TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

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TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE (Regn. No. 211/1992)
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EDITORIAL

Being happy is a state of well-being and contentment that is desired by all individuals. Happiness is both a goal and a journey, and it is influenced by various factors such as personal beliefs, relationships, achievements, and overall life satisfaction.

There are many reasons why happiness is important in our lives. Firstly, happiness improves our overall mental and physical health. Numerous studies have shown that happy individuals tend to have lower stress levels, reduced risk of heart diseases, stronger immune systems, and a longer lifespan. When we are happy, our bodies release endorphins, which are chemicals that promote feelings of pleasure and well-being.

Secondly, happiness influences our relationships and social interactions. Happy individuals tend to have more fulfilling and harmonious relationships with others. People are naturally drawn to those who exude positivity and happiness, making it easier to build strong connections and attract meaningful friendships.

Furthermore, happiness is linked to greater success and productivity. When we are happy, we are more motivated, focused, and creative. We are able to approach challenges and obstacles with a positive mind set, leading to improved problem-solving skills and better outcomes. Happy individuals are also more likely to set and achieve goals, as they have a clear sense of purpose and determination.

So, how can we cultivate happiness in our lives? Firstly, it is essential to focus on self-care and prioritize our well-being. This involves taking care of our physical health through regular exercise, healthy eating, and adequate sleep. Additionally, engaging in activities that bring joy and relaxation, such as hobbies, meditation, or spending time in nature, can significantly enhance our happiness levels.

Building and nurturing positive relationships is another key aspect of happiness. Surrounding ourselves with supportive and uplifting individuals fosters a sense of belonging and connectedness. Actively engaging in social activities, volunteering, or joining community groups can help create a strong support network and contribute to our overall happiness.

Practicing gratitude is also a powerful tool for cultivating happiness. Taking the time to appreciate the good things in our lives, whether big or small, can shift our focus from negativity to positivity. Keeping a gratitude journal or expressing gratitude to others can foster a sense of contentment and appreciation.

Lastly, it is important to set and pursue meaningful goals that align with our values and passions. Having a sense of purpose and working towards something that brings us fulfilment and satisfaction creates a sense of accomplishment and happiness. It is important to remember that happiness is not a destination but a continuous process that requires effort, self-reflection, and a willingness to embrace positivity.

In conclusion, being happy is an essential aspect of our lives. It contributes to our overall well-being, improves our physical and mental health, enhances our relationships, and promotes success and productivity. Cultivating happiness involves taking care of ourselves, building positive relationships, practicing gratitude, and pursuing meaningful goals. It is a lifelong journey that requires continuous self-reflection, self-care, and a mind-set that embraces positivity.

We thank all those members who have helped us by participating in the advertisement appearing for the issue October 2023 – Galaxy Earthing Electrodes (P) Ltd., Supreme Power Equipment Ltd., Sinewaves Solutions India Pvt Ltd., Sastinadha EPC Solutions India Pvt Ltd., Sakthi Transformers, Pentagon Switchgear (P) Ltd., MV Power Consultants & Engineers (P) Ltd., Power Cable Corporation Screened Separable Connection, E Power Engineering, Sri Bhoomidurga Marketing (P) Ltd., Gravin Earthing & Lightning Protection System (P) Ltd., Gajanan Enterprises, Value Engineers, Power Cable Corporation (Cable Network Solution). Velan Infra Projects Pvt Ltd., 3SI Eco Power LLP.

Editor

TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

CONTENTS

LIFE-LONG SUPERVISION AND MANAGEMENT OF SUBSTATIONS BY USE OF SENSORS, MOBILE DEVICES, INFORMATION AND COMMUNICATION TECHNOLOGIES

Background

Substations are key elements in the present and future electricity networks, hosting a wide range of equipment and are responsible for providing key functions for proper grid operation and for "keeping lights on". Their supervision and management are essential for the proper functioning of the electric network.

The equipment currently installed in such substations ranges from established aged equipment to equipment utilizing the latest digital and automation technologies. All those need continuous supervision and management, as well as efficient decision making over decades of their entire life.

While in large HV substations, the installation of permanent supervision/monitoring systems and sensors and use of advanced technologies is a small fraction of the asset cost, in distribution, especially in primary and secondary substations, this might be very different. In addition, due to the large number of such substations, distributed over large areas, obtaining life data from installed equipment, and keeping this data updated is presently costly.

Smart technologies including new intelligent sensors and monitoring systems, mobile devices, fast communications, and robotic devices can allow to collect a lot of real-time, life data at many locations at affordable cost.

The resulting large amount of alphanumeric and multimedia data, collected over the lifetime of substation equipment, needs proper data models, systematic management and validation, long time storage, easy retrieving for data processing. Lifetime data is a valuable source of information, for advanced mathematical algorithms, and for better asset management, maintenance, and operational decisions.

The changes in the electrical networks due to distributed energy resources, power electronics, weather events and the evolution of society, raise new challenges for substation equipment to manage and keep it at any time operational. The digitization and the evolution of power equipment itself with built in intelligence, sensors and communications can provide new ways to execute on-site activities and interaction with nearby humans or robotic devices, regarding status, history, events or required actions.

Advanced data processing technologies, Artificial Intelligence (AI) will and are already starting to impact management decisions.

Technologies such as Augmented Reality (AR) and Virtual Reality (VR) are enhancing work on site, training and knowledge transfer.

The supervision and management of substations over their lifetime, needs a holistic view based on engineering background knowledge combined with information, communication and sensing technologies.

The JWG B3/D2.62 and topics envisaged by its Technical Brochure

The present Joint Working Group "**Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies**" continues and extends the work of a previous CIGRE WG B3.44, "Substation servicing and supervision using mobile devices and smart sensing". The focus of the previous WG was mainly on technologies for large substations for servicing and using mobile technologies. The present JWG, is considering the needs of much more numerous smaller primary and secondary substations and is investigating aspects related to life-long supervision and management, needs for lifelong data collection, handling, processing, and decision support.

The goal of the JWG is to identify, starting from utility needs, the current and near-term usable technologies, methods and applications using sensors, mobile devices, the Internet of Things (IoT) and information and communication technologies, data analysis and processing which can improve substation supervision and management over entire life of the substation equipment and improve or provide timely, situation aware and well-founded decision support for operation, maintenance and asset management.

The Joint Working Group is involving mainly members from Study Committee B3 "Substations and electrical installations", and from study committee D2 "Information systems and telecommunication", however input and contributions from other Study Committees will be considered.

The topics of interest for the Working Group require a holistic view of the substations and its operation over lifetime and the sensing, monitoring, and data application to handle all stakeholder needs in terms of operation, repair and maintenance and asset management.

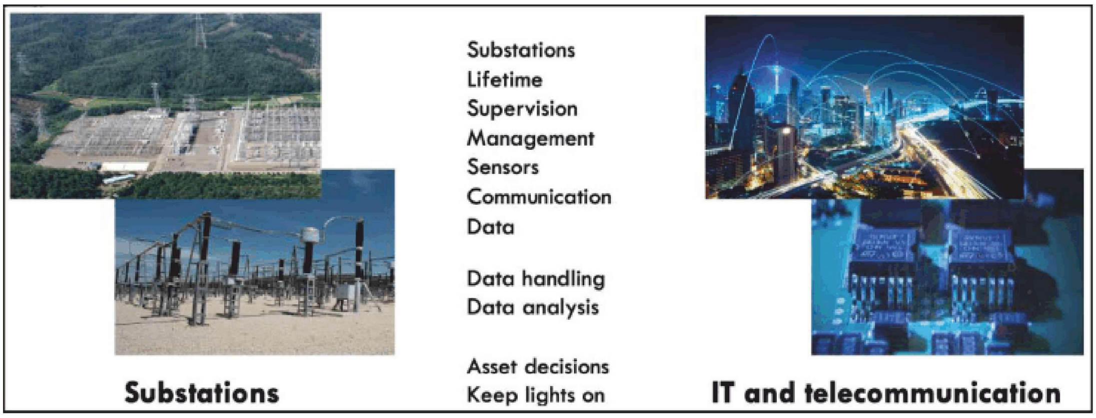


Fig 1 - A holistic view of substation lifetime supervision and management involves substation engineering and data IT and communications

In Figure 1 the two sides are related to substation engineering, installed equipment and operational technologies and to the data, communication and processing IT technologies which need to be considered together. The most important linking element is lifetime data. The most useful support can be derived by combining data processing methods and substation and equipment engineering knowledge.

