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CEEAMA *LiveWire*

E-NEWSLETTER

Published by Consulting Electrical Engineers Association of Maharashtra

Topic for August 2024
SWITCHGEAR

Read interesting articles about Switchgear inside..

CEEAMATECH 2024

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Dates announced inside..!!

Electrical Consultants Newsletter
Volume No. 4 Issue #43
August 2024

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From the Editors Desk,

HAPPY MONSOON TO ALL!!!

Monsoon has steadily and strongly entered all parts of India and caused havoc in the form of flooding, water-clogging, damages to vehicles, structures, and also caused loss of life and cattle. Inspite of this, Monsoon is the most awaited season for Indians. It is the season of hope, smile, new life, and happiness for the farmers. As they say, if farmer is happy the whole society is happy. The auspicious Shravan month falls in Monsoon period and triggers a romantic, devotional and pious mood in the air. No wonder, the most popular Indian classical Raaga, Malhar, literally means the same (mal+har) and is dedicated to the rainy season!

Rains also pose huge challenge to the industry, esp. the electrical industry. There are many cases of short-circuits caused due to reduction in dielectric strength of certain already weak sections of cables or other insulated equipment. Cases of electrocution rises as the human body too offers less resistance to electricity due to moist weather.

As a responsible Electrical Engineer, it is our duty to educate the masses on electric shock and how to handle electricity safely. Monsoon also causes many incidences of damage and fatality due to Lightning strikes. Hope you are all safe and taking due care!

Let's also celebrate our 78th Independence Day on the 15th of August, honoring 77 years of treasured freedom. Let's radiate with pride and a deep sense of patriotism as we unfurl and hoist our tricolour with a gratifying bosom!

HAPPY INDEPENDENCE DAY to all! Stay Happy!!!

Subhash L. Bahulekar

Chief Editor – CEEAMA

From the President's desk:

Hello friends,

After the passing of the hot weather we are facing the wet experience in Maharashtra. We may cross the average rainfall till date compared to last year. The risk factors in electrical system handlers increases. I appeal all electrical working staff on the field to take care of you as well as others.

I took a charge as a president from 1st August 2023 and handover the same to my successor from 1st April 2025. In these last six months CEEAMA Team had planned three technical events as it was mentioned in last month issue. Now our total focus shall be on conducting three technical seminars CEEAMATECH 24-25. I am glad to declare the dates for these events as follows.

1: 5th OCT. CEEAMATECH -1/2024 – LV SWITCHGEARS AND LV PANELS

2: 21st DEC. CEEAMATECH -2/2024 – MV SWITCHGEARS AND MV PANELS

3: 8th MAR, CEEAMATECH -3/2025 – PROTECTION SYSTEMS

On behalf of CEEAMA Team, I assure you about the very knowledgeable speakers which will enrich us all with their vast experience. We are planning additional free time for the stall visits to the participants. We are focusing on students as well as fresh and working electrical engineers from various industries esp. from LV panel manufacturers, EPCs, electrical contractors, etc.

We shall be covering LV switchgears and IEC 61439, understanding and implementation of the standard.

With this I expect the active participation of all my friends from different Industries for all three technical events as above. The details of the agenda shall be circulated at the earliest. Looking forward with your support in these events.

Our AGM to be held in September. The notice of the same shall be circulated to you all by our admin. I appeal everyone to attend the same. The details shall be shared by admin in due course

Please take care and be safe.

Mr. Veejhay Limaaye

Hon. President

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From the Secretary's desk:

Dear friends,

Last week my friend asked me – which battery works in extreme lower temperatures, typically -40oC (Leh – Ladakh region). Basically, during Kargil Vijay Diwas last month, he was wondering what electrical provisions are made during conflicts and wars at such temperatures.

Electricity plays a crucial and multifaceted role during a war or conflict, impacting both military operations and civilian life. Reliable electricity is essential for the operation of command centres, communication systems, and data networks, enabling effective coordination and decision-making. Modern weapons, surveillance systems, and defence technologies rely heavily on electrical power. Military hospitals and field medical units require electricity to operate medical equipment, refrigeration for medicines, and communication systems. Electricity is fundamental for providing essential services such as water supply, sewage treatment, and heating or cooling. Electricity is necessary for the production, storage, and distribution of food and clean water.

Governments take various measures to prepare power plants for war-like conditions to ensure the continuity of power supply, minimize vulnerabilities, and maintain national security. Reinforcing power plants, substations, and critical infrastructure against potential attacks through physical barriers, blast-resistant buildings, and protective enclosures are the known precautions taken in addition to installing advanced perimeter security systems, such as fences, surveillance cameras, motion detectors, and guard patrols. Governments get busy in ensuring that power plants have access to multiple sources of fuel (e.g. coal, natural gas, & oil) to prevent disruption if one source is cut off and implementing smart grid technologies to enhance the resilience and flexibility of the power grid, allowing for better monitoring, control, and rapid recovery from disruptions.

For the record, Lithium-Thionyl Chloride (Li-SOCl2) batteries are known for their excellent performance in extremely low temperatures, making them suitable for applications like remote sensors and military use. Li-SOCl2 batteries have one of the highest energy densities of any lithium battery, providing long-lasting power. Li-SOCl2 batteries have a very low self-discharge rate (around 1% per year), which translates to a shelf life of up to 20 years. They offer a flat discharge curve, which means the voltage remains relatively constant throughout the battery's life. These batteries are typically more expensive than other types of lithium primary batteries. Another type of lithium primary battery that performs well in cold temperatures and is often used in emergency devices and other critical applications is Lithium Manganese Dioxide (Li-MnO2). Li-MnO2 batteries can deliver higher pulse currents, making them suitable for applications requiring bursts of power. The voltage may decrease more significantly over time compared to the flat discharge curve of Li-SOCl2 batteries.

Friends, it is time to meet at an Annual General Body meeting. The CEEAMA Governing Council is finalising the date and venue for the same. Let us meet to discuss the progress till date and the way forward. There are 3 CEEAMATECH events planned, one in October '24, one in December '24 and one in March '25. Your participation is required to make the AGM and the events a great success and I am sure you will.

Wishing all of you a very happy Independence Day. Also wishing you a very happy Raksha Bandhan as well as Krishna Janmashtami in advance.

Mr. Chidambar Joshi

Hon. Secretary

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1.0 Introduction

An arc flash is a type of electrical explosion or discharge that results from a connection through the air to ground or another voltage phase in an electrical system. This event occurs when voltage gap exists and a conductive path is introduced, which can cause an extremely rapid and large release of energy.

Arc flashes can be caused by various factors including equipment failure, poor maintenance, dust, corrosion, or accidental contact with energized parts. The release of energy during an arc flash can cause severe injuries, including burns, hearing loss, and eye damage, and can be fatal. The intense heat can vaporize metal, and the explosion can send molten metal shrapnel flying. The energy released in an arc flash can be significant, often measured in calories per square centimetres (cal/cm^2).

To prevent arc flashes, regular maintenance of electrical equipment, proper training, and the use of appropriate personal protective equipment (PPE) are essential. NFPA 70E is a standard for electrical safety in the workplace that provides guidelines for reducing the risk of arc flash. Conducting an arc flash study, or hazard analysis, helps in understanding the potential risk of an arc flash in a specific electrical system and determining appropriate safety measures, such as proper labelling of equipment and establishing safe working distances.

Occupational safety and health regulations, such as those from OSHA (Occupational Safety and Health Administration) and NFPA 70E (National Fire Protection Association), require arc flash hazard analysis and the use of appropriate protective measures to ensure workplace safety. Arc flash protection is thus crucial for safety and operational integrity.

2.0 The Problem

Arc flashes can generate temperatures up to 35,000°F (19,427°C), which can cause severe burns, injuries, or even fatalities. Proper protection helps prevent these serious injuries to workers. Arc flashes can cause significant damage to electrical equipment, leading to costly repairs and downtime. Protective measures help in mitigating these risks, ensuring the longevity and reliability of electrical systems.

