral not to be grounded
- Vector Group : Dy11y11y11y11 OR Yd11yd11yd11yd11 in case of 5 winding transformer & Dy11y11 OR Yd11yd11 in case of three winding transformer
- Normally total losses 1% of KVA rating of transformer.

As for harmonics, the solar inverter's typical harmonic content is below 1%, which has almost no impact on the system. The lower harmonic profile is because there are no generators and switching and protective controls such as those found on wind turbines. Solar transformers do require step-up duty. Yet, the solar inverter converts DC input from the PV array to AC voltage for the transformer in a smooth transition with no overvoltage from unloaded circuit. Because solar transformers operate at a steady voltage, with the rated voltage controlled by inverters, voltage and load fluctuations are considerably lower than in wind turbines. PV systems also operate close to their rated loads.

Solar-power systems also have special design issues. Because the largest solar inverter size is about 500 kilovoltampere (kVA), designers are building 1,000 kVA solar transformers by placing two inverter connected windings in one box. The transformer must have separate windings to accept completely separate inputs. Design issues also stem from running cables long distances to convert from DC to AC.

Restrictions on inverter size also limit the size of PV systems. Increasing the size by adding more solar inverters into one transformer box is extremely difficult. With the required box size and running cabling to convert DC to AC, things get complex.

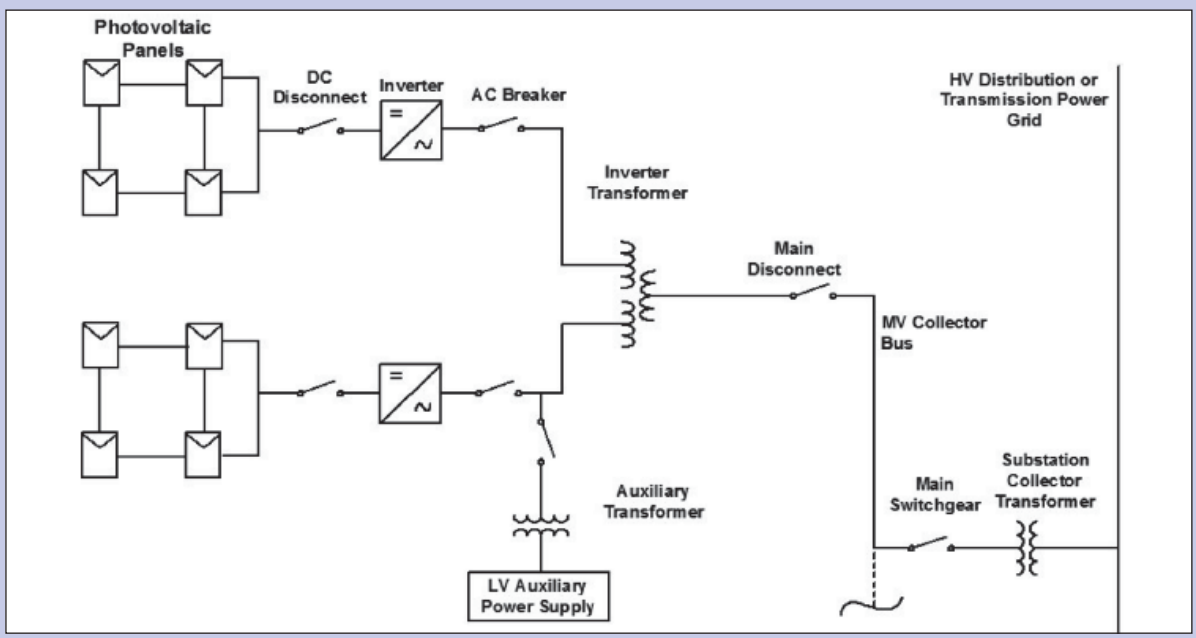
Difference between inverter transformer and power transformer

An inverter is a circuit that converts Direct Current (DC) to Alternating Current (AC). But usually inverter does this conversion at a lower voltage. But electrical and electronical equipment require 110 volt or 220 volt AC for proper operation. Hence after the DC is converted to AC in a inverter circuit, a Power transformer is used to step up this voltage to a higher value (110 volt or 220 volt) and are the fed to the household appliances. Since it is used in inverter it is also called as inverter transformer.

The inverter transformers can also be (and often are) high-frequency transformers, whose main difference from the standard iron-core transformers is that they have ferrite core, far fewer turns of wire per volt, and are smaller and lighter.

"A power inverter, or inverter, is an electronic device or circuitry that changes direct current (DC) to alternating current (AC)."

Layout of Photovoltaic Power Generation



Since all switch-mode power supplies (SMPSs) first convert the mains AC voltage to a DC voltage, they are actually inverters because they turn that rectified DC voltage/current into a high-frequency AC (or pulsating DC) current (of a few kHz to a few hundred kHz) and then run it through an inverter transformer, after which it becomes rectified to DC again (and all this is done to improve the power supply efficiency).

Inverter transformers sometimes called as Electronic transformers because they are commonly used for small power conversion. A transformer is used in inverters in order to get the desired Voltage levels., for e.g., you have an inverter whose output voltage is 22V but your required Voltage is 100V.Then you can use an inverter transformer in order to covert 22V to 100V.

Power transformers are also similar transformers but used large amount of power conversion. This may increase the Voltage, size and weight of the transformer. The large transformers you see in Substations are examples of Power transformers.

All the inverter transformers are power but not all the power transformers are inverter transformers.

Why solar application transformer has normally double LV winding rather than single LV winding?

Because it is connected with multiple solar inverters, hence reduces number of cables and complexity.

Types of Transformers

- Insulating Fluid Filled (IEC 60076-1) : Hermitically sealed with corrugated tank + fire resistant fluid
- Dry Type (IEC 60076-11) : F2/E2/C2 Winding Temperature -65 k(F class) 115K (H class)

Collector Transformer

- Conventional Small Power Transformer connecting the output of inverter transformers to grid.
- OLTC must for voltage control
- Ester Filled Transformers
- LV delta/HV star connected

Grounding Transformers

Zig –zag connected small, 10 second rated unit 3 phase transformer for getting a neutral ■

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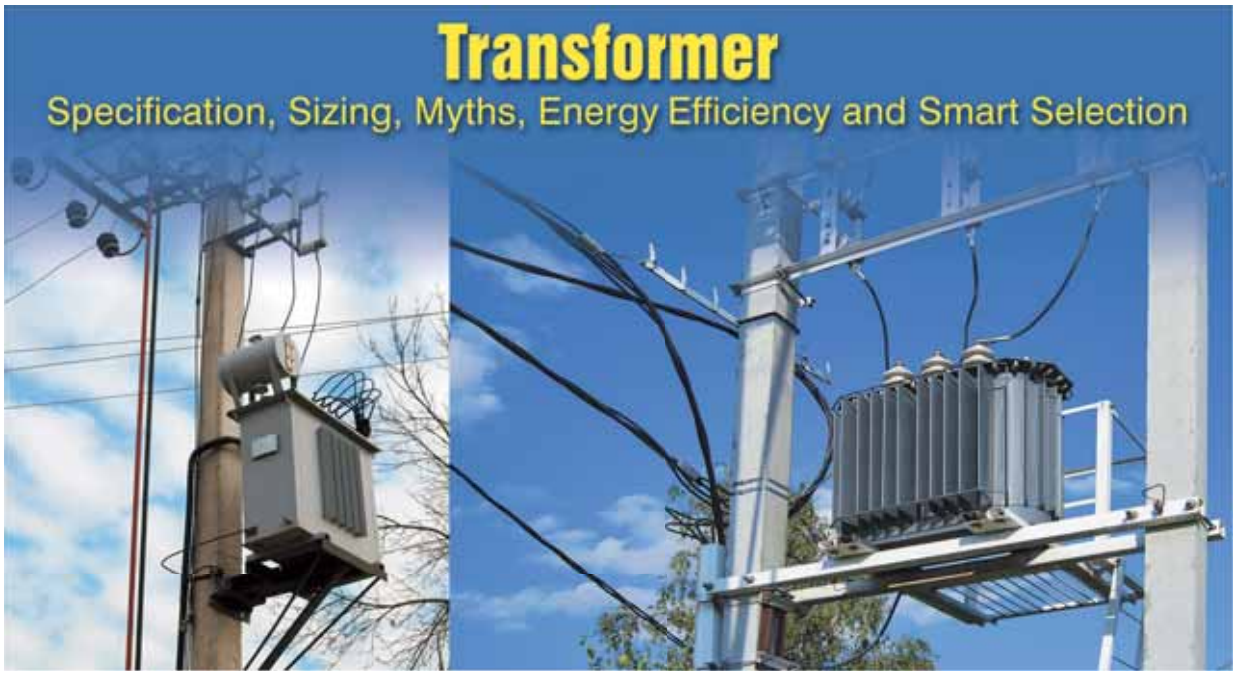


The transformers are a vital component in the power distribution network and should be properly specified as per requirement. There are many instances where deficiencies in design lead to failure(s) due to wrongly sized or under-specified transformers.

The objective of this article is to look at the transformer specification points, clear up any myths, and highlight the proper way to arrive at a transformer specification that truly integrates and delivers the intended system performance.

Core Elements of Transformer Specification

Transformer specification can be categorized into 3 parts:

Electrical Parameters

Today this part has been simplified by IS-1180 or BEE standard. Based on the rating of transformers buyer can select either level of losses L1, L2 or L3 defined in IS-1180 or different Star ratings defined in BEE.

Other parameters like impedance, tapping range, temperature rise, *etc.* are also defined in the standard. If the buyer feels they need more tapping range based on voltage fluctuation, they can specify. Also, the impedance can be varied based on the Short Circuit requirement and transient performance.

The buyer has the scope to optimize the cost by specifying aluminium conductor. For distribution transformer up to 2.5 MVA, Europe and the US produce 70% transformers with aluminium.

Mechanical Design

The construction of tank has to be defined by the buyer. Based on the space and cable layout, buyer can go with a conventional tank with radiator arrangement or corrugated fin wall construction. The corrugated fin wall transformers are compact *w.r.t* conventional tank with radiator.

Also, the buyer should specify for breathing type (with conservator or hermetically sealed transformer). The maintenance requirement for hermetically sealed transformers is much less.

The terminal arrangement to be defined by Buyer for both primary and secondary. Based on the weather conditions and pollution level customer can specify paint requirements.

Di-electric media: Now vegetable oil (Ester) transformers are becoming very popular due to higher flash point. The buyer can specify for mineral oil or Ester transformer.

Fittings and Accessories

The buyer has to specify tapping type (Off-Circuit or OLTC). However, most of the transformer of distribution range is with off-circuit only. Oil temperature indicator (OTI), Winding Temperature Indicator (WTI), Buchhloz Relay, MOG (conventional tank) should be asked by the buyer depending on the protection requirements.

Typical Sizing Guidelines for a Transformer installed in an Industrial Facility

Transformer sizing is carried out based on the following criteria:

1 It should be able to feed the Peak Load continuously,

2 It should have enough Short time ability to feed the base load with starting of largest Motor over baseload,

3 The impedance should be fine-tuned to keep voltage drop within limits during motor starting and at the same time satisfying short-circuit requirements of switchgear.

On top of load requirements, during design stage DESIGN ENGINEER / CONSULTANT can consider Design Margin (Typically 10% to account for design changes during further engineering) and Spare capacity for future (Typically 20% spare capacity for future and to cover safety, reliability and requirements related to power system stability)

Understanding Constraints

In Project document: In Electrical Design Basis, a clear requirement is specified on Voltage Ratings. *i.e.*; Operating Voltage and frequency. However, in the same document maximum limits for current ratings are specified (since the actual requirements are derived during detail engineering)

Typically, the Design Datasheet of Switchgear provides the following information (Current ratings):

- Maximum rated current of main busbar system -> Governs maximum transformer size
- Maximum rated peak and short time withstand current and withstand time -> Governs the minimum transformer impedance.

Role of Power Systems Studies for arriving Main Electrical Parameters of Transformer

A detailed power system study provides answers to many questions regarding the impact of system expansion, short circuit capacity, stability, load distribution *etc*.

The properly planned power system can be defined by its ability of safe operation, future system performance, system reliability, and ability to grow with the production for various operating requirements.

Since the interest is arriving transformer specification, the discussion is limited to load flow studies, short circuit studies, and motor start studies.

Load Flow Studies

This study is used to evaluate the effect on various equipment based on power system configuration, additions or modifications to generation or loads.

With the help of this study, the DESIGN Engineer simulates various cases (from lightly loaded to heavily loaded) can confirm the transformer size and arrive at suitable specification for tap-changer (ensuring near to nominal voltage profiles during different operating conditions).

Key – Take-Aways

1. The optimum transformer taps specification can be determined, which can maintain near nominal voltage at transformer secondary during various operating conditions.
2. Future load/expansion margin can be considered accordingly in load flow analysis.

Short Circuit Studies

This study is used to evaluate the available fault levels and helps in preparing the specification of MV/LV Equipment.

Technically, every electrical equipment should be capable enough to withstand short-circuits and the switchgear elements like circuit breaker should have the ability to make on to a peak short circuit current and break short circuit equivalent to the multiple of their symmetrical short circuit break capacity.

The calculation standards to perform the short circuit study can be IEEE or IEC standard. For INDIA calculations are based on IS13234 (Equivalent to IEC 60909)

Performing the short circuit study at regular design updates helps the study Engineer to:

1. Identify equipment where ratings are exceeded,
2. Specify ratings for plant upgrades and new plant.
3. Contain or reduce fault levels on existing systems,
4. Develop plant and operating procedures to limit fault current.

The worst-cases is identified, which is related with power system operation philosophy and system parameter such as for utility-fed systems consider the maximum short circuit contribution (representing the minimum utility source impedance), in house CPP's considering maximum number of units that may be online.

System impedances – the maximum negative manufacturing tolerances should be used for generator(s), and transformer(s).

Key – Take-Aways

1. Conservative design margin should be considered to allow for future load growth during detailed design or the addition of future loads.
2. Cables impedances can be omitted for conservative results.
3. Minimum %Z is arrived, which is further checked and fine-tuned while performing the motor-start studies.

Motor Start Studies

Large motor starting, owing to its high starting current, results in voltage dip and lasts up to motor starting time.

During this voltage dip, it may cause other motors to pull out if their pullout torque (due to the reduced voltage at bus) is less than the load torque.

Motor-starting studies become very critical when motors are being fed by a weak power source.

Performing motor starting study at regular design updates helps the study Engineer to:

1. Ensure voltage profile during starting by taking corrective actions.
2. Determine the motor acceleration capability and ability to come up to speed especially under full-load conditions.
3. Coordinate the overcurrent and under voltage protection.
4. Determine the suitable starting methods and any special switching arrangements.

It is very critical to identify the worst-case, ensuring the right power system performance for the worst-case condition will minimize various cases to be studied.

For analysis purpose minimum short-circuit contribution from various sources is considered (in calculations), *i.e.*; maximum source impedance.

Key – Take-Aways

1. Larger power-rated transformers improve motor starting capability, but if power rating exceeds the maximum (considering LV Bus Amps limitation), then motors can be specified with alternate starting methods or with reduced inrush currents.
2. Transformers with lower impedances can improve regulation during motor starting, but before making such recommendation it must be cross-checked by performing short circuit studies, so that switchgear has adequate interrupting capability.
3. Fan cooling adds capacity, but does not affect motor starting capability.
4. Adjusting transformer taps will increase the normal operating voltage on a bus, thus improving motor starting capability.

Step by Step Procedure to Size Transformer

Step: 01 Data Collection

1 System details and it's operational requirements, voltage level, clients requirements

2 Downstream connected loads and it's loading scenarios, details of largest load and,

3 Constraints on maximum transformer size and short-circuit capacity of switchboard.

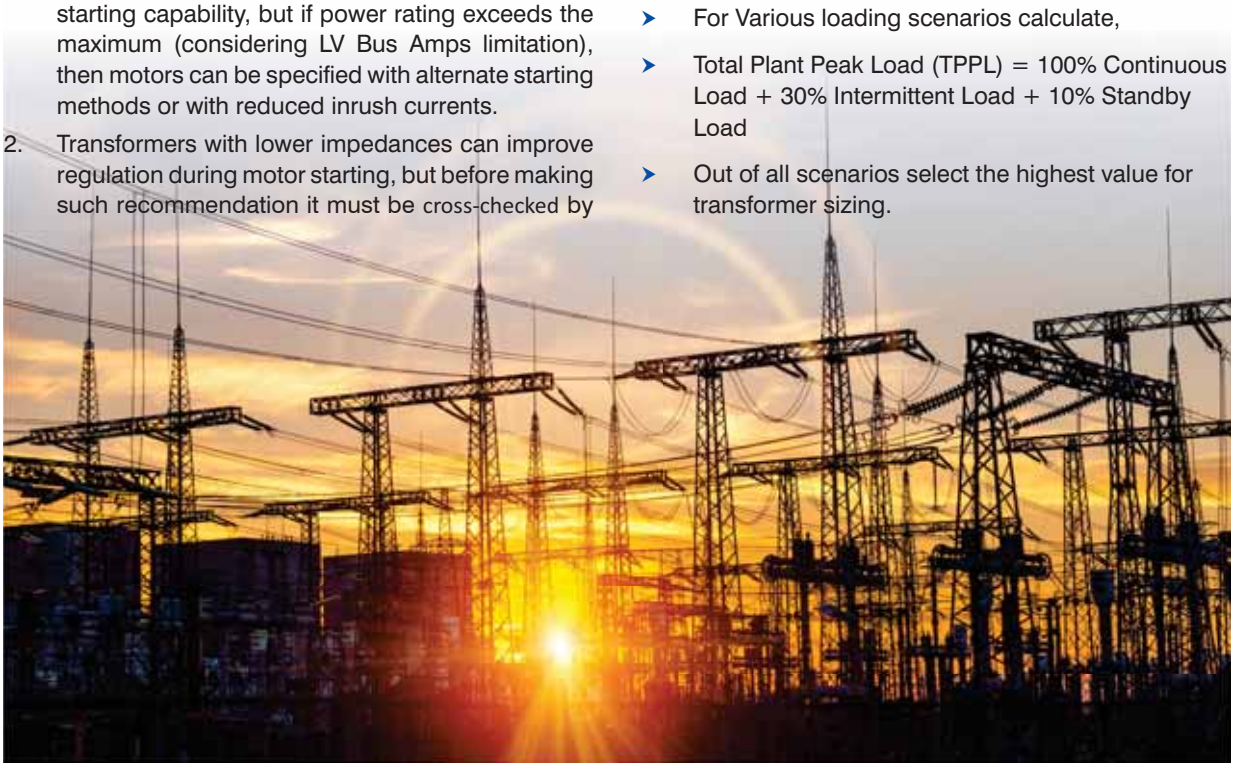
Step: 02 Calculate:

Step: 02.1 Understanding Constraints:

- Maximum size of transformer, which can feed switchboard say 'S_{max}'
- Maximum and minimum source short circuit power and specification of switchboards (Short-circuit ratings).

Step: 02.2 Load Flow Studies:

- For Various loading scenarios calculate,
- Total Plant Peak Load (TPPL) = 100% Continuous Load + 30% Intermittent Load + 10% Standby Load
- Out of all scenarios select the highest value for transformer sizing.



- Minimum Transformer Size (kVA) S_{min} = TPPL (kVA) x 1.10 x 1.20
- Choose the nearest standard transformer size and its impedance as per IEC-60076 / IS 2026.

Check Point

If $S_{min} < S_{max}$

If Yes,

✓ Then no further simplification, proceed to Step: 2.3

If No,

✓ Then split LV switchboards, or shuffle loads based on criticality (service) of the load.

✓ For each switchboard perform load flow studies, *i.e.*; Go to Step: 02.2

Step: 02.3 Short-Circuit Studies:

- Evaluate short circuit contribution from motors (asynchronous motors)
- Evaluate short circuit contribution from source (Transformer)
- Evaluate overall short circuit current of the downstream switchboard -> Thereby arrive at %Z of the transformer (minimum requirement)

Step: 02.4 Motor Start Studies:

- Perform motor start study
- Perform re-motor start study
- Evaluate the voltage profile at the terminals of motor (which is being started and as well as at terminals of running motors) and at bus level of switchboard.

Check Point

If voltage profile is within limits,

If Yes,

✓ Then, chosen %Z of the transformer is selected and on top of it, design tolerance and manufacturing tolerance is added (typically 7.5-10% extra)

If No,

✓ Then look for possibilities. These can be change(s) in motor starting mechanism or transformer size or switchgear configuration.

Step: 03 Summarizing Specification

- Arrive at kVA, %Z of transformer, which meets design requirements.

Myths of Transformer Specification

- Copper transformer is more efficient than aluminium transformer: Efficiency has nothing to do with the conductor. It is related to losses. Hence for the same losses, both copper and aluminum transformer will have same efficiency.
- Copper transformer is having higher life than aluminum transformer: Life of a transformer is nothing, but the insulation life. Proper cooling design and maintenance are the key for life, as the insulation for copper and aluminium transformer remains same.
- Primary system fault current should be withstood by transformer windings: If faults occur at the primary side network, the transformer will be bypassed automatically. As the bushing metal parts are the part of the network, only primary bushing terminal should be suitable for that. The winding has no impact due to the primary network fault. Only secondary fault current will be controlled by transformer impedance and windings will be impacted by forces.
- Specifying short circuit withstand time greater than 2 sec *i.e.* 3 sec or 5sec: People are confused with the time. There are two parts of the short circuit. When short circuit happens, there is an asymmetrical fault current and symmetrical fault current. The first 10-12 cycles are asymmetric. The first peak is approximately 2.5 times of symmetric current. The asymmetric peak is considered for mechanical force calculations; hence no time is required to be mentioned. For symmetric current, thermal calculations need to be done. Based on the time allowed to flow of short circuit current, the conductor size will be designed.