The relevant, accurate, reliable, and often complex multimedia data or time series from substation operation and events, from sensors and monitoring equipment, from inspection or diagnostic and maintenance activities, need to be collected over lifetime and cleaned, validated, processed, stored, and permanently analysed.

The JWG will consider the following aspects:

1. Identify **the utility needs regarding life-long supervision and management activities**, for equipment in substations which can benefit from state-of-the-art sensors, intelligent devices and information and communication technologies (ICT). Short-term and mid-term needs for supervision, for enabling optimised management and on-site activities, for refurbishment, for prevention of human and environmental hazards, for staff training and support, and for use during normal and emergency situations, will be considered. A world-wide survey will attempt to identify the current situation, activities, trends, and strategies.
2. Identify and review the present **status and trends of sensors, intelligent devices, information and communication technologies and applications,** usable for substation life-long supervision and management. Consider fixed or mobile sensor devices, sensor networks, sensors built-in or attached to substation equipment, and sensing by devices used or worn by humans, robots, or drones. Identify the evolution of sensors and intelligence build in power equipment and possible new interaction possibilities of this equipment with humans and robotic devices. Identify potential benefit and limitations.Take into consideration presently usable and mid-term expected technologies. Identify appropriate architecture(s) for collecting, processing, long-time storage and handling lifetime data, suitable for use with present and future sensing technologies.

3. **Identify and analyse life-long data related aspects for distribution substations and equipment, technologies and challenges and make recommendations**. This will include: 1) How to effectively address equipment and substation many decades encompassing lifetime data, in a sustainable and systematic way, in the view of the existing and upcoming large amounts of data over the lifetime of equipment. Consider discrete life data, time series and multimedia data from: supervision, inspection, events, operation, maintenance, environmental conditions, catastrophic situations, failures etc., as collected by smart sensors or sensor networks, human inspections, human activities such as work on-site, collected by robots and drones, etc. 2) Consider and identify appropriate data models, consider long data storage aspects, data retrieval for processing and management, the possibility to have a digital equivalent or twin of installed equipment such that can handle relevant information, that can be aware on equipment's own status and history, and which can possibly communicate with human and autonomous robotic devices. 3) Identify and recommend approaches and technologies suitable for the equipment lifetime data needs, which can be used immediately or available in the mid-term.
4. **Identify the current situation and applications** using supervision, smart or mobile and ICT technologies used or tried world-wide for substations needs, including lessons learned, benefits or limitations.
5. Conclude and issue recommendations for lifetime supervision and management of substations.

Courtesy:NicolaieFantana, Convenor CIGRE JWG B3/D2.62 &
Koji Kawakita, Chairperson of Study Committee B3

SUBSTATION DESIGN APPLICATION GUIDE – 13

7. Auxiliary Supply System

7.1 Batteries/Chargers And Dc Distribution

The battery, charger and DC distribution system in any substation is vital as it provides auxiliary power to the protection relays, control equipment and primary plant.

Many modern protection relays rely on an auxiliary DC supply to drive the electronic measuring circuitry and circuit breakers almost invariably have shunt trip coils and closing coils which activate the circuit breaker mechanism.

Most high voltage equipment is designed to operate down to at least 85% of rated control voltage for closing and circuit breakers are required to trip down to 70% volts. At the other end of the scale, equipment will normally tolerate 110% of rated control volts continuously, i.e. for a 125V DC system the voltage ranges are 106.25V to 137.5V (closing) and 87.5V to 137.5V (tripping). These voltages are taken at the equipment terminals not at the battery terminals and therefore the DC distribution system must be carefully designed to avoid excessive volt drops when supplying DC auxiliary power to equipment.

Other common voltages used for control batteries are 34V, 54V and 250V and quite often a mixture of 125V or 250V and 54V will occur in one substation with the 54V battery system being used for remote control and telecommunications.

The DC system is also used for other purposes where continuity of supply is critical to the operation of the substation e.g. circuit breaker mechanism charging motor drives and motorised dis-connector drives.

A typical system would consist of the following equipment:

2 - 30A, 125V output, 415V, 3 phase, 50 Hz input, constant voltage chargers with current limit feature incorporating high voltage, low voltage and charger fail alarms, selection of 'Float' or Boost charge facility and suitable instrumentation.

2 - 250Ah, 55 cell lead acid battery on acid resistance (usually wooden) stands.

1 - Distribution board with incoming supplies selectable to either battery by switches or links with outgoing fused ways for various loads including Protection and Control (one per protection panel) Site Ring main, Busbar Protection Panel and Emergency Lighting.

7.2 LVAC Distribution System

The LVAC system (or more correctly MVAC system) is the main source of auxiliary supplies for the substation, providing power for heating, lighting, battery charging, cooling fan motors, tap changers, AC motor drives for dis-connectors, etc.

On most substations the LVAC supplies are derived from two sources to give security. On major substations these two sources may be supplemented by a small diesel or gas turbine driven generator which starts automatically to maintain essential services on loss of the two main supplies.

The usual sources of LVAC are:

a) Local Electricity Area Board 415V or 11kV network

b) Auxiliary supplies transformers fed from 132/11kV or 132/33kV transformer secondary's

c) Auxiliary windings of earthing transformers

d) Tertiary windings of supergrid transformers via auxiliary transformers and voltage regulators

Quite complex automatic changeover schemes are sometimes required, particularly where auxiliary generators are used, which offer selection of Main Supply and Standby Supply and section the distribution board into 'Essential' and 'Non Essential' supplies before starting and switching in the generator on loss of both incoming supplies. On restoration of the main supply the diesel generator will normally be arranged to shut down automatically to conserve fuel. Auxiliary / Earthing Transformers help to limit the fault current to the LVAC board.

Method 1

Let us consider an auxiliary / earthing transformer with an impedance of 4.5%, on its rating of 250kVA.

If the voltage of the auxiliary / earthing transformer is 33/0.4kV, then the fault limited by the auxiliary earthing transformer is as follows:

Fault limited= $\frac{250 \text{ x } 100}{4.5}$ kVA

$\therefore$ The fault current on the 400V side (LV side)= $\frac{5556 \times 10^3}{\sqrt{3} \times 400}$

Method 2

Fault current = $\frac{100}{4.5}$ x LV current

LV current of the transformer $= \frac{250 \times 10^3}{\sqrt{3} \times 400} = 360.8$A

$\therefore$ Fault current= $\frac{100 \times 360.8}{4.5}$

This method can be used to adjust any transformer impedance to calculate the required fault current.

Example:

Let us consider a transformer 132/33kV with 15% impedance on its own rating of 120 MVA.

Fault current on the 132kV HV side = 31.5 kA

What is the fault limited on the 33kV side?

Fault Limited $= \frac{120}{15} \times 100MVA$ = 800 MVA

The fault current on the 33kV side (LV side) $= \frac{800 \times 10^6}{\sqrt{3} \times 33 \times 10^3}$ = 13.99 kA = 14 kA

If we want the fault to be limited to 40kA on the LV side, then the impedance of the transformer has to be reduced.