Arc flash incidents can result in extended downtime for repairs and investigations, impacting productivity and business operations. Protection measures help in preventing such incidents and maintaining operational continuity. Failing to provide adequate arc flash protection can lead to legal consequences, including fines and lawsuits, as well as increased insurance premiums.

Implementing arc flash protection involves training employees to recognize hazards and use protective equipment correctly, which enhances overall safety culture within the organization. This could cost some investment. By prioritizing arc flash protection, organizations can ensure a safer working environment, comply with regulations, protect valuable assets, and maintain operational efficiency.

3.0 Transitioning to an arc flash compliant system

By systematically progressing towards arc flash compliance organizations can transition from their existing power system to an arc flash compliant system, enhancing safety and reducing the risk of arc flash incidents. Transitioning from an existing power system to an arc flash compliant system involves several key changes and steps listed below:

- Conduct a thorough arc flash hazard analysis to identify potential arc flash hazards and determine the incident energy levels at various points in the electrical system. Use software tools and industry standards (like IEEE 1584) to model the electrical system and calculate arc flash boundaries and energy levels. Update electrical drawings, schematics, and documentation to reflect the findings of the hazard analysis.
- Implement engineering controls to reduce arc flash energy levels where possible. This may include adjusting protective device settings, installing arc flash relays, or upgrading equipment. Consider using arc-resistant switchgear, current-limiting fuses, or other equipment designed to minimize arc flash hazards.
- Label electrical equipment with appropriate arc flash warning labels that indicate the incident energy level, arc flash boundary, and required personal protective equipment (PPE). Provide employees with appropriate arc-rated PPE based on the incident energy levels identified in the hazard analysis. This may include arc-rated clothing, face shields, gloves, and other protective gear. Ensure that PPE is maintained in good condition and replaced as needed.

- Provide comprehensive training to employees on arc flash hazards, safe work practices, and proper use of PPE. Conduct regular refresher training and drills to ensure ongoing awareness and preparedness.
- Develop and implement written safety procedures for working on or near electrical equipment. This should include lockout/tagout procedures, safe work distances, and emergency response plans. Ensure that employees follow safe work practices and use appropriate PPE when performing electrical work.
- Implement a regular maintenance and testing program for electrical equipment to ensure it remains in good working condition and protective devices operate correctly. Periodically review and update the arc flash hazard analysis to account for changes in the electrical system or work practices.
- Establish a formal arc flash safety program that outlines responsibilities, procedures, and policies for managing arc flash hazards. Conduct regular safety audits and inspections to ensure compliance with arc flash safety requirements.
- Develop and practice emergency response plans for arc flash incidents, including first aid procedures and coordination with local emergency services. Ensure that first aid supplies and emergency equipment are readily available and accessible.

Arc Flash Protective Clothing PPE

Some time ago OSHA identified Arc Flash and Arc Blast as being a significant hazard. Since that time OSHA determined that workers shall be provided with clothing that did not worsen their condition if exposed to this multi-hazard event.

As a result of this identification and directive to protect, experts throughout North America came together to generate a consensus standard which would determine levels of protection. These levels of protection have been adopted by NFPA 70E® and CSA Z462 and identified as Arc Flash PPE Categories.

It is important to understand that these Arc Flash PPE Categories are not designed to protect from all injury, but to mitigate the impact of an Arc Flash on the individual. The first choice should always be to reduce or eliminate the hazard.

The Arc Flash PPE Categories identified below are derived from NFPA 70E® and CSA Z462 standards subject to periodic change. You should verify current requirements for your location and type of work to ensure compliance with local requirements and regulations.

*Refer to NFPA 70E® Annex M Layering of Protective Clothing and Total System Arc Rating for complete details on layering.

Formerly referred to as Hazard Risk Category (HRC)0 - the above is still a safe uniform and acceptable "base layer" when using "Task Wear" PPE for Arc Flash Hazards

Arc Flash Hazard
PPE Category 1
Arc-Rated Clothing
- Minimum Arc-Rating of 4 cal/cm²
- Arc-Rated long sleeve shirt and pants or Arc-Rated coverall
- Arc-Rated face shield or arc flash suit hood
- Arc-Rated jacket, parka, rainwear, or hard hat liner as needed

Protective Equipment
- Hard hat
- Safety glasses or goggles
- Ear canal insert hearing protection
- Heavy duty leather gloves
- Leather footwear as needed

Arc Flash Hazard
PPE Category 2
Arc-Rated Clothing
- Minimum Arc-Rating of 8 cal/cm²
- Arc-Rated long sleeve shirt and pants or Arc-Rated coverall
- Arc-Rated face shield and Arc-Rated balaclava or Arc-Rated flash suit hood
- Arc-Rated jacket, parka, rainwear, or hard hat liner as needed

Protective Equipment
- Hard hat
- Safety glasses or goggles
- Ear canal insert hearing protection
- Heavy duty leather gloves
- Leather footwear

Arc Flash Clothing

Arc Flash Hazard
PPE Category 3
Arc-Rated Clothing
- Minimum Arc-Rating of 25 cal/cm² System may be comprised of Arc-Rated long sleeve shirt, pants, coverall, arc flash suit jacket and arc flash suit pants
- Arc-Rated arc flash suit hood
- Arc-Rated gloves
- Arc-Rated jacket, parka, rainwear, or hard hat liner as needed

Protective Equipment
- Hard hat
- Safety glasses or goggles
- Ear canal insert hearing protection
- Leather footwear

Arc Flash Hazard
PPE Category 4
Arc-Rated Clothing
- Minimum Arc-Rating of 40 cal/cm² System may be comprised of Arc-Rated long sleeve shirt, pants, coverall, arc flash suit jacket and arc flash suit pants
- Arc-Rated arc flash suit hood
- Arc-Rated gloves
- Arc-Rated jacket, parka, rainwear, or hard hat liner as needed

Protective Equipment
- Hard hat
- Safety glasses or goggles
- Ear canal insert hearing protection
- Leather footwear

84

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4.0 Challenges in adopting Arc Flash compliant system

Organisations and senior managers might be reluctant to incorporate provisions for arc flash protection for several reasons ranging from costs, implementation downtime, etc.

Incorporating arc flash protection requires thorough risk assessments, adherence to specific standards, and potentially complex changes to procedures and infrastructure. The perceived complexity can deter organizations from taking action.

Lack of Awareness is one of the main reason for non-implementation of Arc Flash compliance program. There could be a lack of understanding about the severity of arc flash hazards and the importance of protection. If decision-makers and employees are not fully informed about the risks, they may not see the need for investing in protective measures. Further, implementing arc flash protection measures can be expensive. This includes the cost of PPE, training, risk assessments, and necessary modifications to equipment and facilities. Organizations might hesitate due to budget constraints. Some workplaces might believe that the risk of an arc flash incident is low based on past experiences. This complacency can lead to a false sense of security and a decision to forego protective measures.

Resistance to change is an important aspect of the human behaviour and needs to be seen in perspective. Employees and management might resist changes to established workflows and practices. There can be a reluctance to adopt new safety protocols, especially if they are seen as cumbersome or if they slow down operations. Lack of in-house expertise to conduct proper risk assessments and implement protection measures can be a barrier. Organizations might not know where to start or how to effectively implement arc flash protection. Organizations that are focused on short-term financial performance might prioritize immediate cost savings over long-term safety investments. This short-term thinking can delay the implementation of necessary safety measures.

Regulatory compliance ambiguity, in some regions or industries, for arc flash protection might be unclear or not strictly enforced, leading to less motivation for compliance. Addressing these concerns requires raising awareness about the risks and benefits of arc flash protection, demonstrating the long-term cost savings associated with preventing accidents, and providing clear guidance and support for implementation.

References:

1. Electrical Engineering Portal
2. https://en.trainor.no/app/product/elearning
3. Mitigating Arc Flash Hazards – Schneider
4. www.cementexusa.com

Contributor

Chidambar V Joshi

ABSTRACT

This article is an overview of the components of Low Voltage Switchgear Panel or LT panel. Images are inserted at several locations for reference. A typical example of SLD is used to illustrate how LT panel is represented in 2D form.