Maximum efficiency of the transformer at 40% - added value?

This is again a wrong perception. Kindly check the maximum efficiency & efficiency @ 40% load from Table 1. Total loss defines the maximum efficiency. Whenever the buyer specifies maximum efficiency at 40% load, the manufacturer will increase the no-load loss to achieve the maximum efficiency at the specified load. This requirement pushes manufacturer to forcibly go with inferior quality of CRGO material. Also, there is an increase in no-load losses.

Does Specifier need to Specify B_{max} and Current Density?

As the limit of over-fluxing is well defined in IS-1180 and also losses are specified and very low, the customer should not specify induction level. Nowadays, due to standards, operating B_{max} is very less (< 1.7T).

Due to specified low losses in standard, the current density is already low and need not required to be specified.

Table: 1 Maximum Losses for 11 kV Voltage Class Distribution Transformer (Table 6 of IS-1180 Part-1 , 2014 , Clause 7.8.1.1)

Sl. No.	kVA	%Z	Energy Efficiency Level-1				Losses Level-1			
			50% Load (Watts)	100% Load (Watts)	Max NLL (Watts)	Max LL (Watts)	Load @ ME	Max. Efficiency	Efficiency @ 40%	Efficiency @100%
i	250	4.25	1050	3150	350	2800	35.36	99.21%	99.21%	98.76%
ii	315	4.25	1100	3275	375	2900	35.96	99.34%	99.34%	98.97%
iii	400	4.25	1300	3875	442	3433	35.88	99.39%	99.38%	99.04%
iv	500	4.25	1600	4750	550	4200	36.19	99.40%	99.39%	99.06%
v	630	4.25	2000	5855	715	5140	37.30	99.40%	99.39%	99.08%
vi	1000	5.00	3000	9000	1000	8000	35.36	99.44%	99.43%	99.11%
vii	1250	5.00	3600	10750	1217	9533	35.73	99.46%	99.45%	99.15%
viii	1600	6.25	4500	13500	1500	12000	35.36	99.47%	99.47%	99.16%
ix	2000	6.25	5400	17000	1534	15466	31.49	99.52%	99.50%	99.16%
x	2500	6.25	6500	20000	2000	18000	33.33	99.52%	99.51%	99.21%

Energy Efficiency – Manufacturing, Operation

Energy efficient transformers are defined under Indian directive IS 1180. Distribution transformers must be energy efficient, this is with due consideration to minimum operational energy losses.

For ready reference, extracts from Regulations of India for transformer design are tabulated, for typical case for HV – 11 kV, LV – 433 V (Refer Table 1). The reader can make a note of total losses at 50 % and 100 % load (in similar way reader can refer IS-1180 Part-1 for efficiency levels 2 and 3).

EN ECO design specifies for a less no-load loss but INDIAN regulation specifies for much lower load-loss.

Also, an efficient transformer should also have the least impact on the environment and hence, design optimisation during manufacturing and design, which uses minimum material to comply specification and reliability. Here material refers to copper, aluminum, oil, steel *etc*.

Energy efficient manufacturing process is good to have so that during manufacturing process minimum power is used (in factory).

The noise level of the transformer also impacts the environment. The manufacturer should ensure the noise level much below the standard (NEMA TR-1)

Summary

The higher cost of the transformer is related to lower operational losses. However, the higher cost of the transformer can be justified by utilizing the 'Capitalisation Formula for Transformer Losses' (CBIP Publication No. 295).

The lifespan of a transformer built with aluminium winding is the same as copper.

For transformers installed in fire hazard areas, it is preferable to go with an ester filled transformer. There are two kinds of ester – Natural and Synthetic Ester.

Power system studies are very critical and must be done in advance to freeze the design requirement of the transformers. It will also help to better understand power system behaviours under all conditions.

In accordance with the national and international standard(s) (IEC / ANSI / IS), transformer windings can withstand short-circuit for 2 sec. If the buyer specifies for more time, the transformer will incur more costs.

Further Reading

Large aluminium distribution transformer by Prasenjit Paul, Michel Sacotte, Frederic Walter (IEEE, 2012 1st International Conference on Power and Energy in NERIST (ICPEN))

CBIP Publication No. 295. ■

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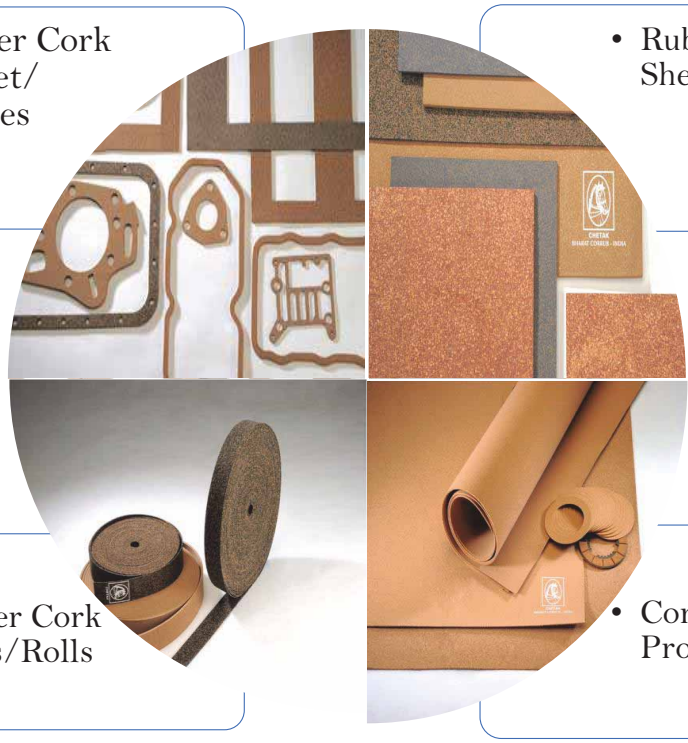

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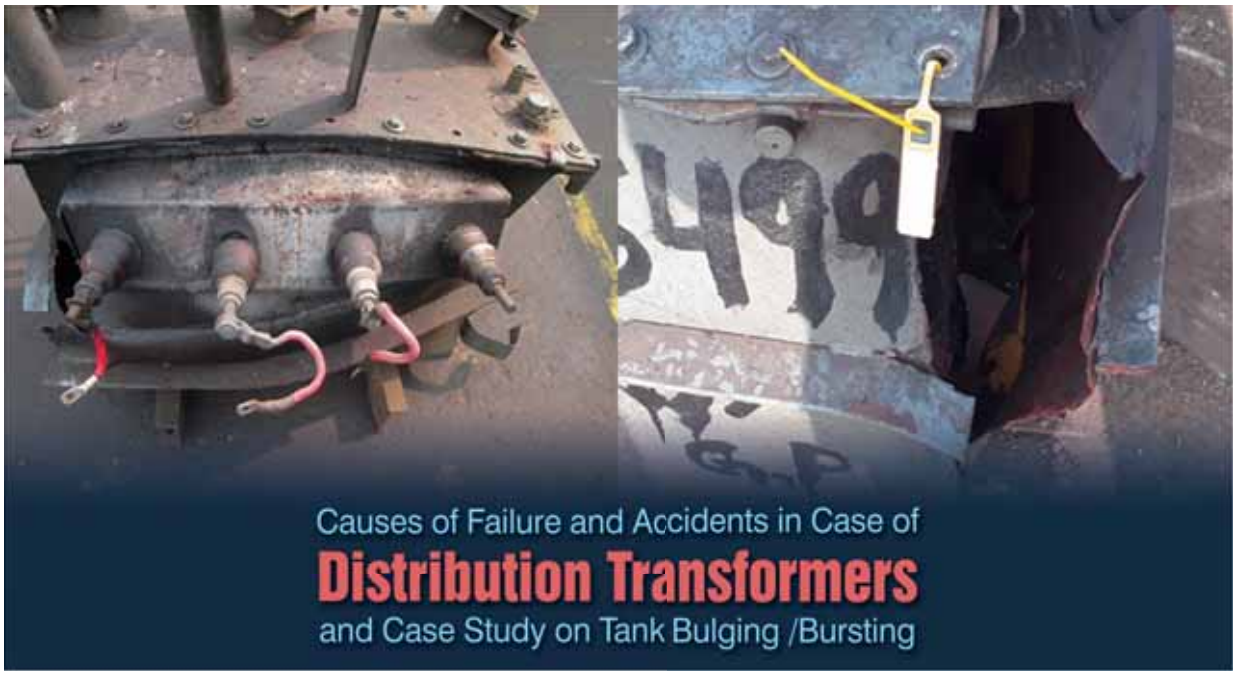


Introduction

- Distribution Transformer is one of the most important equipment in power system that provides the final voltage transformation in the electrical power distribution system, stepping down the voltage to the level used by the consumer.
- Barring few private distribution utilities, were failure rate of Distribution transformers is around 1-2 % , failure rate of Distribution transformers in public utilities is very high, ranging in two digits.
- In this article we will see
  - Causes of failure of Distribution transformers
  - Causes of accidents in Distribution transformers
  - Hard Facts on manufacturing and Usage of Distribution transformers
  - Couple of Case study of Distribution transformer tank bulging and bursting
  - Recommendations

Causes of Accidents in Distribution Transformers

- Accident is an event that happens by chance or that is without apparent or deliberate cause
- In case of distribution transformers and distribution S/stn., accident takes place due to ;

Protection device not operating due to non availability/ setting inappropriate/by passed, in case of ;

- Inter turn Insulation failure due to mechanical damage during manufacture, long term overload and over voltages, deteriorated oil.
- Thermal fault caused by overloading of transformer, poor connections at bolted connections with cables or draw rod of bushings, deteriorated oil.
- Partial discharges may occur due to incomplete oil impregnation leaving cavities , high humidity in paper, arcing between bad connections, adjacent disks, broken brazing
- Eddy current heating in magnetic core due to malfunction of the magnetic circuit. Large negative or zero sequence currents, or circulating currents in the tank and core lead to heating
- Pressure builds up inside tank during internal fault.

Sub Standard tank fabrication, In appropriate Welding and Pressure Testing

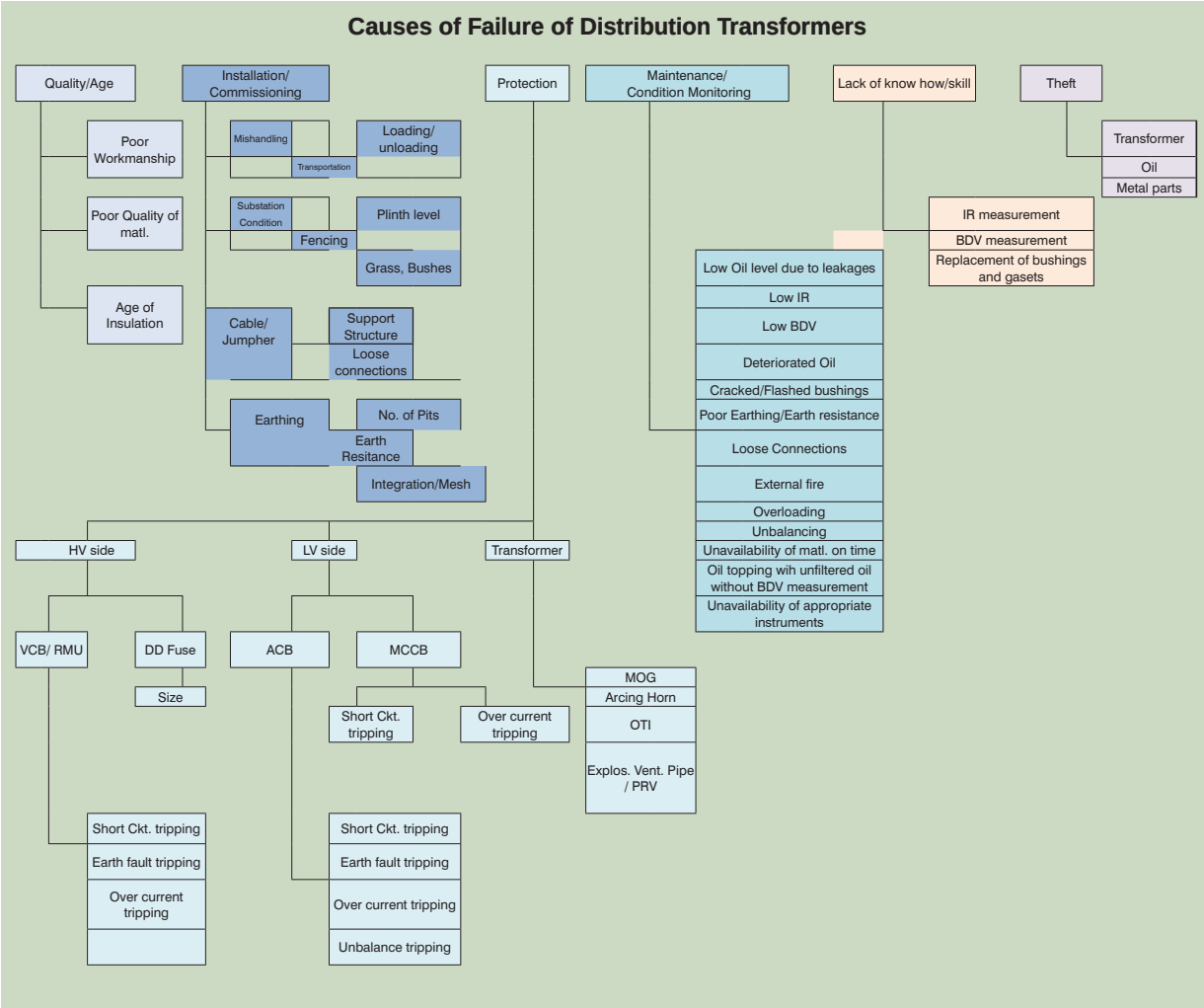
- Low thickness of tank wall sheet used then specified
- Pressure builds up inside tank during internal fault leading to transformer tank or cover being blown out.

Absence of strict maintenance practices

- Oil spillage due to leakage/seepages resulting into fire.
- Uncleaned S/Stn.'s with grass , bushes etc.

Site condition

- Trees near S/Stn,'s having branches over transformers.



People

- Tress passing in S/Stn.'s resulting into accident.
- Residents of multi storey buildings near S/Stn.'s throwing garbage inside it.

Civic deptt.

- Unauthorized colonies and load growth.

Hard Facts on manufacturing and Usage of Distribution Transformers

Lot of small scale industries are manufacturing Distribution Transformers which compromises for small financial gains and utilities people also do not or not able to give much attention on distribution transformers.

Few hard facts on distribution transformers manufactured at small scale industries

- Use of low thickness of tank wall MS Sheet then what is specified.
- Quality of welding in fabrication of tank.
- Less clearance between core coil assembly and tank.
- Length of pipe inside conservator connecting to main tank too long.
- Drain & filter valves welded from outside but no hole inside the tank.
- Air release socket welded on top cover but no hole inside .
- PRV installed but inside there is no hole.
- No provision of standard safety device.
- Poor quality of HV and LV metal parts.
- Poor quality of gaskets, washers, oil seals.
- No primer, no surface treatment on tank resulting into rusting at very early stage.

Few hard facts on distribution transformer in field

- Breather not Installed/Sold/Theft .
- Breather pipe is plugged .
- Line man using higher size of fuse wire to avoid tripping.
- LT side protection such as MCB, MCCB not Installed/Sold/Theft .

- HV and LV terminal connectors sold /theft.
- Cable connection by twisting the conductor on poor quality metal part.
- Earth resistance too high
- Integration/Mess Earthing not in practice.
- Surge arrestor damaged/not Earthed.
- S/Stn.'s not fenced
- Uncleaned S/Stn.'s

Case studies on Distribtion Transformer Tank bulging and bursting

Case study on Distribution Transformer Tank bulging and bursting is to put light on;

- Protection, Specification, Know how and manufacturing practices to be taken care by both manufacturer and utility.
- Sub standard manufacturing practices at small scale manufacturer for small financial gains.
- Standard pressure required to test transformer tank.
- Requirement of safety /protection devices for distribution transformers in the standard IS 1180 Part 1 2014

Case 1 – Bursting of 25 kva trf. tank in Khatloi village in Shahpura near Jaipur.

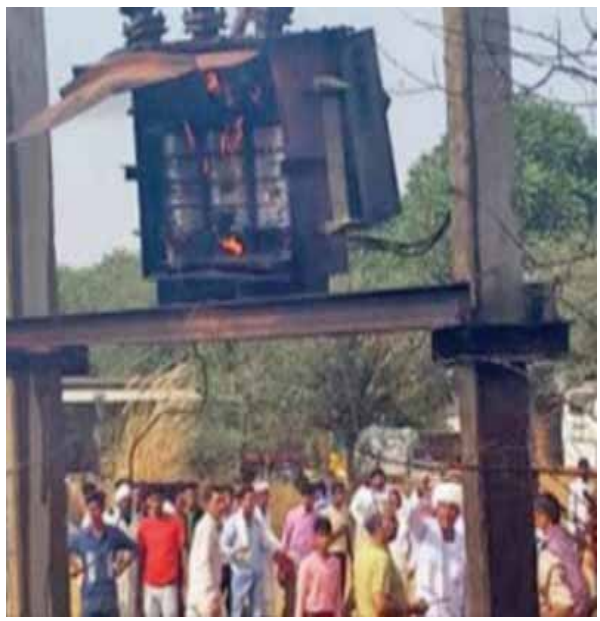
Case 2 – Bursting of 25 kva trf. tank at Vikaspuri, New Delhi.

Case 1 – Bursting of 25 kva trf. tank in Khatloi village in Shahpura near Jaipur

- On 31st Oct 2017, a 25 kva trf. tank bursted in Khatloi village in Shahpura ,near Jaipur.
- 14 persons were killed and 22 injured due to explosion and throwing of hot oil over marriage party which was passing by.
- Transformer was installed 3 days ago from the day of accident and load was approx. 11 kw.

In the reports of media on the basis of questioning from Discom's technical association, queries and inputs on watts app group of engineers, few reasons which were/may be the causes are listed below

- Transformer heated up due to high temperature during the day.
- Failure of explosion vent valve.
- Faulty Earthing.
- HT side gang operated switch missing.
- Breather not available and its pipe plugged.
- Inappropriate HV fuses
- Sturdy tank construction



- We all know, that, fault condition created inside the transformer tank, decomposes the oil, which generates the pressure inside the transformer tank, which is to be released by Saftey/Protection devices, Explosion vent pipe or PRV.

- We all also know that, as per IS 1180 part 1, 2014, plain trf.'s tank upto 200 kva to be tested at pressure 80 KPa for 30 minutes, as a type test and 35 KPa for 10 minutes as a routine test.
- We all know, that, size of sheet of tank wall used for fabrication of 25 kva 3-Ph trf.'s is min. 3mm and welding should be by expert welders.

From the pictures, condition of the transformer, tank wall sheet bending and opening from three sides, raises question marks on following,

- Pertains to manufacturer
- Thickness of sheet of tank wall.
- Quality of welding .
- Pertains to manufacturer and utility
- Pressure testing of tank /design both Type and Routine.
- Pertains to utility
- Although not meant for pressure releasing, but breather missing and pipe is plugged.
- Size of HV fuse wire used.

Pertains to BIS, Utility and manufacturer

- No provision of explosion vent pipe.
- As per IS 1180 part 1 2014 , pressure relief device or explosion vent upto 200 kva is optional.

Case 2 – Bursting of 25 kva trf. tank at Vikaspuri, New Delhi

One of the the largest private utility in India, following cutting age technologies, with failure rate of DT's around 1 %, faced one case of bulging and bursting of tank of 1 no. 25 kva trf. in 2017.

- Subject transformer was procured from a small manufacturer .

- The subject trf. is free breathing trf. with breather installed.
- Explosion vent pipe is provided in this trf. with diaphragm 0.4 mm thickness.
- PRV is also provided in this trf. of rating 0.4 kg/ cm2.
- HV side DD fuse used is of size 32 .
- LV side MCCB is of 100 amp.

Tank bulges from both the major sides

Opening of welding joint from one of the edges breaking stiffener also

Despite of Explosion vent pipe getting ruptured, PRV operated and DD fuse blowing off as per site report, Tank bulged and bursted

Following are the observations and cause of bulging and bursting

- Poor welding quality , resulting in opening of tank from one of the edges.
- The tank wall sheet of subject transformer was found to be of 2.75 mm against specified 3.15 mm.
- Subject case is sub standard manufacturing practices at small manufacturers.