Rating of the transformer is 120 MVA, current on the LV side i.e. 33kV = 2100A

Impedance of the transformer $= \frac{2100 \times 100}{40 \times 10^3}$ = 5.25% on its own 120MV rating

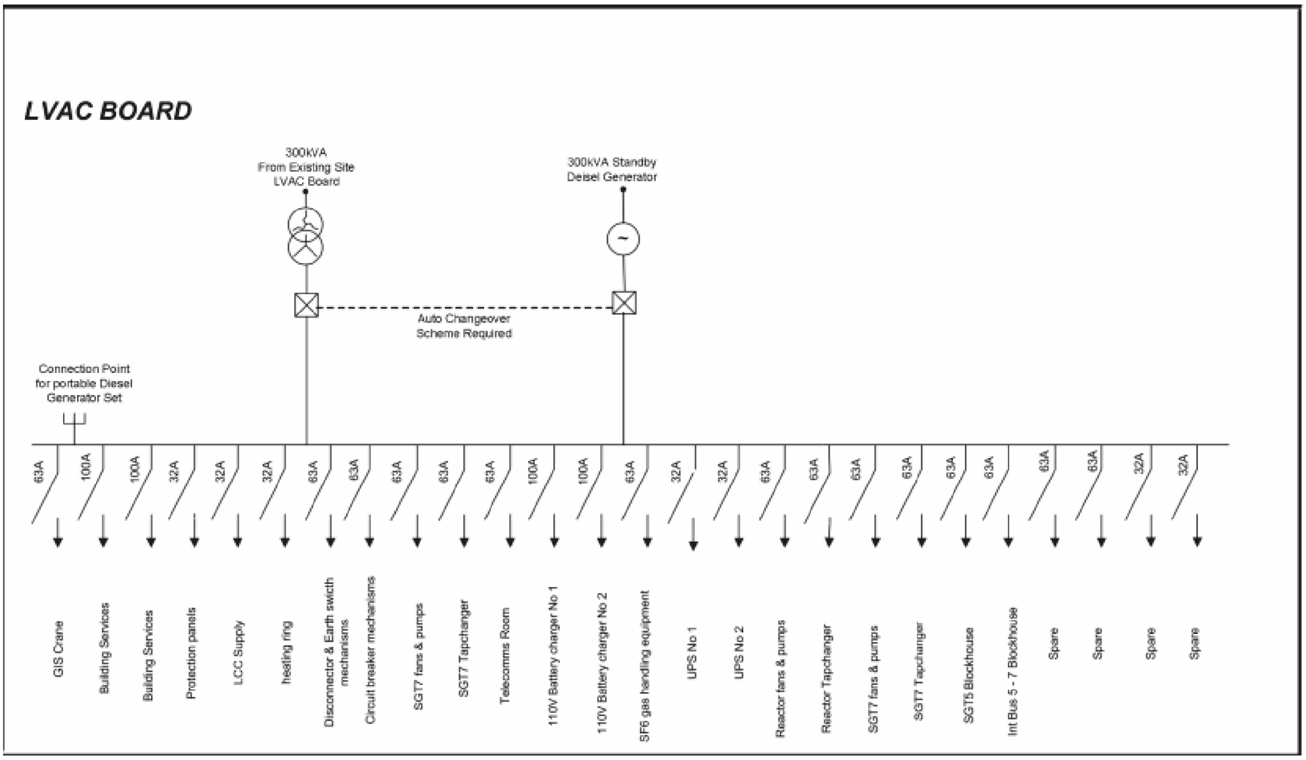
7.3 A.C. Supplies

A.C. supplies provide energy for drives, compressors, charging batteries, lighting and heating. Usually two independent sources of supply are used with 100% redundancy and automatic emergency switching. It should be noted that external supplies tend to be less reliable than sources fed through a station transformer from the main substation circuit. If supplies are taken from the MV network it should be ascertained that there is a degree of independence from the HV substation itself.

7.4 Diesel Generation

Diesel Generators are used to provide a back-up LV supply in important substations for loads up to about 800kVA and are activated automatically in the event of failure of the main LVAC supply (or supplies).

A diesel generator would be designed to provide energy for the essential components of the substation for a specified period of time (usually the estimated time it will take to restore the main supply). The components considered to be essential may vary from substation to substation and may include circuit breaker drives (or charging of their energy source), charging of batteries, operation of dis-connectors, cooling of transformers and emergency lighting.



(To be Continued)

Courtesy: V. AyaduraiBsc, C.Eng, FIEE

Engineering Expert

ELECTRICAL MAINTENANCE UNIT
(QUESTION &ANSWERS) - 20

Instrumentation fundamentals

1. What are the classifications of industrial instrumentation?

   a. Information gathering instrumentation.

   b. Regulating instrumentation.

   c. Protective instrumentation.

2. What are the units of pressure?

   Pounds / inch^2 *and* kg / cm^2.

3. What is the use of BAROMETER?

   Barometer is used to measure atmospheric pressure.

4. What are the methods used to measure the flow?

   Mechanical (float) type and ultrasonic type methods are used to measure the flow.

5. What is the equivalent of atmospheric pressure?

   One atmospheric pressure is equal to 10 meters of water column or 760 mm of mercury.

6. What method is used to measure the level?

   Bubbler method is used to measure the level.

7. State some elements of pressure measurement.

   Manometer, Diaphragm gauges, Bellows, Strain gauges etc.

8. State some elements of flow measurement.

   Orifice, Venturi tubes, flowrator (rotameter) etc.

9. State some thermocouple.

   Copper – constantan, Iron – constantan.

10. What is the purpose of instruments?

    The purpose of instruments is to measure, safeguard the process for efficient plant operation.

    Instruments are very accurate and fast acting. This accuracy and speed is not possible by human. Also in some places there may be too much heat for man to work or somewhere there may high radiation field. In such cases instruments provide remote operation.

11. What is primary element and what should be its response?

    Primary element is one, which senses the condition of process, and converts it to some other form, which can be measured accurately. Example in a bourden gauge the pressure if changed to the uncoiling (displacement), which can be measured. The response of primary element is that it should convert the condition in to some other form, which can be interpreted and measured easily.

12. Name some process variables, which are appropriate for our plant with examples.

    Process variables with examples, which are appropriate to our plant, are

    a. Flow – flow of D_2O in PHT system.

b. Temperature – temperature of coolant in PHT system.

c. Level – moderator level.

d. Speed – speed of turbine.

e. Voltage – voltage generated by main generator.

f. Neutron flux – number of neutrons produced in reactor during operation.

g. pH – pH of moderator.

13. What is use of 2/3 logic in our plant?

All our protection instruments (system) are triplicated to have following uses.

a. To increase system integrity.

b. To decrease faulty trips.

c. Maintenance can be done on one protective instrument without shutting down the whole system.

We don't want our plant (reactor) to trip just because one instrument failed. So we have triplication (2/3 logics) in protection instruments. The trip signal will pass if only two out of three switches operate. Of only one operates there will be no trip. This logic is used to trip the reactor in our plant.

14. What is resistance temperature detector (RTD) and mention some examples?

Resistance temperature detector is an instrument, which is used to measure temperature. This uses the property that the resistance of a metal changes (increases of decreases) with temperature. This is very accurate. These will be a wire, which will senses the temperature and changes its resistance as the temperature changes. This varying in resistances if measures by an external electronic or electrical circuit calibrated to measure temperature.

Different types of RTD's are Platinum, copper, nickel.

15. What is recorder and how it is useful to our plant?

Recorder is an instrument, which gives instantaneous values as well as records the values.

Recorder can show us where a fault has occurred if reactor trips. It also gives us past information recorded in it. It saves human effort because an operator cannot sit and record the information required and it is very difficult task to an operator.

Fire fighting

1. How combustion takes place?

For combustion to take place three elements are needed. They are *fuel, heat* and *oxygen.* This is called the triangle fire. Combustion can not survive without these three. Remove any one of them, combustion ceases to take place. So wherever fuel, oxygen and heat is there together combustion takes place.

2. How many types of extinction media's are used in fire fighting?

a. Sand.

b. Water.

c. Foam.

d. Carbon – di – oxide.

e. Dry chemical powder.

f. Halons

3. What are the classifications in fire?

   a. Class A – Ordinary fire like burning of paper, wood etc.
   b. Class B – Oil fire like burning of petrol, diesel, LPG etc.
   c. Class C – Gas and dust fire like burning of butane, acetone, natural gas etc. and burning of dust like uranium dust, sodium dust etc.
   d. Class D – Metal fire like burning of uranium, thorium, sodium etc.
   e. Class E – electric fire example transformer or switchgear fire etc.

4. How many types of fire extinguishers are there and state their suitability?

   a. Soda acid type – suitable for Class A type of fires.
   b. Foam type – suitable for Class A and Class B type of fires.
   c. Carbon-di-oxide type – suitable for Class B, Class C and for Class E type of fires.
   d. Dry chemical powder – suitable for Class B, Class C, Class D and Class E fires.
   e. Halons BCF (bromo chloro difluoro methane) – suitable for Class A, Class B, Class C and Class E types of fires.

5. At what areas of risk the Co2 flooding system, mulsifyre systems are provided?

   Co_2 flooding system is provided in diesel generator and turbine oil tank area. Mulsifyre system is provided in generator transformer, start up transformer and unit transformer areas.