1. What is LT panel?

- Low voltage distribution equipment consists of devices that distribute and switch electrical power and protect electrical circuits. LV Switchgear Panel is one such equipment which houses components working at voltage levels less than or equal to 1000V. LV switchgear panel is nothing but LT (Low-Tension) panel.

2. Major Components of LT Panel:

- **Circuit Breakers:**
  They are switching devices which connect or disconnect a circuit. Various type of circuit breakers used in LT panel are Air circuit breaker, Moulded Case Circuit Breaker, Miniature Circuit Breaker, etc.



The above images give a pictorial representation of typical ACB, MCCB & MCB respectively.

- **Motor Starters:**
  Most of the industrial load is of motors. These motors need to suit the torque-speed characteristics of the load they are connected to. Hence, to serve that purpose without disturbing the system parameters, motor starters have proved to be one of the solutions. There are several starters like DOL starter, Star-Delta Starter, Soft Starter, VFD, etc. Below are images of VFD & soft starter respectively.

- **Measuring meters:**
  They are used to measure & display various electrical parameters like voltage per phase, current per phase, power factor, power consumption, energy, etc. Meters can be analogue or digital. Nowadays, digital meters are more popular due to its precision & less space requirement.

The first image is a digital multifunction meter which is capable of measuring every important electrical parameter where as the images following it are analogue meters which can measure current & voltage respectively.

- **Protection relays:**

These are switching devices which provide a tripping signal to the circuit breaker in case of any abnormality in the circuit. This signal operates the circuit breaker and in turn ensures the safety of equipment associated along with that circuit. The relays provide various protections like differential protection, overcurrent protection, overload protection, motor protection, etc. Numerical microprocessor-based relays are widely used nowadays as they can consolidate number of protections in a single unit. A few examples are displayed here.

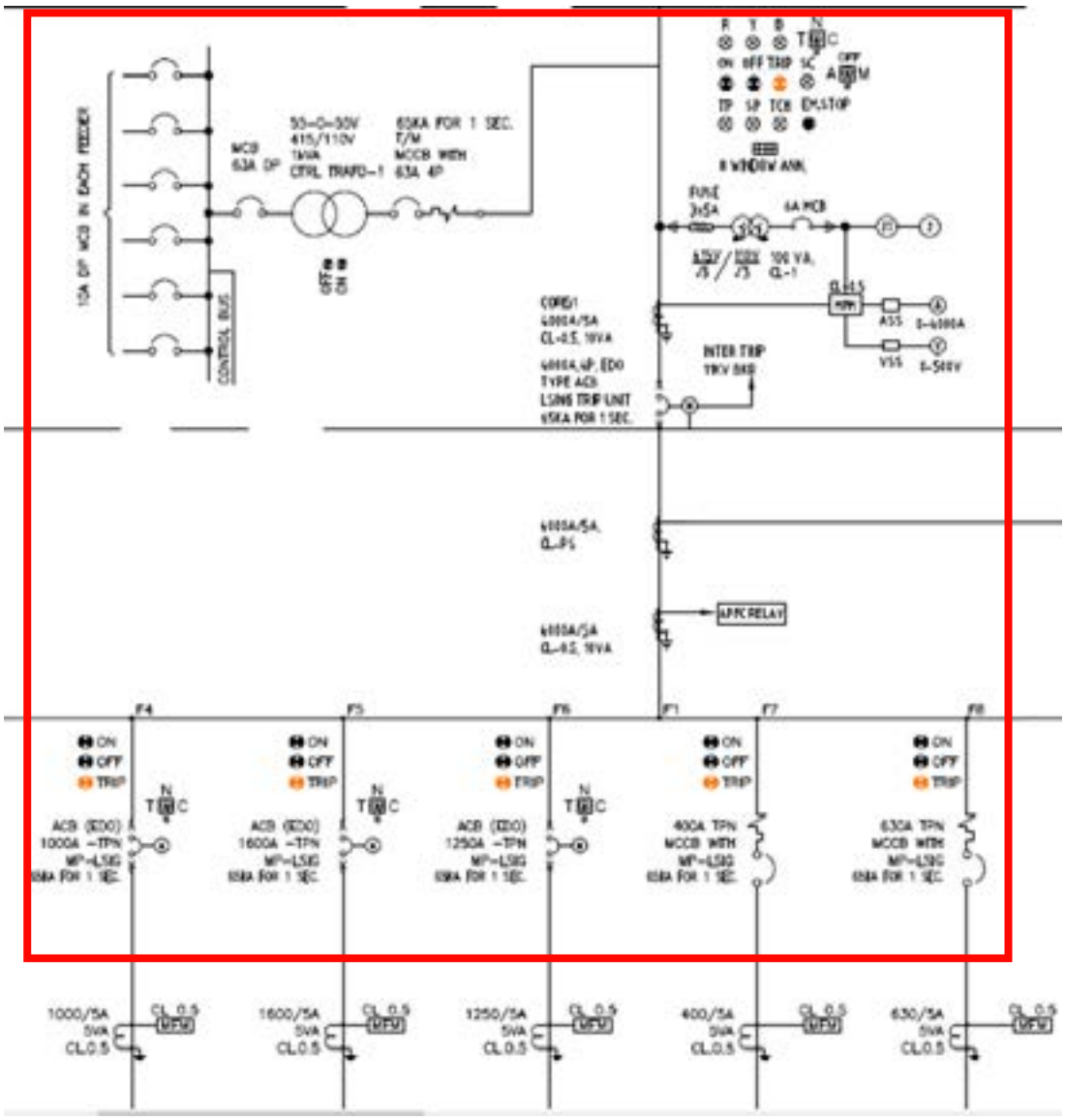
- **Indication lamps:**
  They are used to show status of the panel, fault, ON condition, OFF condition, etc. Different colours are used for different indications. Red, yellow & green indication lamps are shown here.

- **Selector switches:**
  Auto-manual switch & Local-remote switch are two types of selector switches which are widely used in industries.

3. Representation of LV panel in Single Line Diagram:

There are many components in LV panel including breakers, indication lamps, relays, cables, busbars, motor starters, etc. The diagram below is a representation of how LV panel is shown in the SLD. Various components such as indication lamps, switches, breakers, CT, PT are indicated. Let's glance over sizing & selection of few of them.

Indicating lamps in the SLD are denoting phases, status as well as faults. These are located on the front cover of the panel for every feeder. Trip-Neutral-Close switch, Auto-Manual switch, 8 window annunciator and Emergency stop are located on the front cover of the panel. There is a tapping taken from the incoming cable which is fed to 1 kVA Control Transformer-1 through 63A MCCB. This 415V/110V AC transformer will feed the control bus which is segregated into number of outgoings. These outgoings will further supply indication lamps, and small power requirements of the panel. The fault level of the system is 65kA. Hence, the components shall be rated for this fault current. The CT & PT are indicated with their respective accuracy classes. MFM with accuracy class 0.5 is attached to ASS & VSS. The ACB used is of 4000A, electrical draw out type with LSIG trip unit.



4. Type 2 co-ordination:

A set of components working together is a system & for proper functioning of the system, co-ordination is very necessary. Co-ordination in electrical system is matching the characteristics of short circuit protective devices, contactor or downstream devices to ensure that motor peak off current do not rise above the levels that feeder can withstand. There are two types of co-ordination – **Type 1 & Type 2.**

Under short circuit conditions, the contactor or the starter shall cause no danger to person or installation, the motor feeder or starter may not be suitable for further use without repair or replacement is **type 1 co-ordination**. The disadvantage of not able to use the contactor or starter without repair or replacement is overcome by **type 2 co-ordination**. It is defined as "Under short circuit conditions, the contactor or the starter shall cause no danger to person or installation, and the motor feeder or starter shall be suitable for further service without repair or replacement."