Recommendations

Both the Case study's on Distribution Transformer Tank bulging and bursting presented in this article bring out the fact that;

- IS 1180 PART 1 2014 required revision for making following mandatory ,
  - Pressure relief device or explosion vent upto 200 kva , as part of standard accessory instead of optional.
  - Review standard pressure required to test transformer tank.
- Standard manufacturing practices to be made compulsory for small scale units of distribution transformers in order to produce quality product.
- Both manufacturer and utility to ensure not to compromise with standard accessories of transformers.
- With failure sometimes leading to the extreme consequence of fire and explosion, there is a need specifically to train and inform engineers those are into transformer maintenance and monitoring.
- In view of failure rate of Distribution transformers, which is very very high pan India barring few private utilities , IS 1180 PART 1 2014 should also make following mandatory ,
  - DMCR relay for rating 1 Mva and above.
  - MOG/Oil level sensor for rating between 400 kva and above
  - Making RMU/VCB on 11 kv side and ACB on 433 v side mandatory for transformers 400 kva and above
  - Making MCCB on 433 v side , mandatory for transformers less then 400 kva ■

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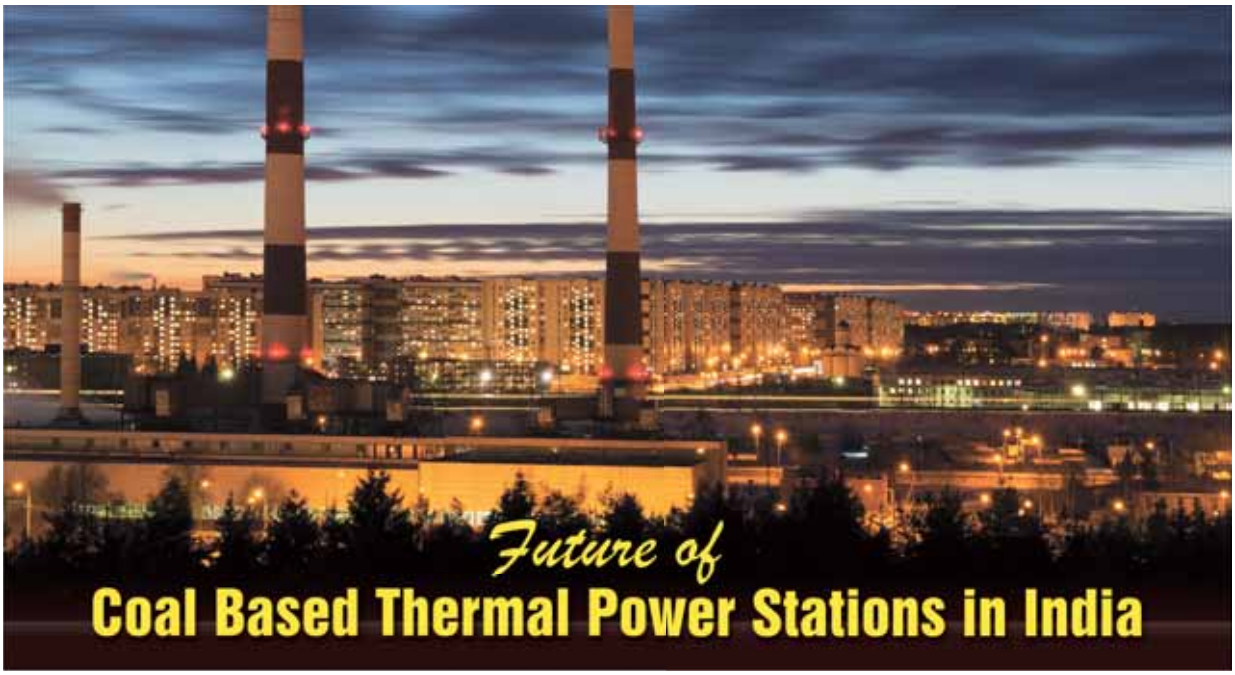

Coal based generation in India accounts for approximately 55% of India's installed electricity capacity, representing more than 190 GW distributed among central, state and private sector entities. Coal has been and will remain vital to the country's energy infrastructure and economic development. Growth in industrial activity, population, economic prosperity and urbanization along with per-capita energy consumption will continue to drive increases in power demand for years to come. These forces have also made India's electricity generation sector one of the fastest growing in the world. Net electricity generation in India is expected to grow at an annual rate approximately @ 4 % per year.

During the past few years India has developed more aggressive renewable goals. In 2015, India's government announced a target of 175 GW of renewable energy capacity by 2022, which includes 100 GW solar power, 60 GW of wind power, 10 GW of biomass-fired power and 5 GW of small hydropower. In the current impetus in renewable energy by Indian government, coal continues to remain backbone of the power sector and the economic in general, primarily due to its contribution to total power generation and the multiplier effect it has on the economy. Both renewable and conventional sources of fuel have a role to play in sustainable India's growth. A number of challenges faced by coal based plants have however increasingly put them at risk of being stranded.

Poor financial health of discoms and debt overhung have created a situation of artificial demand scarcity – a significant number of houses remain to be connected to the grid or have 24 hours access, while discom's continue to remain reluctant to sign new long term PPAs with generating companies. With PPAs often being a precursor to the allocation of FSAs, plants without PPAs are exposed to coal supply uncertainty. Fuel prices are also been on the rise over on the past few years, a period in which imported coal prices have been failing year-on-year. A large number of projects have run into execution challenges leading to time delays and cost overrun. Approximately, 50 GW of total installed capacity of India is stranded. Capital infusion and operational improvement have limited potential to turn these plants around. Performance remains strongly linked to government policy and strong policy intervention is required to shore up the stressed assets.

The long term outlook for coal is also far from heartening. Government policy is directly and indirectly supports renewable capacity addition. With renewable achieving grid parity, there has been a reversal in the merit order of discom. In addition, plants dependent on imported coal are also at a significant price risk as seen in the case of coal import from Indonesia. This is in contrast to domestic coal where prices are fixed in the medium term period. There also remains very limited scope for new investment in this sector given the capacity addition planned over the next five years.

Even in economics higher dependency on renewable, conventional plants continue to play a critical function as topping plants. This is an outcome of intra-day fluctuations in demand and solar load and as such can only be partly mitigated to through off-peak pricing. However, a major change is needed in the operations and management of conventional power plants to effect this shift from base load to topping cycle. Incentives across the value chain need to be aligned with the objective of inculcating flexibility in operations. This also mandates the necessary technological changes to enable plants to run at lower minimum load. Further, in order to balance the interests of coal based thermal plants against the

imperative to increase of renewable capacity, key policy interventions are required. In addition, changes in coal supplies generating companies are needed to ensure that coal based generation remains competitive.

Key issues on which the future of coal based power stations depends are as below:

Technical Minimum Capacity

Technical viability of plants goes for a toss if they run under 55 per cent capacity utilisation – a fact which is recognised by the Central Electricity Regulatory Commission. It is detrimental for the plant boilers and leads to drastic reduction in plant life. These plants are designed to run at very high capacity utilisation – around 85 per cent. When they runs much below full load, it consumes more coal leading to under recovery of energy charges, as regulations does not provide for this. Plants without power purchase agreement for even a portion of their capacity are in for trouble. Reduction in capacity utilisation leads to decline in revenue income for the plant. At less than 60 per cent capacity utilisation the margin, which would otherwise provide for operating costs including interest cost, other than coal costs, would get wiped off. These plants are headed for trouble. In order to accommodate high quantum of renewable energy into the grid, thermal plants are likely to run at low plant load factor (capacity utilisation) in future. CEA has also estimated that all coal-based thermal power plants need to brace for drastic fall in capacity utilisation to as low as 48 per cent by 2022 as additional non-thermal electricity generation capacities come on stream.

Lack of water

Lack of water and uncertainty of monsoon in India, drought is also creating challenges for a country with a preference for coal, as a lack of water reduces hydroelectric generation while simultaneously hindering the use of water by the coal industry. Water scarcity is just another element for India to balance as they look towards the future and make decisions now that will serve their future energy needs. As energy sources become more diversified, they will benefit from using digital tools to improve reliability, efficiency and maintenance costs as they focus on near-term energy challenges while transitioning to a new, longer-term energy mix.

Water plays a crucial role in ensuring smooth operations of a thermal power plant. It is a key input in thermal power generation; it is typically used at a plant for cooling tower make-up, ash disposal, demineralization plant make-up, air conditioning, and coal dust suppression etc. One unit of electricity generated from a coal-based plant requires around three liters of water. In the recent past, due to weak monsoon the availability of water has been a key concern for power developers. The shutdown of thermal power plants owing to water shortage has been increasing year to year. Unfortunately, with the existing thermal power plants facing operational hurdles owing to water shortage, water availability is likely to be one of the biggest challenges for new thermal power plants.

Renewable Growth

Regardless of where a nation falls on the transformation spectrum, power generators and utilities that rely on coal-fired power plants must adapt to support the new energy mix. As fossil fuels, including coal, work to meet energy demand in conjunction with renewables, dispatch varies. The expectation that coal plants need to ramp up and cycle on and off to complement growing usage of renewable energy sources is putting a strain on their infrastructure and creating inefficiencies that are impacting profitability.

The need for energy security and reduction in CO_2 emissions has led to a gradual shift from conventional power-generating sources towards renewables across the country. Governments worldwide have provided support measures and mandated a certain share for renewable energy in the overall energy mix. To provide support for these plans, numerous incentives have been introduced to support the development of renewable energy sources and offer a level playing ground. Price of renewable energy is set to reach parity with coal-based generation and even surpass it. Combined with the government's targets for renewable energy capacity of 175 GW by 2022, coal-based generation is likely to face strong headwinds. Now would be the right time for the government to re-think coal's contribution to India's energy mix and formulate a strategy to use existing capacity effectively as well as prevent accumulation of non-performing assets in the future.

Cycling can damage a plant and impact its life expectancy compared to base load operations. But

strategic modifications, software, analytics and operational changes can minimize the impact and

cost of cycling. Coal plants are challenged to balance the tradeoffs between meeting demand and taking advantage of favorable market pricing. All coal plants grapple with finding a balance with these tradeoffs. Analytics and optimization solutions can automate this process, allowing plant owners to set their business strategies, constraints and desired outcomes.

Environmental Norms

Power companies are facing rising government interference in energy markets such as policy decisions with respect to renewable support, phase-out plans, and stringent environmental norms. India has also revised its long-term energy plans, and has introduced stringent environment norms and safety measures in order to continue with their coal based thermal power plant development. The country has already initiated the process of tackling overcapacity by stringently holding back the construction of new coal-fired power plants. In addition, the government approved new measures to combat the air pollution from large combustion power plants that account for one-third of the countries'

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emission of toxic pollutants. These plants are required to meet the revised emission targets by 2021, based on which permission for carrying out operations will be granted.

The air-fuel mix component provides real-time optimization by manipulating controls related to fuel and air mixing to improve heat rate, reduce NO_x and better control CO. It uses neural network based optimization and model predictive control to extract insights about the combustion process, determines the optimal balance of fuel and air flows in the furnace and responds to changing conditions in the boiler. It adjusts the control system biases for consistent positioning of dampers, burner tilts, over fire air and other control parameters to work towards objectives, such as to minimize NO_x and CO and reduce dry gas heat loss.

The soot-cleaning component provides real-time optimization to determine when each soot-cleaning device should be activated in order to improve heat rate and reduce unnecessary wear and tear on the boiler. This can prevent unplanned downtime by not blowing on already clean surfaces, thus causing tube ruptures. Plant Optimization provides the inputs and decision making analysis that can improve production, reduce heat rate and increase operating margin. Decommissioning of coal-fired power is expected due to environmental regulations and an abundance of renewable energy at a competitive price.

Lower Plant Load Factor

Thermal plants have run at the lowest capacity in 15 years, plagued by a combination of acute fuel scarcity and the inability of cash-starved distribution companies to buy electricity from plants using costly imported fuel. Most coal-based power plants can't recover even their operating costs. Ironically, new plants using the fuel-saving 'supercritical' technology are the worst hit as their efficiency decreases at low utilization. Power companies forced to cut down their generation due to fuel shortage and distribution utilities' reluctance to buy imported fuel-based high cost electricity. While distribution companies are forcing power cuts on consumers despite availability of electricity. It is surprising to see plants are backing out of generation in most of the month for want of demand. This clearly shows the distribution utilities is suppressing demand to avoid buying the high cost power resulting in low PLF. One of the reason for low PLF of thermal power stations is due to increased share of clean energy in some of the states. In order to fulfill the renewable purchase obligation, the distribution companies are bound to purchase certain percentage of its total energy from renewable sources.

Plant Opti mization

Modern coal power plants rely on a complex network of sensors, actuators, digital controllers and supervisory computers to operate and coordinate each of the plant subsystems. Hundreds of feedback control loops serve to monitor plant processes and perform appropriate control actions, aiming to maintain optimum operating conditions regardless of system disturbances such as changes in coal quality or load demand. But the complex, highly interrelated nature of power plant parameters means that closed loop control is highly challenging, and the plant is often not operated to the limit of its potential capabilities.

Coal operators will need to understand how to support India's evolving mix of electricity generation. Coal plants will need to operate more efficiently to support the grid as renewables rapidly increase. Coal plant operators that use digitalization to manage flexibility, maintenance costs and emissions will be positioned to operate efficiently and profitably moving forward.

Observations

Renewables generation is increasing in India resulting in pressures on coal plants that is similar to other regions regarding emissions and maintenance costs. However, India coal plants also suffer from efficiency challenges and operating costs as a result of fuel mix. Market forces such as disruptive technologies, regulatory norms, changing consumer behaviour, competitive forces (new entrants), ageing asset performance with an increased need of reliability, decarbonisation efforts to tackle climate change, increased renewable power generation, and growth of distributed energy resources (DER) are affecting the India's power utility landscape. The power sector is gradually undergoing a transformation driven by these factors. The electricity grid is now getting smarter, power generation is becoming cleaner, and greater consumer choice and control is being observed. Following are some of the key trends being observed in the power industry today.

- Capacity additions have slowed down with the project pipeline drying up. Capacity additions in recent years is even lower than that of renewables. Going forward, the Central Electricity Authority (CEA) has projected that no new coal-based plants would be needed before 2027.
- Lack of demand from discoms along with a spurt in renewable power generation has led to drastically reduced plant load factors (PLFs).
- Of late, fuel availability issues for power plants have resurfaced. A number of projects have reported low reserve coal stocks owing to a combination of factors, including a demand surge and rail transportation issues.
- Moreover, the magnitude of the stressed coal-based power capacity problem remains large, owing to a host of reasons including a dearth of fresh power purchase agreements (PPAs) and the non-availability of fuel supply agreements, besides the inability of promoters to infuse equity and service debt. The government is, however, planning to address these issues through a host of strategies including auctioning of stressed plants, encouraging their acquisition by public sector undertakings, as well as through the modification of PPA norms.
- Meanwhile, to comply with the emission norms, the focus of developers is on installing/upgrading

air emission control systems, improving water and wastewater management, and deploying more effective fly and bottom-ash handling strategies. However, given that these entail significant capex, developers are awaiting more clarity on tariffs and cost recovery mechanisms to be duly compensated.

- Developers are also revisiting their O&M strategies in light of the energy efficiency targets for thermal power plants, coal washing requirements, safety improvements, etc. Modernisation of the ageing fleet through digitisation is also gaining traction to help improve generation and reliability, and keep them in business.
- Flexibilisation is becoming a focal point for plant operators due to the growing share of intermittent renewable power generation. It is being increasingly realised that with greater renewables in the grid, coal-based power plants would need to be flexibilised to run at partial loads.

Conclusion

Coal-fired power plants play a critical role in supplying global energy and will remain a major contributor into the future. But inefficiencies, high emissions, low reliability, low plant load factors and the expansion of renewables and solar will continue to be major challenges. With the shift in the role of coal based generation, it is imperative that a framework be developed to support conventional generation in the transition while not compromising on the countries renewable aspiration. Operations Optimization is designed to help power generators tackle increasingly complex and challenging operational issues, meet business demand, align people and systems, and reach "true" plant capacity while still reducing cost, downtime and emissions.

In order to accommodate high quantum of renewable energy into the grid, thermal plants are likely to run at low plant load factor (capacity utilisation) in future. In fact, it has suggested that a market mechanism through regulatory intervention needs to be evolved so that the owners of thermal plants are able to recoup the investment and at the same time, customers are not unnecessarily burdened with high tariff. ■

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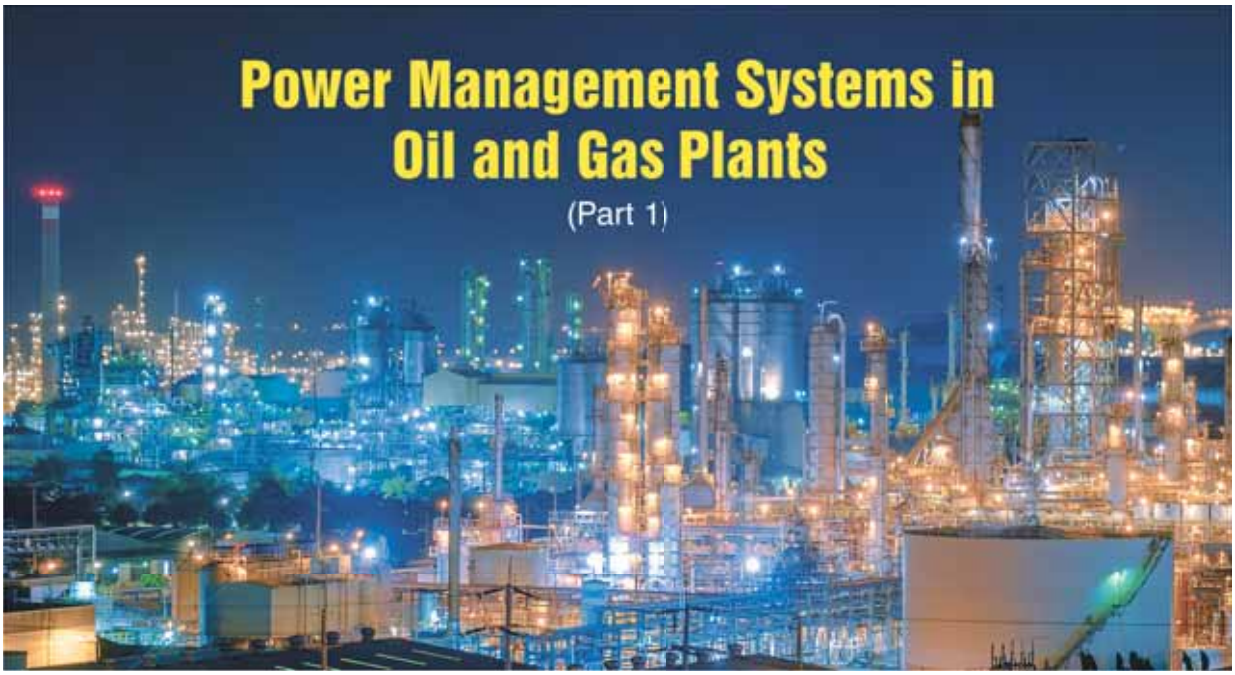


This paper describes Power Management Systems and highlights their need in self sufficient Electric Power Systems especially in Oil and Gas Plants. It enumerates on the typical inputs required for designing such a system and how the main functions of a Power Management System are realized in a sample plant.

Oil and Gas plants are inherently required to achieve a high level of production and production availability (expected availability could be anywhere between 95% to 98.8%) with no loss to personnel and assets – plant safety. To ensure such availability, the electrical system for the plant, in turn, needs to be designed for high availability of the order of 99.99% to 99.999%. Moreover, to ensure availability and safety, the electric system needs to be controlled such that no equipment is operating outside its operating regime and the switching operations are implemented safely and to the extent required through use of automatic functions.

For achieving such control of the electrical system, the electrical quantities in the system have to be accurately measured and status of equipment have to be closely monitored. Measurement of electrical parameters can be accomplished in a variety of ways, including the use of direct-reading discrete instruments, like voltmeter, ammeter, KW meter etc, or a microprocessors based multifunction meter or directly from the modern numerical relays which have measurement capabilities. Status monitoring on the other hand, helps the operators to know the configuration of the power system at any given time through indication of the status of all switching elements in the electrical network. In addition, status monitoring is also used for indicating the healthiness of the system, alarm and trip status of the network itself or network components. Status indication along with metering helps operators to efficiently supervise the network and safely implement the switching operations. A typical Electrical Network Monitoring System (ENMS) may have the following functionalities:

- Display Single Line Diagrams on Visual Display Units (VDUs).
- Status indication and reporting, alarms and printing reports
- Data acquisition, logging and archiving.
- Display of trends which can anticipate abnormalities
- Control of peripheral hardware; e.g. VDUs, Keyboards and printers.
- Communication with the Supervisory Control and Data Acquisition (SCADA) system.
- Continuous monitoring of Voltage, current, frequency, kW, kVArs,
- Logging and recording of faults, their timing and duration, as well as, the above parameters before and after the occurrence of fault.
- Auto-Changeover logic and command.

However, most Oil and Gas plants have their own Captive Power Plants (CPP) driven by the fact that most of these plants are located in remote locations where grid power may not be easily available on one hand and inhouse availability of cheap gas to run the Gas Turbine Generators constituting the CPP on the other.

The key issues in the operation of these standalone captive power plants are their reliability (achieved mainly through redundancy), stability of the system, their ability to survive trip and upset conditions and their operation at high load factors (85% to 90%) for most economical fuel consumption. Monitoring and Control of such standalone CPPs and the plants which they feed power to, requires certain specialized management functionalities which traditional ENMSs cannot provide.

These specialized management functionalities can be achieved through Power Management Systems (PMS). The specialized functionalities of a Power Management System pertaining to distribution systems with inhouse CPP are [1] :

a) Active power sharing for generators
b) Reactive power sharing for generators
c) Condition monitoring of the gas turbines
d) Scheduling the starting up and shutting down of the main generators
e) Auto-synchronizing of the main generators
f) High-speed load shedding
g) Low-speed load shedding
h) Inhibiting the starting of large motors
i) Isochronous control of system frequency
j) Isochronous control of system main bus bar voltage
k) Control of the reacceleration of motor loads
l) Communication with the ENMC, SCADA systems.