6. What are the equipments kept inside the hose boxes?

   a. Double female adapter (1 No).
   b. Delivery hose pipe (50 feet – 2 Nos).
   c. Branch pipe (1 No).
   d. Valve wheel (1 No).
   e. A hose box key (situated in a cabinet at side of hose box).

7. How water is used in a fire?

   Water is used as a cooling effect in a fire.

8. How foam is used in a fire?

   Foam is used as a blanketing effect in a fire.

9. Which extinguisher you use for electronic equipment fire?

   Co_2 or DCP type fire extinguisher can be used on fire involving electronic equipments.

10. What you mean by starvation method?

    Starvation method means elimination of fuel from the fire.

11. What is the name of powder used in Dry Chemical Powder extinguisher?

    Sodium-bi-carbonate.

12. What you mean by cooling method?

    Cooling method means elimination of heat from the fire.

13. What you mean by blanketing method?

    Blanketing method means elimination of oxygen from the fire.

14. Why Co_2 is used on Class E fire?

Co_2 is a non-conductor of electricity.

First aid

1. What is the golden rule of first aid?

   Do first thing first, artificial respiration, stop bleeding and treat shock. Do not attempt too much, reassurance, avoid crowing and transfer.

2. What do you mean by diagnosis?

   Determining the nature and courage of a disease.

3. For a bleeding what is the first aid?

   Take care to stop the bleeding by giving pressure.

4. What is the first aid for bone injury?

   Support the injured part and painkillers.

5. What is the first aid for burn cases?

   Water, warm fluids should be given when the victim is conscious.

6. How we can differentiate the bleeding from artery and vein?

   By the colour of the blood which is bleeding.

7. What is the first aid for chlorine inhaled victims?

   Remove the victim from the source, fresh air and artificial respiration if necessary.

8. What is the first aid for dog bite?

   Suck the wound and spite out.

9. What is the first aid for snakebite?

   Bath the wound and constrictive bandage. Give warm drinks and rest to the patient and artificial breathing if necessary.

D_20 handling

1. What is the instrument name used for accurate measurement of IP?

   Infra red spectro photometer.

2. How D_20 vapour is recovered?

   Dryer recovers D_20 vapour.

3. What is the amount of D_20 used in moderator?

   140 tonnes.

4. Name the heavy water plants in India.

   a. Nangal.

   b. Kota.

   c. Baroda.

   d. Tuticorn.

e. Talcher.

f. Thal (under construction).

g. Hazira (under construction).

h. Malugum (under construction).

5. Define reactor grade and down graded D_20.

Reactor grade D_20: If the isotopic purity of a given D_20 is more than or equal to 99.7% then the D_20 is reactor grade D_20.

Down grade D_20: If the isotopic purity of a given D_20 is less than 99.7% then the D_20 is downgraded.

6. What precautions should be taken while working in high tritium areas?

Use respirators, plastic suits, VP suits if concentration of tritium is very high. Avoid getting hurt while working because tritium may go through the skin by sweat to the blood. If by chance, there is tritium intake in the body drink lots of fluids.

7. Why spillage of D_20 is to be avoided?

Cost consideration: D_20 very costly and very valuable. Cleaning of spillage also cost and extra manpower to be deployed.

Tritium hazard: D_20 contains tritium, which when spilled becomes tritiated vapour and finds access through human body. Tritium is a radioactive material. It is a beta emitter.

8. What is ice plugging?

If there is a need to repair a valve of D_20 PHT system, there are no other valves to shut of D_20. So we use plastic bags on pipes and it has dry ice. Then liquid nitrogen is poured inside the bag. Due to the low temperature the D_20 inside pipeline solidifies preventing any flow of D_20 when valve is removed. This is called the ice plugging.

9. Name the methods by which D_20 leak can be detected.

a. By beetles.

b. D_20 losses through stack monitoring.

c. Tritium monitoring.

d. In heat exchangers the leakage can be found by taking samples of process water from all heat exchanges and counting the tritium activity.

10. Name the D_20 recovery methods.

a. Manual mopping and vacuum cleaning.

b. Active drainage recovery.

c. Vacuum mopping recovery.

d. Dryers recovery.

e. Vapour recovery

11. Name the features for reducing D_20 leaks.

a. Reduce valves and fittings in the pipelines.

b. Use welded joints instead of flanged joint.

Courtesy: https://www.scribd.com/document/244623258/Question-and-Answers-Electrical-Maintenance-Unit

UPDATED CENTRAL ELECTRICITY AUTHORITY (MEASURES RELATING TO SAFETY AND ELECTRIC SUPPLY) REGULATIONS, 2023 - 2 - CHAPTER II

DESIGNATED PERSON, CHARTERED ELECTRICAL SAFETY ENGINEER, TRAINING AND CERTIFICATION

3. Designated person to operate and carry out the work on electrical lines and apparatus.

(1) The supplier or consumer, or owner of electrical installation, owner or agent or manager of a mine, or agent of any company operating in an oil-field or owner of a drilled well in an oil-field or a contractor who has entered into a contract with a supplier or a consumer, or owner of electrical installation, owner or agent or manager of a mine, or agent of any company operating in an oil-field or owner of a drilled well in an oil-field to carry out duties incidental to the generation, transformation, transmission, conversion, distribution or use of electricity shall designate person for the purpose to operate and carry out the work on electrical lines and apparatus.

(2) The supplier or consumer, or owner or agent or manager of a mine, or agent of any company operating in an oil-field or the owner of a drilled well in an oil-field or a contractor referred to in sub-regulation (1) shall maintain a record, in paper or electronic form, wherein the names of the designated person and the purpose for which they are designated, shall be entered.

(3) No person shall be designated under sub-regulation (1) unless-

(i) he possesses a certificate of competency or electrical work permit, issued by the Appropriate Government; and

(ii) his name is entered in the register referred to in sub-regulation (2).

4. Inspection of record of designated person

(1) The record maintained under sub-regulation (2) of regulation 3 shall be produced before the Electrical Inspector as and when required.

(2) If on inspection, the Electrical Inspector finds that the designated person does not comply with sub-regulation (3) of regulation 3, he shall recommend the removal of the name of such person from the record.

5. Electrical Safety Officer

(1) All suppliers of electricity including generating companies, transmission companies and distribution companies shall designate an Electrical Safety Officer for ensuring observance of safety measures specified under these regulations in their organisation for construction, operation and maintenance of electrical system of all generating stations, transmission lines, substations, distribution systems and supply lines.

(2) The Electrical Safety Officer shall possess a degree in Electrical Engineering with at least five years' experience in operation and maintenance of electrical installations or a Diploma in Electrical Engineering with at least ten years' experience in operation and maintenance of electrical installations:

Provided that the Electrical Safety Officer designated for mines shall possess educational qualification as mentioned in sub-regulation (2) with at least five years of experience in operation and maintenance of electrical installations relevant to mines.

(3) For every electrical installation including factory registered under the Factories Act, 1948 (63 of 1952) with more than 250 kW connected load and mines and oil-field as defined in the Mines Act, 1952 (35 of 1952), with more than 2000 kW connected load, the owner of the installation or the management of the factory or mines, as the case may be, shall designate Electrical Safety Officer under sub-regulation (1) and having qualification and experience specified in sub-regulation (2), for ensuring the compliance of the safety provisions laid under the Act and the regulations made thereunder:

Provided that the Electrical Safety Officer shall carryout recommended periodic tests as per the relevant standards, and inspect such installations at intervals not exceeding one year, and keep a record thereof in Form I or Form II or Form III or Form IV, as the case may be, of Schedule II of these regulations; test reports and a register of recommendations in regard with safety duly acknowledged by owner; compliances made thereafter; and such records shall be made available to the Electrical Inspector, as and when required.

6. Chartered Electrical Safety Engineer

(1) The Appropriate Government shall authorise Chartered Electrical Safety Engineer from amongst persons having the qualification and experience as per the guidelines issued by the Authority to assist the owner or supplier or consumer of electrical installations for the purpose of self-certification under regulation 32 and regulation 45 of these regulations.

(2) The Appropriate Government shall upload the name of the Chartered Electrical Safety Engineer, as soon as any person is authorised as Chartered Electrical Safety Engineer, on the web portal of the Government or the Department dealing with matters of inspection of electrical installations for the information of the owner or supplier or consumer.