5. Standards:

- IS 5 - Colours for ready mixed paints and Enamels
- IS 732 - Code of Practice for Electrical Wiring Installations
- IS 694 - PVC insulated cables for working voltages up to and including 1100 V
- IS 15528 - Co2 flooding system by DISH
- IEC 60051 - Direct acting indicating analogue electrical measuring instruments and their accessories
- IEC 60044-1 - Current Transformers
- IEC 60044-2 - Voltage Transformers
- IEC 60228 - Conductors of insulated cables
- IEC 60255 - Electrical Relays
- IEC 60269 - Low Voltage Fuses
- IEC 60189 - Low- Frequency cables and wires with PVC insulation and PVC sheath
- IEC 60258 - Direct acting recording electrical measuring instruments and their accessories
- IEC 60417 - Graphical symbols for use on equipment
- IEC 60617 - Graphical symbols for Diagrams
- IEC 60529 - Degrees of Protection provided by enclosures (IP Code)
- IEC 60071 - Insulation Co ordination
- IEC 60664 - Insulation coordination for equipment within low voltage systems
- IEC 60255 SET - Measuring relays and protection equipment set
- IEC 61439 - Low voltage switchgear and control gear assemblies
- IEC 60068 - Environmental testing
- IEC 60947-1 - Low voltage switchgear and control gear, Part-1 General Rules
- IEC 60947-2 - Low voltage switchgear and control gear, Part-2 Circuit Breakers
- IEC 60947-3 - Low voltage switchgear and control gear - Switches, disconnectors, switch-disconnectors and fuse combination Units
- IEC 60947-4 - Low-voltage switchgear and control gear - Contactors & Motor Starters
- IEC 61641 - Low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault
- IEC 61869 SET - Instrument Transformer set

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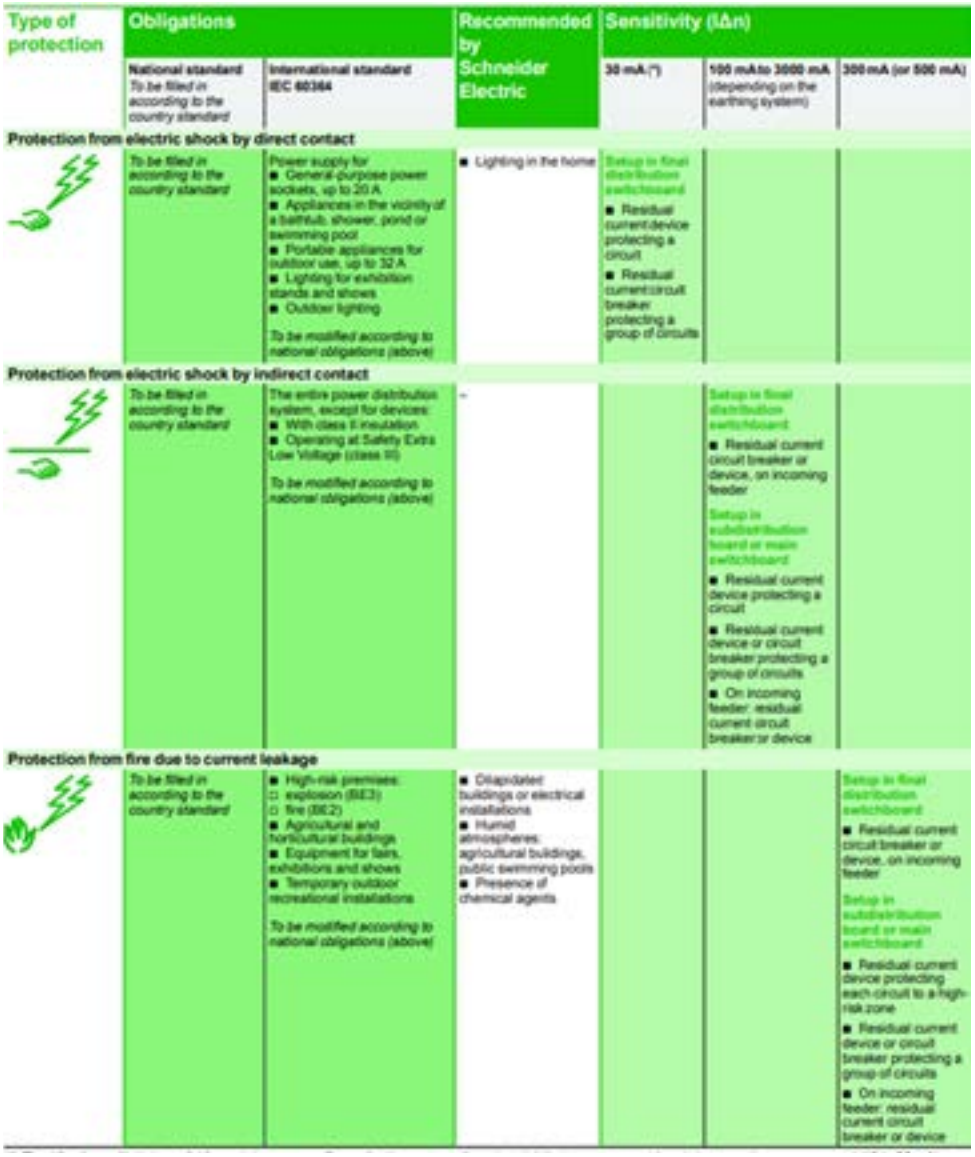
RCCB Sahi Hai, Lekin Kaunsa Sahi Hai?

RCCBs and Mutual funds share a common trait - the necessity is known, but selecting the right one remains a challenge. The National Electric Code and CEA regulations emphasize the importance of RCCBs in final distribution boards, with Regulation 42 mandating RCCBs for Earth Leakage Protection. Some Electrical inspectorates also mandate RCCB installation at the metering point for LT consumers 1kW and above. The lingering question is, "Which RCCB should we use?"

RCCBs are classified not only on sensitivity but also on the type of tripping. We shall look at both aspects of selection and how to combine it. We can start with the sensitivity.



Type of protection	Obligations		Recommended by Schneider Electric	Sensitivity (IΔn)		
	National standard *To be filled in according to the country standard*	International standard IEC 60364		30 mA (*)	100 mA to 3000 mA (depending on the earthing system)	300 mA (or 500 mA)
Protection from electric shock by direct contact						
	To be filled in according to the country standard	Power supply for ■ General-purpose power sockets, up to 20 A ■ Appliances in the vicinity of a bathtub, shower, pond or swimming pool ■ Portable appliances for outdoor use, up to 32 A ■ Lighting for exhibition stands and shows ■ Outdoor lighting *To be modified according to national obligations (above)*	■ Lighting in the home	Setup in final distribution switchboard ■ Residual current device protecting a circuit ■ Residual current circuit breaker protecting a group of circuits		
Protection from electric shock by indirect contact						
	To be filled in according to the country standard	The entire power distribution system, except for devices: ■ With class II insulation ■ Operating at Safety Extra Low Voltage (class III) *To be modified according to national obligations (above)*	-		Setup in final distribution switchboard ■ Residual current circuit breaker or device, on incoming feeder Setup in subdistribution board or main switchboard ■ Residual current device protecting a circuit ■ Residual current device or circuit breaker protecting a group of circuits ■ On incoming feeder: residual current circuit breaker or device	
Protection from fire due to current leakage						
	To be filled in according to the country standard	■ High-risk premises: □ explosion (BE3) □ fire (BE2) ■ Agricultural and horticultural buildings ■ Equipment for fairs, exhibitions and shows ■ Temporary outdoor recreational installations *To be modified according to national obligations (above)*	■ Dilapidated buildings or electrical installations ■ Humid atmospheres: agricultural buildings, public swimming pools ■ Presence of chemical agents			Setup in final distribution switchboard ■ Residual current circuit breaker or device, on incoming feeder Setup in subdistribution board or main switchboard ■ Residual current device protecting each circuit in a high-risk zone ■ Residual current device or circuit breaker protecting a group of circuits ■ On incoming feeder: residual current circuit breaker or device

1. 30mA: This is the most extensively used sensitivity which is recommended for Residential flats and small offices where direct contact is possible. It is also very easily available and can be bought from even a small electrical shop.