The main advantages of PMS [1] are :

- Improved Range and accuracy of plant measurements and display
- Improved range and type of alarms, messages and event recording
- Better control by the control room personnel
- Greater Confidence in the performance of the plant
- Addition of special technical facilities e.g. auto-synchronizing, load sharing, load shedding, condition monitoring, managing the tap-changing of transformers
- Communication with SCADA systems
- Improved Data logging, trending and archiving

Main Functions of a Power Management System

A: Active and Reactive Power Sharing of Generators

A.1: The PMS has to provide facilities for the control and supervision of the Generators (Gas Turbine, Steam Turbine Generators normally used in such Plants). The PMS has to fulfil the following objectives:

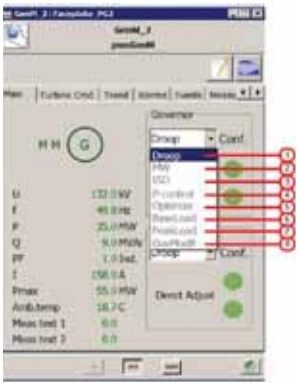
- Regulate the active and reactive power produced by in-plant Generators when the Electrical Network (or parts of) is connected in parallel with external grid in order to keep pre-defined active and/or reactive power setpoint at Grid exchange point.
- Regulate the Speed and Excitation of in-plant Generators when the electrical network (or parts of) is isolated from the Grid in order to keep pre-defined frequency and/or voltage setpoint at point of common coupling.
- Detect the electrical network contingencies and automatically engage the appropriate control scheme (grid connected / island) to be applied to the generator governors and AVRs. The electrical network contingencies determine the Plant modes of operation (The status of critical breakers i.e Incomers, Bus couplers and Tie breakers at applicable voltage levels)
- Alert the operators when the normal operating conditions (power imported from Grid and /or power delivered by Generators) exceeds preset limits.
- Control start and stop of Generators (especially GTGs) to facilitate adequate electrical power supply scenario for Power and Frequency control
- Share the Active and Reactive load of the Generators according to their capability characteristics
- Provide HMI facilities for control and supervision of modes, setpoints, limits, etc. during run-time operations.

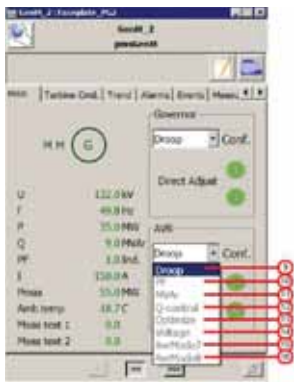
A.2 : Typically, PMS will have the facility to measure the kW, KVAR, Voltage, Frequency and power factor of each generator using accurate transducers which relay the information to the PMS controllers via say 4-20mA signals (Transducers with ideally 120msec or less response time at 50Hz, 100msec or less at 60Hz, accuracy 0.1% like Siemens Secam-T Multifunction Transducers). Selection of appropriate response time of transducers plays an important part as incorrect response times may cause the generators to hunt while being controlled by PMS. These signals are then input to soft PID loops as shown in Figure 2 (typical and not attributed to any vendor) and the output of the control blocks are fed to Pulse Width Modulators which vary the duration of the pulses as a kW (speed) and KVAr (voltage) increase or decrease signal to the Governor and AVR system for Active and Reactive Power Control respectively. The gains of the PID controller loops are normally tuned at site.

A.3: Generator Modes

Traditionally, the possible operational modes for generator governors at equipment/field level (Unit Control Panel of generators) are Isochronous Mode and Droop Mode. Similarly, for AVRs the possible operational

modes are Voltage and Droop. However, each supplier of PMS will have his own standard software solutions in his PMS which will be built on these traditional field operating modes. For this paper we standardize around ABBs PMS object library product (without loss of generality). The possible solutions offered by ABB are as shown below:





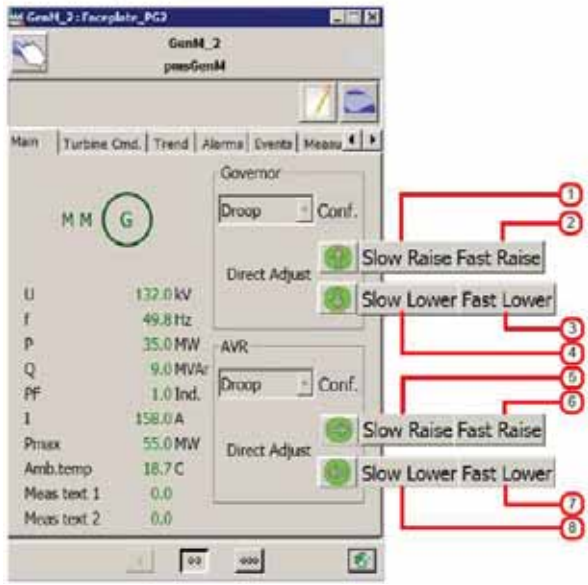
Governor Modes			AVR Modes		
Field	PMS-level (i.e. generator faceplate)	Equipment-level (i.e. field device)	Field	PMS-level (i.e. generator faceplate)	Equipment-level (i.e. field device)
1	Droop	Droop	9	Droop	Droop
2	MW	Droop	10	PF	Droop
3	ISO	ISO	11	MVAr	Droop
4	P-control	Droop	12	Q-control	Droop
5	Optimize	Droop	13	Optimize	Droop
6	Baseload	Baseload	14	Voltage	Voltage
7	Peakload	Peakload	15	Avrmode7	(spare)
8	Govmode8	(spare)	16	Avrmode8	(spare)

Fig 1- Typical Governor Modes of a supplier

Governor Droop Mode or Manual Mode

In this case the Field Governor mode and the PMS mode are both in Droop. In this Droop mode the Operator is presented with Manual Raise/Lower commands for the Governor. The operator can issue Fast Raise/Slow Raise commands. Fast Raise commands have longer pulse width durati ons. Slow Raise commands have smaller pulse width durations. Similarly the Operator can issue Fast lower/Slow Lower commands. The pulse width for the Raise/Lower commands can be adjusted by engineer with appropriate rights.

Fig. 3 shows how the Faceplates displays/covers the explained functionalities for Droop mode:



Field	Indication
1	Governor - slow raise
2	Governor - fast raise
3	Governor - fast lower
4	Governor - slow lower
5	AVR raise - slow raise
6	AVR raise - fast raise
7	AVR lower - fast lower

Fig 3- faceplate display for Droop Mode

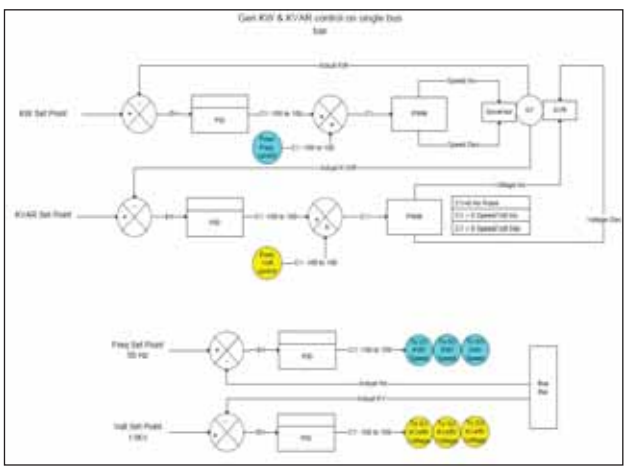


Figure 2a Typical PID loops for set Governor and AVR control

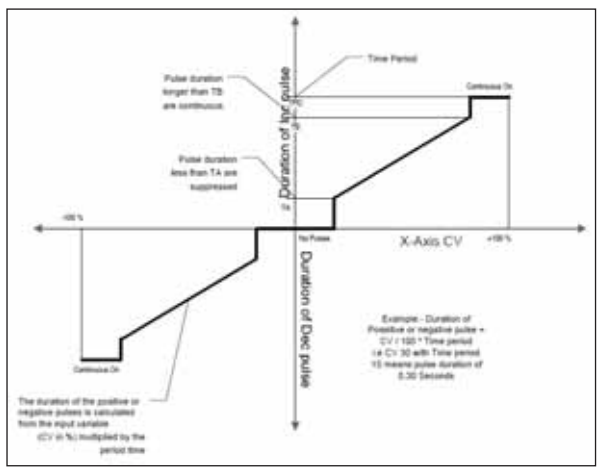
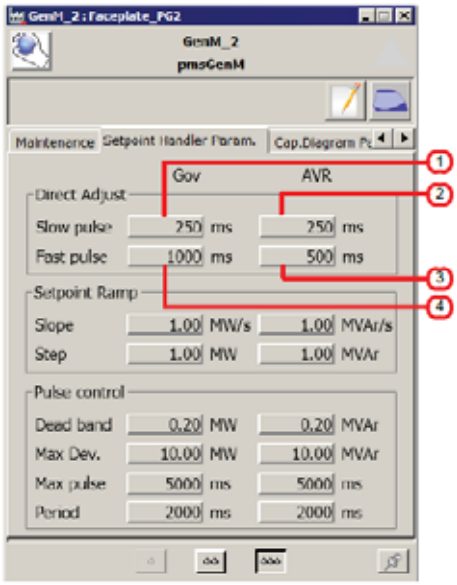


Figure 2b : Pulse Structure from PWM



Field	Indication	Configuration method	Description
1	Gov. Short	Numerical input field	Pulse duration for governor slow raise / slow lower buttons
2	AVR Short	Numerical input field	Pulse duration for AVR slow raise / slow lower buttons
3	AVR Long	Numerical input field	Pulse duration for AVR fast raise / fast lower buttons
4	Gov. Long	Numerical input field	Pulse duration for governor fast raise / fast lower buttons

Fig 4- Fast and slow pulse parameters

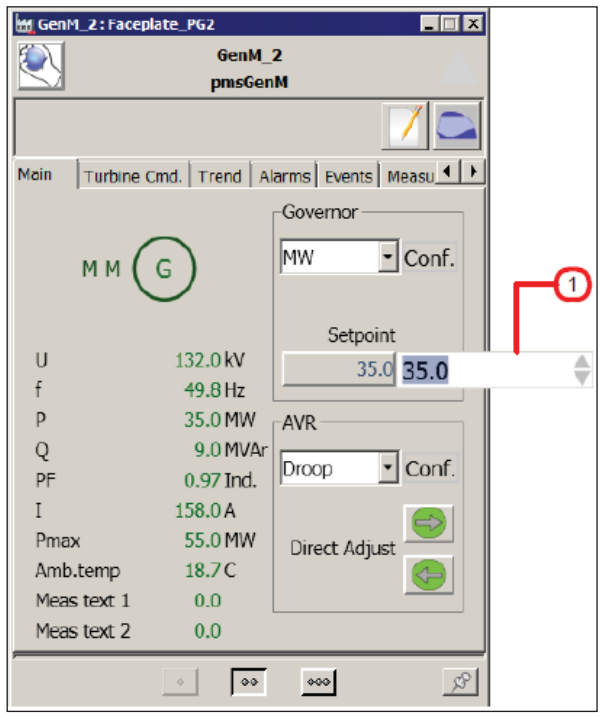
Governor MW Mode or Semi Auto mode:

In this case the Field Governor mode is Droop and the Mode at PMS level is MW mode. In MW Mode the Operator is presented with a MW setpoint entry window, where he can enter the desired MW setpoint for the Governor. Then the Generator module gives raise/lower pulse to the Governor to bring the Working point of the Governor within the deadband close to the Setpoint. The raise/lower Commands Pulse width is controlled by the Generator module depending on the difference between the working point and the setpoints. The pulse width is directly proportional to the difference in the Setpoint & working point value. However the Length of the Maximum pulse, the Step up & Step down Ramp rates & Slope rates for the Setpoints are controllable/ tunable by the Engineer with Appropriate rights. The below snapshots Fig 5 shows how the Faceplates displays/covers the explained functionalities for MW Mode.

Governor P-Control or Auto Mode:

In this case the Field Governor mode is Droop and the Mode at PMS level is Auto mode/P-Control mode. The Auto Mode is a supervisory mode for the Generator module. In this mode the Generator module gets setpoint from the Supervisory P-Control (Active Power) module. The P-Control monitors the electrical network and accordingly distributes the Setpoints to the Generators automatically based on capability. The Generator module gives raise/lower pulse to the Governor to bring the Working point of the Governor within the deadband close to the Auto Setpoint. The pulse tuning parameters are common for both MW mode & P-Control mode.

The below snapshots shows how the Faceplates displays/covers the explained functionalities for Auto Mode:



Field	Indication	Configuration method	Description
1	MW	Numerical input field	When MW mode is active, the desired setpoint value for the active power can be entered.

Fig 5-Faceplate display for MW mode

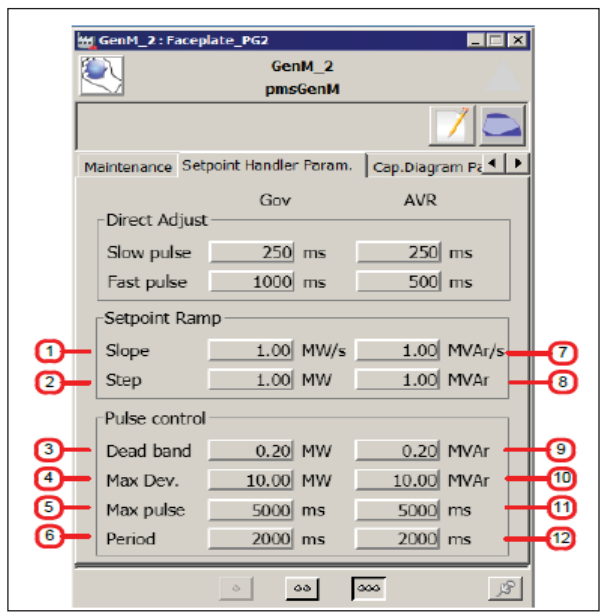


Fig 6a-Fast and slow pulse parameters

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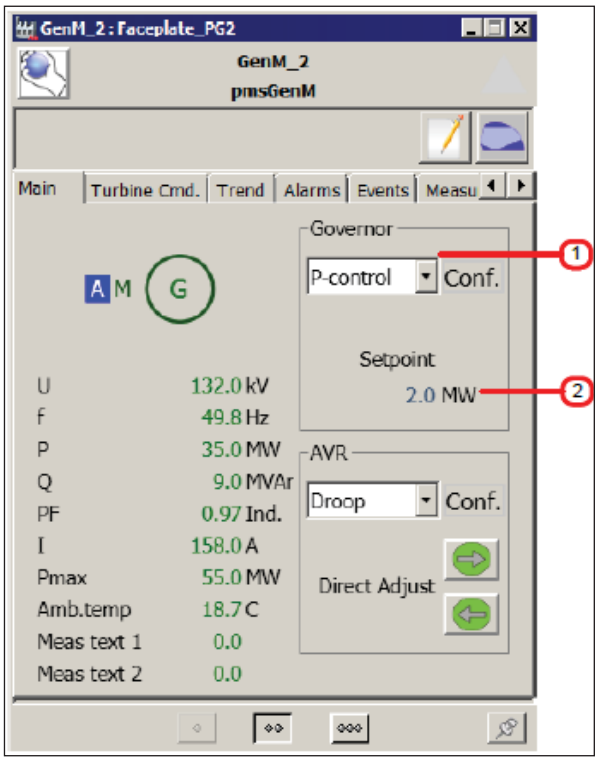
Field	Indication	Configuration method	Description
1	Gov: Slope	Numerical input field	Setpoint parameter
2	Gov: Step	Numerical input field	Setpoint parameter
3	Gov: Dead band	Numerical input field	Setpoint parameter
4	Gov: Max Dev.	Numerical input field	Setpoint parameter
5	Gov: Max Pulse	Numerical input field	Setpoint parameter
6	Gov: Period	Numerical input field	Setpoint parameter
7	AVR: Slope	Numerical input field	Setpoint parameter
8	AVR: Step	Numerical input field	Setpoint parameter
9	AVR: Dead band	Numerical input field	Setpoint parameter
10	AVR: Max Dev.	Numerical input field	Setpoint parameter
11	AVR: Max Pulse	Numerical input field	Setpoint parameter
12	AVR: Period	Numerical input field	Setpoint parameter

Fig 6b Table explaining the indications

Governor Isochronous Mode:

In this case the Field Governor mode is Isochronous and the mode at PMS level is also Isochronous mode. In this mode there is no control action from PMS. The PMS simply monitors the Generators Working points. The Isoc machine takes corrective control action to maintain the plant at desired setpoint frequency. This control action is done by the Primary control system supplied by the corresponding STG/GTG Vendors.

The ABB PMS allows only one machine to be in Isochronous mode per electrical network. If a second Isochronous machine is brought in the Electrical network, the Central Mode manager



Field	Indication	Configuration method	Description
1	P-control	Drop-down menu	Governor mode P-control
2	P-control	Numerical field	Setpoint value received from Active Power Control function

Fig 7- P-control mode of Governor

which monitors the modes of different Generators automatically forces it to droop mode.

The different modes of GTG/STG AVR is explained below:

AVR Droop Mode or Manual Mode:

In this case the Field AVR mode and the PMS modes are Droop. In this Droop mode the Operator is presented with Manual Raise/Lower commands for the AVR. The operator can issue either Fast Raise/Slow Raise commands. Fast Raise commands have longer pulse width durations. Slow Raise commands have smaller pulse width durations. Similarly the Operator can issue Fast lower/Slow Lower commands. The pulse width for the Raise/Lower commands can be adjusted by engineer with appropriate rights.

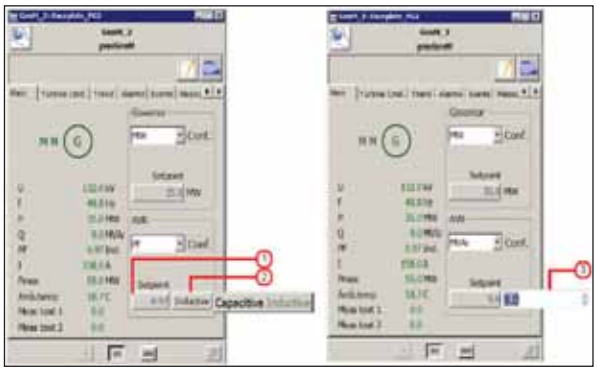
AVR MVAr Mode or Semi Auto mode:

In this case the Field AVR mode is Droop and the Mode at PMS level is MVAr mode. In MVAr Mode the Operator is presented with a MVAr setpoint entry window, where he can enter the desired MVAr setpoint for the AVR. Then the Generator module gives raise/lower pulse to the AVR to bring the Working point of the AVR within the dead band close to the Setpoint. The raise/lower Commands Pulse width is controlled by the Generator module depending on the difference between the working point and the setpoints. The pulse width is directly proportional to the difference in the Setpoint & working point value. However the Length of the Maximum pulse, the Step up & Step down Ramp rates & Slope rates for the Setpoints are controllable/tunable by the Engineer with Appropriate rights.

AVR PF Mode or Semi Auto mode:

In this case the Field AVR mode is Droop and the Mode at PMS level is PF mode. In PF Mode the Operator is presented with a PF setpoint entry window, where he can enter the desired PF setpoint for the AVR. Then the Generator module gives raise/lower pulse to the AVR to bring the Working point of the AVR within the deadband close to the Setpoint. The raise/lower Commands Pulse width is controlled by the Generator module depending on the difference between the working point and the setpoints. The pulse width is directly proportional to the difference in the Setpoint & working point value. The pulse tuning parameters are common for both MVAr mode & PF mode.

The below snapshots Fig 8 shows how the Faceplates displays/covers the explained functionalities for MVAr & PF Mode:



Field	Indication	Configuration method	Description
1	PF	Numerical input field	When PF mode is active, the desired setpoint value for the reactive power can be entered.
2	PF	Push button	Button for selecting Capacitive/Inductive side
3	MVAr	Numerical input field	When MVAr mode is active, the desired setpoint value for the reactive power can be entered.

Fig 8-Faceplate displays of AVR PF and MVAr modes

AVR Q-Control or Auto Mode:

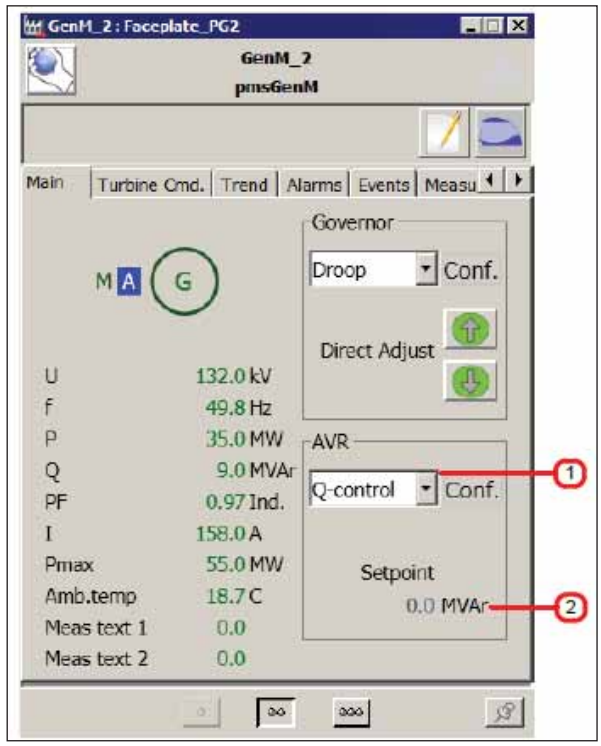
In this case the Field AVR mode is Droop and the Mode at PMS level is Auto mode/Q-Control Mode. The Auto Mode is a supervisory mode for the Generator module. In this mode the Generator module gets setpoint from the Supervisory Q-Control (Reactive Power Control) module. The Q-Control monitors the electrical network and accordingly distributes the Setpoints to the Generators automatically based on capability. The Generator module gives raise/lower pulse to the AVR to bring the Working point of the Governor within the dead band close to the Auto setpoint. The raise/lower Commands Pulse width is controlled by the Generator module depending on the difference between the working point and the setpoint. The pulse tuning parameters are common for both MVAr mode & PF mode.

AVR Voltage Mode

In this case the Field Governor mode is in Voltage mode and the mode at PMS level is also Voltage mode. In this mode there is no control action from PMS. The PMS simply monitors the Generators Working points. The Voltage machine takes corrective control action to maintain the plant at desired setpoint voltage. This control action is done by the Primary control system supplied by the corresponding STG/GTG Vendors.

The ABB PMS allows only one machine to be in Voltage mode per electrical network. If a second Voltage mode machine is brought in the electrical network, the Central Mode manager which monitors the modes of different Generators automatically forces it to droop mode.