7. Safety measures for operation and maintenance of generating station

(1) The Engineers and Supervisors engaged or appointed to operate or undertake maintenance of any part or whole of a generating station shall hold degree or diploma in Engineering relevant to the electrical installations from a recognised institute or university.

(2) The Engineers and Supervisors engaged or appointed for operation and maintenance of generating station shall have successfully undergone the type of training as specified by the Authority in its guidelines issued under sub-regulation (4) from time to time, within two years from the date of engagement or appointment.

(3) The Technicians to assist Engineers or Supervisors shall possess a certificate in appropriate trade, preferably with a two years course from an Industrial Training Institute recognised by the Central Government or the State Government and shall have successfully undergone the type of training as specified in sub-regulation (4), within two years from the date of engagement or appointment:

Provided that the existing employees, as on the date of notification of these regulations, who are extending technical assistance to Engineers or Supervisors and do not have requisite qualification as mentioned in this regulation, shall have to undergo the training either from Power Sector Skill Council or from training institute recognised by the Authority for carrying out trade specific course as per the guidelines issued by the Authority and get certificate as mentioned above within two years from the date of notification of these regulations.

(4) The Authority shall issue guidelines for the training for operation and maintenance of generating station within six months of the notification of these regulations:

Provided that the duration and content of the training course shall be as specified in the guidelines.

(5) The owner of every generating station shall arrange for training of personnel engaged or appointed to operate and undertake maintenance of the generating station from its own institute or any other institute recognised by the Authority or State Government as per the guidelines and shall maintain records of the assessment of these personnel issued by the training institute in the format prescribed in guidelines and such records shall be made available to the Electrical Inspector, as and when required.

(6) The certificate of recognition of the training institute under these regulations shall be displayed by the Institute on its website at home page.

(7) Notwithstanding anything contained in sub-regulation (4), the training syllabus may be customised by the owner of the generating station of capacity below 100 MW owning the training institute for the purpose of imparting training to its employees under intimation to the Authority.

8. Safety measures for operation and maintenance of transmission and distribution systems

(1) TheEngineers or Supervisors engaged or appointed to operate or undertake maintenance of transmission and distribution systems shall hold degree or diploma in appropriate trade of Engineering from a recognised institute or university.

(2) The Engineers and Supervisors engaged or appointed to operate or undertake maintenance of transmission and distribution systems shall have successfully undergone the type of training specified in guidelines as per sub-regulation (4), within two years from the date of engagement or appointment.

(3) The Technicians to assist Engineers or Supervisors shall possess a certificate in appropriate trade, preferably with a two years course from an Industrial Training Institute recognised by the Central Government or State Government and should have successfully undergone the type of training as specified in guidelines as per sub-regulation (4), within two years from the date of engagement or appointment:

Provided that the existing employees, as on the date of notification of these regulations, who are extending technical assistance to Engineers or Supervisors and do not have requisite qualification as mentioned in this regulation, shall have to undergo the training either from Power Sector Skill Council or from training institute recognised by the Authority for carrying out trade specific course as per the guidelines issued by the Authority and get certificate as mentioned above within two years from the date of notification of these regulations.

(4) The Authority shall issue guidelines for the training for operation and maintenance of transmission, distribution systems within six months of the notification of these regulations:

Provided that the duration and content of the training course shall be as specified in the guidelines.

(5) Owner of every transmission or distribution system shall arrange for training of their personnel engaged or appointed to operate and undertake maintenance of transmission and distribution system, in his own institute or any other institute recognised by the Authority or State Government as per the guidelines and shall maintain records of the assessment of these personnel issued by the training institute in the format prescribed in guidelines and such records shall be made available to the Electrical Inspector, as and when required.

9. Training and Certification of personnel engaged for operation and maintenance at Load Despatch Centres

(1) The personnel engaged for operation and maintenance at the control room shall hold degree or diploma in Electrical Engineering or in related trade of Engineering from a recognised institute or university.

(2) The Authority shall issue guidelines for the training and certification of personnel engaged for operation and maintenance at control room within six months of the notification of these regulations:

Provided that the roles and responsibilities of the certification agency, duration and content of the basic and advance certification and training course shall be as specified in the guidelines.

(3) The certification agency shall be a training institute recognised by the Authority:

Provided that the Load Despatch Centre shall arrange for training and certification of load despatcher from the certification agency recognised by the Authority as per guidelines issued under sub-regulation (2) of this regulation within six months of their engagement:

Provided further that no personnel shall be engaged as load despatcher without certification:

Provided also that existing employee engaged in Load Despatch Centre shall be trained as per guidelines specified under sub-regulation (2) of this regulation within two years from the date of coming in force of these regulations.

(4) The training institute shall maintain records of the assessment of load despatcher in electronic form in the format prescribed in guidelines specified under sub-regulation (2) of this regulation and such records shall be made available to the Secretary, Central Electricity Authority on annual basis.

(5) The personnel other than the load despatcher engaged in the Load Despatch Centre shall undergo requisite training in their related work in the Load Despatch Centre within six months of their engagement.

(6) The Load Despatch Centre shall submit the details of certified load despatchers and the training details of the other personnel to Secretary, Central Electricity Authority on annual basis in the prescribed format:

Provided that Appropriate Government may provide suitable incentive to load despatchers on successful completion of training.

10. Keeping of records and inspection thereof

(1) The generating company or licensee shall maintain records of the maps, plans and sections relating to supply or transmission of electricity in physical or digital form and provide the same to the Electrical Inspector for inspection as and when required.

(2) The Electrical Inspector shall supply a copy of the report of inspection referred to in sub-regulation (1), to the generating company or licensee, as the case may be.

11. Deposit of maps

Whenever a licence is granted by the Appropriate Commission, two sets of maps specifying the particular for which the licence is granted shall be signed and dated corresponding to the date of notification of the licence by an officer designated by the Appropriate Commission:

Provided that one set of maps shall be retained by the designated officer and the other set shall be furnished to the licensee.

12. Deposit of printed copies

(1) Every person who is granted a licence shall, within thirty days of the grant thereof, have physical or digital copies of the licence and maps showing the area of supply as specified in the licence to exhibit the same for public inspection at all reasonable times at its head office, local offices, if any, and at the office of every local authority within the area of supply.

(2) Every such licensee shall, within the aforesaid period of thirty days, supply free of charge one copy of the licence along with the relevant maps to every local authority within the area of supply and shall also make necessary arrangements for the sale of physical or digital copies of the licence and maps to all persons applying for the same, at a price to be notified by the Appropriate Government from time to time.

13. Plan for area of supply to be made and kept open for inspection

(1) The licensee shall, after commencing supply of electricity, forthwith cause a plan, to be made in physical or digital form, of the area of supply, and shall cause to be marked thereon the alignment and in the case of underground works, the approximate depth below the surface of all the existing electric supply lines, street distribution boxes and other works, and shall once in every year cause that plan to be duly corrected so as to show the electric supply lines, street distribution boxes and other works for the time being in position and shall also made sections showing the approximate level of all his existing underground works other than service lines.

(2) Every plan shall be drawn to such horizontal and vertical scale as the Appropriate Commission may require: Provided that no scale shall be required unless maps of the locality on that scale are for the time being available to the public.

(3) Every plan and section so made or corrected, or a copy thereof, marked with the date when it was made or corrected, shall be kept by the licensee at his principal office or place of business within the area of supply, and shall at all reasonable times be open to the inspection of all applicants, and copies thereof shall be supplied.

(4) The licensee shall ensure that all new and old plans and sections shall be compatible to the Global Positioning System mapping or mapping through any other latest technology.

(5) The licensee shall, if required by an Electrical Inspector, and, where the licensee is not a local authority, by the local authority, if any, concerned, supply free of charge to such Electrical Inspector or local authority a duplicate copy of every such plan or section or a part of the same duly corrected.

(6) The copies of plans and sections under this regulation shall be supplied by the licensee to every applicant on the payment of such fee as the Appropriate Commission may, by regulation, specify.

Courtesy: https://cea.nic.in/

TRANSFORMING TRANSFORMERS: THE POWER OF DIGITALISATION

In today's rapidly evolving energy landscape, the concepts of digitalisation and digital twin have emerged as powerful tools to drive innovation and optimise the operation of complex systems. As we explore the interactions between these concepts, we discover their significance in various aspects of power transformer operations, including predictive maintenance and performance optimisation. Moreover, we examine the role of digital twins in enhancing visibility, facilitating proactive decision-making and mitigating risks. By leveraging these technologies, the power industry can achieve greater efficiency, reliability and sustainability, ultimately shaping a resilient energy future.