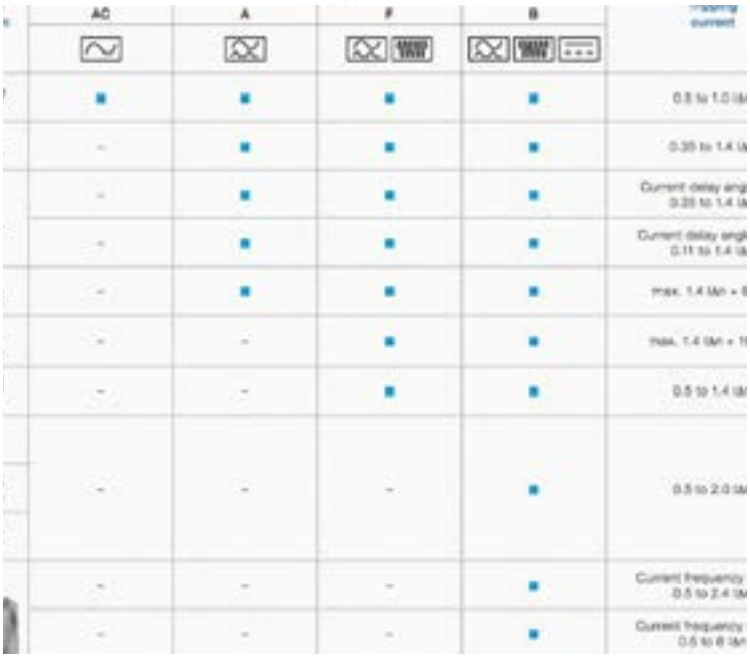
2. 100mA: It is another popular sensitivity used in Industries where there is indirect contact with the load. It is used where risk of Electrocution is low and protection against earth leakage is sought to protect equipment along with personnel.

3. 300mA: This is a rating recommended for Fire Protection and is normally installed in sub-distribution boards which feed the final DBs. This is recommended for Floor Distribution DBs (VTPN/TPN) which feed the shops/flats in a building. This is necessary to detect Earth Leakage (typically through Insulation damage/failure) before it turns into fire.

4. 10mA: This is a very important rating which is mandatory for Showers, Sauna, Steam baths, etc. where user may be in wet condition. It is also recommended for kindergarten and old age homes where the users have much less sensitivity than normal human.

5. 500mA: This is a very specific rating recommended by some OEMs of lifts or heavy machinery. It is primarily meant to detect leakage due to insulation failure in the equipment and preventive action to avoid longer downtimes.

When selecting a Residual Current Circuit Breaker (RCCB), considering the type of tripping is crucial. Below are the various types of RCCBs available:



1. Type AC: This is the most popular type of RCCB which is readily available. It is recommended only for pure sinusoidal loads which is practically absent today. Presence of harmonics in the system disrupts its tripping which can cause nuisance tripping or no tripping; both of which can compromise safety.

2. Type A: This type of RCCB is recommended for Pulsating DC loads. I recommend this in the flats where LED lighting, Computers and Electronic Equipment have become common place. This will ensure tripping even in the presence of some harmonics and protect personnel and equipment from damage.

3. Type F: This is recommended for Inverter loads like Lifts, Washing Machines, Large Air conditioners, etc. where the harmonic distortion can be very high. In case these loads form a major part of the load, it is recommended to install a dedicated RCBO for them separate from the lighting load.

4. Type B: This type of RCCB is recommended for EV chargers, Batteries as well as Output of Rooftop Solar Inverters. It is able to trip in high harmonic environment as well as Pure DC loads. Without this, EV charging should be prohibited as even a small leakage can result in safety hazard.

Just as there is a mutual fund suited to every financial goal, there is an RCCB suited for your safety goal (based on application). Seeking the advice of a competent electrical engineer can help you choose the right RCCB based on your load profile, similar to how a financial advisor helps you select your investment based on your financial profile.

An RCCB tripping is a sign that your home is safe, while indicating problems that need immediate attention. I would like to firmly state that 'Nuisance tripping' is a phrase used to cover up errors in wiring, wrong earthing or wrong selection of RCCB. Tripping of RCCB is a sign of leakage current. The reasons for it vary from insulation failure to accidental connection of neutral to earth or just plain wrong selection. It can be ascertained through a careful inspection of the electrical system. Taking corrective action will ensure the RCCB will not trip in normal operation.

RCCBs protect you from shock and tripping is a call for corrective action. Bypassing the RCCB or replacing it with higher sensitivity is the worst thing one can do. It is an invitation to harm personnel or damage equipment. Please refrain from it and instruct your electricians not to indulge in such practices. Rather, get the wiring inspected by a qualified electrical engineer and ensure better safety through corrective measures.

References :

1. RCCB catalogue of Schneider Electric
2. A guide to RCCB Selection by ABB India.

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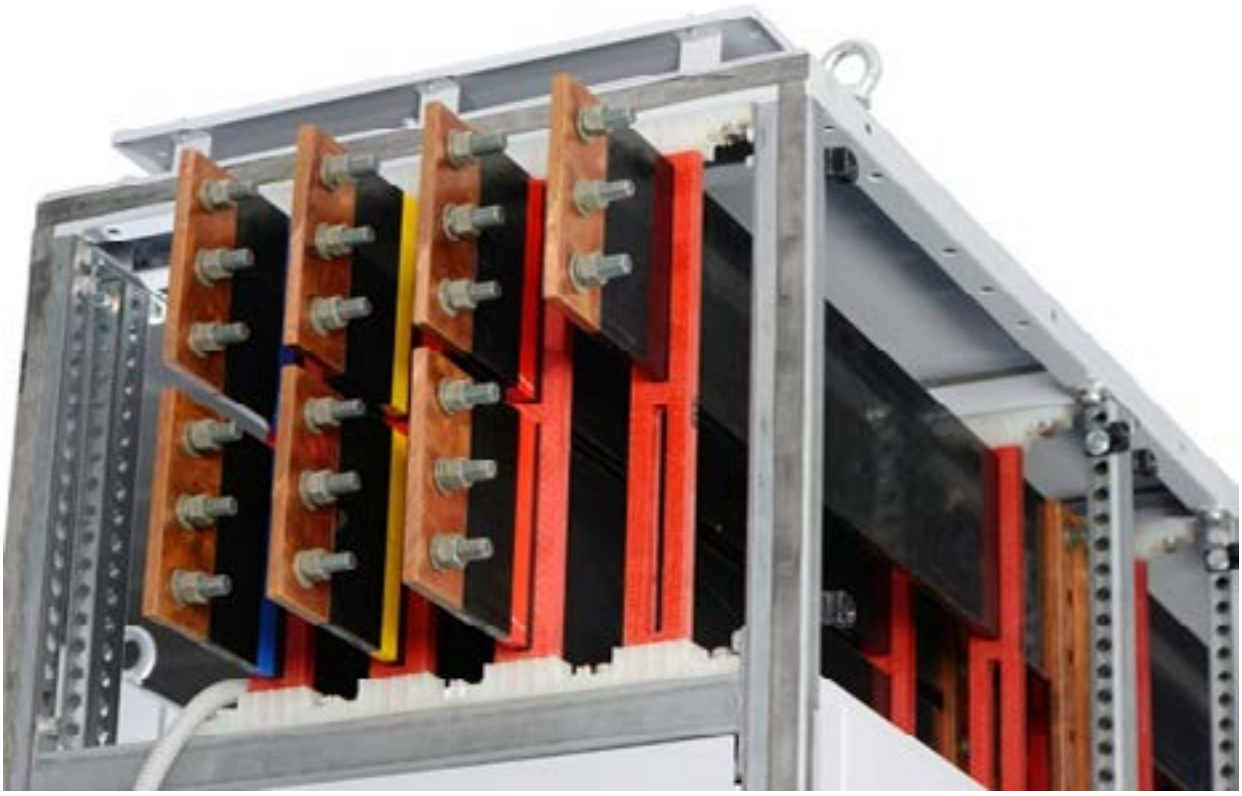
V L Engineers and Electrical Consultants

Energy Efficient Double Deck Busbar Arrangement

The use of double deck busbar arrangement to enhance energy efficiency.