The Optimize mode, both for the governor and the AVR, is for future use and function is not presently available in the current version of PMS library.



Field	Indication	Configuration method	Description
1	Q-control	Drop-down menu	AVR mode Q-control
2	Q-control	Numerical field	Setpoint value received from Reactive Power Control function

Fig 9- Faceplate display for AVR Q-Control Mode

A4 Participation factors

Active Power Control or P-Control : The participation factor determines how much each GTG/STG will contribute to (or participate) in the power control scheme. It is a percentage (%) of the total active power demand calculated by P-Control in order to bring the control variable (i.e. Grid import or Bus Frequency) within the deadband of the reference setpoint. The P-Control automatically calculates the participation factors based on the available control margins of the participating GTGs/STGs, with Governor acting in Auto mode. The control margins are defined according to the P/Q capability characteristics of the turbine generator. The participation factor depends on the control direction. If the control direction is positive (e.g. when the frequency is lower than the setpoint) the calculation is based on the positive control margins; if the control direction is negative (e.g. when the frequency is higher than the setpoint) the calculation is based on the negative control margins.

Reactive Power Control or Q-Control : The participation factor determines how much each GTG will contribute to (or participate in) the power control scheme. It is a percentage (%) of the total reactive power demand calculated by Q-Control in order to bring the control variable (i.e. Grid MVAr import or Bus Voltage) within

the dead band of the reference set point. The Q-Control automatically calculates the participation factors based on the available control margins of the participating GTGs, with AVR acting in Auto mode. The control margins are defined according to the P/Q capability characteristics of the turbine generator. The participation factor depends on the control direction. If the control direction is positive (e.g. when the voltage is lower than the setpoint) the calculation is based on the positive control margins; if the control direction is negative (e.g. when the voltage is higher than the setpoint) the calculation is based on the negative control margins.

A.5: Capability Diagram

The capability margin characteristics of the generator are presented in a dynamic diagram, which shows the operational envelope and the working point (i.e. active and reactive power) of the turbine-generator.

In the Capability diagram Fig. 10c, the "+" symbol refers to the current Working of the Machine. The "O" or Circle symbol refers to the Set point of the Generator.

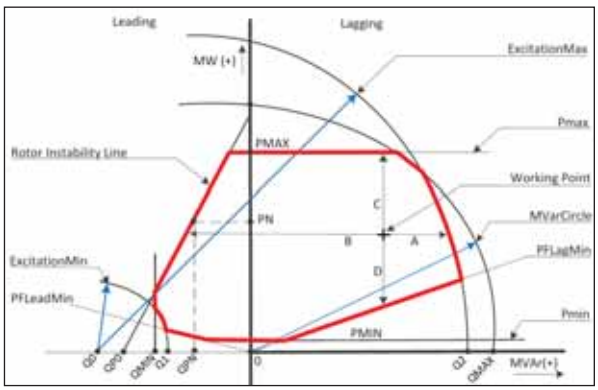


Fig 10a- Typical Capability Diagram

PARAMETERS OF GENERATOR CAPABILITY DIAGRAMS						
			GTG		STG	
Name	Description	Remark	VALUE	UNITS	VALUE	UNITS
PMAX	Max. Pushing Power	Turbine limit	20.5	MW	33 (class F is used)	MW
PN	Nominal Active Power		14.25.5	MW	32 (class B is used)	MW
PMIN	Minimum Operating Power		0.3	MW	3 (for generator, PMIN for turbine is unknown)	MW
PFLagMIN	Minimum Power factor Lagging	Minimum Inductive Powerfactor	0.25		+0,85 (at PN, class B is used) +0,85 (at PMAX, class F is used)	-
PFLeadMIN	Minimum Power factor Leading	Minimum Capacitive Powerfactor	0.25		-0,949 (at PN)	-
QMIN	Minimum Reactive Power Leading		10.6	Mvar	-15,20 (at 0 MW)	Mvar
QMAX	Maximum Reactive Power Lagging	Stator heating limit	21	Mvar	+19,63 (at PN, using class B) +21,82 (at PMAX, using class F) +29,24 (at 0 MW, using class B) +32,66 (at 0 MW, using class F)	Mvar
QPN	Minimum Reactive Power at PN	Stability limit	6.7	Mvar	-13,71	Mvar
QP0	Fictive Reactive Power at 0 MW	Stability limit	11	Mvar	-16,00	Mvar
Q0	Fictive Center for Excitation Radius		14	Mvar	21,87	Mvar
Q1	Minimum Excitation at 0 MW		13	Mvar	11	A
Q2	Maximum Excitation at 0 MW	Rotor heating limit	23.7	Mvar	30,1 (using class B) 37,9 (using class F)	A

Fig 10b-Typical values of the parameters for a sample plant

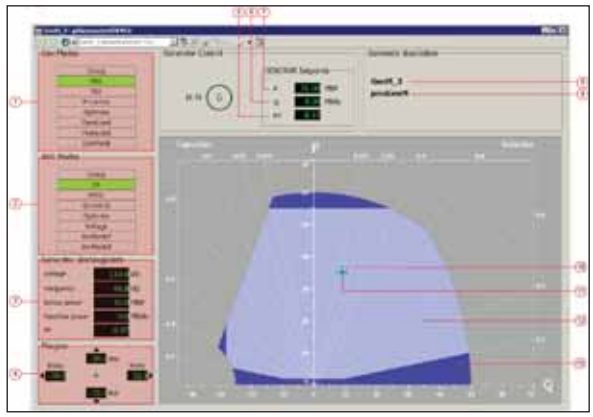


Fig 10 c- Programmed Capability Diagram

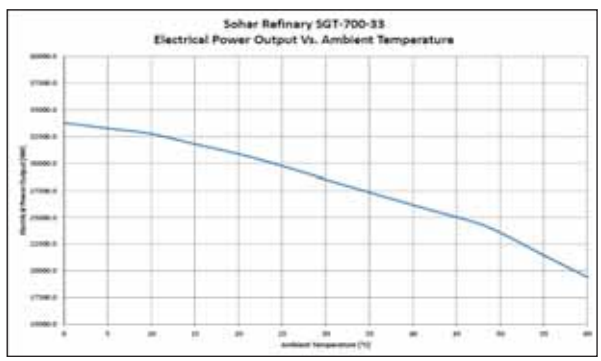
Field	Indication	Configuration method	Description
1	Gov Mode	Text indication	Governor mode of operation
2	AVR Mode	Text indication	AVR mode of operation
3	Working point	Numerical field	Main measurements
4	Margins	Numerical field	Margin values A, B, C, D from boundaries, ref. Fig. 2-31
5	Setpoint: PF	Numerical field	Setpoint value for power factor
6	Setpoint: Q	Numerical field	Setpoint value for reactive power
7	Setpoint: P	Numerical field	Setpoint value for active power
8	Generator: Tag	Text indication	Tag name of Generator module
9	Generator: Description	Text indication	Description of Generator module
10	Blue circle	Graphic diagram symbol	Indication of setpoint
11	Green cross	Graphic diagram symbol	Indication of working point
12	Light blue area	Graphic diagram area	Operational envelope
13	Dark blue area	Graphic diagram area	Area outside the operational envelope

Fig 10d-Referenced Table for Capability Diagram

A.6 Generator Derating and Degradation Curves

The rating of the Gas Turbine Generator (GTG) is normally guaranteed by the Generator Vendor at a rated ambient temperature. As the ambient temperature changes, the output of the GTG changes. The change can be captured in the form of a derating curve (Fig 11) which gives the GTG output vs the temperature. This curve can be solicited from vendor for given operating parameters. The derating curve can be defined with a polynomial fit and fed into the PMS.

In addition, Gas Turbine power output gets degraded with the no of hours of operation (state of cleanliness of the combustion equipment and power turbine blades). The typical nominal degradation curves for a GTG with Gaseous Fuel and Oil fuel are as shown below in Fig 12:



Operational conditions		
Inlet duct pressure loss	5	mbar
Outlet duct pressure loss	25	mbar
Ambient pressure	1.028	Bar(a)
Relative humidity	30	%
Fuel LHV	44332	kJ/kg
Load	100	%
Generator frequency	50	Hz
Power factor	0.85	-
Exhaust temp. Limit	570	°C

Fig 11-Derating Curve for Gas Turbine Generator

The PMS can be programmed to compute the de-rated and degraded power output of any running generator in the system and subsequently arrive at the spinning reserve (of the generator in question) which is available at that instant of operation. The degradation curves Fig 12 as shown below will be readily available from the Generator vendor for different fuel type and one can define a polynomial fit for the piecewise curves and program same in the PMS. Alternatively (better method) the Generator vendor can be solicited to provide spinning reserve (Generator de-rated and degraded output minus the current active load on the generator) at any instant of operation, ambient temperature and degradation status, from the Generator Unit Control Panel, as a 4-20mA Hardwired signal to PMS.

Maximum permissible generation = Derating Factor X Degradation Factor X Maximum Rated Output at design ambient temperature.

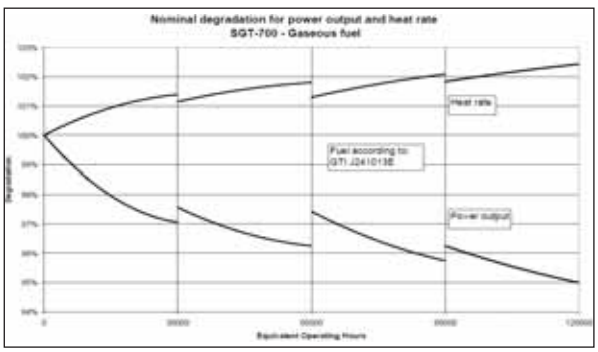


Fig 12a-Degradation curves for Gaseous Fuel

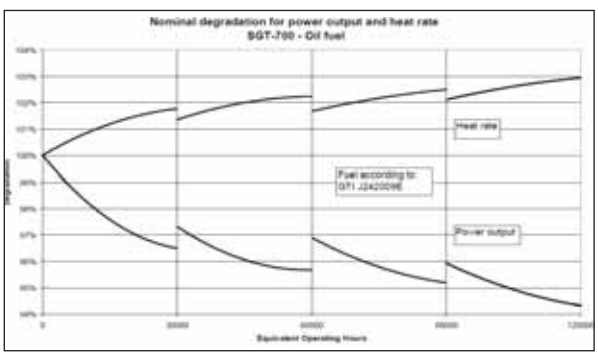


Fig 12b-Degradation curves for Oil Fuel

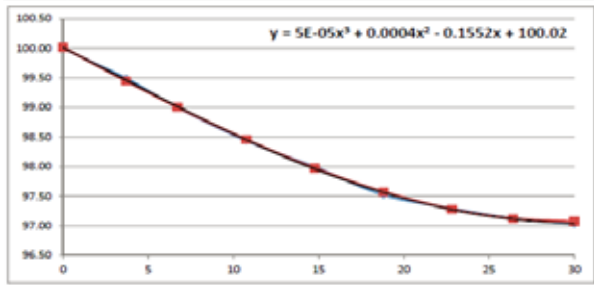
Data is based on assumption that the compressor is clean and that the unit has operated in accordance with Operation & Maintenance manuals. The GT is operated mainly on Base load.

The overhauls are assumed to consist of:

Equivalent Operating Hours	Level	Activities
30 000	B-overhaul	Replacement of vane stage 1 and 2 Replacement of blade stage 1 and 2 Heat shields replaced on condition
60 000	C-overhaul	Compressor cleaned Replacement of vane stage 1 and 2 Replacement of blade stage 1 and 2 Heat shields replaced on condition
90 000	B-overhaul	Replacement of vane stage 1 and 2 Replacement of blade stage 1 and 2 Heat shields replaced on condition

First 30000 hrs

Equivalent Fired Hours in thousands:	Degradation in % from Vendor Supplied Curve	Degradation in % from Polynomial Equation	% Error
0	100.00	100.02	0.0200
3.700	99.50	99.45	-0.0465
6.720	99.00	99.01	0.0104
10.750	98.44	98.46	0.0228
14.776	98.00	97.98	-0.0251
18.806	97.52	97.58	0.0567
22.835	97.30	97.28	-0.0155
26.418	97.13	97.12	-0.0042
30	97.03	97.07	0.0453



SGT-700 Natural gas as fuel

Fig 13- Excel Polynomial fit of the generator degradation curves which can be programmed in the PMS.

It will be worthwhile to pause here and deliberate on spinning reserve. Classically, Spinning Reserve = Maximum permissible generation – current active load.

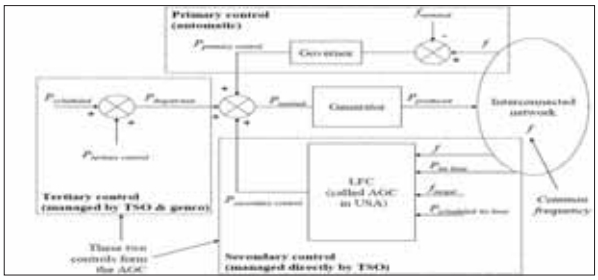
A more apt definition of spinning reserve can be had as follows: "The spinning reserve is the unused capacity which can be activated on decision of the system operator and which is provided by devices that are synchronized to the network and able to affect the active power"

Primary control: local automatic control which delivers reserve power in opposition to any frequency change;

Secondary control: centralized automatic control which delivers reserve power in order to bring back the frequency and the interchange programs to their target values;

Tertiary control: manual change in the dispatching and unit commitment in order to restore the secondary control reserve, to manage eventual congestions, and to bring back the frequency and the interchange programs to their target if the secondary control reserve is not sufficient.

A pictographic representation is as given below. In theory, a generating unit could participate in all three levels of control (Primary, Secondary and Tertiary), however spinning reserve would include only secondary and tertiary control reserves as shown below.



TSO- Transmission system operator

Fig 14-Types of control for a typical generating unit

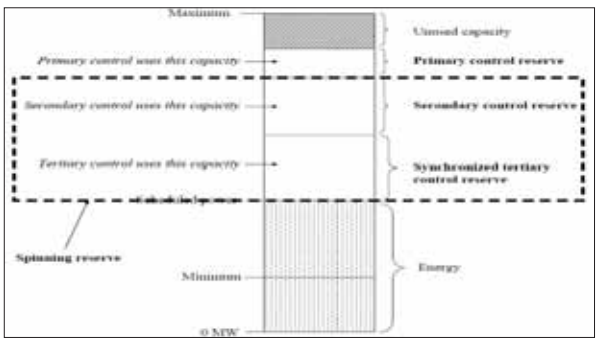


Fig 15 -Representation of the spinning reserve of a generating unit that participates in all three levels of frequency control

For Turbine driven Generators there is an additional handicap - Allowable sudden load change. The turbines can accept a comparatively small % sudden load change at any instant (see Fig 16 below). For the Gas generators studied, the allowable sudden load change is plotted vs the Gas Turbine Generator load in %. As can be seen at a loading of 70% or so and above, the sudden loading is about 1 MW for ISO rating and design ambient rating (43 deg C). The sudden loading is considered nil for steam generators (steam in the steam chest supplying remaining steam generators cannot change suddenly).

So, when a running generator trips, there is a frequency dip in the system where the remaining generators are required to take up the load of the tripped generator instantly. Since the generators cannot be ramped up instantly (except to their sudden load change limits), the frequency of the system dips. If there is ample spinning reserve in the system, then normally contingency based load shedding will not be triggered, on the other hand if spinning reserve is not adequate, the load corresponding to the additional spinning reserve required will be automatically calculated and tripped priority wise by the PMS. The operator is expected to ramp up the remaining generators to their new set points using the tools available in the PMS. ■

Stephen R. Fernandes
Petrofac Engineering India Pvt. Ltd.

The world has been rocked by a radically new technology whose potential and pace of adoption has surprised even the harshest of critiques. Every industry is gearing up to adopt it in one way or another. **Blockchain** technology launched after the US financial crisis of 2007-08, that led to the global recession, broke into public consciousness in 2012-13 with its iconic application – Bitcoin, a cryptocurrency whose jaw-dropping rise both puzzled and intrigued the general population. Ardent support led to its fierce but volatile rise. Since its inception, this esoteric cryptocurrency continues to reshape the global financial markets. Blockchain, the less-understood albeit foundational technology powering Bitcoin, is the real technological game changer, an innovation in some ways as radical as the Internet itself. It provides an opportunity to reshape the Digital economy, empower consumers and secure the digital world. It's worth emphasizing that Blockchain and Bitcoin are not the same. Blockchain is a technology, where as Bitcoin is an application based upon Blockchain. From the early days of powering Bitcoin, Blockchain has come a long way in becoming the foundational technology for many type of transaction that may or may not require a crypto currency. Non-crypto currency applications infect are the real game changers for the Power industry.

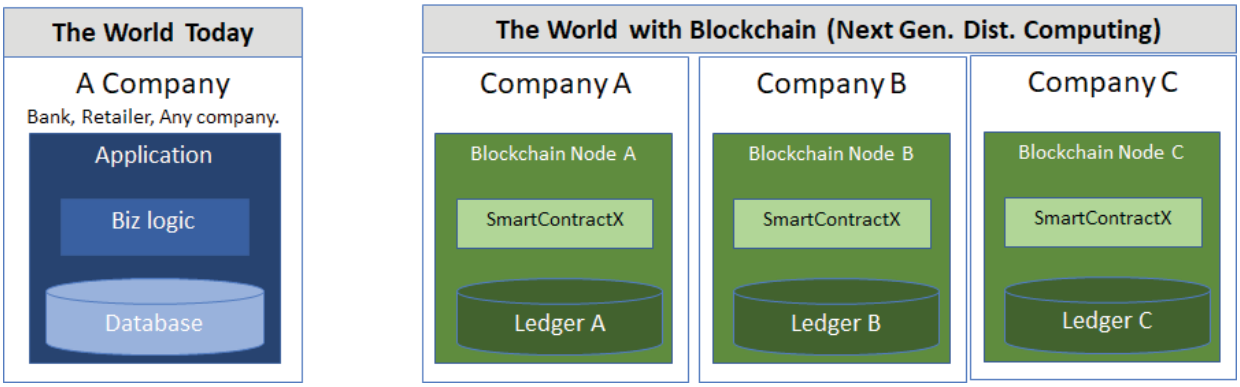
Blockchain's Impact For Power Industry

Early indicators from implementations of Blockchain in the United States, Europe and Australia in the power sector suggest that Blockchain can radically simplify energy transactions, reduce overhead costs and improve operational efficiency. The technology fundamentally decentralizes and democratizes execution of any transactions in an environment that may not be pre-ordained for trust. It can reduce latency, reduce operational cost and eliminate dependency on intermediaries. The core innovations of Blockchain are coincidentally a perfect enabler for energy transactions because without Blockchain the solutions are uneconomical and unsustainable whereas with Blockchain, the transactions can be economized and expedited with near real-time controls. Blockchain technology's core innovation is its distributed ledger, "trustless" protocol and consensus-driven capabilities (described below) that can track almost any asset, rewire any transaction and reduce dependency on traditional intermediaries.

Broadly speaking, Blockchain can impact all aspects of Power digitization initiatives while fostering the development of new business models and revenue streams. It can accelerate integration of renewables, reduce operational inefficiencies, eliminate transactional latency, improve cybersecurity and reduce cost. It can track assets, improve measurement & verification, enhance power quality and improve supply chain management. It can also accelerate adoption of national programs such as Perform, Achieve and Trade (PAT) Schemes for energy efficiency and balancing of the supply and demand and trading of Energy Saving Certificates (ESCerts). Blockchain can impact almost every aspect of Power generation, transmission, delivery and consumption.

What Is So Different About Blockchain?

Today's Information Technology is based upon a simple paradigm where a company or an organization



controls operation of a computer application. As shown in Figure 1, any organization such as a bank, an Insurance company, a retailer, an airline, a telecom company, a social media company or any company that uses computer systems, is responsible for running the application and managing its data. This company is solely responsible for operating this application as its control is centralized with the company, and the company has exclusive responsibility of the application and its data. With Blockchain, the paradigm changes. Rather than a single company being responsible for the control or functioning of the application and its data, the responsibility is split between two or more companies or nodes – this is by design. This "decentralization" when combined with a "democratize" approach to executing business logic on the data is the real game changer. Unlike traditional computing paradigms, Blockchain provides a new approach for computer applications where decentralization and democratization are at the core of its functioning. These fundamental changes can empower customers unlike ever before, facilitate new transactions economically, enable unprecedented cyber-security capability and deliver trust guarantee for all participants.

How Does Blockchain Work Compared to Today's Computing Solutions?

Three key innovations of Blockchain – namely Consensus, Smart Contract and Distributed Ledger are the basis for the new computing paradigm that provides a game changing opportunity. First, a *Distributed Ledger* is a "distributed" database that is resident across all participating nodes. This distribution of databases or ledgers is unlike conventional replicated database systems, because in a Blockchain based application each node performs independent verification of each transaction prior to accepting the data. Hence each copy of this distributed ledger is independently verified and validated copy of data. This process provides autonomy to each node while operating within the controls established by all participants. This governance model ensure that each node even while working independently, must also produce the same results. This guarantees that each node, although independent, works within the rules established by the collective thereby guaranteeing that a single node cannot monopolize the data even while working independently. Second, a *Smart Contract* – which is the business logic for the application, is replicated across each node allowing each node to operate on the data – again independently. This means that operations on the data are decentralized as the control is no longer resident with a single node or with a single company. Third, *Consensus*, a key innovation of Blockchain is the process via which, an actor such as a Data mining company, validates the data based upon the business logic and creates valid and trustworthy blocks of data. Each block of data may have one or more transactions. Once a block is created, it is chained with a previous block. Over time, each block is part of a long chain of connected blocks and a Blockchain emerges. It is important to mention that the actor who is responsible for Consensus building i.e. one who creates a block, is nominated and selected based upon a decentralized control model as well. In traditional computing paradigm, the actor who controls the business logic and operates on the data, is the company that holds the data such as the airline, the retailer, or the insurance company etc. With Blockchain, the actor may be (though not necessarily) an external organization that is democratically selected via a Consensus driven processes known as Proof of Work, Proof of Stake, Proof of Authority and few other techniques. A Consensus driven process results in identification of a leader who is then nominated to act as the creator of a Block. The creator of the Block associates its private signature (private key) to the Block thereby eliminating the possibility for any one else to alter the data (intentionally or unintentionally). Once created, the Block is immutable. This immutability is a key attribute of Blockchain that establishes verifiable trust through traceability. It is important to note that a Blockchain can be a private blockchain or a public blockchain. A public blockchain is open to any qualified party and the consensus is typically offered with the consensus protocol commonly known as "Proof of Work". In a private Blockchain, the consensus is established via a smaller subset of Consensus builders commonly

known as "Proof of Stake" and "Proof of Authority". The Private Blockchain is a good way for Power companies to embrace Blockchain as it provides more control to Utilities, consumes less electricity and does not allow open access to any party.