Accelerating the energy transition: the three Ds approach

The three Ds of the energy transition refer to three key elements driving the transformation of the global energy system.

These elements are decarbonisation, decentralisation and digitalisation.

- Decarbonisation refers to reducing or eliminating carbon dioxide (CO2) and other greenhouse gas emissions from the energy sector. It involves shifting away from fossil fuels and increasing the share of renewable energy sources.
- Decentralisation shifts away from centralised energy generation and distribution, where power is predominantly produced in large power plants and transmitted over long distances to consumers. Instead, the focus is on a more distributed energy system characterised by smaller-scale and localised energy generation.
- Digitalisation, also known as the digital transformation of the energy sector, involves the application of digital technologies, data analytics and advanced communication systems to optimise energy generation, distribution and consumption. It encompasses various technological advancements, such as smart grids, Internet of Things (IoT) devices, artificial intelligence (AI), machine learning and data analytics. Digitalisation plays a crucial role in optimising energy use, improving grid reliability and integrating renewable energy.

Understanding Digitisation, Digitalisation and Digital twin concepts

"Digitalisation" and "digitisation" are often used interchangeably but have slightly different meanings.

Digitisation refers to the process of converting analog data into digital form. For example, in the context of power transformers, digitisation may refer to converting analog data from sensors or instruments into digital signals that can be processed and analysed by a computer or other digital device.

On the other hand, digitalisation refers to the broader process of using digital technologies to transform business processes, operations and customer experiences. For example, with power transformers, digitalisation may involve digitising data from sensors and instruments and using advanced analytics, machine learning and other digital technologies to analyse that data and make predictions about the transformer's performance.

In short, digitisation is the first step in digitalisation, which involves using digital technologies to improve performance, efficiency and outcomes.

Digitalisation and digital twin are closely intertwined concepts that are part of the ongoing technological advancements in various industries, including the energy sector.

A digital twin is a virtual representation or a digital replica of a physical asset, system, or process (Figure 1). It is a digital counterpart that mimics the behaviour and characteristics of its physical counterpart in real-time or near-real-time. Digital twins are created using various data sources, including sensors, design information and historical inspection data, to capture and model the physical asset's behaviour and performance. The digital twin creates a feedback loop where the real-time data collected from the physical system is fed into the digital twin for analysis and prediction. The results and insights obtained from these models can then be used to update and improve the digital twin, ensuring their accuracy and relevance over time.

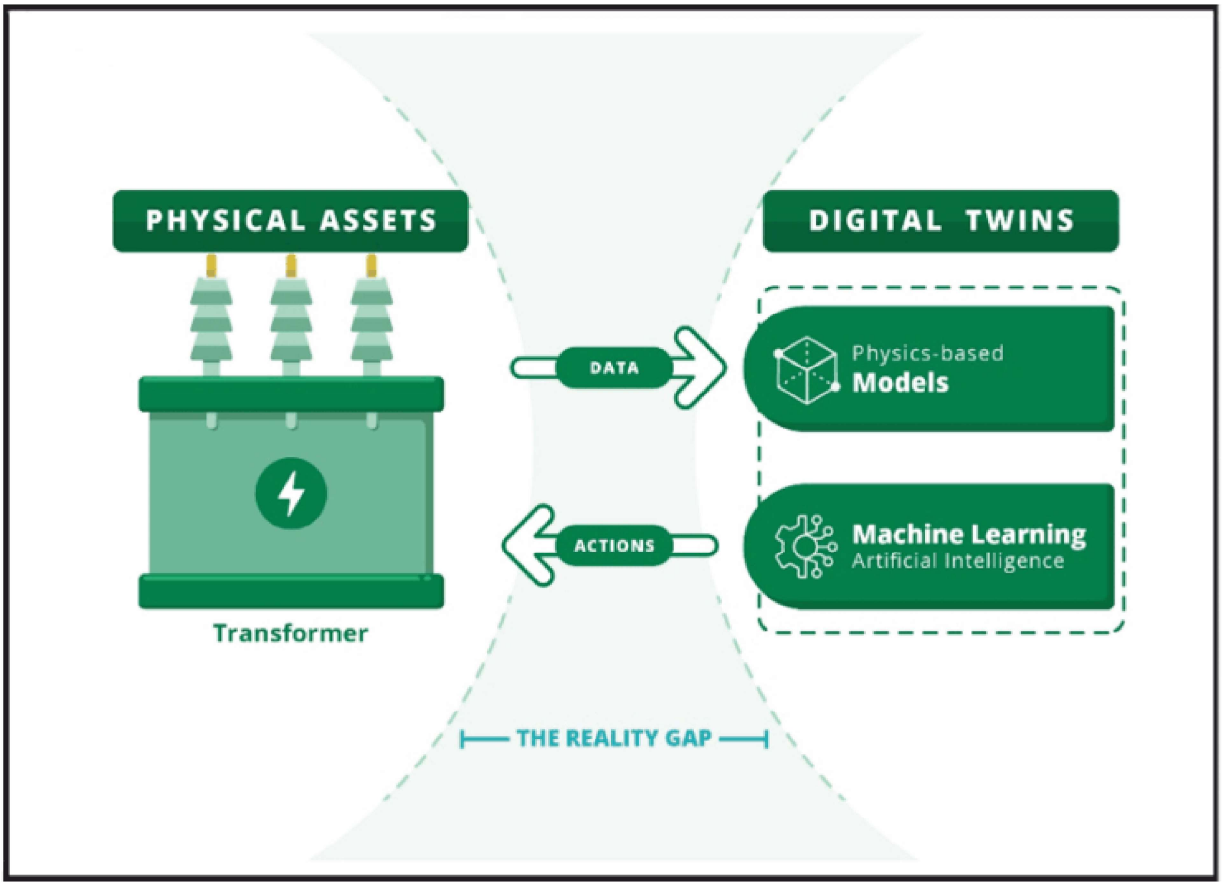


Fig 1 - The digital twin concept (from CIGRE JWG A2/D2.65)

As digitalisation advances, it provides the necessary infrastructure and technologies to collect vast amounts of data from physical assets and systems.

Digital twins can be created in the energy sector for various components, such as power plants, transmission networks and strategic assets like power transformers. These digital twins enable operators and engineers to monitor and analyse the performance of these assets, identify potential issues or inefficiencies, simulate different scenarios and optimise operations.

Harnessing the power of digitalisation and digital twin for power transformers

Digitalisation and digital twin concepts are applied to power transformers to enhance their monitoring, maintenance and overall performance.

- Digitalisation allows for real-time monitoring of power transformers by integrating sensors that collect data on parameters such as temperature, load level, dissolved gas in oil, bushing tap current, vibrations and partial discharges. By continuously monitoring the transformer's condition, potential issues or abnormalities can be detected early on, allowing for timely maintenance and preventing costly failures.
- Digital twins can be created for power transformers, representing their physical counterparts in a virtual environment. The digital twin can simulate different operating scenarios, monitor performance and predict future behaviour. Data analytics such as physics-based models, AI algorithms, hybrid models and

statistical tools help identify optimisation opportunities, evaluate the impact of operational changes such as dynamic overloading and test maintenance strategies without affecting the physical transformer. Prognostics involve forecasting the future performance and health of the transformer, estimating the remaining useful life and assessing the probability of failure.

As supply chain challenges continue to emerge, the application of digitalisation and digital twins holds great potential in effectively managing risks associated with transformer fleets. In the face of difficulties in procuring replacements, these technologies offer asset management alternatives by enabling life extension strategies, optimising maintenance practices and enhancing overall operational efficiency.

When implementing digitalisation in power transformers, it is important to prioritise regulatory compliance and safety requirements. Special attention must be given to cybersecurity measures to ensure the protection of the system from potential cyber-attacks that may jeopardize its safety and reliability.