Abstract

Our planet faces a growing energy demand, & energy efficient product plays a critical role in achieving this goal. Development of energy efficient products will reduce the overall carbon footprint and is a stride towards sustainability and such efforts are crucial in mitigating the effects of climate change. Power distribution products & solutions over its life cycle consumes a lot of energy and it is immanent to reduce the carbon footprint of these products. Especially the solutions/switchboards meant for the AC distribution is subjected to less efficiency due to the skin effect and proximity effect. These effects lead to higher power losses, contributing to the increased heat generation and ultimately increasing the stress on the climate.

This paper deliberates on the energy efficient double deck busbar configuration for switchboards. This` is a significant step towards a sustainability by enhancing energy efficiency and reducing power losses.

I. Skin effect & proximity effect and it's impact on current flow.

AC (alternating current - changes current direction forward and backward periodically) is commonly used for powering businesses by the virtue of its ability to transform from one voltage level to another and ability to transmit over long distances. The DC (direct current – in a single direction steadily) is commonly used in batteries, automotives and electronic devices. Each of them has their own advantages and disadvantages.

While AC does have some inherent drawbacks, such as the skin and proximity effects, these are manageable and far outweighed by its advantages. Notably, our entire electrical grid is built upon AC, a testament to its effectiveness in delivering power across vast distances. The skin effect is the propensity of an alternating current (AC) to distribute itself within a conductor such that the current density is greatest near the conductor's surface and diminishes with increasing conductor depth. The alternative current interacts with the conductor forming an electromotive force which vary in magnitude and phase throughout the cross-section of the conductor, being large in the centre and smaller towards the edge as shown in Fig. 1.

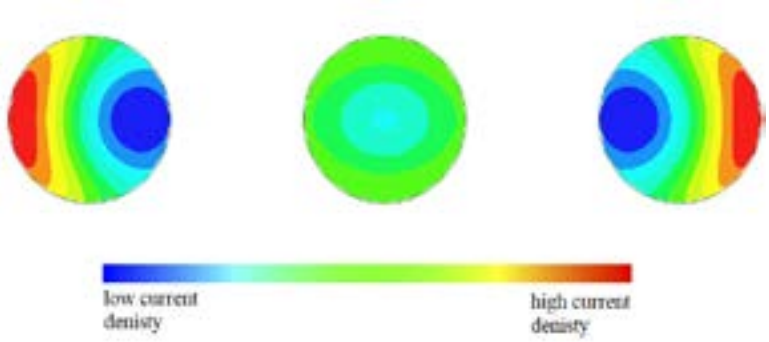


Fig. 1. Skin and proximity effect leads to uneven current distribution.

The magnitude of this effect increases with frequency and the size and shape of the conductor. The interaction of the conductor's magnetic field with other conductors of different phases, which are close to one another causes further distortion in current density. Depending on the flow direction, as illustrated in Fig. 1., this tends to move the current density to one side of the conductor. The conductor's resistance tends to rise because of this action. The frequency and conductor configuration affect the proximity effect's intensity.

II. Horizontal busbars

Low voltage (LV) systems are available up to 6300A and can be further increased to 7500A under certain circumstances. Horizontal busbars (HBB) are responsible for carrying such high ratings of current. Multiple circuits are fed via vertical busbars (VBB), which are tapped off from horizontal busbars (HBB).

Maximum proportion of copper is used by HBB in a single vertical. Therefore, it becomes extremely important to optimize HBB design and enhance the thermal performance. As stated earlier, a busbar should have the desired ampacity throughout its lifespan, withstand the electrodynamic forces due to short circuits, lower watt losses, ease of fabrication and good heat dissipation.

A. Double Deck Busbar System

The revolutionary double deck busbar system offers the maximum benefits as compared to the conventional systems. In double-deck configuration, the buses are stacked one above the other contrary to the conventional configuration, wherein the buses are placed one beside the other (Fig. 2). The multi-physics analysis carried out proves the superiority of double-deck configuration.

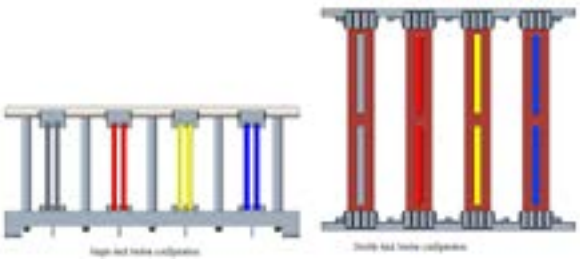


Fig. 2. Single deck and double deck main busbar configuration with busbar supports – side view

a) Current Distribution :

Studying the degree of uniformity in the distribution of current throughout the cross-section of a conductor is vital in understanding the performance of the conductor. Busbars are arranged in a double deck configuration to minimize the effects of proximity and skin. A comparison study was performed between double deck system and the standard single deck system using FEM software. In contrast to a traditional system, the results in Fig. 3. show a uniform distribution of current in a double deck configuration. When the current distribution is more uniform, the power losses can be reduced and hence, improved thermal performance.

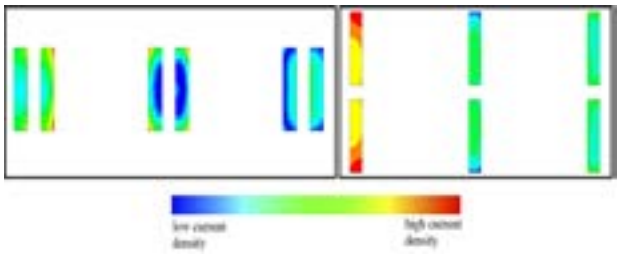


Fig. 3. Current Density between single deck and double deck

Significant effect is observed on busbar efficiency due to busbar arrangement and its profile. It has been stated in Copper for Busbars (by Copper Development Association, Pub.22, 1996) that double deck bus configuration has low skin effect and proximity effect for a.c. systems. While Aluminium Busbar (by A.G. Thomas & P.J.H Rata) mentions that comparing the current carrying capacity of conductors of multiple profiles with the same cross-sectional area, it can be observed that the conductor can carry 1.5 times more current for the same cross-section of a given conductor if they are arranged in double deck configuration.

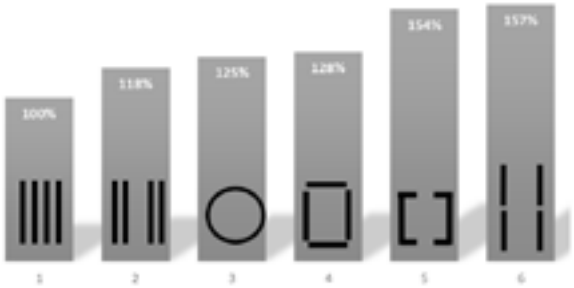


Fig. 4. Double deck system is the most superior among the given configurations.

b) Heat Dissipation & Temperature Rise performance:

It is apparent from observation; the double deck busbar has more surfaces exposed to the air rather than the conventional busbar configuration.

This results in better heat dissipation in double deck system. This has been proved from FEA as well. As given in Fig. 5., the temperature rise was found to be much lower in double deck system than the conventional system.

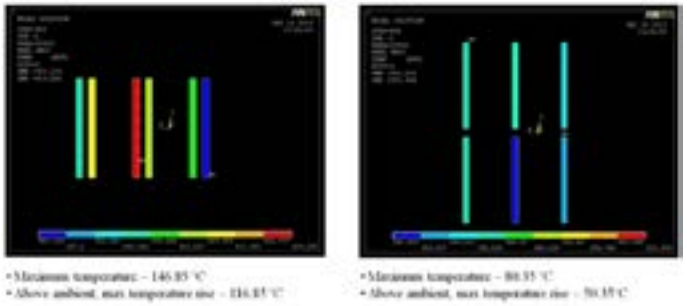


Fig. 5. Temperature Rise Performance between single deck and double deck

c) Better Short Circuit Performance:

During a short circuit, the busbars are subjected to electrodynamic forces. The intensity of the electrodynamic forces is directly proportional to the distance between supports (bus bracing) and inversely proportional to the effective distance between the main conductors. The double deck busbar system can be more robust. FEA was employed to prove the same for double deck and single deck system (Fig. 6.). After the analysis, it is observed that double deck busbars experience less electrodynamic forces compared single deck busbars.