Blockchain For Power Equipment Manufacturers

Most of the Power equipment manufacturers and their customers have a lot to gain with Blockchain. At the very least, Blockchain, like the Internet is about to become ubiquitous. Like the internet your solutions will need to support Blockchain or at a minimum your solutions will need to operate on a Blockchain. Either way, Blockchain will be an enabler that will enable equipment manufacturers to deliver more capabilities and more functionality, at a reduced cost and optimized cost. Here are 18 use cases where Blockchain can be applied by Power equipment manufacturers:

1 Improve Internal Operations – Use Blockchain to improve supply chain, track parts and assets, and streamlining industrial processes.

2 Improve Quality Control and Independent Measurement & Verification – Provide a verifiable and auditable log of test data related to quality and to provide transparency to customers and regulators about quality of equipment and test results.

3 End to end Parts Traceability – For guaranteeing customers that you are using authentic parts by creating a digital ID that authenticates and document the origin of parts.

4 Reduce Liability issues – Issues related to moving parts and components from one place to another can be reduced. Any tampering, damage and lost parts can eb avoided.

5 Deliver chain of Custody – Provide tamper proof chain of custody.

6 Ensure Compliance — Provide complete records for auditing and regulatory compliance purposes.

7 Manage 360 degrees Asset Life-cycle management – Enable your customers (Utilities etc), to manage, track and govern the overall lifecycle of assets.

8 Improved Customer Service with Condition based asset management.

9 Perform proactive asset management – with reduced downtime by ordering replacement parts prior to failure.

10 Smart Grid and Power Digitization – Leverage data produced by AMI/AMR Smart Metering to deliver next generation of customer services including improved Outage Management and reduce aggregated technical and commercial (AT&C) losses.

11 Transactive Energy – Integrate Wholesale market with Distribution Utilities to deliver customers with calibrated price signals so customers can optimize their energy consumption and get more choices.

12 Energy Conservation – Improve Energy conservation measures that improve energy efficiency in buildings and commercial customers including ensuring that there is traceability and verification of adherence to energy conservation building codes.

13 Harness the data – Unlock the data produced by millions and billions of IoT devices.

14 Solve Tech Challenges – With the emergence of IoT devices, Analytics, AI, Robotics, and upcoming 5G, there is an opportunity to leverage Blockchain in integrating these technologies across a single platform that becomes the basis for next generation of services and solutions.

15 Prosumers and DER Integration – Enable the next generation of prosumers who are both producers and consumers of electricity. Facilitate the integration of DERs on demand.

16 Provide behind the meter visibility to Utilities who are traditionally 'blind' to behind the meter equipment.

17 Connected Home – Blockchain can be used to integrate the connected home with the main grid. This integration will complete the loop with an otherwise disconnected consumer and their home.

18 Energy Management – Blockchain can be used to manage energy data, for benchmarking and for compliance reporting.

Conclusion

The question is not whether Power equipment makers will need Blockchain or not, but rather when will it be appropriate for equipment makers to leverage Blockchain. Utilities are starting to leverage Blockchain based solutions from small vendors. To harness Blockchain, Utilities and Power equipment manufacturers will need to plan, prepare, and harness this new technology in incremental steps, so that it provides meaningful value and serves their broader mission.

About Energy Blockchain Consortium

Energy Blockchain Consortium (EBC or The Consortium) is a global organization that is head quartered in Fort Lauderdale, Florida, United States. EBC is a *non-profit* consortium of companies in the Energy industry, interested in using Blockchain technology in a meaningful and reliable manner to solve industry's most compelling problems and address new opportunities. ■

Sudhir (Tony) Giroti

(*Master's in Electrical & Computer Engineering, University of Massachusetts and Bachelor of Engineering in Electrical Engineering, Delhi College of Engineering*)

Chairman, Energy Blockchain Consortium

INDIAN STANDARDS
BIS

BIS Young Professionals' Programme

The Fourth BIS Young Professionals programme was organized on 18-19 March 2019 in Pune. The workshop was organized in line with IEC Young Professional program. The objective of the programme is to help Young Professionals (YPs) in the electro-technical industry of India to appreciate the importance of standards and to encourage them to participate in National and International Standardization at the start of their careers.

The workshop was inaugurated by Dr. R K Bajaj, DDG (Standardization), BIS who introduced the program, dedicating it to the next generation of Standardizers for providing them an opportunity to be aware of the national & international standardization processes and to appreciate how to maximize benefits from being involved in standardization. Mr Dennis Chew, Regional Director, International Electro-technical Commision (IEC), Asia Pacific Regional Centre, participated as the speaker on International Standardization in the field of Electro-technical Sector. Experience sharing by IEC YPs, Mr Vivek Arora from IEEMA and Mr Hem Thukral from EY was well appreciated by upcoming YPs. Mr Rajeev Sharma, Head ETD and Mr J R Chowdhury from BIS also attended the program and share their experiences.

The programme was a big success and was attended by about 60 Young professional from different Electro-technical Industries. It is expected that the workshop would create interest of the young professionals in standardization and would result in enhancing their participation in standards development, thereby creating a stronger standards ecosystem in the country. More YP programs are planned around the country in coming days.

ELECRAMA
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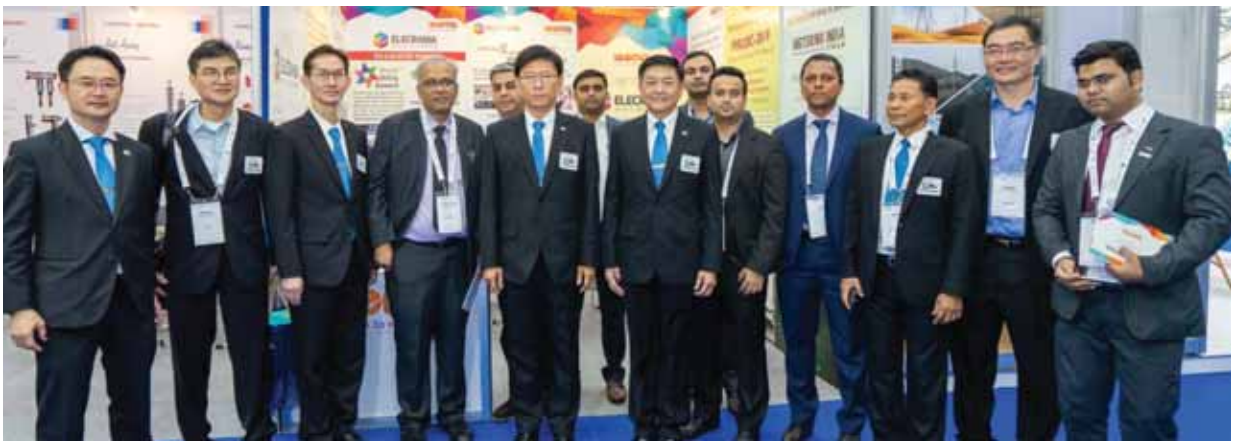
IEEMA's participation at IEEE-PES GTD Asia 2019



Governor of EGAT, Electricity Generating Authority of Thailand, Provincial Electricity Authority, Thailand and Metropolitan Electricity Authority, Thailand with President IEEMA and other IEEMA members at IEEMA Stall.

Aligning with Hon'ble Minister of Commerce Shri Suresh Prabhu's vision to boost Indian exports and exploring new markets globally, IEEMA has taken various initiative to expose the membership with new overseas market and new opportunities.

These initiatives include taking business delegations to numerous business destinations across the globe. These markets are identified by the membership as potential market i.e. Thailand, Cambodia, Lao PDR, Indonesia, Brazil, Bangladesh, Africa etc, and Participating in the overseas exhibition as IEEMA-Indian Pavilion which exposes IEEMA membership to large number of buyers and stakeholders.

These initiatives, as the feedback received from membership, has surely helped the IEEMA members to identify the potential buyers, partners etc to multiply their business.

Given the energy demand and the development plan of the Thailand, the country has been identified as the potential market for IEEMA members and on the initiative of President IEEMA Mr. Harish Agarwal, IEEMA has taken 2 business delegation in Thailand in the year 2018 and taking the initiative forward it was decided to participate in IEEE PES GTD Asia 2019 as IEEMA India pavilion and take IEEMA's engagement in the region to next level.

The IEEE-PES Thailand Chapter had hosted the IEEE-PES GTD Grand International Conference & Exposition Asia 2019 (IEEE-PES GTD Asia 2019) from 19-23 March 2019 in Bangkok, Thailand. This will be the 40th year for "IEEE-PES T&D Conference and Exposition", which is the largest conference and exposition on Power & Energy being held biannually in North America. This was the first time exposition held outside the USA .

IEEMA had actively participated in the exposition and taken a 90 Sqm Pavilion in it. Total 5 companies participated under IEEMA Pavilion.

Apar Industries Ltd, KEC International Limited, Supreme & Co. Yamuna Power & Infrastructure

President IEEMA, Mr. Harish Agarwal extending Invitation of ELECRAMA 2020 to Mr. Boonsak, President Thai Electrical and Mechanical Contractors Association (TEMCA)

Mr. Manoranjan Sahu, Commercial Representative, Embassy of India, Thailand with President IEEMA and Other Participants under IEEMA-India Pavilion.

Limited. CTR Manufacturing Industry was also part of IEEMA pavilion as delegate. The Exposition had more than 400 exhibitors from across the globe, 10000+ Visitors, 24 conference tracks and 300+ International speakers.

The exposition provided an excellent opportunity to IEEMA members to meet and interact global audience and present their products and offerings. Mr. Manoranjan Sahu, Commercial Representative, Embassy of India, Thailand graced the IEEMA pavilion and interacted with the participants.

IEEMA-India Pavilion has some key visitors including the governors of EGAT, Electricity Generating Authority of Thailand, Provincial Electricity Authority, Thailand and Metropolitan Electricity Authority, Thailand.

President IEEMA, Mr. Harish Agarwal extending Invitation of ELECRAMA 2020 to Mr. Sam Hsieh, International Affairs Department, TEEMA, Taiwan

Glimpses

GLOBAL SCENARIO

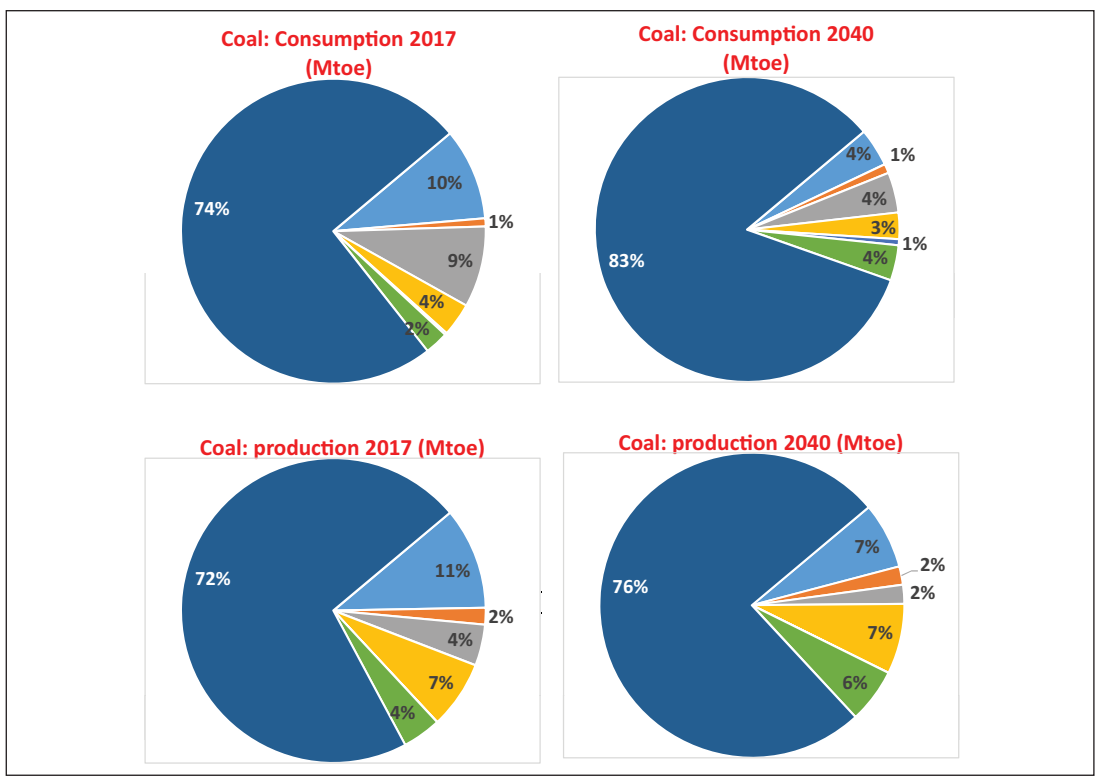
World Coal Consumption Production (Mtoe)

Coal Consumption

Million tones of oil equivalent	1995	2010	2017	2020	2030	2040	1995-2017	2017-2040
North America	512	536	364	330	209	147	-1.5%	-3.9%
S. & Cent. America	19	28	33	33	35	36	2.5%	0.4%
Europe	434	366	321	285	196	155	-1.4%	-3.1%
CIS	149	126	132	125	110	102	-0.6%	-1.1%
Middle East	5	10	8	10	17	23	2.2%	4.5%
Africa	79	100	93	90	105	136	0.7%	1.7%
Asia Pacific	1025	2439	2780	2905	2975	3027	4.6%	0.4%
World	**2224**	**3606**	**3731**	**3779**	**3647**	**3625**	**2.4%**	**-0.1%**

Coal Production

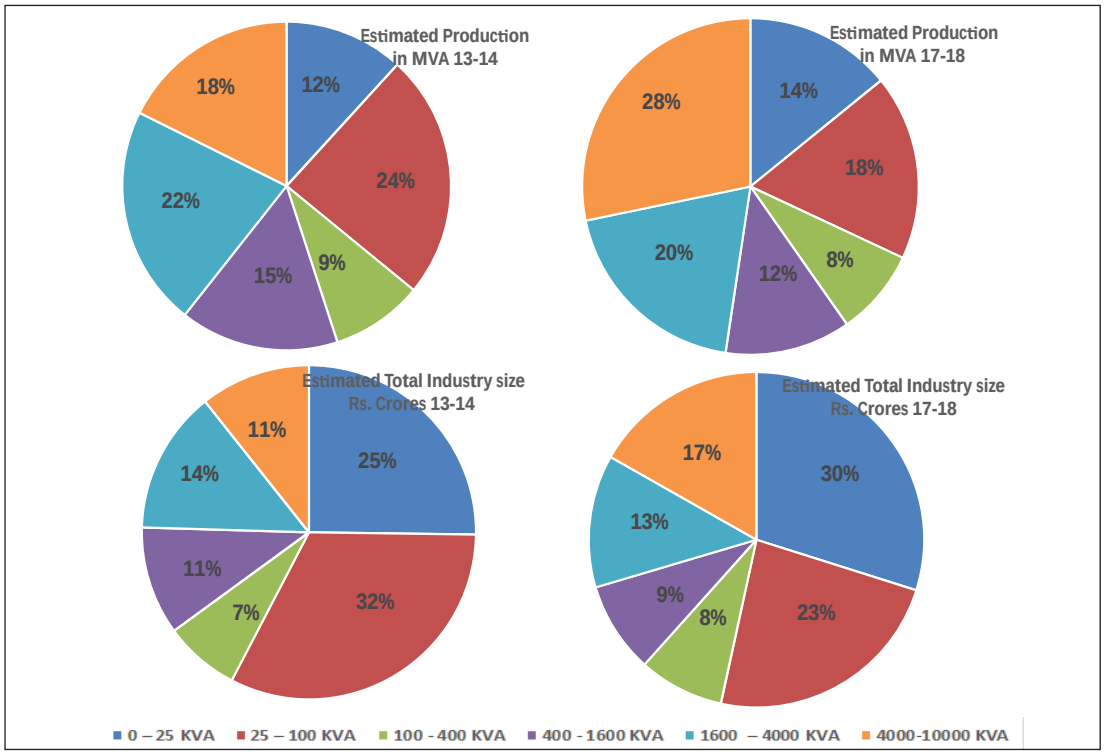
Million tones of oil equivalent	1995	2010	2017	2020	2030	2040	1995-2017	2017-2040
North America	575	566	408	393	333	256	-1.6%	-2.0%
S. & Cent. America	25	56	67	65	69	71	4.7%	0.3%
Europe	303	197	165	143	100	74	-2.7%	-3.4%
CIS	200	232	272	277	275	272	1.4%	0.0%
Middle East	1	1	1	1	1	0	0.5%	-4.0%
Africa	122	147	155	155	173	211	1.1%	1.4%
Asia Pacific	1016	2403	2702	2716	2739	2767	4.6%	0.1%
World	**2240**	**3602**	**3769**	**3751**	**3688**	**3651**	**2.4%**	**-0.1%**

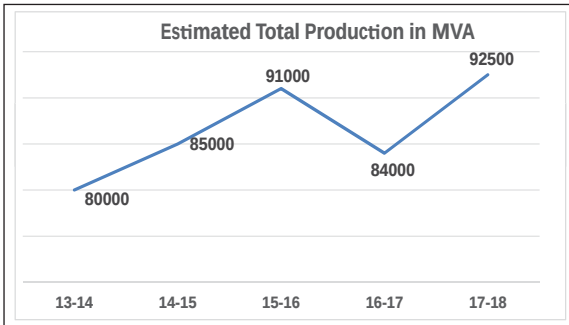


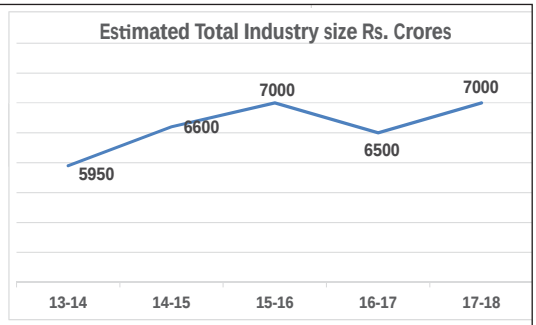
Source: BP

INDIAN SCENARIO

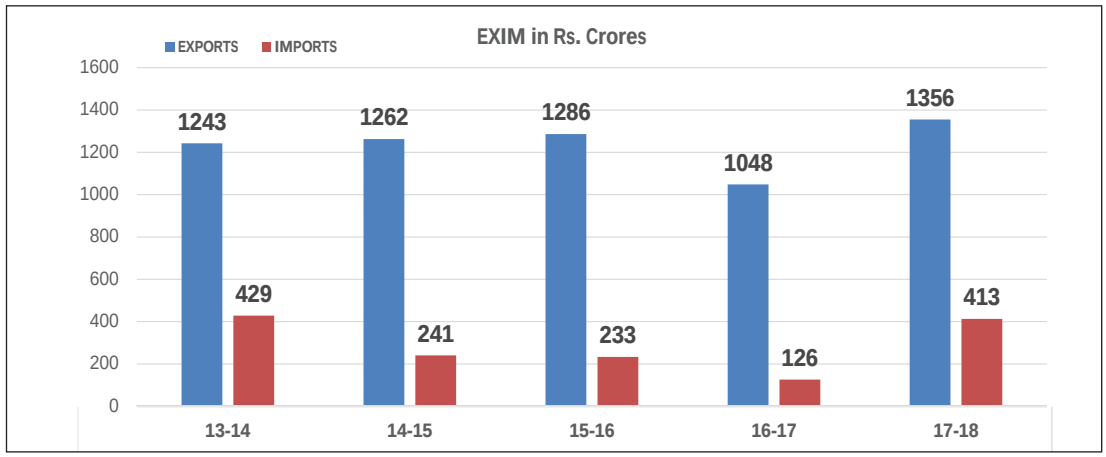
INDIAN DISTRIBUTION TRANSFORMER INDUSTRY







Note: Above data is estimated by IEEMA DT industry experts using market intelligence over IEEMA statistics