Digitalisation and digital twin concepts are closely intertwined with various activities conducted by CIGRE in the domain of power transformers (Study Committee A2). These concepts find applications in several areas, including modelling, condition assessment, maintenance, material performance, ageing, sensors and diagnostics. CIGRE has dedicated working groups focusing on exploring and advancing these areas. Here are some examples:

- Transformers Thermal Modelling: One of the areas where digitalisation and digital twin concepts are applied is in the dynamic thermal modelling of transformers. CIGRE's Working Group A2.60 is actively studying this field, aiming to develop improved models and methodologies for accurately predicting and managing the thermal behaviour of transformers.
- Transformer Digital Twin: The concept of the digital twin for transformers is being explored by the Joint Working Group (JWG) A2/D2.65. This group is focused on understanding the potential and future perspectives of digital twin technology for transformers, investigating its benefits, challenges and possible implementation strategies.
- Another area where digitalisation plays a crucial role is in interpreting critical monitoring data for transformers. CIGRE's JWG A2/D1.67 is working on developing guidelines and best practices for effectively interpreting the data collected through online dissolved gas monitoring systems. These guidelines aid in assessing the condition and health of transformers based on the dissolved gas analysis (DGA).

Overall, digitalisation and digital twin concepts have significant relevance and impact on various aspects of power transformers within CIGRE's activities. These concepts enable advancements in thermal modelling, provide insights into transformer health through condition assessment and diagnostics, guide maintenance practices, explore the potential of digital twin technology and facilitate the interpretation of critical monitoring data. By actively researching and developing guidelines in these areas, CIGRE contributes to the continued improvement and optimisation of the industry's power transformer operation and maintenance practices.

Courtesy:Patrick Picher, Researcher - Project manager,

Institut de recherche Hydro-Québec

and

Tara-Lee MacArthur, Senior Engineer.

CIGRE Advisory Group Leader, Director

When Digital Transformation is done right,
it's like a Caterpillar turning into a Butterfly
but when done wrong,
all you have is a really fast Caterpillar ----

HARMONICS IN POWER SYSTEM & MITIGATION – 3

Harmonic Mitigation Techniques

Two types of Mitigation Techniques

1) To handle the harmonic current in the system by providing K type transformer which will handle the harmonic current without temperature increase.
2) To reduce the harmonic current into the system by providing harmonic filters.

Type of Harmonic Filters:

1) AC/DC Line choke filters in series with the load.
2) Passive harmonic filters
   a) Tuned filters (tuned reactor + capacitor)
   b) De Tuned filters (Detuned reactor + capacitor)
3) ZigZag Transformer.
4) Active harmonic filters.
5) Hybrid filters (combination of active & passive filters).

Active Filter:

1) These filters are parallel device that works like a noise cancellation system.
2) They inject equivalent & quite opposite frequencies to cancel out the harmonic frequency.
3) These filters also offer added current to improve the power factor.

AC Line Choke:

1) The line choke increases the system impedance & thereby decreases the short circuit current level at the point.
2) In this case though the current THD will reduce Voltage THD will increase due to higher impedance and correspondingly decrease in short circuit current level.
3) The voltage drop at the output of line choke is reduced and depends on the impedance of the choke.
4) The normal impedance of the line choke should be 3 to 5%.
5) By providing 5% impedance choke the current THD will reduce by 65%.
6) As V = L x di/dt positive rise of current will cause a voltage to be induced which in opposite direction to the applied voltage, the induced voltage subtracts from the applied voltage and thereby limiting the rate of rise of current.

Tuned & De Tuned Filters:

1) This type of filters does not require a power supply to operate like AHF.
2) It depends only on passive components -Inductor, Capacitor & Resistance.
3) Passive components are used to form a tank circuit which will operate at the same resonant frequency in respect of unwanted harmonics.
4) The passive harmonic filter blocks the unwanted harmonics.
5) It will improve the Power Factor in the system by improving the distortion PF.

6) De tuned filter does not destroy harmonic components. Only 50% harmonics will pass through the filter.

7) It will only prevent the harmonic current from increasing in amplitude.

Zig Zag Transformer:

ZIG ZAG transformer is the combination star delta connection and it has the both advantages of star and delta. Harmonic voltages presented in system to some extend can be cancelled in zigzag windings due to opposite connection of winding coils. It provides low impedance to zero sequence components and thereby third harmonic suppression.

COMPARISON BETWEEN PASSIVE AND ACTIVE HARMONIC FILTERS

Passive Harmonic Filter (PHF)	Active Harmonic Filter(AHF)
1 PHFare filters in True sense	AHFare not Filters but those only inject opposite nature of distorted current in the line. Thus only the power quality towards the source is improved and never down the line.
2 These filters actually short circuit & remove the high frequency current (distortion of harmonics) from the distribution network	AHF do not short circuit or remove the harmonics current. But only try to improve the wave form towards source
3 These Filters do not allow harmonic current to circulate in the network which results in elimination of equipment breakdown due to harmonics	AHF do not stop harmonic currents circulating in the Network
4 The reliability of operation of protective relays improves when harmonic current are filtered from the network	Protective relays keep misbehaving
5 Clean the entire system whether down the line or up the line if the locations of connections are selected properly	Do not show the behaviour because as explained those are not actually filters
6 Very rugged, maintenance free and any breakdown can be attended easily by the user at site	AHF are complicated technically, use sophisticated electronic and software hence the maintenance is difficult and every time manufacturer having to be contacted. Service charges will be high
7 More economical	Costlier
8 Running losses are low	Running losses are high
9 Will be getting over loaded due to sudden change in load. Can be overcome by oversize designing or providing parallel filters	Do not have tendency of getting over loaded. Also many such units can be paralleled

Harmonic Measurement Method as Per IEEE 519

Voltage Limit – THD

Very Short Time reading (3secs) – ***Daily*** 99th percentile (3secs) value less than 1.5 times of table value.

Short Time reading (10 min) – ***Weekly*** 95th percentile (10 min) value less than the table value.

Current Limit – TDD

Very Short Time reading (3secs) – ***Daily*** 99th percentile (3secs) value less than should be less than 2 times of table value.

Short Time reading (10 min)

– ***Weekly*** 95th percentile (10 min) value should be less than 1.5 times of table value.

– ***Weekly*** 95th percentile (10 min) value should be less than the table value.

The highest value among the above three will be taken as for penalty.

TABLE-VOLTAGE HARMONIC DISTORTION LIMITS - IEEE 519-2014

Bus Voltage PCC	**Individual Harmonic %**			**Total Harmonic THD %**		
	Limits	Daily 99th percentile (3 sec)	Weekly 95th percentile (10 min)	Limits	Daily 95th percentile (10 min)	Weekly 99th percentile (10 min)
$V \leq 1.0$ K	5	7.5	5	8	12	8
1 KV < $V \leq$ 69 KV	3	4.5	3	5	7.5	5
69 KV < $V \leq$ 161 KV	1.5	2.25	1.5	2.5	3.75	2.5
161 KV < V	1	15	1	1.5	2.25	1.5

Table - Current Distortion Limits - IEEE 519-2022 - Rated Voltage 120 V - 69 KV

I_{sc} / I_L	2 <= h < 11				11 <= h < 17				17 <=h < 23			
	Limit (%)	**99th** percentile daily 3 sec	**99th** percentile weekly 10 min	**95th** percentile weekly 10 min	**Limit (%)**	**99th** percentile daily 3 sec	**99th** percentile weekly 10 min	**95th** percentile weekly 10 min	**Limit (%)**	**99th** percentile daily 3 sec	**99th** percentile weekly 10 min	**95th** percentile weekly 10 min
<20	**4**	8	6	4	**2**	4	3	2	**1.5**	3	2.25	1.5
20<50	7	14	10.5	7	**3.5**	7	5.25	3.5	**2.5**	5	3.75	2.5
50<100	**1**	20	15	10	**4.5**	9	6.75	4.5	**4**	8	6	4
100<1000	**12**	24	18	12	**5.5**	11	8.25	5.5	**5**	10	7.5	5
>1000	**15**	30	22.5	15	7	14	10.5	7	**6**	12	9	6

I_{sc} / I_L	23<= h <35				35<= h <50				TDD LIMIT			
	Limit (%)	**99th** percentile daily 3 sec	**99th** percentile weekly 10 min	**95th** percentile weekly 10 min	**Limit (%)**	**99th** percentile daily 3 sec	**99th** percentile weekly 10 min	**95th** percentile weekly 10 min	**Limit (%)**	**99th** percentile daily 3 sec	**99th** percentile weekly 10 min	**95th** percentile weekly 10 min
<20	**0.6**	1.2	0.9	0.6	**0.3**	0.6	0.45	0.3	**5**	10	7.5	5
20<50	**1**	2	1.5	1	**5**	1	0.75	5	**8**	16	12	8
50<100	**1.5**	3	2.25	1.5	**0.7**	1.4	1.05	0.7	**12**	24	18	12
100<1000	**2**	4	3	2	**1**	2	1.5	1	**15**	30	22.5	15
>1000	**2.5**	5	3.75	2.5	**1.4**	2.8	2.1	1.4	**20**	40	30	20

Note: 1) $h \leq 6$, Even Harmonics are limited to 50 % of the Harmonic limit shown in above table value.