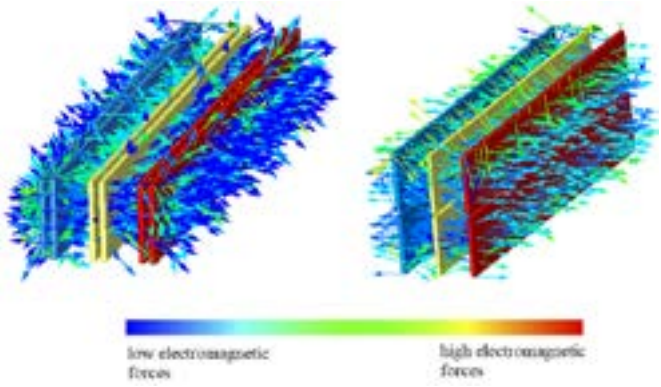


Fig. 6. Electrodynamic forces

III. Conclusion

Extensive FEA and design verification has proven that the double deck bus configuration offers superior efficiency compared to the single deck conventional setup. For current ratings beyond 2500A, this improved thermal performance coupled with better heat dissipation reduces the energy burden for the end customers aligning with their sustainability goals.

This system boasts to be 157% more efficient than conventional single-deck systems. Double deck system improves the entire thermal stability of the system for currents as high as 8000A. The short-circuit performance of a double-deck system is better as it experiences lesser electrodynamic forces

Contributed by

Lauritz Knudsen Electrical and Automation
(Formerly L&T Electrical and Automation)

***** Image from the standard used only for visual representation, the article is only to promote the usage of standard

Abstract

The IEC 61439 series of standards forms the backbone of the switchboard industry laying down the stringent test rules set by International Electrotechnical Commission. The need of a new standard was felt as the erstwhile standard was ambiguous on responsibility of the OEM and assembly manufacturer. It also became a necessity to enhance safety quotient of the entire LV system and to focus on overall performance because the installation spaces are becoming compact everyday and % transformer loading is increasing thereby pushing the LV systems to their limits. The 61439 series of standard for low-voltage switchgear and control gear assemblies was enforced in January 2009, which replaced its older version i.e., IEC 60439. Post 2014, even IS-8623 got superseded by IS-IEC 61439 ensuring it as the only accepted standard in the country. The 61439 series ensures safety of equipment & operating personnel and guarantees that switchboard is constructed to withstand the electrical, mechanical, and thermal stresses. Because of this there is significant reduction in the risk of incidents, injuries to personnel and livestock and fires in the event of fault.

This not only ensures quality but also provides a clear roadmap for manufacturers, enabling a more streamlined design and testing process. The design verification carried out yields significant cost savings due to enhanced durability of the product thus adding commercial benefits to the customers. Manufacturers who adhere to accepted standards frequently have improved brand reputation, fostering trust among stakeholders and customers. The paper aims to bring forth the advantages of complying the switchboard with IEC 61439.

I. Distinct responsibility of OEM & assembly manufacturer

The switchboards complying with the IEC 61439 undergo the stringent verification process. The intertwining of the different verification types ensures that there is no stone left unturned for the end user's safety.

The unique OEM (original equipment manufacturer) and assembly manufacturer model helps the

switchboard designer to manufacture the board remotely, without the need of having in-house production centre. The switchboard undergoes the verification by assessment, comparison, and testing, which helps the OEM to have flexibility to comply the other variants without the need to re-test. Wherever necessary the test may be carried out, but only when the verification by other methods is not possible. The clear demarcation of the role of panel builder and the OEM helps to put the panel builder at ease by making sure that the OEM is responsible for the design of assembly and empowers the panel builders at the same time to decide any deviation of design with the confirmation from OEM. The chart below explains how the OEM and assembly manufacturer (panel builder) perform their roles.

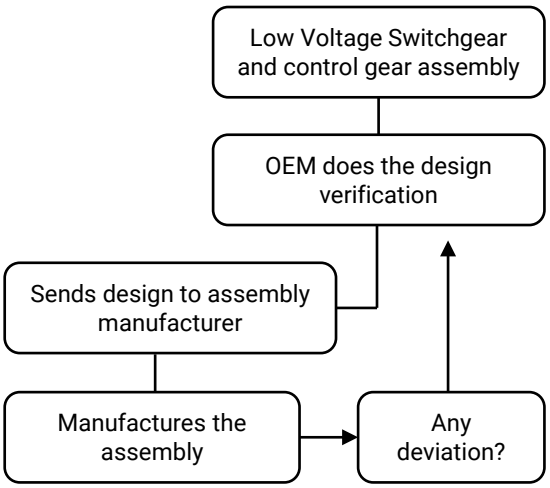


Fig. 1. Role of OEM and assembly manufacturer

Thus, such uniqueness of the standard ensures that there is no anticipation without verification. As said earlier, the streamlined process for each sub-part for different products helps to draw a pathway for OEM, eliminating the subservience to deviated design, ultimately increasing risk of hazard.

II. Ease of use

The switchboard designers comply the switchboard by fulfilling its construction and performance requirements. The IEC enlists seven construction and four performance requirements respectively.
The split between the design verifications helps to identify whether the assembly is strong enough to external factors and at the same time no deterioration is observed in the operation of the equipment inside it. In layman's terms, the design verification implies "follow all the rules, and you will be safe". For example, the standard compels the switchboard to undergo, if in case of doubt, an additional power frequency test post short-circuit withstand strength test to verify that the insulation properties of the assembly are maintained. This exemplifies how the blend in the design verifications enables complete protection and by simply following the guidelines, the designers do not have any uncertainty in terms of safety.

III. Empowering industries through standardization and innovation

Countries and regions frequently use international standards to create national or regional standards. For instance, IEC International Standards actually make up over 80% of European electrical and electronic standards. Conversely, regulations are policies or guidelines that are created and upheld by a local, state, or federal government. For switchboards, the regional standard for India is IS/IEC 61439, which is laid in line with IEC while having some minor changes. The IS/IEC 61439 supersedes, IS 8623:1993. The IS/IEC 61439 is identical to IEC 61439-1:2011. Thus, it can be seen, that likewise many other regional switchboard standards are drafted on the grounds of IEC.

IV. Shedding off the old skin of IEC 60439

The IEC 60439, first released in 1985, was meant for low voltage switchgear assemblies. The concept of partially type tested assemblies did not make it necessary to do all the tests. However, the new IEC 61439, makes it necessary for the designer to conduct all the design verifications on an assembly. The 60439-1 standard served as both product standard and general rules for assemblies, which is now segregated in IEC 61439-1 (general) and -2 (for power switchgear and control gear assemblies).
This distinguishment helps the consumer to understand that an assembly can comply with part 2 to 7 but mandates it to be complied with part 1. Correspondingly, a conformance cannot be established by simply complying with part 1 and a product must be tested in accordance with its dedicated standard.

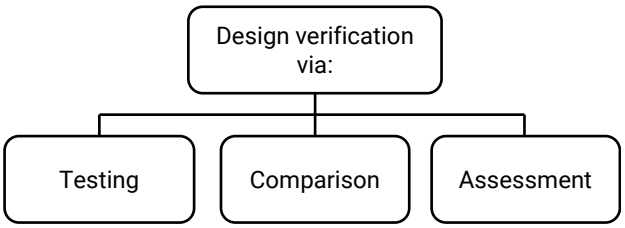


Fig. 2. Design verification methods of IEC 61439

Prima facie, for someone who is well accustomed with the old IEC 60439 standard, there is frequent misunderstanding that, fewer aspects are to be taken care when testing for the new 61439. However, this is untrue, because IEC 60439 is now obsolete and IEC mandates to use the new 61439. The most vital aspect of the new IEC 61439 is that it allows the user to assess a particular functional unit or a busbar or any other part and verify it without the need of carrying out the test. The assessment refers to the different standards which ensures safety, for e.g., verification of the temperature-rise may be made by calculation in accordance with the method of IEC TR 60890. Similarly, another beneficial aspect is the verification by comparison. The design verification by comparison with the tested reference can be done. These flexibilities, yet robustness make the IEC 61439 one of the most popular standards in switchboard industries.