Source: Ministry of Commerce

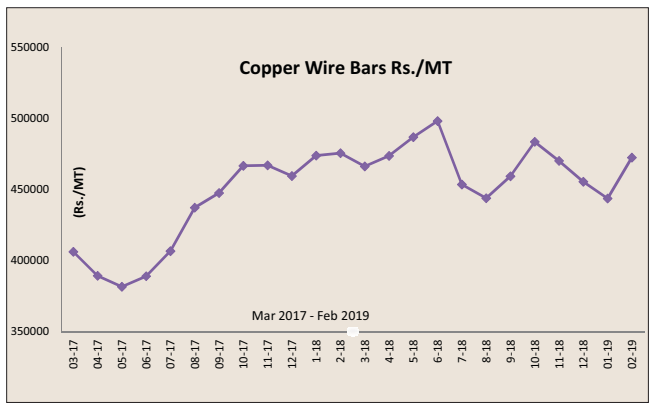
BASIC PRICES & INDICES

BASIC PRICES AND INDEX NUMBERS

	Unit	as on 01.02.19
IRON, STEEL & STEEL PRODUCTS		
BLOOMS(SBLR) 150mmX150mm	`/MT	37422.00
BILLETS(SBIR) 100MM	`/MT	38362.00
CRNGO Electrical Steel Sheets M-45, C-6 (Ex-Rsp)	`/MT	64500.00
CRGO ELECTRICAL STEEL SHEETS		
a) For Transformers of rating up to 10MVA and voltage up to 33 KV	`/MT	259380.00
b) For Transformers of rating above 10MVA or voltage above 33 KV	`/MT	322500.00
NON-FERROUS METALS		
Electrolytic High Grade Zinc -	`/MT	222600.00
Lead (99.97%) -	`/MT	176000.00
Copper Wire Bars	`/MT	472388.00
Copper Wire Rods	`/MT	482023.00
Aluminium Ingots - EC Grade (IS 4026-1987)	`/MT	155286.00
Aluminuium Properzi Rods - EC Grade (IS5484 1978)	`/MT	161236.00
Aluminium Busbar (IS 5082 1998)	`/MT	221900.00

	Unit	as on 01.02.19
OTHER RAW MATERIALS		
Epoxy Resin CT - 5900	`/Kg	500.00
Phenolic Moulding Powder	`/Kg	103.00
PVC Compound - Grade CW - 22	`/MT	134000.00
PVC Compound Grade HR - 11	`/MT	135000.00
Transformer Oil Base Stock (TOBS)	`/ KLitre	66201.00
OTHER IEEMA INDEX NUMBERS		
IN-BUSDUCTS (Base June 2000=100) For The Month December 2018		253.98
IN - BTR - CHRG (Base June 2000=100)		347.86
IN - WT (Base June 2000=100		255.31
Wholesale price index number for 'Insulators' (Base 2011-12 = 100) for the month Dec. 2018		113.80
Wholesale price index number for 'Manufacture of Basic Metals (Base 2011-12 = 100) for the month December 2018		112.30
Wholesale price index number for' Fuel & Power (Base 2011-12 = 100) for the month December 2018		102.80
All India Average Consumer Price Index Number For Industrial Workers (Base 2001=100) December 2018		301.00

Estimated, NA: Not available



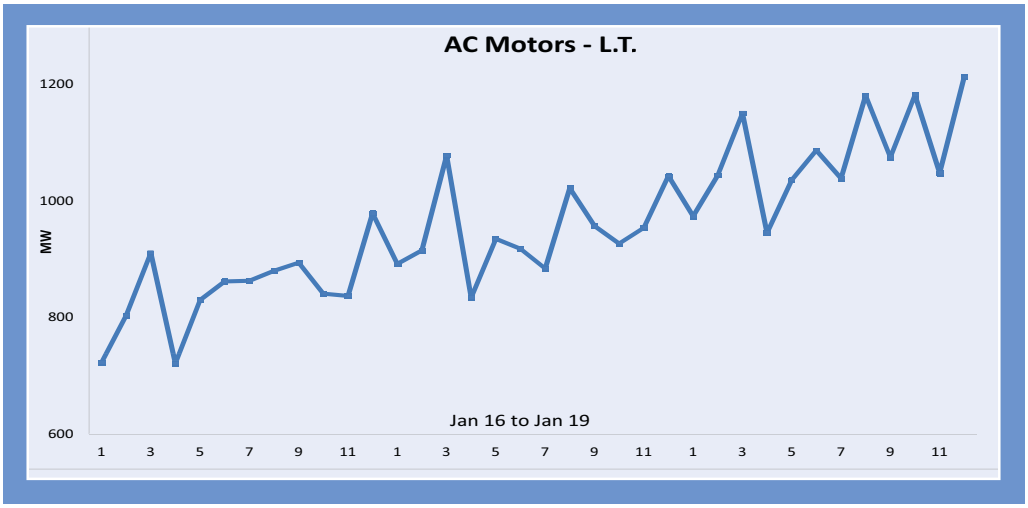
The basic prices and indices are calculated on the basis of raw material prices, exclusive of excise/C.V. duty wherever manufactures are eligible to obtain MODVAT benefit.

These basic prices and indices are for operation of IEEMA's Price Variation Clauses for various products. Basic Price Variation Clauses, explanation of nomenclature can be obtained from IEEMA office.

Every care has been taken to ensure correctness of reported prices and indices. However, no responsibility is assured for correctness. Authenticated prices and indices are separately circulated by IEEMA every month. We recommend using authenticated prices and indices only for claiming price variation.

IEEMA Database

PRODUCTION STATISTICS



Name of Product	Accounting Unit	Production		
		For the Month	From Feb 18 to	Highest Annual
		Jan. 2019	Jan. 2019	Production
Electric Motors*				
AC Motors - LT	000' KW	1208	13227	11686
AC Motors - HT	000' KW	276	3843	5091
DC Motors	000' KW	40	456	618
AC Generators	000' KVA	NA	NA	12766
Switchgears*				
Contactors	000' Nos.	1284	NA	10625
Motor Starters	000' Nos.	233	NA	1986
Switch Disconnector Fuses	Nos.	79938	NA	947878
Miniature Circuit Breakers	000' Poles	14068	NA	166447
Circuit Breakers - LT	Nos.	270806	NA	2736967
Circuit Breakers - HT	Nos.	6107	78579	75732
Custom Built Product	Rs. Lakhs	10548	NA	265267
HRC Fuses & Overload Relays	000' Nos.	1286	NA	16875
Power Cables*	KM	68023	808093	680430
Power Capacitors - LT & HT*	000' KVAR	4497	58932	53417
Transformers				
Distribution Transformers	000' KVA	4651	57817	49608
Power Transformers	000' KVA	14745	227729	234922
Instrument Transformers				
Current Transformers	000' Nos.	95	945	705
Voltage Transformers	Nos.	10180	126562	114488
Energy Meters*	000' Nos.	3652	NA	32761
Transmission Line Towers*	000' MT	94	1109	1250
* Weighted Production				

IEEMA Database

NA – Not Available

INTERNATIONAL NEWS

Artificial Intelligence can spur production of safe, clean fusion energy

Artificial Intelligence (AI) can speed up the development of safe, clean and virtually limitless fusion energy for generating electricity, claim researchers.

A team of scientists at the US Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) and Princeton University are applying deep learning to forecast sudden disruptions that can halt fusion reactions and damage the doughnut-shaped tokamaks that house the reactions.

"This research opens a promising new chapter in the effort to bring unlimited energy to Earth," said Steve Cowley, director of PPPL

"AI is exploding across the sciences and now it's beginning to contribute to the worldwide quest for fusion power," he added in the current issue of Nature magazine.

The deep learning code also opens possible pathways for controlling as well as predicting disruptions.

With AI, "we've accelerated the ability to predict with high accuracy the most dangerous challenge to clean fusion energy," added Bill Tang, a principal research physicist at PPPL.

Unlike traditional software, which carries out prescribed instructions, deep learning learns from its mistakes.

Accomplishing this seeming magic are neural networks, layers of interconnected nodes -- mathematical algorithms -- that are weighted by the programme to shape the desired output.

The next step will be to move from prediction to the control of disruptions.

"Rather than predicting disruptions at the last moment and then mitigating them, we would ideally use future deep learning models to gently steer the plasma away from regions of instability with the goal of avoiding most disruptions in the first place," said collaborator Julian Kates-Harbeck, a physics graduate student at Harvard University.

Lebanese parliament approves plan to restructure electricity

Lebanon's parliament has passed amendments necessary to implement a plan to restructure the country's crumbling electricity sector.

Wednesday's approval was widely expected in the country that has suffered electricity problems since the civil war ended in 1990. Subsidies to the state electricity company cost the government nearly $2 billion a year.

The approval came as hundreds of civil servants protested amid reports that their wages might be cut as part of austerity measures.

The plan aims to secure an additional 1,450 megawatts of temporary power by next year so that total output will reach 3,500 megawatts - enough to provide 24-hour electricity.

On the longer term, the plan calls for power production to be increased by more than 3,000 megawatts over the next six years by building new plants and relying more on renewable energy.

Israel Electric signs General Electric to build gas power unit

State-owned Israel Electric Corp said, it will pay General Electric about 1 billion shekels ($280 million) to build and maintain a new unit at one of its power stations.

Israel Electric (IEC) said it has an option to partner with GE on a second unit as well at the Orot Rabin power station in the coastal city of Hadera.

The new gas-powered units, each with capacity to produce 630 MW of electricity, will replace older units that run on coal.

Israel has pledged to stop producing electricity from coal by 2030, and IEC said it was committed to bring the first new unit online by June 2022, and the second about half a year later.

Sterlite Power inks pact for Pampa project in Brazil

Sterlite Power said it has signed an agreement for Pampa transmission project in Rio Grande do Sul, Brazil, entailing an investment of Rs 1,394.79 crore. "The agreement is for batch 13, won at energy transmission auction held by ANEEL (Brazilian Electricity Regulatory Agency)," Sterlite Power said in a statement.

Completion of the project is expected in March 2023, and signing of the pact represents an important milestone in the company's evolution, it added.

The company however said it will ensure ahead of schedule delivery just like other projects in India.

The project includes construction of three energy transmission lines totalling 316 km, two substations and 1,544 MVA transformation capacity, with annual allowed revenue of 74.72 million Brazilian real (about Rs 133.98 crore) and an investment of 777.8 million Brazilian real (about Rs 1,394.79 crore).

"Given the strong contractual framework, including long concession tenures (30 years) and inflation-protected revenues (which help lower the forex risk), the Brazil market presents us with a clear vision to implement projects in a time bound manner. We hope to replicate our successes in India in Brazil too," said Ved Mani Tiwari, CEO - Global Infrastructure Business, Sterlite Power.

Sterlite Power develops power transmission infrastructure and has projects exceeding 12,500 km in circuits and 20,500 MVA in India and Brazil.

GE Power India bags Rs 142 crore order from NTPC

GE Power India said it has been awarded a Rs 142 crore order by government-owned power utility NTPC for supply and installation of low nitrogen oxide (NOx) combustion system for 10 gigawatts of thermal power plant capacity across the country.

This is the first project awarded on such a large scale by NTPC to install low NOx combustion technology at its thermal power plant fleet.

The project involves in-combustion system modification of the boiler by staging the combustion air in the furnace to reduce the generation of fuel and thermal NOx during the combustion process.

The combustion modification technology can help reduce 30 to 40 per cent of NOx emissions from these coal-fired boilers up to a level of less than 400 mg/Nm3 at 6 per cent oxygen content in flue gas on dry gas basis at induced draft fan outlet.

The low NOx combustion system will be delivered in a phased manner over a period of over 30 months.

"With more than 150 GW of coal-fired plants operating at sub-critical level, India is the world's second largest NOx emitter, contributing close to 30 per cent of annual NOx emissions of the country's industrial sector," said Lalit Sankrani, Clean Combustion Leader at GE South Asia.

"While the industry is slowly waking up to adopt new technologies such as flue gas desulphurisation for curbing SOx emissions from thermal power plants, there is still a journey to be covered as far as addressing NOx emissions are concerned. It is high time de-Nox solutions are also taken seriously to address the emissions compliance needs for the country," he said in a statement.

Earlier in September 2018, GE was selected by NTPC and Tata Chemicals to upgrade two coal-fired boilers in India with low NOx firing system: NTPC's 2 x 490 thermal plant at Dadri in Uttar Pradesh and the 2 x 136 TPH Boiler Tata Chemicals Ltd at Mithapur in Gujarat.

Tanzania eyes 10,000 MW power generation capacity by 2025

Tanzania aims to have six times its current power generation capacity by 2025 through investment in thermal and renewable energy, deputy energy minister Subira Mgalu told parliament. The East African country boasts reserves of over 57 trillion cubic feet (tcf) of natural gas, but faces periodic power shortages.

Investors have long complained that a lack of reliable power hurts business in the country."Implementation of various power generation projects will increase the capacity of our national power grid from 1,602 megawatts presently to 10,000 megawatts by 2025," Mgalu told parliament.

Tanzania has said it plans to export surplus electricity to energy-starved nations in eastern and southern Africa once it has boosted its generation capacity."We need to have abundant and reliable power from an energy mix that includes hydropower, natural gas, solar and wind," Mgalu said.

The government awarded a tender last year to a joint venture of Egyptian companies, El Sewedy Electric Co and Arab Contractors, to build a $3 billion hydroelectric plant at Stiegler's Gorge that will produce 2,100 MW upon completion in three years time. Conservationists oppose construction of the power plant in a world heritage site and an independent study has suggested the cost could rise to up to $9.85 billion

Battery storage, smart grid, efficiency firms raise $210 mn in Q1 2019: Report

Battery storage, smart grid, and energy efficiency firms raised $210 million in the first quarter (Q1) of 2019 globally, according to a recent report by Mercom Capital Group.

This was a decrease from $472 million raised in Q1 2018, global clean energy communications and consulting firm said in its report on funding and mergers & acquisitions (M&A) activity of these sectors.

"Total corporate funding -- including venture capital (VC), debt, and public market financing -- in battery storage came to $130 million in nine deals compared to $110 million in 14 deals in Q4 2018. In a year-over-year (y-o-y) comparison, $299 million was raised in 12 deals in Q1 2018," the report said.

It further added that VC funding, including private equity and corporate venture capital, raised by battery storage firms in Q1 2019 came to $78 million in seven deals, down significantly compared to $299 million raised in 12 deals in Q1 2018 but up quarter-over-quarter compared to $67 million in 11 deals in Q4 2018.

"Utility and oil and gas funds were active investors in battery storage and smart grid companies in Q1 2019, including Tokyo Electric Power, Total Energy Ventures, Chevron Technology Ventures, Centrica, and Shell Ventures," it added.

In Q1 2019, announced debt and public market financing for battery storage technologies increased to $52 million in two deals, compared to $44 million in three deals in Q4 2018, an 18 per cent increase.

"Total corporate funding in smart grid came to $32 million in 16 deals compared to $272 million in 10 deals in Q4 2018. In a y-o-y comparison, $1.3 billion was raised in nine deals in Q1 2018," the report added.

VC funding for smart grid companies decreased in Q1 2019 with $32 million in 15 deals compared to $266 million in nine deals in Q4 2018. In Q1 2018, $75 million was raised in seven deals.

The decrease in funding was largely due to ChargePoint's $240-million deal in the fourth quarter, the firm said.

One million dollars were raised in one debt financing deal in Q1 2019, compared to $6 million raised in one deal in Q4 2018. In a y-o-y comparison, $1.25 billion was raised in two debt financing deals in Q1 2018.

2 more nuclear power plants in India soon, says Department of Atomic Energy chief

India will soon have 12 more nuclear plants soon to improve the power situation and ensure there is a free flow of uninterrupted power supply for both industries and residential use, a statement issued here quoted Secretary of the Department of Atomic Energy (DAE), K N Vyas, as saying.

"Nuclear technology helps in betterment of lives through varied usages and is an irreplaceable source of clean, pollution-free energy," the statement quoted Vyas, who is also the Atomic Energy Commission of India's Chairman, as saying at the 11th International Forum AtomExpo 2019, sponsored by Rosatom State Atomic Energy Corporation, held in Sochi, Russia, recently.

He said the founder of Indian nuclear programme, Homi J. Bhabha, had envisaged that nuclear technology is going to be "very essential" and not just in the power sector but for other societal uses intended for betterment of life.

"We believe that when it comes to clean energy, there is no substitute to nuclear energy as it is sustainable and without interruption, one can have clean energy," the statement said citing the Secretary's remarks.

Citing the record run of Kaiga Nuclear Power Station, he said a small unit of indigenously-developed 220-250MW reaction has completed 962 days of uninterrupted run

at about 99.3 per cent capacity and the amount of electricity it has generated is "tremendous".

Vyas said the first stage of India's indigenous nuclear power programme has now attained maturity with 18 operating Pressurised Heavy Water Reactors (PHWRs).

The AtomExpo was held in Sochi with the the motto this year being 'Nuclear for better life', with over 3,600 participants from 74 countries in attendance, including new ones like Qatar, Bahrain and Nicaragua.

Lenders to power projects invoke IBC norms to keep stressed assets in NCLT

Lenders to power projects will cite one day default clause under Insolvency and Bankruptcy Code (IBC) to defend their action against erring promoters taken to insolvency under the now defunct February 12, 2018 circular of the Reserve Bank of India (RBI).

Sources said promoters of about half a dozen stressed power entities referred to National Company Law Tribunal have approached the bankruptcy court to quash insolvency proceedings against them as it has become non-maintainable following the Supreme Court order declaring the RBI circular ultra vires.

But banker's are confident that stressed assets referred to NCLT will continue to face bankruptcy proceedings as IBC clearly states such referral even if there is one day delay or default by any entity in meeting its loan commitments.

"There is no question that stressed assets referred to NCLT will come out from there following the apex court's ruling. These assets continue to remain stressed and lenders are sure that resolution under IBC framework would work best for all stakeholders," said chairman and managing director of a leading state-owned financial institution asking not to be named.

"If need be, lenders would also file an affidavit with NCLT to continue the bankruptcy proceedings in the case of companies that faced such action over the earlier RBI circular," he added.

Five stressed power producers, including 3,600 MW KSK Mahanadi Power Co. Ltd., 1920 MW Lanco Amarkantak Power Ltd., 600 MW Avantha Power (Jhabua), 1350 MW Rattan India Nashik Power Ltd. (formerly Indiabulls) and 1,350 MW Rattan India Power (Amravati project) are preparing to oppose insolvency proceedings as lenders filed petitions against them as per February 12 RBI circular. The projects owe about Rs 50,000 crore to banks.

Lanco Amarkantak has sought time from the NCLT to submit documents that suggests that Axis Bank had initiated insolvency proceedings against it under the now-defunct RBI circular. KSK Mahanadi and Avantha Power have also cited the apex court order in earlier NCLT hearing. The other projects are also thinking of taking up the matter in the court.

The February 12 RBI circular had also mandated resolution process by lenders even if there was one day delay in repayment by debtors. This stands annulled by Supreme Court.

However, IBC gives powers to any creditor to take a company to NCLT even if there is one day delay in repayments and the outstanding amount is in excess of Rs 1 lakh. As this provision stands, lenders want to maintain bankruptcy proceedings against assets that remain in stress.

Gas-based plants may get to sell power in spot market

The government is considering a proposal to allow gas-based power plants to sell electricity in the spot market under a subsidy scheme.

"We are contemplating if we can work out a mechanism where these gas-based power plants can also sell on power exchanges without depending on the power purchase agreements," a government official said.

The proposed e-RLNG (re-gasified liquefied natural gas) scheme, being drafted by power and oil ministries as per the recommendations of a high-level empowered committee headed by cabinet secretary PK Sinha, is likely to require lesser than earlier projected subsidy due to softened global crude oil prices, the official said.

As per the proposal, the government is considering gas auction mechanism for the electricity generating units by pooling any domestic gas with LNG and subsidising the tariffs to revive about 25,000 mw projects, the official said.

The scheme is proposed to be run for two years beginning the current fiscal. It will be similar to the e-RLNG scheme run between 2015-16 and 2016-17 based on financial support from the Power System Development Fund.

The government had recently allowed power plants to use coal supplied by Coal India Ltd to supply electricity in short-term market. Industry experts said RLNG price is hovering around $8 per mmbtu (metric million British thermal unit).

In the previous rounds, the government had subsidised the tariffs at Rs 5.50 per unit. The ministry, however, this time might stick to Rs 4.24 per unit tariff that was discovered through its PPA auctions last year. Earlier the government was considering pooling ONGC deep sea gas with LNG.

The government had launched an e-RLNG scheme in March 2015. The scheme was discontinued after two bidding rounds after the power ministry received aggressive bids from companies. Power companies have been demanding the government to restart the scheme as about 7,500-mw capacity is completely stranded while the rest is stressed.

CORPORATE NEWS

MERC approves 700 MW PPA between Distribution and Generation Business of Tata Power for the next five years

Maharashtra Electricity Regulatory Commission (MERC) has allowed the Distribution Business of Tata Power, India's largest integrated power utility to have a Power Purchase Arrangement (PPA) with its generation arm for 700 MW to be supplied from its Trombay Thermal and Hydro plants for a period of five years from 1 April 2019 to 31 March 2024.

After the due diligence for ensuring the reliability of supply and cost competitiveness for the Tata consumers in Mumbai, the Hon'ble Commission, in its order on 26th March 2019, approved the arrangement.

'Tata Power has been serving the city of Mumbai for over a century and continues to be committed to supplying the most reliable and competitive power meeting the needs of their consumers" said Mr. Praveer Sinha, CEO & Managing Director, Tata Power.

Earlier in the month of January, 2019, the Hon'ble Commission has approved, the Power Purchase Agreement (PPA) of Tata Power with BEST for 677 MW.

The process of power tie-up was undertaken by the Distribution Business for its consumers for the period of five years starting 1st April 2019. The existing power tie-up was scheduled to expire on 31st March 2019.

This will ensure cheaper power to Mumbai consumers with the added advantage of inexpensive hydro peaking power. This will also ensure continuity of reliable power supply to Mumbai consumers from embedded Tata Power thermal and hydro generating stations.

NTPC Raises US$ 450 million from international markets

NTPC Limited (NTPC), the largest power generating company in India, priced US$ 450 million 5 Year bond offering in the international markets under its USD 6 billion Medium Term Note (MTN) Programme. NTPC's US$ 6 billion MTN Programme was set up in 2006 and this issuance was the tenth offering under the Programme taking the cumulative amount raised under the MTN Programme to US $ 4.30 billion.