(To be continued)

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For your better Tomorrow Save Energy Today.
SAVE ENERGY. SAVE NATION. SAVE THE PLANET.
Energy Saved is Energy Generated.

THE BACK OF THE HAND MATHEMATICS FOR ESTIMATING ELECTRICAL POWER REQUIREMENTS FOR FIRE FIGHTING PUMPSETS IN RESIDENTIAL BUILDINGS - PART - 3

OUR JOURNEY IN THE LAST TWO PARTS COVERED IN EARLIER ISSUES OF OUR JOURNAL:

Whether it is an architect or any other specialist involved in constructing an residential building, we all know that the ultimate responsibility of designing and finalizing the power requirements for the electrical systems rests on the electrical engineer.

As discussed earlier, the power requirement for the fire-fighting pumpset is not only a major connected and demand load of a building, it is also an priority power requirement (power cannot be drawn from downstream feeders), it is an emergency power requirement hence DG Sets need to be sized also to cater to this requirement.

In the acute situation of water flooding faced by residents, some resourceful residents have tapped their dedicated power supply to fire pumps to run drainage pumpsets!

Hence, we are furnishing the back-of-hand mathematics to this important requirement of estimating roughly the power requirement for fire pumpsets.

BUILDING HEIGHT, M				
APPROXIMATE CALCULATION - 1				
Inputs				
Number of				
Residential Floors	8			
Podium floor	1			
Power estimation for main pump				
Number of		Qty.	App. Height, m	Water head, mwc required
		(1)	(2)	(3)=(1)*(2)
Residential Floors	(a)	8	3.5	28
Podium floor	(b)	1	5	5
Pressure reqd. at hydrant, mwc	(c)=(a)+(b)			35
App. Pressure drop due to frictional loss, mwc	(d)			15
Total pressure drop, mwc	(e)=(c)+(d)			83
Pump head minimum required, mwc (pm)	=(e)			83
Next higher head selected, mwc	(f)			**90**
Pump capacity required, min. as per NBC, LPM(for building ht. upto 45 m as per NBC, sub. Clause 10) (qm)	(g)			**2280**

Main pump kW reqd	(h) = 16.3766*qm* pm/10000/η* 1.15 (factor of safety)			**56**
Immediate next size of motor available, say	(i)			**75**
Power estimation for jockey pump				
Pump head required, mwc (pm)(calculation done for main pump adopted here)	(j)			90
Pump capacity required, min. as per NBC, LPM(for building ht. upto 45 m as per NBC, sub. Clause 10) (qm)	(k)			180
Main pump kW reqd = 16.3766*qm* pm/10000/η	(l)			**4**
Immediate next size of motor available, say	(n)			**5.5**
Total minimum kW required	(o)=(i)+(n)			**80.5**

Furthering Note:

Please note that this exercise is only a preliminary calculation and does not cover all types of risks or situations. Hence, for final design, support of a fire consultant to be solicited.!!

The calculation above is for a 8 storied building. The concluding part of this presentation will furnish the calculation for a 30 storied building. This will help our knowledgeable fellow electrical engineers to take more informed decision on the power requirements.

Be Safe & Happy
and
Wishing all our
Fellow **TNEIEA** *Members*
A Very Happy, Prosperous
and
Safe New Year 2024.

Mr. Muthukrishnan Kalyanasundaram, M.E.
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Services – Fire and Life Safety Consultancy
Email id – mr.k.muthukrishnan@hkmconsultants.com
Contact Number – 9930265069
(Son of Mr. H. Kalyanasundaram – Ex. Best and Crompton Engineering Limited)

Every year millions die in FIRE ACCIDENTS in the Work place and at Home.
Make a change and follow the FIRE SAFETY METHODS.

OFFICE OPENING CEREMONY
on 14.12.2023 at Chennai.

Ganapathy Homam

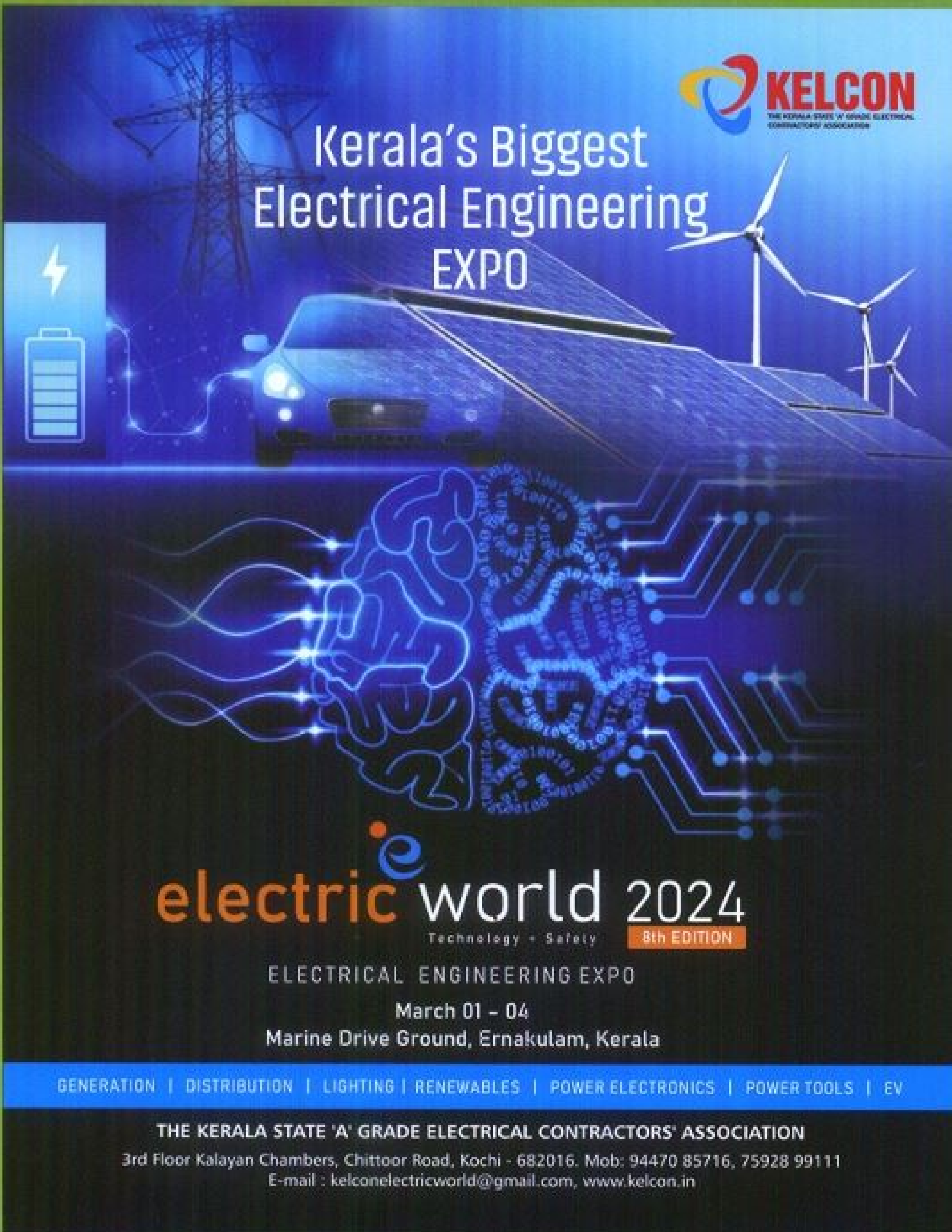
Inauguration

Lighting the Traditional Lamp

Members Gatherings

Members Gatherings

Members Gatherings



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