V. Emphasize on safety

The switchboard conforming to IEC 61439 standards are tested in laboratories accredited by popular agencies. In India testing laboratories such as CPRI & ERDA, ensure that the verification by test is carried out as per the norms laid out in IEC 61439. By this a consumer can ensure the following:

1. Wants to protect operating personnel and livestock from unnecessary risk, at the same time having confidence about the quality of the product.
2. To have evidence of a system's or product's performance, dependability, and safety.

Such accreditation builds trust and confidence among all interested parties in the quality of the low voltage assemblies and its compliance with all IEC 61439.

CONCLUSION

A. General

The purpose of this article was to briefly highlight the aspects of IEC 61439 and how it upholds the safety of the people and livestock. The OEM can easily put forth the merits of IEC 61439. IEC 60439 was withdrawn because it lacked many aspects. The terms like partially tested / type tested assemblies are completely discarded and are irrelevant but has been replaced by much bolder design verification.

B. Lauritz Knudsen Electrical & Automation (LK)

Flag bearer of safety
Safety is of paramount importance when it comes to LV systems, given the inherent risks associated. LK's emphasis on R&D and rigorous testing often ensured the consumers that the offerings are not just

compliant with international safety standards such as IEC but also often set benchmarks for others in the industry. Over the years, we have had garnered trust and respect for its commitment to delivering low voltage solutions that prioritize user safety and system reliability. LK have a comprehensive range of switchboards and switchgear products for various applications. The remarkable designs of Ti™ and Enersys™ switchboards ensure not only complete IEC- 61439 compliance but these ranges offer active & passive arc protection and seismic zone-5 compliance as additional safety features. This ensures the customer can have peace of mind knowing that the electrical system is well-guarded against any potential hazards.

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Congratulations

QUIZ AUGUST 2024

1. Scientist born in July:
   A. Dr. Jayant Narlikar
   B. JC Bose
   C. Pranav Mistry
   D. Kalpana Chawla

2. What is BAS?
   A. Bus Analog System
   B. Building Analog Suppression
   C. Building Automation System
   D. None of the above

3. Typical Shipping sections of LV panels 2-2.5M tall:
   A. 700mm
   B. 1m
   C. 1.8-2.4m
   D. 600mm

4. AYFY Vs. YWY:
   A. Aluminium Vs. Copper Conductor
   B. XLPE Vs. PVC insulation
   C. Flat Vs. Wire Armouring
   D. Both A. & C. above.

5. Industrial Welding receptacle shall be of:
   A. 2 Pin type
   B. 5 Pin type
   C. 4 Pin type
   D. 3 Pin type

6. IFR-IFD-IFC:
   A. Stages of Drawing submission
   B. Battery ionization stages
   C. Instrument Flight Rules with demonstration and control.
   D. Inherent Flame Retardant stages

7. Purpose of Lighting Transformer:
   A. Step up Voltage
   B. Step down Voltage
   C. Limit fault level
   D. Any or more of the above

8. Earth Leakage Relay receives signal from:
   A. ZCT
   B. NCT
   C. Digital Sensor
   D. Ammeter

9. LV Switchboard Horizontal Busbar chamber is located at:
   A. Top
   B. Bottom
   C. Centre
   D. All of the above

10. IoT communication technologies fall into two categories:
    A. Wireless communication technologies
    B. Wired communication technologies
    C. Both A & B
    D. None of the above

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- The Quiz will be open for 10 days from the date of EMAIL.
- Each correct answer received on DAY 1 will get 100 points
- Next days the points will reduce as 90 – 80 – 70 and on 10th day points will be ZERO even if the
- answer is correct.
- All participants will receive E certificate signed by CEEAMA President with the points earned
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"Thank you all for the overwhelming response to the E-NEWS in general and E-Quiz in particular. MCQ based quiz is always tricky and surprisingly can take us aback when we realise our conceptions (misconceptions) about the subject / system / product.

The aim of the feature was to create inquisitiveness in your mind and help you check your technical quotient

quickly. The response will also help us to present articles and webinars on subjects which are important, but which

lack enough awareness / knowledge in general.

It can open a pandora box for our discussions and arguments and probable solutions. Engineering evolves with conception. It gets fuelled with community discussions and capitalist actions. All stakeholders start realising the need to take a closer look and help improve standards as we have seen in the past century. Surely it makes the world a better place.

Wish you all a better luck this time.

Do spread the word.

July 2024 Quiz Answers

1. A. Prasanta Chandra Mahalanobis
2. B. Cathode
3. D. All of the above
4. C. 1906
5. C. Short Circuit Test report
6. B. 300mm
7. A. Disconnection of fault in minimum time
8. A. MCB/MCCB
9. D. All of the above
10. D. Compute grounding impedance

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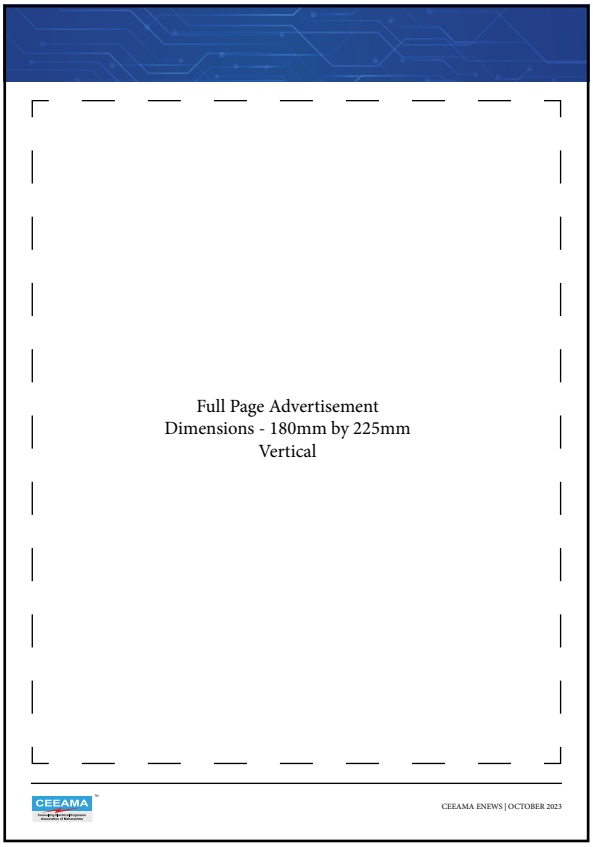

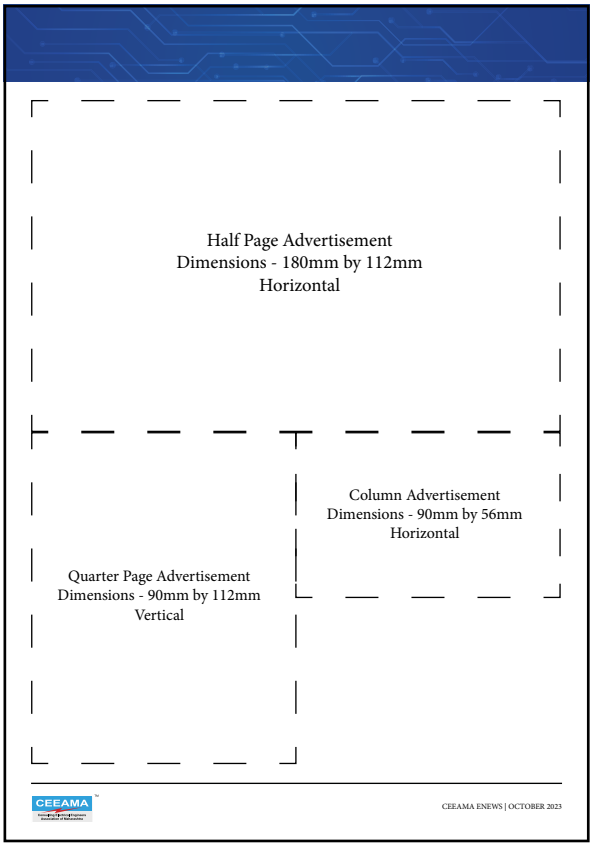

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