Having updated the MTN Programme in December 2018, NTPC was well positioned to take advantage of a supportive primary credit market and conducted comprehensive deal roadshow covering in Singapore, HongKong and London from 21st – 25th March 2019 to reach out to a wide range of fixed income global investors and to appraise them about companies' financials and its future plans. Based on the investors feedback, NTPC launched a USD 450 million senior, unsecured, fixed rate Reg-S 5 year bond transaction with an initial price guidance of Current 5Y US Treasuries yields (CT5) plus 185 bps area on 26th March 2019 (Asia open). The offering was met with strong demand from the investors and the order book reached USD 1 billion within the first hour of deal announcement which further increased to USD 2 billion by noon. The order book attained a peak of USD 3 billion and thereafter the price guidance was revised to CT5+155 bps to CT5+160 bps. The final order book was over US$ 1.80 billion, an oversubscription of nearly 4 times, with orders from more than 100 accounts. The bonds were finally priced at CT5+155 bps with a yield of 3.773% and the coupon was fixed at 3.75% p.a.

In terms of geographical distribution, Asia took the bulk of the subscription at 90%, with supplemental demand of 10% from Europe, Middle East & Africa (EMEA) and offshore US accounts. Distribution by investor type was well diversified as Funds Managers took 69% of the subscription, followed by Banks 22%, Insurance/ Pension 8% and PB/Others 1%.

With a robust portfolio of projects under execution, the Company intends to use the proceeds of the issue to finance its ongoing and new power projects, coal mining projects, acquisition of power plants & renovation and modernization of power stations.

Axis Bank, Mizuho, MUFG, SMBC Nikko and Standard Chartered Bank were the joint lead managers & bookrunners for the offering

L&T Announces a New Strategic Initiative, L&T-Nxt

Larsen & Toubro has announced a new strategic initiative, L&T-Nxt, to define the future of the organization from a fresh perspective. It has been identified as a select initiative in L&T's five-year strategic plan.

"Disruption has become the new order and as we embrace new and frontier technologies, our businesses are leapfrogging into entirely new realms powered by the tremendous benefits of digitalization and analytics," shared Mr. S.N. Subrahmanyan, Chief Executive Office and Managing Director, Larsen & Toubro, referring to the sustained and concerted efforts of the company to embrace digitalization. "We are committing significant investments and talent into this strategic effort and are confident that this will be an enabler for business."

In consonance with the expectations of a new age industry, L&T-Nxt will focus on the areas of Artificial Intelligence, IoT, Virtual Reality, Augmented Reality, Geo□spatial solutions and Cyber Security and leverage the experience that L&T has garnered over the decades.

L&T, through its current construction, EPC and manufacturing businesses, has made one of the largest deployments of IoT, analytics and AI in the industrial sector by converting most operational matters online, finance, human resources, labour, plant, material, etc. into smart, affordable and extremely efficient solutions.

Having reached a critical juncture in its developmental cycle, L&T is training its sights towards accelerating top line and bottom-line growth and, at the same time, expand its potential for value creation by adopting a fresh mind□set and building a new structure ground up.

Mr. J.D. Patil – Senior Executive Vice President (Defence Business) and Member of the Board feels that the era of cyber-physical systems is just beginning. "With the lines between the physical and digital blurring, Industry 4.0 is being founded," he opined. "We see new technology businesses and sunrise enterprises as prime constituents with the latent upside for rapid and substantial value creation."

L&T is ideally placed to capitalize on these huge emerging opportunities with its large palette spanning software□to□hard core engineering, backed by a strong technology base. Capability development in some of these select verticals has been in the works under a long-term strategic plan and L&T's management is focused on incubating and scaling these business, mapping the landscape, formulating the road ahead, and achieving the stated goal with go to market solutions.

Schneider Electric launches new digital ecosystem to drive worldwide economies of scale for IoT solutions

Schneider Electric, the leader of digital transformation in energy management and automation, today announced the launch of Schneider Electric Exchange, the world's first cross-industry open ecosystem dedicated to solving real-world sustainability and efficiency challenges.

Schneider Electric Exchange is empowering a diverse community of solvers to create and scale business solutions and seize new market value. As digitization revolutionizes the way we work and interact, energy fundamentally becomes more distributed. With Schneider Electric Exchange, individuals gain entry to a vast network of technical tools and resources to develop, share, and sell digital and IoT innovations.

"What differentiates Schneider Electric Exchange is that it brings together people across industries and practice areas that share a passion for sustainability and efficiency, enabling collaboration and interaction across ecosystems. While all content, IoT applications, software, datasets, analytics, and tools are available to everyone, we have focused on specific capabilities that fit the needs and expectations of each community," says Hervé Coureil, Chief Digital Officer, Schneider Electric.

Tailored experiences to meet your digital needs

"Digitization continues to revolutionize the way we work and behave. The world can no longer work in independent silos; the need for better integration and collaboration has unearthed new opportunities and solutions. Schneider Electric Exchange brings together a diverse ecosystem of digital innovators and experts, enabling the co-creation of solutions and enriching learning and speed through collective intelligence. Together this digital ecosystem creates, collaborates, and scales business growth," says Cyril Perducat, EVP IoT & Digital Offers, Schneider Electric.

With Schneider Electric Exchange anyone can:

- Reach a larger customer base in otherwise hard-to-reach new markets
- Gain access to a vast library of resources such as APIs, analytics, and data sets to improve digital offers
- Leverage digital tools and expertise to scale solutions and speed up time to market
- Collaborate through a powerful cloud-based platform to share insights and designs, and effectively manage and complete projects

The Minimum Viable Product (MVP) first released in private beta mode in April 2018, then opened to a broader customer base in November. The platform is poised for strong growth and already boosts a global footprint in Europe (35%), APAC (35%), and the Americas (20%).

ERDA's State-of-the-Art Laboratory for Transformers

ERDA's fully automated transformer test facilities are recognized by BIS & NABL for testing of transformers according to IS:1180-2014. The laboratory has been actively engaged in evaluating distribution transformers as per IS:1180 within the framework of the Quality Control Order of 2015 of the Department of Heavy Industries, Govt. of India for mandatory BIS Certification of Distribution Transformers.

Transformers up to 160 MVA, 400 kV Class for Impulse Test, 4 MVA, 33 kV class for short circuit test and up to 2500 kVA, 11 kV to 33 kV for routine tests can be evaluated. In addition, the laboratory also provides a range of field diagnostics and calibration services including site testing of transformers for utilities at Narol (UGVCL) and Jabalpur (MPPKVVCL) and at customer's premises and undertakes research and development projects in relevant areas related to transformers and power systems. Highlights of the transformer laboratory are presented below:

Impulse Test Laboratory

600 kV, 1800 kVA Resonant Test System of Partial Discharge Laboratory

Testing, Evaluation and Calibration

Transformers

- Distribution Transformers
- Power Transformers
- Current Transformers
- Potential Transformers
- Continuously Variable Voltage Auto Transformers
- Dry Type Transformers
- Reactors

Transformer Components

- Paper Covered Copper Conductors
- Paper Covered Aluminium Conductors
- High Voltage Bushings
- Insulators
- CRGO Core Laminations
- Transformer Oil (Routine, DGA, DP & Furan Tests)
- Solid Insulating Materials

Calibration Services

Calibration of CTs and PTs of class 0.05 at laboratory and class 0.1 at site.

Field & Expert Services

- Condition Monitoring by Capacitance and Tan Delta Measurements
- Measurement of No-Load and Load Loss at Site upto 100 MVA, 220 kV
- Harmonic Measurements of Magnetizing Current
- Partial Discharge Measurement
- Failure Analysis
- DIRANA /DOMINO USS (for Paper Moisture Determination)
- Sweep Frequency Response Analysis (SFRA)
- Dielectric Spectroscopy (DIRANA)
- Third Party Testing (220 kV, 100 MVA) using Calibrated Instruments
- Calibration of CTs and PTs
- Testing of CTs and PTs
- Noise Level Measurements
- Online Condition Monitoring by Acoustic Emission Method
- Transformer Oil (New & In-service), Synthetic & Ester Oil
- Dissolved Gas Analysis (DGA) & Furan Analysis
- Degree of Polymerization (DP) of Paper

Research & Development

Major projects executed include:

- Health Index of Power Transformer
- Development of Evolved Hydrogen Gas

Short Circuit Test Laboratory

Power Transformer under Test

Sensor

- Impulse Breakdown Studies on Transformer Oil
- Residual Life Assessment of Transformer
- Heat Transfer Studies on Radiators
- Acoustic Emission Detection Technique for Partial Discharge Detection and Location
- Accelerated Ageing Tests on Distribution Transformers to Assess Insulation Life

Major Infrastructure

- Three Short Circuit Laboratories (120 kA, 570 V (1 No.) and 50 kA, 525 V (2 Nos.)
- Short Circuit Facility for Transformers upto 4 MVA, 33 kV class
- Short Circuit Facility for LT Switchgear upto 50 kA, 1 sec. at 525 V/ 250V
- Routine and Type Testing Facilities for Transformer upto 2500 kVA, 33 kV
- Lightning Impulse Voltage Test Facility upto 1600 kV, 80 kJ for Transformers upto 160 MVA, 100 kV
- Wideband Partial Discharge Bridge and Balance Detector, with shielding room for 245 kV class equipment
- Condition Monitoring by Capacitance and Loss Angle Measurement by Automatic C & Tan Delta Test Instrument
- Type Test Facilities for Potential Transformers upto Class 0.05, 220 kV
- Type Test Facilities for Current Transformers upto Class 0.05, 5000 A, upto 220 kV
- Automatic Microprocessor Based Error Measuring System
- Analyzer for Measurement of Harmonics
- Loss Measurement by Using 0.1 Class CTs & PTs and Digital Power Meter
- Dissolved Gas Analysis (Fully Automated – Head Space Method –based Gas Chromatographs)
- HPLC for Furan Analysis
- Epstein Test Frame for Core Loss Measurement
- Single Sheet CRGO Core Loss Machine
- B-H Loop Machine
- Franklin Insulation Tester
- Acoustic Emission Test Setup for Online P.D Measurement

Forthcoming Training Programs

Programme Title	Date
Testing and Evaluation of Transformer Raw Materials	July 04-05
High Voltage Evaluation Techniques	July 18-19
High voltage evaluation techniques	August 08
Transformer Testing Techniques	August 22-23
Quality Assurance of Wiring Accessories - Switches,Plup& Sockets	September 05-06
Safety & Performance Evaluation of Cables & Accessories	September 26-27
Performance Evaluation of Low Switchgears	October 03-04
Renewable Energy Integration & Its issue	October 17
Condition Monitoring & Health Assessment of Power Transformers	November 07-08
Design Aspects and Performance Evaluation of Motors & Pumps	November 21-22
Energy Audits of Industries & Power Plants	December 5-6
Evaluation of Smart Meters	December 19-20

Rajib Chattopadhyay

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Meeting of Public Policy Cell

A meeting of the Public Policy Cell was held on 10th April 2019, under the Chairmanship of Mr Raj H Eswaran. IEEMA Office

Bearers, Divisional Chairs and other members participated in the meeting. The discussion points of the meeting were

discrepancies in Public Procurement (preference to Make in India) Order of Ministry of Power, procurement policy of Chinese

utilities for barring entry of Indian electrical industry etc. A presentation was made by TPM Consultants on Imports / Exports

and the way forward, during the meeting.

Meeting with Secretary, Department of Heavy Industry

On 10th April 2019, a delegation of IEEMA, comprising of Mr R K Chugh, Vice President; Mr Raj H Eswaran, Chairman; Mr Rohit Pathak, Member; Mr A S Subramaniyan, Member, Public Policy Cell; Mr Sunil Misra, Director General and Mr Sudeep Sarkar, Director, IEEMA called on Dr. Asha Ram Sihag, Secretary, Department of Heavy Industry, Government of India. The main point for discussions were bottlenecks in participation of Indian electrical industry in Chinese Tenders and absence of any reciprocal policy in India on the same. The other points for discussions were replacement of Bank Guarantee with Insurance Guarantee, circumvention of Public Procurement (preference to Make in India) Order, Under-Utilisation of BTG capacities of domestic manufacturers, Cyber Security Threat to intelligent equipment installed in Smart Grid System etc.

Secretary, DHI, informed that so long electricity is in demand, Thermal Plants would be in mainstay, which is also evident from BHEL Ltd. getting good number of BTG orders in the last financial year. Mr Sihag sought details on other issues for his reference.

Meeting with Ambassador and Additional Secretary, Economic Diplomacy and States, Ministry of External Affairs

On 10th April 2019, a delegation of IEEMA, led by Mr R K Chugh, Vice President, met Mr Manoj Kumar Bharti, Additional Secretary, Economic Diplomacy and States, Ministry of External Affairs. The main point for discussions was difficulties in participation of Indian electrical industry in tenders floated by Chinese power utilities and no reciprocal policy in India to check low priced imports of electrical equipment from China, without considering their life cycle cost.

While taking note of the same, Mr Bharti advised IEEMA to bring the matter to the notice of the Secretary, Department of Expenditure and recommend steps for bringing reciprocity in the procurement rules of the Government, which is WTO compliant, along with the role of other line ministries in this.

Meeting with Secretary, Power

On 10th April 2019, a delegation of IEEMA, led by Mr R K Chugh, Vice President, called on Mr A K Bhalla, Secretary, Ministry of Power, Government of India. The discussion point were bottlenecks in participation of Indian electrical industry in Chinese Tenders, suggested reciprocal policy for mandatory testing of equipment in Indian laboratories, Under-Utilisation of T&D capacities of domestic manufacturers etc.

Mr Bhalla took a note of these issues and informed that the Government is working and there would be a demand for smart meters and underground cables in the urban areas.

Meeting on Omnibus Technical Regulation on Safety of Machinery

On 12th April 2019, Mr Sudeep Sarkar, Director, IEEMA attended a meeting called by the Department of Heavy Industry, Government of India, on Omnibus Technical Regulation on Safety of Machinery. The meeting was chaired by Ms. Sukriti Likhi, Joint Secretary, DHI and attended by representatives of major Industry and Trade Associations and the Bureau of Indian Standards. The joint secretary asked the participation organisations to study the draft Technical Regulation, sensitize the industries and send suggested changes / inputs, by 10th May 2019.

IEEMA Chandigarh Chapter Meeting

On 11th April 2019, IEEMA's Chandigarh Chapter Meeting was held. The meeting was

chaired by Mr Hartek Singh, Vice Chairman Northern Region IEEMA. The discussion points in the meetings were planning of Chandigarh Chapter activities and increasing the regional membership through Membership Drive.

Meeting held between IEEMA and NSIC in Howrah

A follow-up meeting was held between NSIC, Howrah represented by Mr. Subodh Jaiswal – General Manager, Mr. Lalan Kumar – DGM, Mr. Rajib Chanda – Chief Manager, Testing & Mr. Palash Bhowmik – Manager, Training and IEEMA represented by Mr. Siddharth Bhutoria – Vice Chairman - ERC, IEEMA & Mr. Partha Pratim Mitra – IEEMA Secretariat at RTS Power Corporation Ltd. Office on 4th April, 2019 to discuss and propose the way forward and activities for setting up the Testing Facilities and Incubation Centres at NSIC's Howrah premises.

Meeting of CII Capital Goods Committee Meeting

Mr R K Chugh, Vice President, and Shri Sudeep Sarkar, Director, IEEMA attended the 3rd Meeting of CII Capital Goods Committee Meeting, on 29th March 2019. The meeting was chaired by Shri Atul Sobti, Chairman and Managing Director, BHEL Ltd. and attended by Office Bearers and other officials of Associations and Capital Goods manufacturers. Senior officials from Bureau of Indian Standards (BIS) were also present for an interactive session with industry representatives.

Mr Chugh presented an overview on recent performance of the electrical industry, which holds the largest share of approx. 65% of the Capital Goods Sector.

Mr. R K Chugh also mentioned about the financial stress in power sector and delayed payments to suppliers from the power utilities, having it's cascading effect on the credit worthiness of suppliers account in the banks and financial institutions.

He further informed about IEEMA's post Budget interactions with Mr Piyush Goyal, Hon'ble Minister for Railways and Coal, where the Minister had instructed that if the power utilities are not paying the approved bills in time because of their financial stress, it should be not classified into an NPA, based on a simple arithmetic of 90 days of elapsed time.

Mr Sudeep Sarkar raised the issue of dual certification of BIS and BEE on the same product i.e. Distribution Transformers, creating severe hardships for the manufacturers, especially the Small and Medium Enterprises because of the dual cost involved, compliance formalities, renewal, procedural delays, and manpower requirements, which is acting as a deterrent for the manufacturers in doing their business with ease. BIS officials took note of the issue and informed that BIS is already working on resolution of this matter.

Seminar on "Currency Hedging"- Manage Forex Risk in volatile currency market

IEEMA in association with EDELWEISS organized seminar on "Currency Hedging" – Manage Forex Risk in volatile currency market., held at Edelweiss House, Kalina, Mumbai on 12th April 2019. The workshop was conducted by Mr. Sejal Gupta, Head – Forex & Rates and Ms. Madhavi Arora, Economist at Edelweiss. The objective of this Workshop was to provide knowledge on managing forex risk while importing and/or exporting in ever volatile currency market by using hedging tools. Twenty delegates from KEC International Ltd., Secure Meters Ltd., Aditya Birla Insulators, KRYFS Power Components Ltd., Hind Aluminium Industries Ltd., Godrej & Boyce Manufacturing Co.Ltd., Dharia Switchgear & Controls Pvt.Ltd. attended the Workshop. The participants' feedback about the Seminar & Faculty was overwhelming and appreciative of clearing all doubts on the subject by both the faculties.

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SPARKS SANS SHOCKS

Extract from Mindful Listening

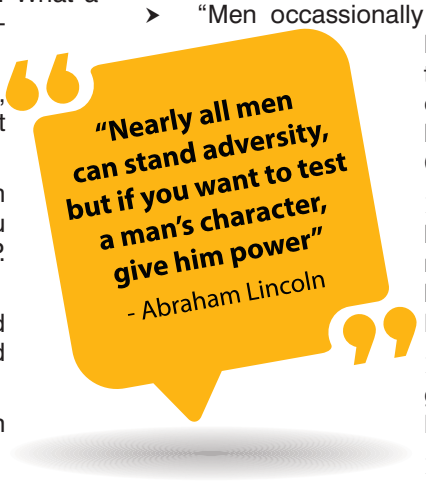
(HBR Emotional intelligence series)

Good listening is seen as a cooperative conversation. In these interactions, feedback flowed smoothly in both directions with neither party becoming defensive about comments the other made. By contrast, poor listeners were seen as competitive- as listening only to identify errors in reasoning or logic, using their silence as a chance to prepare their next response. That might make you an excellent debater, but it doesn't make you a good listener. Good listeners may challenge assumptions and disagree, but the person being listened to feels the listener is trying to help, not trying to win an argument.

While many of us have thought of being a good listener as being like a sponge that accurately absorbs what the other person is saying, what these findings show instead is that good listeners are like trampolines: They are someone you can bounce ideas off of and, rather than absorbing your ideas and energy, they amplify, energize, and clarify your thinking. They make you feel better not by merely passively absorbing but by actively supporting. This lets you gain energy and height, just like someone jumping on a trampoline.

Steven D. Price, 1001 Smartest Things Ever Said

- "One's own thought is one's world. What a person thinks is what he becomes" - Maitri Upanishad
- "We are what we repeatedly do, Excellence is therefore not an act but a habit" - Aristotle
- "You can learn many things from children. How much patience you have, for instance" - Franklin P. Adams
- "Life consists not in holding good cards but in playing those you hold well" - Josh Billings
- "If you can't make it better, you can laugh at it" - Erma Bombeck
- "If you can give your son or daughter only one gift, let it be enthusiasm" - Bruce Barton
- "If there is anything we wish to change in the child, we should first examine it and see whether it is not something that could better be changed in ourselves" - Carl Jung
- "The most difficult thing in the world is to know how to do a thing and to watch someone else do it wrong, without comment" - T. H. White
- "We are here to laugh at the odds and live our lives so well that Death will tremble to take us. " - Charles Bukowski
- "I would feel more optimistic about a bright future for man if he spent less time proving that he can outwit nature and more time tasting her sweetness and respecting her seniority" - E. B. White
- "Love is a canvas furnished by nature and embroidered by imagination" - Voltaire
- "Men are like wine, some turn to vinegar, but the best improve with age" - Pope John XXIII
- "It is easier for a father to have children than for children to have a real father" - Pope John XXIII
- "Sooner or later we all discover that the important moments in life are not the advertised ones, not the birthdays, the graduations, the weddings, not the great goals achieved. The real milestones are less prepossessing. They come to the door of memory unannounced, stray dogs that amble in, sniff around a bit and simply never leave. Our lives are measured by these" - Susan B. Anthony
- "Men occassionally stumble over the truth, but most of them pick themselves up and hurry on as if nothing had happened" - Sir Winston Churchill
- "Never be haughty to the humble; never be humble to the haughty" - Jefferson Davis
- "Who does not grow, declines" - Rabbi Hillel
- "It is a good thing to be rich and a good thing to be strong, but it is a better thing to be loved by many friends" - Euripides



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12th June 2019, India Habitat Centre, New Delhi

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IEEMA Distribution Transformer Division is organising the **first TRAFOTECH-DT Conference on 12th June 2019 at India Habitat Centre, New Delhi.** Theme of this conference is **"Efficient and Reliable Distribution Transformers for Sustainable development"**

200+ delegates are expected pan India from State and Private Discoms, Utilities, CPSUs, Transformer Industry, Consultants, Govt. Bodies, Railways, Academia, Research and Testing Organizations.

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- **Session II** Systemic Improvements
- **Session III** Products & Process for safe and reliable Transformers- Case Studies

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